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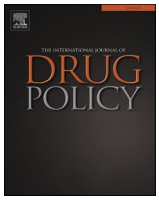

Research Paper

How does climate change impact people who use alcohol and other drugs? A scoping review of peer reviewed literature

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ABSTRACT

Background: The world has experienced devastating extreme weather events, alongside slow-onset processes including increasing temperature means, that scientists agree are manifestations of human-induced climate change. Even with radical action to reduce greenhouse gas emissions, effects of climate change will become increasingly severe.

Objectives: The aim of this review was to classify impacts of climate change for people who use alcohol and other drugs (AoD), as reflected in peer reviewed literature.

Method: A scoping review was conducted to achieve this. Included studies involved a human population, a climate change related exposure, and an AoD outcome. Studies were published in English between 1998 and November 2023. Exposure events of interest included extreme heat, fires, storms, floods, droughts, and longer-term environmental changes. 8,204 studies were screened, with 82 included for data extraction and narrative analysis.

Results: Most papers describe increased AoD use, with smaller numbers showing decreased or unchanged substance use. Some studies identify unplanned withdrawal, changed drug markets, disrupted service access, specific physiological vulnerabilities of AoD users to extreme heat, and compounding effects on mental health. We note the relative absence of peer reviewed studies investigating impacts of climate change on AoD use in low-and middle-income countries. Further, few studies consider impacts that occur because of long-term or gradual climatic shifts such as environmental changes that are detrimental to livelihoods.

Conclusion: It is crucial to document effects of a changing climate on people who use AoD so that policy and services can meet future needs. We call for research to remedy gaps identified in this review.

Introduction

In recent decades, the world has experienced increasingly frequent and intense extreme events including devastating floods, fires, and heatwaves, as well as slow onset shifts such as increasing temperature means (Intergovernmental Panel on Climate Change (IPCC, 2022). Global climate change is upon us and the frequency and intensity of impacts will increase even with radical action to reduce carbon emissions (IPCC, 2023). Climate change's effects for humans include direct impacts from gradual changes to temperatures, seasonality and rainfall; and from extreme events including heat, fires, heavy rain and floods, hurricanes, and typhoons. These in turn impact food and water security, including reduced farming productivity, increased occurrence of diseases, mental health challenges, and trauma, and are linked to loss of livelihoods, destruction of homes and infrastructure, displacement, migration, and worsening gender and social equity (Beggs et al., 2021; IPCC, 2023). Yet agencies that might act to minimise harm to people are relatively unprepared to respond to emerging threats to wellbeing posed

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by the current and future effects of climate change (Berrang-Ford et al., 2021).

Climate change's deleterious effects on mental health are well documented. A recent review of literature associates climate change with increased suicide rates, severe distress after fires or hurricanes, compounded outcomes for people with existing mental health disorders, impacts of service provision changes, and general population distress and negative emotions (Lawrance et al., 2022). Disasters, which are more likely under climate change, have been shown to increase substance use disorders (SUD), with many people who use substances problematically also suffering from post-traumatic stress disorder (Fornili, 2006; Zengin Ispir et al., 2023). Vergunst et al. (2023) provide a granular analysis of pathways connecting climate change with increased prevalence of substance use, which we return to in the discussion section of this paper.

Climate change disproportionately affects people experiencing marginalisation and poverty (IPCC, 2023; Lawrance et al., 2022). The IPCC (2022, p.10) reports with high confidence that: "Approximately 3.3 to 3.6 billion people live in contexts that are highly vulnerable to climate change". Yet while there is substantial discussion of the impacts now and in the future of climate change, including on people's mental health, impacts on people who use AoD are not well documented (Cusack et al., 2011). An exception here is a recent scoping review (Tomassini et al., 2024) which reports on 13 studies with a specific focus on biomedical papers and the concept of climate change. Tomassini et al. (2024) note the scarcity of relevant studies and the over-representation of the USA as the location where data were collected in existing literature. Our research builds on this review through an extended search design and purpose.

The aim of this scoping review is to classify the range of climate change impacts on people who use AoD that are documented in peer reviewed literature. In doing so, we summarise findings of these studies to show broad conclusions drawn within the categories of impacts of climate change that we identify. We emphasise that quality appraisal of included studies was not conducted as part of our review. Findings from included studies are provided to illustrate the kinds of impact identified in literature, providing a conceptual framework for future research.

Our scoping review included peer reviewed papers from any academic discipline written after the signing of the Kyoto Protocol in December 1997, at which point there was widespread global consensus that climatic changes were anthropogenic (United Nations, 1998). As this indicates, the impacts on AoD users identified in the study occurred under an already changed climate. In contrast to Tomassini et al. (2024) who reviewed papers where climate change was explicitly mentioned, we searched for literature on first-order events (both acute and gradual or long-term) where a strong scientific consensus indicates that their frequency and severity have increased under climate change, and will continue to do so (IPCC, 2023). In closing, we note gaps in the peer reviewed literature that should be addressed to support future policy and service provision.

Method

Design

Scoping reviews are a method to systematically identify and map an evidence base to enable identification of research gaps. Consistent with advice on conducting a scoping review, we did not assess study quality (Arksey & O'Malley, 2005). The review protocol was registered with Open Science Framework (MacLean, 2024). Results are reported in accordance with PRISMA-ScR checklist (Peters et al., 2022).

