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THE FALLING CARBON FOOTPRINT OF ACQUISITIVE AND VIOLENT OFFENCES

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Cutting carbon emissions, wherever they occur, is a global priority and those associated with crime are no exception. We show that between 1995 and 2015, the carbon footprint of acquisitive and violent crime has dropped by 62 per cent, a total reduction of 54 million tonnes CO_2e throughout this period. Although the environmental harm associated with crime is likely to be considered lower in importance than social or economic impacts, a focus on reducing high carbon crimes (burglary and vehicle offences) and high carbon aspects of the footprint (the need to replace stolen/damaged property) could be encouraged. Failure to acknowledge these potential environmental benefits may result in crime prevention strategies being unsustainable and carbon reduction targets being missed.

Key words: carbon cost of crime, crime harm, crime drop, crime prevention, crime and environment, environmental harm

Introduction

Crime, like all activities, has environmental impacts. Policing, keeping offenders in prison, protecting property from intrusion or replacing items that get stolen all have an impact on the environment. Yet most existing studies connecting the environment and crime have typically focused on more general relationships between weather and crime (Agnew 2012) or examined specific large-scale environmental disasters (Chunn *et al.* 2002; Uhlmann 2011). It is only more recently that attempts have been made to provide a quantification of the actual environmental (carbon) costs of particular criminal offences (Pease 2009; Skudder *et al.* 2016). However, despite studies demonstrating that crimes result in substantial carbon emissions, these estimates are essentially static in time, with no consideration of the changing nature and levels of crime over time. This is important, with clear evidence that the crime profile has changed substantially over the last two decades.

In recent years, there has been growing interest in addressing the harms resulting from crime in addition to the volumes of crime that occurs. This recognizes the broader impacts of crime, not just to victims, offenders and associated families, but also society more generally. The Office for National Statistics (ONS) in the United Kingdom, for example, has recently developed the Crime Severity Score (CSS) to provide a new measure of crime, which ranks offences according to their seriousness.

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This is premised on the belief that not all crimes should be treated equally, with some crimes causing disproportionate levels of harm. Other research in this area includes the Cambridge Crime Harm Index (CHI) (Sherman *et al.* 2016), victim seriousness judgements (Ignatans and Pease 2016) and the sentencing gravity score (Ratcliffe 2015) amongst others. A ranked or weighted measurement of crime provides several benefits including showing and tracking the change in the severity of crime over time. For example, a weighted measure shows whether more serious crimes are becoming more/less prevalent rather than the crime trend being driven by large-volume, low-level incidents. A weighted measure may also allow police resources to be best targeted to specific areas or to specific offences that cause the most harm as local crime profiles can be produced (ONS 2016*a*).

Whilst a harm-related measure of crime provides a weighted score of criminal offences that takes account of their social impact (and elements of their economic cost), any environmental harm caused by criminal offences has been ignored within existing work. The reasons why this has been neglected until now are likely to be because of the externality of these types of harm. Environmental costs do not have a single victim as the impacts of carbon emissions, which include warmer temperatures or flooding as a result of global warming, are largely felt by humanity as a whole rather than by individuals (see Popovski and Mundy (2012) discussion and definition of climate change victimization). Also these environmental impacts may be felt years after the criminal event, rather than the more immediate social and economic impacts of crime that are felt by victims and the criminal justice system.

Any type of environmental impact, such as carbon emissions that result from criminal offences, however, should be of no less importance than the social and economic impacts. The environment plays a key role in supporting economic activity, both directly through provisions of resources (water, timber and minerals) and indirectly by services provided by ecosystems (carbon sequestration, water purification and nutrient cycling) (Defra 2010). There is also an increasing recognition of the need to connect environmental harms with criminology (Hall 2011) and in light of global targets to reduce carbon emissions, there may be an opportunity to use a focus on the environmental harms of crime to strengthen the justifications for crime prevention. This could have benefits not just for people and the economy but also for the environment and, in theory, provides more sustainable decision making for long-term prosperity.

We examine how the carbon footprint of acquisitive and violent crime[1] has changed over time in England and Wales since 1995. Using police-recorded crime and self-reported victimization survey data, we demonstrate a substantial fall in crime-related carbon emissions in England and Wales over the last two decades. We show that specific crimes (burglary and vehicle offences) and specific aspects of the carbon footprint (the need to replace stolen or damaged items) result in the highest proportion of emissions and may therefore offer the best potential opportunities for further reducing this footprint in the future. Measuring the changing carbon footprint of crime is an important first step in understanding the environmental harm of offences, something which has been notably overlooked by existing measures of crime harm. It also

[1]In the current analysis, we exclude the carbon footprints of drug, fraud and cyber-related crimes, due to limitations with existing methods of quantifying these crimes.

represents an opportunity to consider the potential environmental benefits of crime reduction.

The Crime Drop

Studies have demonstrated that many acquisitive and interpersonal crimes have experienced a downward trajectory since the 1990s, both domestically and across the world (Bunge *et al.* 2005; Aebi and Linde 2010; Tseloni *et al.* 2010; Farrell *et al.* 2014). Whether we have witnessed a concomitant fall in overall levels of crime is less certain. Recent evidence suggests that at least part of the apparent fall in crime could be reflective of a move to more technology reliant activities (e.g. cybercrime), which are less easily measured (Dry 2014; ONS 2016*b*). Others have argued that existing approaches to measuring crime are deficient, either by placing too much emphasis on police activity, failing to accurately pick up the enhanced risks experienced by particularly vulnerable groups of the population, or giving insufficient emphasis to those who experience chronic victimization (Aebi and Linde 2010; Eterno and Silverman 2012; Tcherni *et al.* 2015; Walby *et al.* 2016). Yet whilst there is still considerable disagreement over the precise nature of the changes in *overall* levels of crime, the environmental implications of the apparent reduction in levels of acquisitive and violent related crimes—both 'high carbon' forms of activity—warrants further scrutiny.

Patterns of crime and victimization are changing, with growing evidence that many countries have experienced a general fall in levels of crime over the past two decades. For example, the Crime Survey for England and Wales (CSEW, formerly the British Crime Survey) has reported marked falls in overall levels of crime since a peak of 19 million offences in 1995, with the most recent estimate of 6.3 million offences committed in the year ending March 2016 (ONS 2016*b*). Acquisitive crimes, in particular, appear to be responsible for much of the fall, with burglaries and vehicle thefts showing large declines year-on-year and a fall of more than half since the early 1990s (Van Dijk *et al.* 2007; Farrell 2013; Farrell *et al.* 2014). This general crime decline is echoed across a number of countries including France, Australia, the Netherlands and the United States, where violent crime has fallen by 33 per cent and property crime by 29 per cent since 1990 (FBI 2016).

The crime drop, however, is not universal across all crime types or across all countries, suggesting that these general reductions are masking a more complex reality. Aebi and Linde (2010) show that whilst property offences and homicide have been steadily falling since the 1990s, some violent crimes and drug offences have actually increased in recent years across parts of Western Europe. In England and Wales, the most recent police-recorded crime figures also suggest that violence against the person may be increasing, with similar increases in levels of arson, criminal damage and sexual offences (ONS 2016*b*). Tcherni *et al.* (2015) also demonstrate that the true nature of crime changes is more complex than the general reductions in official crime statistics would suggest. These figures, they argue, provide an increasingly incomplete picture of the true extent of criminal activity, with the apparent declines in acquisitive crime reflecting changing offending habits, rather than a real fall in crime. In particular, they suggest that many offenders may be moving online, a contention that is, at least partially, borne out by evidence, with recent figures from

the CSEW suggesting an estimated 5.8 million fraud and computer misuse incidents occurred in 2015/16 (ONS 2016*b*).