Public consultation

Scoping reviews should entail consultation and public engagement (Arksey & O'Malley, 2005; Peters et al., 2022). EC represented the Alcohol and Drug Foundation (ADF) on our study team. The ADF funds over 270 Local Drug Action Teams across Australia, which increasingly report concerns about effects of a changing climate on substance use in their communities. ADF consulted leaders of the Teams to identify key impacts of climate change for the communities they work in. These discussions inform the structuring of categories identified across included studies.

Eligibility criteria

To be included in this review, studies had to examine two linked concepts: climatic events and processes and their impacts for people who used AoD. In the former category we included drought, floods, extreme temperatures, fires, hurricanes and other extreme winds, and longer-term alteration in environmental conditions. Any documented impacts specific to people who use AoD were considered as relevant outcomes. Peer-reviewed articles in English language published between 1998 and 17 November 2023 were included.

Search strategy

The search was designed and conducted with support from a senior librarian at La Trobe University. Included studies involved a human population, a climate change related exposure, and an AoD outcome. Search terms were identified related to key phrases such as 'substance use' (see Table 1 Search strategy). Three databases were searched (Web of Science, ProQuest Health and Medical Collection and Medline (Ovid)). A total of 8204 studies were included in an Endnote library, with 1616 duplicates removed. This was a large number of papers, but many included the term 'perfect storm' which could apply to studies about climate change as well as other non-relevant concerns. We conducted additional hand and Google searches without identifying additional references.

Study selection and data extraction

Study selection was performed according to agreed inclusion and exclusion criteria (see Table 2, below) and managed in the software program Covidence. Studies were first screened by JdN in two phases: by title and abstract, followed by full text examination. Ambiguous cases were resolved through consultation with SM, with questions regarding clarifying our inclusion criteria put to the full group of researchers. SM reviewed 20 % of the 205 studies included for full text review, excluding six additional papers. After all researchers read four to five papers, our team designed an extraction sheet to identify key paper characteristics (including, for example, location of study, study design, population, time elapsing between event and data collection, and substances involved). Questions were also designed to extract information about different types of impacts, such as 'increased use'. These were developed deductively through discussion within the research team, drawing on members' diverse expertise on climate adaptation, alcohol and drug services and policy. Data extraction for each paper was undertaken independently by two researchers, with consensus on discrepancies managed by SM. Table 3, PICO chart, shows studies included at each stage.

Analysis

Extracted findings were exported to Excel. The initial categories of climate change impacts were refined and recoded to minimise overlap and re-checked with EC to ensure that they were meaningful to the AoD service sector and its users. The paper is structured around the broad categories of impacts identified through this process. We provide numbers of papers analysed in each category to demonstrate the foci of existing studies. Findings from studies coded to each category are summarised in a narrative form (Popay et al., 2006) to illustrate findings.

Table 1
Search strategy.

Search ID#	Search Terms
S1	TS=(drug* NEAR/1 (use OR misuse OR illicit OR illegal OR dependen* OR addict* OR abuse))
S2	TS=((alcohol OR substance* OR ethanol) NEAR/1 (use OR misuse OR dependen* OR addict* OR abuse))
S3	TS=(alcoholism)
S4	TS=(alcoholic*)
S5	TS=(opiate*)
S6	TS=(opioid*)
S7	TS=(amphetamine*)
S8	TS=(heroin)
S9	TS=(marijuana)
S10	TS=(cannabis)
S11	TS=(cocaine)
S12	TS=(GHB)
S13	TS=("party drug*")
S14	TS=(narcotic*)
S15	TS=("angel dust")
S16	TS=(phencyclidine)
S17	TS=(chroming)
S18	TS=(inhalant*)
S19	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18
S20	TS=(climate NEAR/1 (change OR emergency OR crisis OR breakdown OR "break down" OR related))
S21	TS=("global warming")
S22	TS=("global heating")
S23	TS=(heatwave*)
S24	TS=("heat wave*")
S25	TS=("extreme heat")
S26	TS=(fire)
S27	TS=(bushfire*)
S28	TS=(wildfire*)
S29	TS=(flood*)
S30	TS=(drought*)
S31	TS=("extreme weather event*")
S32	TS=("climatic extremes")
S33	TS=(disaster*)
S34	TS=(storm*)
S35	TS=(cyclone*)
S36	TS=(hurricane*)
S37	TS=(typhoon*)
S38	TS=("tropical storm*")
S39	TS=("rising sea level*")
S40	#20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 OR #36 OR #37 OR #38 OR #39
S41	#19 AND #40
S42	#19 AND #40 and 1997 or 1998 or 1999 or 2000 or 2001 or 2002 or 2003 or 2004 or 2005 or 2006 or 2007 or 2008 or 2009 or 2010 or 2011 or 2012 or 2013 or 2014 or 2015 or 2016 or 2017 or 2018 or 2019 or 2020 or 2021 or 2022 or 2023

TS= topic (searches title, abstract, author keywords and keywords plus fields).

Results

We start by outlining the characteristics of the 82 included studies. In the section that follows, we summarise main impacts of climate change for people who use AoD documented in the peer reviewed literature. Table 4 below shows the numbers of studies that related to each included event and identified impacts on people who use AoD. Table 5 (supplementary material) provides more detail on each included study.

Information about included studies

Year of publication

Most of the 82 included papers were published in the second half of our study period. Between 1998 and 2010, 17 studies were published, and between 2011 and 2023, 65 studies were published.