Methodological limitations with the collection of official figures also impact on their ability to provide a true reflection of the extent and nature of the crime drop. Falls in police-recorded crime figures may be as much a reflection of changing policing priorities and recording habits as a real reduction in crime (Aebi and Linde 2010). For example, Burrows *et al.* (2000) demonstrated that estimated levels of domestic burglary (and attempted burglary) were heavily influenced by police reporting and recording practices in the United Kingdom, with the same activity classified as a burglary in one police force failing to be recorded as a crime in another. And despite substantial efforts to improve consistency across police forces with the introduction of the National Crime Recording Standards in 2002, more recent evidence suggests that police recording practices may still be influencing estimates of crime (Flatley and Bradley 2013).[2] Relatedly, the problem of active police non-recording of offences has also been highlighted, leading the UK Statistics Authority (2014: 7) to conclude that there is 'accumulating evidence that suggests the underlying data on crimes recorded by the police may not be reliable' and the subsequent decision to de-designate them as National Statistics.

Changes in the reporting habits of the public can also have a substantial impact on estimated levels of police-recorded crime. Throughout the 1980s, there was a general increase in reporting of crime by the public, which correlated with increasing crime rates (Van Dijk *et al.* 2012). For certain types of offences such as property-related offences, reporting can be higher due to the need for police incident numbers for insurance claims. A recent increase in the willingness of victims to come forward and report serious sexual assaults is also thought to be the main driver of the increased number of sexual offences recorded by police (ONS 2016*b*).

Estimates from the CSEW, a household victimization survey, are not susceptible to the same sources of recording and reporting bias and, as such, are believed to offer a better measure of trends on a consistent basis over time—at least for those crimes that they include (ONS 2014). However, the veracity of the CSEW has also recently been challenged, with Walby *et al.* (2016) demonstrating that the decision to 'cap' repeat victimization at a maximum of five offences may have led to severe underestimates of some crimes, in particular violence against women. There are also many populations missed by the CSEW—most notably vulnerable groups including homeless people and those living in institutions—groups who may experience disproportionate levels of victimization (Hope and Norris 2013). The CSEW also focuses on a narrower band of victim-perceived offences, limiting its coverage of overall levels of crime.

Despite these criticisms, measures of crime in England and Wales are generally regarded as world-leading and provide a long running time series to explore the environmental impacts of changing levels of crime and police activity. The general falls in acquisitive crime and violence noted in police-recorded crime figures are likely to, at least in part, be reflective of real reductions in criminal activity and, certainly, provide

[2]Following a review by Her Majesty's Inspectorate of Constabulary (HMIC) in 2014, it is expected that actions taken by police forces to improve their compliance with the national recording standards have resulted in an increase in the number of offences recorded (ONS 2016*b*).

a robust picture of the extent of police activity (which we anticipate will make a substantial contribution to the overall environmental costs of crime). And the CSEW can provide an estimate of the potential level of criminal activity that does not reach the attention of the police, but which may still result in direct environmental costs for individual victims, at least for those offences 'in-scope'.

Crime and the Environment

Public concern for the environment is a topical issue and global climate change, in particular, has been identified as one of the greatest challenges of our time (United Nations (UN) 2015). Emissions of greenhouse gases[3] resulting from human activities are becoming an increasing problem and have recently reached the 'highest levels in history', producing widespread impacts on human and natural systems (IPCC 2014). Global efforts in response to this challenge such as the Paris Agreement, which brought together nearly 200 countries, set out plans to reduce emissions (UNFCC 2015). Since emissions have global consequences regardless of where they come from (Committee on Climate Change 2016), limiting these impacts remains a complex issue that requires co-ordination across nations and across research disciplines.

Research in environmental crime, however, is conventionally concerned with the enforcement of environmental laws. As such, focus tends to centre on large-scale environmental disasters, which are exceptional or extraordinary cases rather than routine offences (Edwards *et al.* 2013). Incidents such as Bhopal, the world's largest industrial disaster, or the Deepwater Horizon oil spill in the Gulf of Mexico, tend to be discussed often within environmental crime analyses (Chunn *et al.* 2002; Shover and Routhe 2005; Gibbs *et al.* 2010; Uhlmann 2011). Other studies have expanded the connections between crime and the environment by discussing impacts of the weather on crime patterns in different regions (Cohn 1990; Horrocks and Menclova 2011). Hotter or more extreme weather is thought to influence crime by leading to more antisocial behaviour and violent crime because of increased tensions (Agnew 2012), which in turn leads to more calls to service and greater impacts on policing resources (Brunsdon *et al.* 2009). It is only recently that the nexus between crime and climate change has begun to be considered, starting with the work of Pease (2009) estimating the 'carbon cost of crime and its implications'. Carbon emissions, in particular, as the main source of global warming and climatic change, present an important measure of the environmental impact of crime.

There are several connections to be made between crime prevention and climate change mitigation (to contribute towards sustainable development). Firstly, the UN recognizes that elements of public safety, security, rule of law and access to justice are crucial for international development and advancement, including worldwide targets such as the Sustainable Development Goals (now known as the Global Goals) (UN 2015; 2016). Armitage and Gamman (2009) asserted the need to reconcile security with sustainability and emphasize areas of potential synergy in relation to building new homes.

[3]In this case, our carbon footprint measures the six main greenhouse gases as defined by the Kyoto Protocol (United Nations 1998).

Both security and sustainability are in essence preventative actions taken in anticipation of saving larger costs in the future. Costs incurred by victims of crime or the criminal justice system are similar to the costs that result from climate change, as both are preventable and avoidable. They are also similarly pushed to the side-lines in times of economic hardship, with the exception of issues of national security, extremism or critical national infrastructure. Neither security or sustainability, however, is truly mainstreamed within governments, businesses or considered by individuals: Ekblom (2002) highlights the obstacles involved with transferring knowledge of crime prevention into mainstream policing practices, and Kok and de Coninck (2007) provide directions for mainstreaming climate change mitigation and adaptation as they note that so far 'this is hardly happening'. Both fields therefore agree that prompt action will save needless negative future impacts and costs: sea level rise and higher temperatures associated with climatic change or the economic and social burdens associated with crime.

Several studies suggest a further connection between crime and the environment; the potential benefits of viewing any type of crime as a form of pollution (Farrell and Roman 2006; Eck and Eck 2012; Nagin 2012). This argument states that responsibility for social control would be shifted from policing agencies to those who produce criminal opportunities that may generate crime, known as crime generators (Farrell and Roman 2006). These crime generators vary widely across public and private sectors and range from vehicle manufacturers, car owners, car park designers, architects and builders, product designers, credit card companies, internet service providers, financial institutions, alcohol manufacturers retailers and governments (both local and central). These actors reap benefits (profits), whilst society bears the cost of crime and its impacts. This is similar to polluters of carbon emissions where almost no cost is incurred by the originator, but the planet as a whole bears the impacts. Viewing crime as pollution could potentially ensure environmental controls in the same way that polluters pay for other types of pollution to the environment (such as chemicals or wastes released into the atmosphere or into waterways). This idea, however, has also been challenged, as others argue that environmental controls have failed in many areas and so to suggest that crime could be dealt with in this way may be optimistic at best (Lynch *et al.* 2015). As part of this challenge, Lynch *et al.* (2015) also indicate that the scientific definition of pollution cannot be applied to crime in the same way as other pollutants. They assert that for crime to be considered pollution, issues such as the background level of crime must be defined to ascertain when the level of crime exceeds its 'natural' state, something which has not yet been adequately addressed. However, this theory that the impacts of crime, in the form of carbon emissions, are effectively an act of polluting or environmental harm is re-enforced by this study by discussing these impacts over time and exploring the potential routes of reducing this pollution.