Designs

Adapting the highest level of a schema (Centre for Evidence-Based, Medicine), studies were grouped as quantitative experimental (1), quantitative observational (62) qualitative (12) and mixed methods (7).

Across these study types, 31 were longitudinal, i.e., data were collected at multiple time points to identify trends. Of these, nine provided pre- and post-event data, allowing a more accurate assessment of effects.

Country in which the study was conducted

Over half of studies (57) were conducted in the United States of America (USA). Three were conducted in Puerto Rico and seven in Australia and Canada and two in Vietnam. One study was conducted in each of the following countries: Bangladesh, Germany, Switzerland, Korea, India and the United Kingdom.

Location

Thirty-two studies were conducted in an urban or capital city setting. Seven were conducted in a regional setting (i.e. town, non-capital). Eight were conducted in a rural or countryside setting. Thirty-five studies were conducted in more than one geographical location (within one country).

Total number of participants

This ranged from two to 3.4 million participants or respondents, the larger samples representing secondary analyses of institutional datasets.

Types of climate events that impacted study participants

Hurricanes, tornadoes, and cyclones were most frequently reported on in included studies (n = 50). Eleven studies reported on extreme temperature conditions. Eight were considered fire and smoke related events. Six studies reported on flood alone with two reporting on floods together with tornadoes, hurricanes, and fire. One study dealt with drought and another one on a tsunami. Three studies (Kabir, 2018; Pearce et al., 2010; Prno et al., 2011) dealt with longer-term impacts of climate change other than drought.

Identified impacts for people who use AoD

In what follows, we summarise research findings in each impact category.

Increased AoD use

In all, 48 papers identified climate change-related increases in substance use. By far the largest group of these (31) reported increases after Hurricanes Sandy and Katrina in the USA. For example, people who remained in New Orleans after Hurricane Katrina were nearly twice as likely to increase alcohol use (Cepeda et al., 2010; Kishore et al., 2008) (see Flory et al. (2009) for evidence of lower prevalence increase and comparison with national data). Another author (Lemieux et al., 2020, 2010) found that rates of substance use were twice that among social work students affected by Hurricane Katrina compared with other student respondents in a population study in the USA.

Similar findings occurred in relation to other hurricanes. Before and after Hurricane Ike in North America, alcohol use increased by 6 %, with some of these people initiating use (Ma & Smith, 2017). Increased drug use was also reported, with documented relapse after Hurricanes Ike and Maria (Contreras et al., 2023; Williams et al., 2014). Noel et al. (2021) found that self-reported drinking for university staff and students was higher on days before hurricanes than other days in the study period. In Puerto Rico after Hurricane Maria, cannabis and benzodiazepine use roughly doubled (Abadie et al., 2022).

Fires and floods also lead to increased substance use. After fires in Australia people in areas more highly affected (Bryant et al., 2014) and those who were personally affected (Lykins et al., 2023) reported increased drinking. Rates of problem alcohol use remained

Table 2
PRISMA flow chart.