Studies have recently begun to explore the carbon footprint of general forms of offending, estimating the pollution which results from crime. In order to measure this carbon cost, the entire lifecycle of criminal offences needs to be considered. As well as focusing on the criminal event, the manufacture of goods or provision of services before and after the crime takes place also produces carbon emissions which need to be taken into account. As an example, thinking about an incidence of burglary, carbon emissions result from not only preventative measures (manufacture of window and door locks

and energy usage of burglar alarms or security lighting), but from the clean up or consequences of the event (replacement of broken windows and stolen items, provision of victim services and insurance claim services), and lastly the response to the event from the criminal justice system (police response including driving to victims households and carbon associated with police stations, probation services or courts and prison buildings). The sum of the emissions which arise as a result of these activities amounts to the carbon footprint attributable to the crime.

Pease (2009) produced an initial estimate of crime's cost to the environment in England and Wales, suggesting that criminal activity resulted in the production of over six million tonnes of carbon per year. This carbon footprint was estimated by translating the average monetary cost of offences into a carbon value using a carbon multiplier, which designates a volume of CO_2 that arises per pound spent within the economy. However, this initial estimate did not attempt to differentiate between the sources of carbon emissions throughout the lifecycle of each criminal event, allocating the same volume of carbon to policing costs, prison costs, insurance services and the replacement of stolen goods. This is clearly an oversimplification, with varying levels of emissions likely at all stages in the lifecycle of a crime, and the relative contribution of different sources of carbon emissions likely to vary substantially across crime types. For example, more serious offences with long prison sentences for the offender will result in higher carbon emissions associated with the management of prison buildings and more emissions from longer police investigations. In contrast, property offences are likely have a smaller footprint as emissions associated with the criminal justice system response will be much lower and the majority of emissions will be associated with the replacement of stolen items.

Skudder *et al.* (2016) addressed this limitation by applying more detailed carbon multipliers derived from Environmentally Extended Input-Output Analysis (EE-IOA). This more robust footprinting methodology allows detailed footprint estimates for each offence type to be produced from monetized cost of crime estimates, distinguishing different types of spending associated with particular crimes and allocating the most appropriate carbon multiplier to each spend category. Using this more robust methodology, crime in England and Wales in 2011 was shown to be responsible for the emission of approximately four million tCO_2e: equivalent to the direct annual energy use of around 900,000 UK homes (Skudder *et al.* 2016). The study also demonstrated that burglary offences resulted in the largest proportion of the total footprint (30 per cent), due to the large number of burglaries that occur and the comparatively high amount of carbon associated with the replacement of stolen or damaged goods. Emissions arising from the criminal justice system also accounted for a large proportion of total emissions (21 per cent of all offences; 49 per cent of police-recorded offences). Homicide was found to have a very high carbon footprint per offence (over 70 tonnes CO_2e) due to the emissions associated with a costly police investigation and long prison sentence served by the offender. However, due to the low rates of homicide, they only represented around 1 per cent of the total carbon footprint of crime.

Despite these studies exploring the carbon footprint associated with specific criminal offences, there is currently no evidence demonstrating how crime has changed over time and how this may have translated into carbon costs or reductions. We might reasonably expect that as certain types of crime have fallen, so have the carbon

emissions that result. However, multiple factors may offset the falling number of offences when the resultant carbon footprint is analysed. For example, if more carbon-intensive offences (those with a higher footprint per offence) have increased in number over time, the footprint may go up despite a fall in the total number of offences.

Although estimating the footprint in this way may show that the carbon footprint due to crime has dropped, we cannot definitively say whether or not *absolute* savings of carbon emissions have occurred. This is because we need to consider how money might be spent in the absence of crime. When an incident is prevented, money is saved as the police do not need to respond. However, this money may be re-spent on other types of police efforts, or by other parts of the Government. The emissions associated with the re-spend may offset the expected emissions reductions due to the reduction of crime. This is known as the rebound effect, and failure to take account of rebound effects when assessing carbon emissions reductions can lead to shortfalls in the achievement of climate policy goals (Sorrell 2007; Druckman *et al.* 2011). Since the scale of this re-spend and any potential offset of emissions remains uncertain, we focus on presenting the potential reductions in emissions and potential benefits in terms of environmental harm measures, rather than describing absolute savings.

Methodology

A 'carbon footprint' typically provides a measure of all greenhouse gas emissions caused by a person, product, organization or nation (Carbon Trust 2015). The units for carbon footprints are commonly either tonnes of carbon dioxide (tCO_2) or tonnes of carbon dioxide equivalent (tCO_2e). CO_2 is the primary greenhouse gas emitted through human activities, whereas CO_2e is a measure used to express the impact of multiple greenhouse gases (carbon dioxide, methane, nitrous oxide, etc.) in terms of the amount of CO_2 that would create the same amount of warming. To contextualize the environmental impact of everyday activities, one tonne of CO_2 is produced by driving around 3,250 miles in an average petrol car or by flying around 5,000 miles[4] on a long-haul flight (Defra 2015).

In this study, we estimate the environmental harm, in the form of a carbon footprint, associated with acquisitive and violent crime in England and Wales annually from 1995 to 2015,[5] focusing specifically on changes in the magnitude of the carbon footprint and the main components of this overall footprint. Following Skudder *et al.* (2016), we calculate offence-specific carbon footprint estimates that correctly attribute emissions across the lifecycle of each criminal event. The offence-specific carbon estimates are then multiplied by the estimated number of offences that occurred across the time series to generate a total carbon footprint for each offence category, for each year.

[4]Mileage estimated using Defra's (2015) conversion factors for company reporting by calculating how many miles of each transport type generated a footprint of one tonne CO_2e.

[5]All crime statistics are reported by financial years and are labelled as 2015/16 (for example). Years such as 2015/16 will be referred to as simply 2015, in this study.

We restrict our focus to acquisitive (e.g. burglary, theft and shoplifting) and violent (e.g. homicide, assault and robbery) crime because these offences have the most robust measurement across time and there is sufficient detail about the monetized costs associated with these offences to estimate a carbon footprint (Brand and Price 2000; Dubourg *et al.* 2005; Home Office 2011). We do not estimate carbon footprints for drug offences, fraud and online offences. Fraud and online-related offences are omitted because currently no established measures of these offences over time exist. Many of the carbon costs associated with online and drug offences are also complex to attribute as they may originate overseas (e.g. drug production), take place across national borders, rarely reach the attention of the criminal justice system or have no physical component. These exclusions mean that we are only able to provide a partial picture of the overall trend of the carbon footprint due to crime and may potentially be masking other carbon costly activities.

Data

Annual estimates of crime are derived from the 'Crime in England and Wales' statistical bulletins, published by the UK's ONS. We use both police-recorded crime[6] and CSEW data to mitigate the coverage problems associated with each individual measure. Police-recorded crime figures provide a picture of general trends in a wide range of offences and are also likely to be a robust estimate of those criminal activities which reached the attention of the criminal justice system. In contrast, whilst the CSEW is more narrow in scope, it is not affected by the known recording and reporting biases of police-recorded crime, affording us an insight into the carbon costs of those offences that are not reported. However, whilst we are confident that our estimates represent the best possible with current data sources, these estimates remain constrained by the well-known limitations of official crime figures.

We calculate carbon footprint estimates of two subsets of crime statistics (police-recorded and estimated unrecorded crime), as well as total crime. We distinguish crimes in this way to ensure the carbon costs of the criminal justice system are accurately reflected in our footprint estimates, with only those offences that are recorded by the police including emissions associated with policing, the courts and prisons.

To provide an estimate of crime that goes unrecorded, we use the total number of offences captured in the CSEW, minus the offences that are recorded by police in matching categories. For example, if one million burglaries are estimated to have occurred in 1995, as reported in the crime survey, but police recorded only 300,000 in the same year, the estimate of the number that went unrecorded is 700,000.[7] The CSEW data used spans the whole period between 1995 and 2015 (ONS 2016*b*), but pre-2001

[6]The police-recorded crime data used is a combination of two datasets. We use figures from the most recently released figures to cover the period 2002 to 2015 (ONS 2016*b*). Since the introduction of the National Crime Recording Standard (NCRS) in 2002, statistical bulletins on police-recorded crime do not include years prior to this because of the difference in counting rules, which may skew comparisons of these statistics. However, to enable analysis back to 1995, we use figures from an historic dataset (Home Office 2012) to estimate crime between the years of 1995 and 2002.

[7]By focussing on recorded and unrecorded crime, we acknowledge that we do not account for all police activity for those offences that are reported, but ultimately not recorded. This is a comparatively small number of offences (particularly in recent years) and is only a small fraction of the police effort expended on dealing with recorded offences. As such, there is a possibility that we are slightly underestimating the cost of unrecorded crime.

was only conducted every two years rather than annually. Therefore, the years 1996, 1998 and 2000 are omitted from the time series.

Carbon footprinting crime over time

To allocate a carbon footprint estimate to each specific offence type, we use the EE-IOA estimates developed by Skudder *et al.* (2016). This matches the Home Office economic and social costs of crime estimates (Brand and Price 2000; Dubourg *et al.* 2005; Home Office 2011) with the carbon multipliers produced by Defra (2015) to produce a carbon footprint estimate for each cost across the crime lifecycle for each included offence type. For example, the estimated health service cost of a homicide, £934, is multiplied by a human health services carbon multiplier (0.25 kg CO_2e/£) to produce a health service footprint of just over 234 kg CO_2e, and the estimated prison services cost, £138,839, is multiplied by a accommodation services carbon multiplier (0.45 kg CO_2e/£) to produce a prison services footprint of 62,208 kg CO_2e. Importantly, these estimates cover the full lifecycle of the criminal act and amount to the total carbon footprint of each offence considered. Emissions that occur after the crime event (e.g. years of prison sentences served by the offender) are attributed to the year in which the crime occurred and are not spread out amongst the years studied. The offence-specific carbon footprints for unrecorded crime are smaller, omitting all costs (and associated emissions) arising from the criminal justice system.

The offence-specific carbon footprint estimates are matched with the offence categories in each crime dataset (Table 1). The CSEW dataset has fewer categories of crime and does not include measures of homicide, sexual offences or commercial offences (shoplifting, commercial robbery or commercial criminal damage).[8]

To produce the annual carbon footprint estimates, the number of offences committed each year in each crime category is multiplied by the equivalent offence-specific carbon footprint. For example, the carbon footprint of burglary (in a dwelling) is 1.1 tCO_2e for recorded offences and 0.7 tCO_2e for unrecorded offences (when the criminal justice system emissions are excluded). In 1995, the number of police-recorded burglaries was 640,000, which produces an estimated 0.7 million tCO_2e (1.1 * 640,000). The number of unrecorded burglary offences in 1995 was 1.75 million, producing 1.2 million tCO_2e (0.7 * 1,750,000). All burglary in a dwelling for the year 1995 therefore emits around 1.9 million tCO_2e (0.7 million + 1.2 million tCO_2e).

As well as calculating the carbon footprint by offence type, we also detail the source of emissions across the time series. For example, the 1.1 tCO_2e associated with a recorded incidence of burglary arises from several sources of spending: 100 kg CO_2e from defensive expenditure (security and insurance), 450 kg from replacing stolen property, 180 kg from policing and 170 kg from prison services amongst others (Skudder *et al.* 2016). How the proportion of emissions from these sources has changed over time with the rise and fall of the number of offences is also presented within our results in order to highlight the sources of emissions where savings or increases of carbon have occurred.

[8]Some information, on sexual offences, for example, is available in the self-completion module of the CSEW; however, these data are not available in all years of the time series.

TABLE 1 *Offence category matching process*

Offences with a carbon footprint estimate (from Skudder *et al.* 2016)	Matched offence categories		
	Police-recorded offences, 1995–2002	Police-recorded offences, 2002–15	Crime survey offences, 1995–2015
Homicide	Homicide	Homicide	
Serious wounding	Violence against the person (VAP)—with injury	Violence with injury	Wounding
Other wounding	VAP—without injury, less serious wounding, Actual Bodily Harm (ABH) and other injury	Violence without injury, ABH, assault with injury and less serious wounding	Assault with minor injury
Sexual offences	Sexual offences	Sexual offences	
Common assault	Common assault, racially or religiously aggravated common assault and assault on a constable	Assault without injury, racially or religiously aggravated assault and assault without injury on a constable	Violence without injury
Robbery	Robbery of personal property (known as 'Robbery' 1997 and before)	Robbery of personal property	Robbery
Burglary in a dwelling	Domestic burglary	Domestic burglary	Domestic burglary
Theft—not vehicle	Other theft offences	Total other theft offences, bicycle thefts and theft from the person	Other household theft, bicycle theft, theft from the person, other theft of personal property
Theft of vehicle	Theft or unauthorized taking of motor vehicle	Theft or unauthorized taking of a motor vehicle, aggravated vehicle taking	Theft of vehicles
Theft from vehicle	Theft from a vehicle	Theft from a vehicle	Theft from vehicles
Attempted vehicle theft	Interfering with a motor vehicle	Vehicle interference	Attempts of and from vehicles
Criminal damage	Criminal damage	Criminal damage	Criminal damage
Burglary—not in a dwelling	Other burglary	Burglary in a building other than a dwelling and non-domestic burglary	
Commercial—robbery	Robbery of business property	Robbery of business property	
Shoplifting	Theft from a shop	Shoplifting	
Commercial—criminal damage	Criminal damage to a building other than a dwelling	Criminal damage to a building other than a dwelling	

Results

Figure 1 shows how the overall (combined total recorded and unrecorded) carbon footprint of acquisitive and violent crime changes over time, between 1995 and 2015. The carbon emissions resulted from around 5 million police-recorded and 15 million unrecorded offences in 1995, which dropped to around 3.5 million recorded and 4 million unrecorded offences in 2015 (a crime drop of 63 per cent (30 per cent for recorded crime and 74 per cent for unrecorded crime).