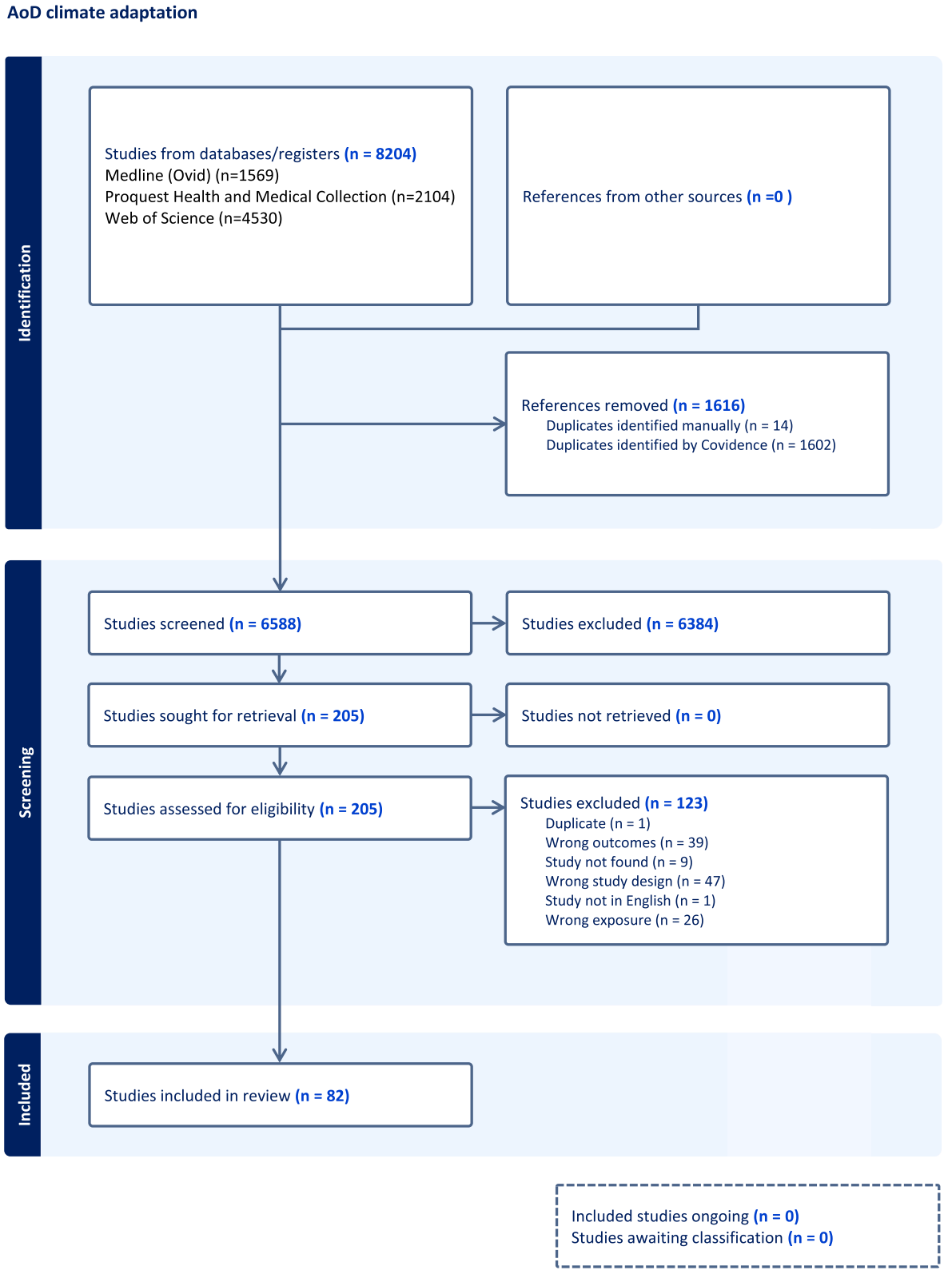

Table 3
PICO.

Population	
Include	Exclude
*People who use alcohol and other drugs	*People who do not use AoD *Impacts on tobacco users *Impacts for workers with these people
Intervention/Exposure	
Include	Exclude
*Climate change: drought, extreme weather events, fires, floods, longer-term change in temperature	Events not considered first-order impacts in IPCC report, i.e. COVID
Comparator/Context	
Include	Exclude
*none	
Outcome	
Include	Exclude
* Impacts on metal health, drug use, alcohol use, other needs *And/or service responses *And/or other outcomes	*Impacts, service responses or outcomes for people who do not use AoD or which are unrelated to AoD use *Any impacts of climate change that effect everyone – not specially people who use AoD
Study Characteristics	
Include	Exclude
*Empirical studies conducted present after 1998, published in peer-reviewed journals. *English language	*Reviews, opinion pieces, reports, papers published prior to 1998

comparatively high at subsequent timepoints (Bryant et al., 2021, 2018). In Tamil Nadu, India, nearly 5 % of a sample of people affected by flooding reported increased substance use (Bandla et al., 2019).

Effects of exposure may be felt outside the country where the climate events occur. A study of Swiss people exposed to a tsunami in Asia found increased substance use after return to Switzerland, with differences in substances used by men and women (Vetter et al., 2008).

AoD services also recorded increased demand after climate- related events, likely reflecting increased problematic use. Greater numbers of criminal justice system referrals to SUD treatment programs were recorded after Katrina (Shuler et al., 2017) and texts to services for crises including substance use increased in the period immediately after Hurricane Ida (Wertis et al., 2023). A paper reporting on the 2016 Baton Rouge area flood in Louisiana, USA found a 70 % increase in Medicaid funded substance- abuse and addiction disorder visits (Phillippi et al., 2019).

It is unusual for studies to report on AoD impacts ensuing from longer-term climate events, although some research exists. Subsistence hunter Inuit people in northern Canada are facing increased weather variability and new seasonal patterns, making hunting more dangerous and less predictable (Pearce et al., 2010). Some traditional travel routes can no longer be used due to snow melt and reduced availability and accessibility of wildlife impacts livelihoods. Participants in a qualitative study suggested that this had led to increased drug and alcohol use in the community, with subsequent effects such as foetal alcohol syndrome, family violence and child neglect (Pearce et al., 2010). In another Canadian Inuit community, long-term impacts of climate change were linked with increased alcohol bootlegging, alcoholism and public drinking (Prno et al., 2011). In Bangladesh, over two-thirds of interviewees in a study identified similarly that climatic changes were reducing capacity to practice cultural and livelihood activities. They argued that subsequent boredom and loss of identity led to an increase in their or their families' AoD use (Kabir, 2018).

A few studies provide pre-event data to support more accurate assessment of changed AoD use than self-report data. For example, Beaudoin (2011)) identified a 185 % increase in alcohol consumption post Hurricane Katrina. High school students in southwestern Louisiana ($n = 280$) participated in a drug abuse prevention intervention trial prior to a hurricane (Rohrbach et al., 2009). A quarter of subjects reported non-use of alcohol prior to a hurricane and alcohol use 19 months after it (this may be due in part to increased use as people age).

Longitudinal studies suggest that increases in AoD use that occur after climate-associated events may reduce over time. Hurricane Sandy survivors used alcohol to cope significantly more often at 16 months post-event than at 28 months post event (Lowe et al., 2017). In a longitudinal study, Shin et al. (2010) observed in Korea that patterns of AoD use were higher for one to one and a half years after flooding and subsequent landslide and then declined.

Many studies focus on factors that mediate increased AoD use. It is unsurprising that pre-disaster AoD use prevalence predicts substance use problems after climate-associated events for both adults and adolescents (e.g. Ritchie et al., 2021; Schroeder & Polusny, 2004; Shin et al., 2010).

Those who experienced the most significant exposure to, or effects of, the events such as hurricanes (such as food and water shortage, loss of houses or cars, or work disruption) were most likely to increase alcohol use or other substance use (Hicks et al., 2022; Kishore et al., 2008; Locke et al., 2020; McCann-Pineoet al., 2021; Peek-Asa et al., 2012; Vetter et al., 2008). Cerdá et al. (2011) found that high level exposure to Hurricanes Katrina or Rita was associated with increased alcohol use, whereas low-level exposure was not. After Hurricane Ike, teenagers who did not evacuate were more likely to report heavy drinking, marijuana, or cocaine use than those who did evacuate (Temple et al., 2011).

Trauma is also a significant factor. After Hurricane Katrina, people with a history of trauma were more likely than others to increase alcohol use (Hakim et al., 2022; Marzuk et al., 1998). Puerto Rican hurricane survivors who moved to the USA and who internalised their trauma and cultural stress were significantly more likely to be problem drinkers than those who did not (Schwartz et al., 2022). Other studies highlight post-traumatic stress disorder as a mediating factor between extreme event exposure and drug (Peters et al., 2010; Prost et al., 2016) or alcohol use (Ritter et al., 2011). Hakim et al. (2022) assessed effects of tornado exposure among 'at risk' USA adolescents, finding that subsequent marijuana use initiation was more likely for those high in 'temperamental fear' involving anxiety in reaction to a perceived threat.

As observed above, many included studies show that pre-existing mental health conditions increased subsequent likelihood of substance use after climate-related events (e.g. Begum et al., 2022). Six months after a fire in Fort McMurray in Canada, people with generalised anxiety disorder were about three times more likely to report drug related problems (but not alcohol) and had significantly elevated alcohol and other substance use compared with those who did not (Agyapong et al., 2018, 2021).

Other negative life events were found to predict adolescent substance use after hurricane exposure (Rohrbach et al., 2009; Schroeder & Polusny, 2004). Homelessness increased vulnerability for both psychiatric illness and heroin use for people displaced after Hurricane Katrina (Shuler et al., 2016).

Support in the months following a disaster is an important factor in mitigating increases in substance use (Cerdá et al., 2011). Bountress et al. (2017) showed that genetic susceptibility to excessive alcohol consumption increased the likelihood of disaster exposed adolescents drinking alcohol. This effect was mediated by availability of emotional support. In a qualitative study of Latino day labourers in New Orleans after Katrina, Valdez et al. (2010) found that a lack of social services and medical care made them feel isolated, contributing to increased alcohol, marijuana, or cocaine use. Conversely, in Beaudoin et al.'s (2011) study of the same event, high levels of neighbourliness were correlated with greater likelihood of increasing alcohol use over time. (See also Ma & Smith, 2017 on the positive role of social cohesion in moderating increased alcohol use).

Few studies investigate whether climate change-associated events lead to changed rates of SUD. Prevalence of SUD among adults in the Fort McMurray area a year after wildfires was almost twice that in the Canadian population (Belleville et al., 2021), but North et al. (2004)

Table 4
Number of studies related to events and their impacts on people who use AoD.

	Increased AoD use	Decreased substance use, mixed or no effect on substance use	Disrupted service access	Vulnerability to extreme heat	Changes to drug markets	Unplanned withdrawal	Compounding mental health problems
Hurricanes/cyclones/tornado	31	14	12		5	6	1
Fire	7	3			1		
Floods	4						
Hot weather	2			10			1
Longer-term environmental changes	3	0	1				1
Tsunami	1						
Drought		1					
Effects total	48	18	13	10	6	6	3

NB some studies consider more than one climate event and identify more than one impact for people who use AoD.

found no change in alcohol abuse disorders after flooding. However, overall, people with SUD present at hospitals at higher numbers after climate-related events (Moise & Ruiz, 2016; Phillippi et al., 2019).

Decreased substance use, mixed or no impact on substance use

Declines in AoD use are also observed in the literature (18 studies), particularly in the immediate aftermath of an event, due to disrupted supply. Post Hurricane Katrina, dealers of substances including heroin and crack cocaine were able to increase their prices up to double or triple (Bennett et al., 2011; Dunlap et al., 2012, 2009). Many people ceased or reduced drug consumption as a result.

Some people used the opportunity of displacement after Hurricane Katrina to cease drug use (Cepeda et al., 2010; Dunlap et al., 2012) reporting motivation to do so after coping with the event and relocating (Tiburcio et al., 2009). Lack of money, as people reestablished themselves and found housing in New Orleans, also decreased funds available for drugs. At the same time, vouchers for rents and utilities and employment programs, motivated them to change their lives (Timpson et al., 2009). More people in New York City (NYC) who injected drugs reduced substance use than increased it, during the week after Hurricane Sandy (Pouget et al., 2015). Alcohol consumption dropped after Hurricane Florence, which the authors speculate stemmed from uptake of critical emergency work (Noel et al., 2021). Similarly, availability of school-based health care in areas affected by Hurricane Katrina reduced students' subsequent marijuana use by 13 % (Hutchinson et al., 2012).

Many studies that identified increased use of one substance in the section above observed that this did not apply to other substances. For example, Pesko (2018) found evidence of increases in some forms of substance use post-storm surges, but not binge drinking (see sections on disrupted service access and changed drug markets for additional examples). Cepeda et al. (2010) found that 36 % of evacuees after Katrina decreased ecstasy use, while 34 % reported increasing marijuana use with a slightly smaller percentage (29 %) reporting increased alcohol use. Patterns might also change. Abadie (2022) found that the proportion of injecting drug users who reported injecting four or more times daily declined, where low frequency (one time or less per month) increased from 3 % to 23 % of the sample.