The total carbon footprint of acquisitive and violent crime dropped by 62 per cent between 1995 and 2015. This year-on-year decline accumulates to a total environmental harm reduction of over 54 million tCO_2e over the 20-year period, representing a substantial decline in carbon due to the associated drops in these types of

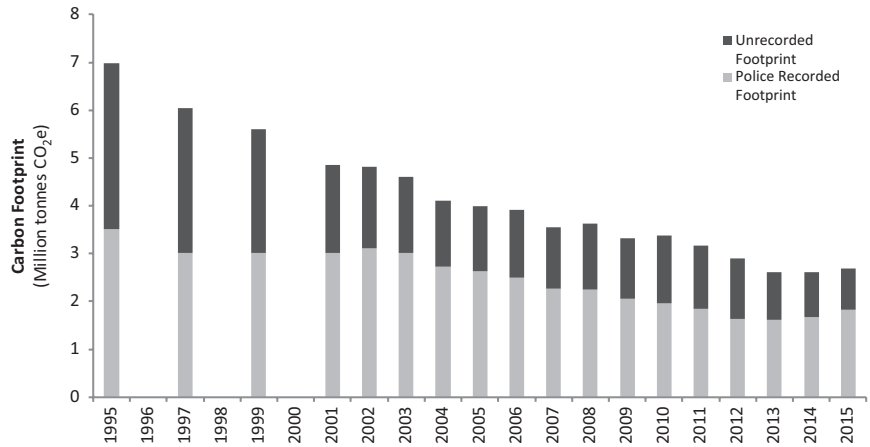

FIG. 1 Carbon footprint of total crime (police recorded and unrecorded) between 1995 and 2015.

offences. In 1995, the footprint was estimated at around 7 million tCO_2e (3.5 million tCO_2e each attributed to both recorded and unrecorded offences), declining to 5 million tCO_2e in 2001. The footprint fell further to a low of 2.6 million tCO_2e in 2013 with a slight increase to 2.7 million tCO_2e in the most recent year (2015). This, however, represents over four million fewer tCO_2e resulting from acquisitive and violent crime per year than in 1995. As the number of unrecorded offences that occurred fell more sharply than the number of police-recorded offences, emissions from police-recorded offences make up a larger proportion of the overall carbon footprint in more recent years (over 60 per cent in 2014, compared to 50 per cent in 1995).

The number of police-recorded offences fell from 5 million to 3.5 million between 1995 and 2015, a decline of 30 per cent. But the carbon footprint from these offences fell by 48 per cent over the same period, from 3.5 million tCO_2e to 1.8 million tCO_2e. This means that by 2015, 1.7 million tCO_2e less was emitted per year. This accounted for a total drop in carbon of over 20 million tCO_2e. The number of unrecorded offences fell by 74 per cent between 1995 and 2015, a substantially larger drop than police-recorded figures. Similarly, the estimated carbon footprint arising from the unrecorded offences declined by 75 per cent from approximately 3.5 million tCO_2e in 1995 to 860,000 tCO_2e in 2015, a reduction of over 33 million tCO_2e. As the carbon footprint arising from unrecorded offences does not include emissions from the criminal justice system, these crimes produce a smaller footprint per offence than police-recorded crime.

To contrast this environmental harm estimate to a measure of social harm, the CSS for England and Wales showed a decline in the severity of recorded crime of 29 per cent between 2002 and 2015 (although the most recent year saw a rise of 10 per cent) (ONS 2016*a*). The carbon footprint over this period dropped from 4.81 million tonnes CO_2e to 2.68 million tonnes CO_2e, a drop of 44 per cent (with a rise of 2 per cent in the most recent year). The failure to consider environmental harms of crime in existing harm scores may, therefore, mean we are underestimating the harm reduction resulting from the general crime drop over the last two decades, with a substantial reduction seen in the environmental contribution.

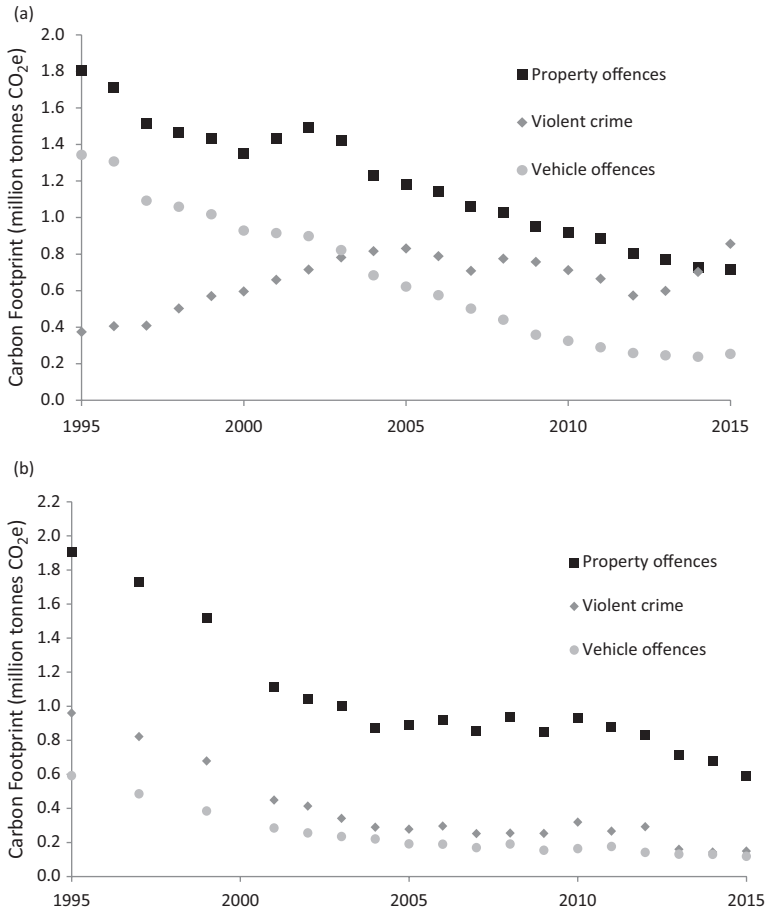

FIG. 2. (a) The carbon footprint of police-recoded crime, split by offence type. (b) The carbon footprint of unrecorded crime, split by offence type.

To better understand the reasons for the steep decline in carbon emissions across the time series, we compared the carbon footprints split by the types of offences within Figure 2a (police-recorded crime) and Figure 2b (unrecorded crime).

The large proportion of carbon emissions from property offences[9] is notable in both Figure 2a and 2b. As the number of offences declined, the carbon footprint of police-recorded property offences (Figure 2a) has more than halved from nearly 1.9 million tCO_2e in 1995 to 770,000 tCO_2e in 2015. Burglary (combining both in a dwelling and not in dwelling), in particular, produced the most emissions of any offence at 1.5 million tCO_2e in 1995 and 490,000 tCO_2e in 2015. Figure 2a also shows a clear reduction in the carbon arising from police-recorded vehicle offences. In 1995, vehicle offences accounted for 1.3 million tCO_2e (1.1 million tCO_2e of which was from vehicle theft), dropping to 620,000 tCO_2e by 2005 to just 250,000 tCO_2e in 2015. In contrast, the

[9]Including burglary, shoplifting and criminal damage.

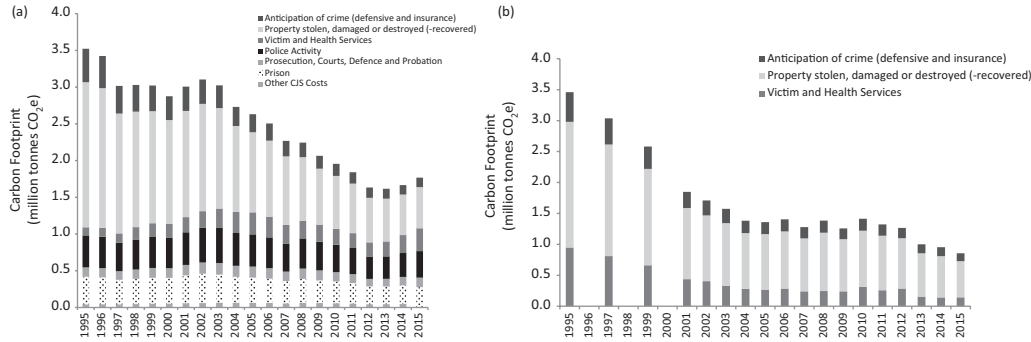

FIG. 3. (a) The carbon footprint of police-recoded crime, split by expenditure category source of emissions. (b) The carbon footprint of unrecorded crime, split by expenditure category source of emissions.

footprint attributed to violent crime[10] steadily increased over this period from 370,000 tCO_2e, peaking at 800,000 tCO_2e by 2015. This increase is largely from the 'other wounding' offences which grew from 140,000 tCO_2e to over 430,000 tCO_2e over the period.