Some studies find relatively little impact of climate-related events on substance use. Exposure to disasters including fire, tornado, or flood by age five increases likelihood of adult mental health disorders but not substance use (Maclean et al., 2016). Danielson et al. (2017) studied 2000 families affected by tornedos and found no clear trends in adolescent substance use. In Australia, Gunn et al. (2012) found that drought-affected farmers aged 25–44 used alcohol as a coping strategy more than other farmers did and that this significantly predicted psychological distress, but that overall substance use did not rank highly as a strategy for dealing with distress. Typhoon exposure was not correlated with increased alcohol use in a study by Ritter et al. (2011). North et al. (2004) noted no new alcohol abuse or dependence among participants who lived in areas affected by flooding in the Mississippi River and its tributaries. In a study of urine screens provided in opiate maintenance programs pre- and post- Hurricane Sandy, no significant differences in results positive to substance use were reported (Gupta et al., 2017). In contrast to other studies of Hurricane Sandy, Schwartz et al. (2016) found no direct correlation between exposure and subsequent substance use.

Disrupted service access

Thirteen studies address reductions in availability of services, mostly concerning unavailability of opioid treatment programs such as methadone provision or needle and syringe programs after disasters. Veterans in areas affected by the 2004–5 hurricane seasons in the USA decreased attendance at SUD clinics (it is unclear whether this is due to reduced access or reduced need) (Frahm et al., 2013). After various hurricanes, some opioid treatment services were severely flooded and closed (Griffin et al., 2018; Gupta et al., 2017; Matusow et al., 2018). After Hurricane

Sandy, only 30 % of opioid treatment clients were able to obtain sufficient take home doses to avoid withdrawal (Pouget et al., 2015). Many people previously using opiate substitution therapies moved to illicit opiates due to disrupted service availability or clinic closures (Abadie et al., 2022; Elliott et al., 2017; Griffin et al., 2018; Matusow et al., 2018; Pouget et al., 2015). Clinicians at an opioid treatment service estimated that 27 % of service users relapsed to heroin use shortly after Hurricane Sandy (Matusow et al., 2018). In Australia, pharmacies closed or reduced hours of availability after a flood. Pharmacies that remained open were unable to cope with demand. Where people did not have access to their prescriptions or identification documents, pharmacies were unable to supply them with medication such as methadone or buprenorphine (O'Dwyer et al., 2020).

These service disruptions lead to harms. Some people exposed to Hurricanes Sandy (Pouget et al., 2015) and Maria (Abadie et al., 2022) shared needles after needle exchanges closed, exposing them to risk of blood-borne viruses. After Hurricane Maria, opioid treatment services disruption, combined with availability of fentanyl on the drug market, led to increased overdoses (Abadie et al., 2022). Also, after hurricanes, a lack of available hospital beds for substance abuse treatment meant that people were discharged earlier than they would otherwise have been, sent to another hospital far away (Shuler et al., 2016), or retained in hospital due to closure of other services (Conrad & Lavigne, 2013). In contrast, Ruskin et al. (2018), reporting on Hurricane Sandy, found no effect of losing access to medical care on alcohol consumption after a disaster.

Vulnerability to extreme heat

In extreme heat people who use alcohol, opioids, and stimulants are at greater risk of adverse consequences than others – with higher rates of emergency department visits, heat-related illness, and overdose including symptoms such as loss of consciousness, hypotension, and impaired respiration (Parks et al., 2023; Ryus & Bernstein, 2022; Yoo et al., 2021). This may be exacerbated by substance use associated effects of sedation and dehydration (Chang et al., 2023; English et al., 2022; Ryus & Bernstein, 2022). Ten papers report on this.

Page et al. (2012) explored a nationally representative sample from the UK and found that people with a primary diagnosis of SUD, along with younger patients, were most likely to die in a heatwave. Those with SUD who died were mostly using opiates, though it is unclear whether this caused deaths or whether opiate users have physical co-morbidities that make them vulnerable to heat stress. Marzuk et al. (1998) found that fatal cocaine overdoses (but not those related to other drug use) increased steadily over 31.1 °C (88°F). Nori-Sarma et al. (2022) found that in days of higher ambient heat, USA emergency departments recorded increased visits due to SUD. In some circumstances, elevated AoD poisoning during hot weather might also be due to increased consumption (Hensel et al., 2021). Concerningly, people who use AoD were reportedly reluctant to access heat shelters due to worry that they would not be welcomed (Price et al., 2018).

Changes to drug markets

People sometimes initiated new drug use after their usual substances or opiate substitution treatment became unavailable (i.e. Elliot et al., 2017). Most studies that highlighted changed drug availability were conducted in New Orleans after Hurricanes Katrina and Sandy. Displaced people who already used drugs reported shifting to legal drugs for easier access (Dunlap et al., 2009). Also reported were increased marijuana, methamphetamine and ecstasy use. These substances were more accessible in Houston where many moved to after Katrina (Bennett et al., 2011; Cepeda et al., 2010). Labourers who stayed in New Orleans reported new use of crack cocaine due to availability (Valdez et al., 2010).

Drug markets may become more harmful after disasters. After Hurricane Katrina, dealers offered cheaper prices and purer heroin to reestablish markets when people returned to the city, increasing risk of overdose (Bennett et al., 2011). When established dealers evacuated after a disaster, new dealers moved in who were less concerned about their clients' welfare (Abadie et al., 2022). Drug markets also shifted after Hurricane Katrina destroyed lower-socio-economic suburbs (Bennett et al., 2011) and dealers became active in new areas.

Unplanned withdrawal

Six papers reported unplanned withdrawal as a result of events associated with climate change, as also reported above as decreased use. Reduced supply of drugs after Hurricane Sandy led to nearly 60 % of injecting drug users in NYC experiencing withdrawal in the week after Hurricane Sandy and 70 % of those on opioid maintenance therapy missing dosing (Pouget et al., 2015). One participant describes enduring withdrawal from opiate treatment after Hurricane Sandy while being evacuated from his submerged home by boat (Matusow et al., 2018). Elliot et al. (2017) report that of a sample of NYC opioid users enrolled in substitution programs, almost half used heroin or illegally obtained prescription drugs to avert withdrawal due to displacement from home programs and lack of transportation to other programs (see also Griffin et al., 2018; Matusow et al., 2018). Due to decreased illegal drug supply after Hurricane Katrina, people reportedly gathered outside a hospital with guns, trying to access drugs they thought were inside (Druss et al., 2007).

People displaced by disasters need to find and negotiate new drug markets. For fear of unplanned withdrawal, some opioid users refused to evacuate after Hurricane Katrina (Dunlap & Golub, 2011).

Compounding mental health problems

Most studies operate from an assumption that climate-associated events impact on mental health, subsequently increasing rates of AoD use, some of which are reported above. A much smaller number of studies suggest that increased AoD use after climate-related events in turn exacerbates mental health problems.). In Vietnam, Dang (2022) found that people who used psychoactive substances were at higher risk of mental health disorder hospitalisation after heatwaves. Inuit in Canada who had addictions similarly found it more difficult to cope with impacts of climate change on their environment (Pearce et al., 2010). Stukova et al. (2023) found that post Hurricane Maria, substance use elevated risk of depression or anxiety disorders and Gunn et al. (2010) found that alcohol and drug use in Australian farmers positively predicted drought-related distress.

Discussion

In this section, we reflect on what the literature described above tells us about impacts of climate change on people who use AoD. We also identify important gaps in peer reviewed literature. These include the impacts of climate change on people who use AoD in low-and middle-income countries (LMIC); and impacts of longer-term and gradual environmental shifts.

Our review highlights the role of climate change in altering patterns of AoD use. The majority of studies (48) identified increased use of a range of substances rather than declines, mixed effects or no changes in use (18 studies) during the study period, providing additional support for the assertion that climate change leads to increased AoD use (Vergunst et al., 2023; Zengin Ispir et al., 2023). The extent, however, of changes in prevalence of SUD is less well understood.

Unplanned withdrawal is commonly an effect of experiencing climate-associated disasters. This is due to disrupted drug supply and unavailability of opioid maintenance therapy (methadone or buprenorphine) services. Withdrawal can be exacerbated by heat stress (Cusack et al., 2011). Studies reviewed here highlight the importance of ensuring that syringe exchange, opioid replacement programs, and hospital services remain open and accessible for people unexpectedly withdrawing from AoD.

Unplanned withdrawal evidently occurs alongside changes to drug markets. Yet changes to drug markets go beyond what is reported above,

especially in LMIC. For example, reports suggest that climate change is likely to increase the supply of some dependency-forming drugs (especially heroin and cocaine). Farmers facing water and climate insecurity are more likely to turn to producing crops of opium poppies, which are criminalised but more lucrative and agriculturally robust (Brisman et al., 2018; Kienberger et al., 2016; Olivera-Villarroel & Celis, 2020; Parenti, 2015; Winston, 2022). Over time, other drug crops may also become harder to grow. Thus, synthetic drugs may become more available than plant-based ones, as has been documented in a report on drug supply in Afghanistan (Winston, 2022). Changes to supply of grapes for wine production are predicted, but how this will affect alcohol consumers is not well understood (Mira de Orduña, 2010). Broader work indicates that supply chains of all sorts are likely to be badly impacted (Sun et al., 2024).

Heat stress is the most direct health effect of climatic changes (Patz et al., 2014). Some studies included here document that people who use alcohol, opiates, stimulants or medications to manage substance use are more likely to be hospitalised or die during extreme heat events (Cusack et al., 2011; Hansen et al., 2008; Nitschke et al., 2007). Stimulants including amphetamines and cocaine are dangerous during heatwaves because they increase muscular activity and therefore body heat (Cusack et al., 2011; Martinez et al., 2002).

As noted above, Vergunst et al. (2023) identify five pathways to increased AoD use that are associated with climate change, one of which concerned the operation of mental health as a mediating factor. We identify papers where AoD use after climate events exacerbates mental health conditions and speculate that the relationships between AoD and mental health problems after exposure to climate-related events is likely often to be synergistic rather than linear.

Other pathways to increased substance use identified by Vergunst et al. (2023) are less evident in the peer reviewed literature we analysed. These include longer-term destabilisation and changes to established behaviour patterns and physical health burdens. Climate anxiety is a further pathway to increased AoD use identified by Vergunst et al. (2023). Although rarely described in studies included in our review (for an exception see Lykins et al., 2023), research outside the parameters of this study suggests that climate anxiety is particularly felt by young people.