Figure 3a and 3b show the same carbon footprint of both police-recorded and unrecorded crime, but this time split by the *source* of emissions throughout the lifecycle of the offences. This includes emissions from spending in anticipation of crime (defensive measures such as security and insurance), spending as a consequence of the crime having taken place (replacing stolen property, use of the health service and victim services) and also the criminal justice system costs (policing, prisons, probation, etc.). Unrecorded offences do not result in emissions from the criminal justice system, and so these are excluded from Figure 3b.

Carbon emissions from the cost of replacing stolen, damaged or destroyed property are shown as the largest proportion of both recorded and unrecorded violent and acquisitive crime (around two million tCO_2e for each source of crime figures in 1995). These emissions, however, also showed the largest decline over the 20-year period (dropping to 560,000 tCO_2e for recorded crime and 580,000 for unrecorded crime).

For police-recorded crime, the footprint for anticipation of crime spending (insurance or defensive expenditure) has also declined noticeably over the period falling from around 500,000 tCO_2e in 1995 to 130,000 tCO_2e in 2015. Conversely, the emissions arising from victim and health services rose over the period (an increase of 130,000 tCO_2e per year). This is most likely due to the increased number of violent offences that has occurred in recent years.

For unrecorded crime, the total footprint rapidly decreased over time from around 3.5 million tCO_2e in 1995 to 860,000 tCO_2e by 2015. The proportions of the three sources of emissions, however, have remained relatively stable over the 20-year period. Emissions from replacing stolen or damaged property accounts for around 60 per cent of the footprint in the early years of the series, rising to 70 per cent in later years. Emissions from anticipation of crime activities decreased as a share of total emissions from 27 per cent to below 15 per cent and the victim and health services emissions remained at around 15 per cent throughout.

[10]Including homicide, wounding, sexual offences, robbery and assault.

Discussion

The carbon footprint associated with acquisitive and violent crime is large (Skudder *et al.* 2016), but in recent years, the falling number of these offences has resulted in fall from around seven million tCO_2e for the year 1995, to below three million tCO_2e for 2015. This fall results in a total reduction of over 54 million tCO_2e over the 20-year period studied—broadly equivalent to around 10 per cent of the current UK's annual carbon emissions (DECC 2015).

The large reductions for burglary (both recorded and unrecorded) and vehicle offences (predominantly recorded offences), coupled with the high carbon cost of these offences, are largely responsible for the substantial reductions of carbon emissions over this period, more than offsetting the rise of emissions associated with the increasing number of violent crimes. For recorded offences, the decline in the carbon footprint is more prominent than the fall in the number of offences (48 per cent carbon drop compared to a crime drop of only 30 per cent). This clearly demonstrates that there is not a straightforward relationship between the number of offences and the resulting carbon footprint. As the different types of crime rise or fall, the carbon footprint is altered over time, an environmental impact that is not currently considered by existing estimates of crime volume, harm or impact. Targeted prevention at specific carbon-intensive offences in the future may have a disproportionate effect on the overall environmental impact of crime.

Carbon emissions arise from various sources throughout the crime lifecycle, including actions in anticipation of crime, replacing stolen or damaged items, policing, incarceration and health service costs. For both recorded and unrecorded offences, a large proportion of the footprint arises from replacing stolen or damaged items (around 33 per cent of recorded crime and over 60 per cent of unrecorded crime). The carbon arising from activities in anticipation of crime (such as security, crime prevention measures or insurance) is relatively low compared to impacts arising after the crime has occurred (replacing property, health services and criminal justice system activities). Emissions from actions in anticipation of crime have also fallen sharply over time for both recorded and unrecorded offences.

Compared to the social and economic impacts of crime, the environmental harms associated with crime may seem marginal; but to overlook these impacts risks crime prevention strategies being unsustainable in the future. The three 'pillars' of sustainability—social development, economic development and environmental protection—must be equally acknowledged as part of decision making (UN 2005). There is also a risk of carbon reduction targets—such as the Climate Change Act (2008) within the United Kingdom—being missed if carbon emissions associated with crime and the criminal justice system are not reduced wherever possible. Although the continued drop in carbon over the last two decades is an encouraging trend, more could be done to reduce the environmental impact of acquisitive and violent crime and further decrease the carbon footprint. A continued focus on specific offences (burglary and vehicle crime) and particular sources of emissions (the need to replace stolen property) may further decrease these environmental impacts.

Measuring the environmental harm of crime adds to growing body of work considering the true harms resulting from criminal offences. This is important because simply measuring the volumes of crimes that occur assumes that all crimes are created equal, when clearly different offences have varying impacts on victims, society, the economy

and the environment. Only by considering all of the potential harm caused by crime can crime prevention policy be truly sustainable. We also learn from this approach that as the crime profile has changed over time, so have the environmental harms produced as a result. As offences have differing carbon footprints, the environmental harm has actually reduced more than the number of offences over time and acknowledgement of these potential environmental benefits of crime prevention could help further reduce these emissions in the future.

Our use of the economic and social cost of crime estimates differs from other measures of the harm caused by crime, making it difficult to combine this with other harm indices. The CSS (ONS 2016*a*) and Cambridge CHI (Sherman *et al.* 2016), for example, weight crime types by sentence days served. Although this is a straightforward approach to produce a weighted index of harm, to estimate the environmental impacts of crime using only the sentencing guidance would omit several important elements of criminal offences where carbon emissions arise, consequently leading to an underestimate of the environmental harm caused. Sentence days served is just one area where the environmental impact of criminal activity is felt, with the length of sentence given to offenders directly impacting on the carbon footprint of each individual offence (those with longer prison sentences clearly being associated with a larger footprint than community served sentences for example). However, this does not consider other sources of carbon including those resulting from policing activity, criminal justice service operation, victim experiences and unrecorded crime categories (Ignatans and Pease 2016). As a result, we did not attempt to weight the environmental impact of crime by any existing harm index, but instead present our comprehensive footprint estimates in their entirety.

Our study demonstrates that all types of crime have environmental impacts in the form of carbon emissions, not just large-scale environmental disasters. The emissions that arise from crime are a form of pollution, which contributes directly to the problem of climate change. There is also a potential negative feedback loop between the emissions associated with crime and global warming, with the emissions to the atmosphere as a result of crime leading to increased temperatures, and these warmer temperatures in turn leading to more crime occurring from rising tensions (Agnew 2012). An opportunity may be seized, therefore, to reduce these long-term adverse indirect effects of crime. This can be achieved either by devising policies to target carbon-intensive offences, or at the very least ensuring that the carbon impacts of crime are taken into account within policy and decision making. Cutting crime may therefore be seen to provide a sustainable solution that provides not only social and economic benefits, but also environmental benefits.

This study is not without its limitations. Most notably, we have assumed that the carbon footprint of each offence has not changed over time. This assumption of course is a simplification as energy efficiency improvements and the move towards renewable energy sources have meant a fall of carbon emissions per unit of expenditure over recent years (Committee on Climate Change 2013). As such, it is likely that our results underestimate the carbon cost of acquisitive and violent crime in earlier years, and hence the total carbon reductions. Future research could explore this impact in more detail by utilizing varying carbon multipliers across the time series.

The carbon footprint estimates also only include emissions that arise as a result of the offences occurring, so we cannot definitively say whether the potential reductions

have resulted in absolute savings or not. A true savings calculation would need to take into account any emissions associated with how public and private money currently spent in association with criminal offences would be spent in the absence of crime (Skudder *et al.* 2016). For example, if the number of violent crimes falls, the money saved on treating victims in hospital or on keeping offenders in prisons does not necessarily result in a saving in terms of carbon emissions. This money may simply be re-invested in other government services that produce similar (or higher) carbon emissions. Thus, we have focussed on presenting the potential reductions in emissions, not absolute savings, as these depend on how money spent in the absence of crime is used.

Finally, not all types of crime are included within the study, fraud and online crimes being notably absent. It is increasingly becoming clear that patterns of criminal activity are changing, with a growing number of offences being committed in virtual spaces online. These types of offences may have inherently fewer carbon emissions associated with them as no physical items need replacing and the offences are much less likely to come to the attention of police. But although it has been estimated that around 5.8 million fraud and computer misuse offences were experienced in 2015, with around half of the fraud offences being cyber-related (ONS 2016*b*), the level of under-reporting is less clear. Under-reporting of cyber crime happens for a number of reasons including victims potentially not perceiving what has happened as a crime, not knowing where or how to report it, or believing that the police cannot do anything in response to the incident (McGuire and Dowling 2013). Any carbon footprint associated with cyber offences are also inherently different from other types of crime as they have no physical location, the harm to victims is usually reimbursed by banks and other financial institutions (meaning there is greater involvement of these institutions to prevent these kinds of crime) and the policing of these offences is vastly different and utilizes different types of technology. For these reasons, estimating the carbon footprint of online offences is not possible using the current methodology and as a result only a partial picture of the true scale of the carbon footprint of crime has been presented.

The results of this study tell a previously untold story that may enable policy makers to take the environmental impacts of crime into account, and potentially seize win–win opportunities that further reduce the carbon emissions due to crime, alongside attempts to prevent crime itself. Of course, when setting policy, we acknowledge that the severity of criminal offences will, generally, take priority over efforts to reduce carbon emissions. Also, it is unrealistic to expect police or criminals to consider their carbon footprints. However, crime prevention policies that acknowledge these environmental impacts and the potential benefits in terms of carbon emissions reductions of crime prevention or reduction, as observed over the last few decades, are now possible.

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References

Aebi, M. F. and Linde, A. (2010), 'Is There a Crime Drop in Western Europe?', *European Journal on Criminal Policy and Research*, 16: 251–77.

Agnew, R. (2012), 'Dire Forecast: A Theoretical Model of the Impact of Climate Change on Crime', *Theoretical Criminology*, 16: 21–42.

Armitage, R. and Gamman, L. (2009), 'Sustainability via Security: A New Look. Built Environment', 35: 297–301.

Brand, S. and Price, R. (2000), *The Economic and Social Costs of Crime*. Home Office Research Study No. 217, Home Office.

Brunsdon, C., Corcoran, J., Higgs, G. and Ware, A. (2009), 'The Influence of Weather on Local Geographical Patterns of Police Calls for Service', *Environment and Planning B: Planning and Design*, 36: 906–26.

Bunge, V. P., Johnson, H. and Balde, T. (2005), *Exploring Crime Patterns in Canada*. Crime and Justice Research Paper Series, Canadian Centre for Justice Statistics and Time Series Research and Analysis Centre.

Burrows, J., Tarling, R., Mackie, A., Lewis, R. and Taylor, G. (2000), *Review of Police Forces' Crime-Recording Practices*. Home Office Research Study No. 204, Home Office.

Carbon Trust (2015), 'What Is the Carbon Footprint of a Product or Service?', Carbon Trust, available online at http://www.carbontrust.com/client-services/footprinting/footprint-measurement/carbon-footprint-software/ (accessed February 2017).

Chunn, D., Boyd, S. and Menzies, R. (2002), 'We All Live in Bhopal: Criminology Discovers Environmental Crime', in S. Boyd, D. Chunn and R. Menzies, eds, *Toxic Criminology: Environment, Law and the State in Canada*. Fernwood Publishing.

Climate Change Act (2008), Elizabeth II, Chapter 27, London, UK.

Cohn, E. G. (1990), 'Weather and Crime', *British Journal of Criminology*, 30: 51–64.

Committee on Climate Change (2013), 'Reducing the UK's Carbon Footprint and Managing Competitiveness Risk', available online at https://www.theccc.org.uk/wp-content/uploads/2013/04/CF-C-Summary-Rep-web1.pdf (accessed February 2017).

—— (2016), 'Climate Change Act', available online at https://www.theccc.org.uk/tackling-climate-change/the-legal-landscape/climate-change-act-and-uk-regulations/ (accessed February 2017).

DECC (2015), '2013 UK Greenhouse Gas Emissions, Final Figures', Department of Energy and Climate Change, available online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/407432/20150203_2013_Final_Emissions_statistics.pdf (accessed February 2017).

Defra (2010), 'Economic Growth and the Environment', available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69195/pb13390-economic-growth-100305.pdf (accessed February 2017).

—— (2015), 'Government Conversion Factors for Company Reporting', available online at http://www.ukconversionfactorscarbonsmart.co.uk/ (accessed February 2017).

Druckman, A., Chitnis, M., Sorrell, S. and Jackson, T. (2011), 'Missing Carbon Reductions? Exploring Rebound and Backfire Effects in UK Households', *Energy Policy*, 39: 3572–81.

Dry, T. (2014), 'Crime Is Not Falling, It's Moved Online, Says Police Chief', *The Telegraph*, available online at http://www.telegraph.co.uk/technology/internet-security/10779356/Crime-is-not-falling-its-moved-online-says-police-chief.html (accessed February 2017).

Dubourg, R., Hamed, J. and Thorns, J. (2005), *The Economic and Social Costs of Crime against Individuals and Households 2003/2004*. Home Office.

Eck, J. E. and Eck, E. B. (2012), 'Crime Place and Pollution', *Criminology & Public Policy*, 11: 281–316.

Edwards, S. M., Edwards, T. D. and Fields, C. B. (eds) (2013), *Environmental Crime and Criminality: Theoretical and Practical Issues*. Routledge.

Ekblom, P. (2002), 'From the Source to the Mainstream Is Uphill: The Challenge of Transferring Knowledge of Crime Prevention Through Replication, Innovation and Anticipation', in N. Tilley, ed., *Analysis for Crime Prevention, Crime Prevention Studies*, Vol. XIII, 131–203. Willan Publishing.

Eterno, J. A. and Silverman, E. B. (2012), *The Crime Numbers Game: Management by Manipulation*. CRC Press.

Farrell, G. (2013), 'Five Tests for a Theory of the Crime Drop', *Crime Science*, 2: 1–8.

Farrell, G. and Roman, J. (2006), 'Crime as Pollution: Proposal for Market-Based Incentives to Reduce Crime Externalities', *Crime Reduction and the Law*, 8: 14–33.

Farrell, G., Tilley, N. and Tseloni, A. (2014), Why the Crime Drop?', *Crime and Justice*, 43: 421–90.

FBI (2016), 'Uniform Crime Reports as Prepared by the National Archive of Criminal Justice Data', available online at http://www.ucrdatatool.gov/ (accessed February 2017).