Most of the studies reported here describe acute weather events. In contrast, studies that seek to understand the impacts of experiencing compounding climate related events and gradual changes over longer periods of time are poorly represented in our review. Exceptions here are studies of adaptation by Canadian Inuit (Pearce et al., 2010; Prno et al., 2011), Bangladeshi hill dwellers (Kabir, 2018), Australian farmers (Gunn et al., 2012) and people who use AoD in NYC (Parks et al., 2023). Lawrance et al. (2022) argue that the ongoing incremental impacts of global climatic changes are key drivers of mental health-associated harmful AoD use, indicating that this is an area worthy of greater research attention.

Longer-term environmental changes effect drivers to consume substances. A report (thus excluded from the study) from Indonesia documents how men and boys in rural fisheries need to work longer hours due to diminishing stock associated with climatic changes. Hence, some use amphetamine-type substances to enable them to stay at sea longer. Some men also drink alcohol more heavily to cope with the distress of being unable to provide for their families (Fauziah et al., 2023).

Despite the likelihood that people in LMIC are, and will continue to be, most affected by climate change (IPCC, 2023; World Health Organization, 2021) fewer than 10 % of included studies were conducted in these places. Three-quarters of studies included in our review report on data from the USA. We identified no studies from Africa, a continent that already experiences disproportionate impacts of climate change (IPCC, 2023). Relatively few studies investigate impacts in rural or regional settings. Related to the North American locus of most included papers, more than half investigate impacts of hurricanes and tornadoes.

Displacement to new areas after events such as hurricanes is described in included studies. However, mass migration and displacement of people due to gradual rising sea water and areas of the world becoming increasingly difficult to inhabit is already underway, especially in LMIC (IPCC, 2023). We know that drug use flourishes in refugee camps (Winston, 2022), but other effects of large-scale displacement on AoD use are as yet largely unknown. All these impacts have implications for the provision of services to AoD users, including treatment programs, pharmacies and other social services.

The study includes papers that have addressed the effects of service disruption on AoD users, but research into the experiences of the workers providing those services was not identified through the search process. Workers in AoD services experience the climatic events while also as trying to maintain services for people who use AoD. It is also likely that some AoD users will be distressed as a result of climate impacts, and thus more difficult to provide services for (e.g. Denham & Rickards, 2022). This is a topic that also requires further research.

Limitations of the study include that we did not conduct quality appraisal to assess the veracity of findings in included studies. Further, we focus only on peer reviewed papers, excluding grey literature such as government reports. We did this because of the difficulties involved in comprehensively searching grey literature. We excluded studies considering effects that are less directly influenced by climate than weather. For example, COVID-19 is not considered a first order effect of climate change (IPCC, 2023), although its effects may be compounded by climate and pandemics are predicted to occur more frequently in the future. A review of mental health effects of climate changes suggests that these are underreported (Lawrance et al., 2022). Climate-related changes in AoD use patterns are likely also to be overlooked. Finally, the included papers are almost all observational in design, because the exposure event (related to climate change) is not assigned by researchers (see Centre for Evidence-Based Medicine). Intensity of events varies, and time elapsing between exposure and data collection (especially where events are long-term or gradual) differs across studies, making it difficult to synthesise findings.

Conclusion

We build here on the only existing scoping review of impacts of climate change on people who use AoD (Tomassini et al., 2024) to identify broad categories of impacts. We identified the following impacts of climate-associated events: increased AoD use, especially in the short-term, decreased or unchanged substance use, unplanned withdrawal, changed drug markets, disrupted service access, specific physiological vulnerabilities of some AoD users to heat, and compounding effects on mental health. We note the relative absence of peer reviewed studies investigating impacts of climate change on AoD use in low-and middle-income countries. Further, impacts of longer-term or gradual climatic shifts (rather than acute events) are rarely documented in existing literature (see, for example, Tomassini et al., 2024) .

Importantly, the impacts of climate change on AoD use are highly contextual and situated, and responsive to interactions between types of climate change-related hazards, socio-economic vulnerabilities, and material conditions experienced in a place and time. Therefore, further in-depth, localised, longitudinal studies are required to support understanding and interventions in specific locations.

Climate change adaptation entails actions to support human and natural systems to cope with current and anticipated impacts of living in a world of global heating, to minimise harms and to accrue benefits where possible (IPCC, 2023). Governments and AoD services have an important role into the future in supporting people to manage during extreme events and throughout slow onset events such as increasing mean temperature. Success in meeting this responsibility requires a clear evidence base concerning the current and future impacts of climate change for people who use AoD. This scoping review demonstrates the need for AoD policy and service responses to support adaptation to climate change, as well as identifying research required to address the

gaps in peer reviewed evidence.

CRediT authorship contribution statement

Sarah MacLean: Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Julia de Nicola:** Writing – review & editing, Investigation, Formal analysis, Data curation. **Kimberlea Cooper:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Heather Downey:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Jacqui Theobald:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Lisa de Kleyn:** Writing – review & editing, Methodology, Investigation, Data curation, Conceptualization. **Todd Denham:** Writing – review & editing, Methodology, Investigation, Data curation, Conceptualization. **Eleanor Costello:** Writing – review & editing, Methodology, Conceptualization. **Lauren Rickards:** Writing – review & editing, Validation, Methodology, Investigation, Conceptualization.

Declaration of competing interest

The authors have no interests to declare.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.drugpo.2024.104649.

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