Flatley, J. and Bradley, J. (2013), 'Analysis of Variation in Crime Trends: A Study of Trends in 'Comparable Crime' Categories Between the Crime Survey for England and Wales and the Police Recorded Crime Series Between 1981 and 2011/12', Office of National Statistics, available online at https://www.ons.gov.uk/ons/guide-method/method-quality/specific/crime-statistics-methodology/methodological-note–analysis-of-variation-in-crime-trends.pdf (accessed February 2017).

Gibbs, C., Gore, M. L., McGarrell, E. F. and Rivers, L. (2010), 'Introducing Conservation Criminology Towards Interdisciplinary Scholarship on Environmental Crimes and Risks', *British Journal of Criminology*, 50: 124–44.

Hall, M. (2011), 'Environmental Victims: Challenges for Criminology and Victimology in the 21st Century', *Journal of Criminal Justice and Security*, 13: 371–91.

Her Majesty's Inspectorate of Constabulary (HMIC) (2014), 'Crime Recording: Making the Victim Count', HMIC, available online at http://www.justiceinspectorates.gov.uk/hmic/publications/crime-recording-making-the-victim-count/ (accessed February 2017).

Home Office (2011), 'Revisions Made to the Multipliers and Unit Costs of Crime Used in the Integrated Offender Management Value for Money Toolkit', available online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/97813/IOM-phase2-costs-multipliers.pdf (accessed February 2017).

—— (2012), 'Offences Recorded by the Police in England and Wales: By Offence and Police Force Area, 1990 to 2011–12', available online at https://www.gov.uk/government/publications/offences-recorded-by-the-police-in-england-and-wales-by-offence-and-police-force-area-1990-to-2011-12 (accessed February 2017).

Hope, T. and Norris, P. A. (2013), 'Heterogeneity in the Frequency Distribution of Crime Victimization', *Journal of Quantitative Criminology*, 29: 543–78.

Horrocks, J. and Menclova, A. K. (2011), 'The Effects of Weather on Crime', *New Zealand Economic Papers*, 45: 231–54.

Ignatans, D. and Pease, K. (2016), 'Taking Crime Seriously: Playing the Weighting Game', *Policing*, 10: 184–93.

IPCC (2014), 'Summary for Policymakers', in Core Writing Team, R. K. Pachauri and L. A. Meyer, eds, *Climate Change 2014 Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. IPCC.

Kok, M. T. J. and de Coninck, H. C. (2007), 'Widening the Scope of Policies to Address Climate Change: Directions for Mainstreaming', *Environmental Science & Policy*, 10: 587–99.

Lynch, M. J., Barrett, K. L., Stretesky, P. B., Long, M. A., Jarrell, M. L. and Ozymy, J. (2015), 'Crime as Pollution? Theoretical, Definitional and Policy Concerns with Conceptualizing Crime as Pollution', *American Journal of Criminal Justice*, 40: 843–60.

McGuire, M. and Dowling, S. (2013), 'Cyber Crime: A Review of the Evidence. Research Report 75. Chapter 4: Improving the Cyber Crime Evidence Base', Home Office, available online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/246756/horr75-chap4.pdf (accessed February 2017).

Nagin, D. S. (2012), 'Crime as Pollution', *Criminology & Public Policy*, 11: 275–8.

ONS (2014), *Discussion Paper on the Coverage of Crime Statistics*. Office for National Statistics.

—— (2016*a*), 'Research Outputs: Developing a Crime Severity Score for England and Wales Using Data on Crimes Recorded by the Police', available online at https://www.ons.gov.uk/peoplepopulationandcommunity/crimeandjustice/articles/researchoutputsdevelopingacrimeseverityscoreforenglandandwalesusingdataoncrimesrecordedbythepolice/2016-11-29 (accessed February 2017).

—— (2016*b*), 'Crime in England and Wales, Year Ending March 2016', available online at https://www.ons.gov.uk/peoplepopulationandcommunity/crimeandjustice/bulletins/crimeinenglandandwales/yearendingmar2016 (accessed February 2017).

Pease, K. (2009), *The Carbon Cost of Crime and Its Implications*. ACPO Secured by Design.

Popovski, V. and Mundy, K. G. (2012), 'Defining Climate-Change Victims', *Sustainability Science*, 7: 5–16.

Ratcliffe, J. H. (2015), 'Towards an Index for Harm-Focussed Policing', *Policing*, 9: 164–83.

Sherman, L., Neyroud, P. W. and Neyroud, E. (2016), 'The Cambridge Crime Harm Index: Measuring Total Harm from Crime Based on Sentencing Guidelines', *Policing*, 10: 171–83.

Shover, N. and Routhe, A. S. (2005), 'Environmental Crime', *Crime and Justice*, 32: 321–71.

Skudder, H., Druckman, A., Cole, J., McInnes, A., Brunton-Smith, I. and Ansaloni, G. (2016), 'Addressing the Carbon-Crime Blind Spot: A Carbon Footprint Approach', *Journal of Industrial Ecology*. doi: 10.1111/jiec.12457. http://onlinelibrary.wiley.com/doi/10.1111/jiec.12457/abstract (accessed February 2017).

Sorrell, S. (2007), *The Rebound Effect: An Assessment of the Evidence for Economy-Wide Energy Savings from Improved Energy Efficiency*. UKERC.

Tcherni, M., Davies, A., Lopes, G. and Lizotte, A. (2015), The Dark Figure of Online Property Crime: Is Cyberspace Hiding a Crime Wave?', *Justice Quarterly*, 33: 890–911.

Tseloni, A., Mailley, J., Farrell, G. and Tilley, N. (2010), 'Exploring the International Decline in Crime Rates', *European Journal of Criminology*, 7: 375–94.

Uhlmann, D. M. (2011), 'After the Spill Is Gone: The Gulf of Mexico, Environmental Crime, and the Criminal Law', *Michigan Law Review*, 109: 1413–61.

UK Statistics Authority (2014), 'Assessment of Compliance for the Code for Practice or Official Statistics: Statistics on Crime in England and Wales (produced by the Office for National Statistics)', available online at http://www.statisticsauthority.gov.uk/assessment/assessment/assessment-reports/

assessment-report-268---statistics-on-crime-in-england-and-wales.pdf (accessed February 2017).

UNFCC (2015), 'Adoption of the Paris Agreement', United Nations Framework Convention on Climate Change, Available online at https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf (accessed February 2017).

United Nations (1998), *Kyoto Protocol to the United Nations Framework Convention on Climate Change*. UN.

—— (UN) (2005), 2005 World Summit Outcome. United Nations, available online at http://www.who.int/hiv/universalaccess2010/worldsummit.pdf (accessed February 2017).

—— (2015), *Thirteenth United Nations Congress on Crime Prevention and Criminal Justice: Doha 12–19 April 2015*. United Nations.

—— (2016), 'The Global Goals for Sustainable Development', United Nations, available online at http://www.globalgoals.org/ (accessed February 2017).

Van Dijk, J. A., Van Kesteren, J. and Smit, P. (2007), *Criminal Victimisation in International Perspective*. Boom Juridische Uitgevers.

Van Dijk, J., Tseloni, A. and Farrell, G. (eds) (2012), *The International Crime Drop: New Directions in Research*. Springer.

Walby, S., Towers, J. and Francis, B. (2016), 'Is Violent Crime Increasing or Decreasing? A New Methodology to Measure Repeat Attacks Making Visible the Significance of Gender and Domestic Relations, *British Journal of Criminology*, 56: 1203–34.