Disruption and Adaptability: Unlocking Insights into Low Carbon Travel

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ABSTRACT

This paper identifies disruption as a potential powerful lens through which to understand and, in turn, influence travel behaviour. Our conceptualisation of disruption is broad and includes natural (i.e. volcanic ash clouds, extreme weather) or anthropogenic (i.e. strikes, terrorist attacks, life-events and policy shifts) situations and events which can have a variety of origins and take on numerous time, social and spatial scales. Based on research so far undertaken within a three-year qualitative and quantitative study of disruptive events and travel practices in the UK, this paper offers a way of bringing these diverse events together under a common conceptual framework of the relationship between the origins of disruptive events, the nature of these events and their impacts and outcomes. Five dimensions of disruption are identified which flesh out the mechanisms behind the triggers, outcomes and impacts and highlight the far-reaching implications that disruptive events can have on the way sectors and even society develops. Using a review of the literature and data collected from case studies of flooding and fuel shortages, a broad typology of responses from travellers is identified which goes well beyond those typically measured and modelled in standard evaluations of travel behaviour. In addition to developing our theoretical understanding of the relationship between disruptions, agents and social structures, the paper seeks to challenge current thinking about data needs and incremental policy design to achieve lower carbon transport.

Keywords: disruption, travel behaviour, churn

1. Introduction

This paper introduces the potential to use disruptive events as a tool to investigate and understand travel behaviour. Ultimately, it is contested, that these insights will lead to the design of new types of policy solution (bringing together organisations and individuals) to reduce the impacts of rising travel demand. The paper begins in this section within an introduction to the theories surrounding the power of disruptive events as an analytical lens before it sets out a framework which can be used to classify different sorts of disruptive event. In the medium term this will allow a more structured analysis of the impacts of different types of event. It then describes the data collection processes for two case studies of major disruptive events (a flood and a fuel shortage) from 2012. The data was captured during and/or immediately after the events and such data is rare. Initial analysis of both events is then presented which leads us to a broader categorisation of behavioural responses than is typically allowed for in most data collection and modelling exercises. The final section brings forward some implications for future work.

Academic research supports the claim that disruptions can lead to significant societal and technical developments (Graham, 2011; Graham and Thrift, 2007; Petroski, 2006). This means that the study of disruptions has high societal relevance and might provide major theoretical contributions. Indeed, our claim is that structure-agent theory (Berger and Luckmann, 1966; Boissevain, 1974; Bourdieu, 1977; Coleman, 1990; Giddens, 1984) can be potentially reviewed under the light of disruption theory.

Structure-agent theory has provided a valuable advancement by means of arguing that structures have power, but not unlimited power, to influence individuals. Individuals have, conversely, power, but not unlimited power, to self-determination and to influence the structures which constraint their behaviour. However, structure-agent theory has not yet fully acknowledged how important disruptions are in terms of facilitating the development of structures, in terms of facilitating changes in the practices and understandings held by agents, and in terms of changing the relationships between agents and structures. In an era as ours when risk and uncertainty play such an important role (Adams, 1995; Beck, 1992 [1986]; Giddens, 1999), it seems to us quite important to develop further contributions on the role of disruptions on the way society and technology move forward. This paper specifically aims at providing small steps in this theoretical vein adopting a focus on the transport sector. The idea that it is possible to learn important lessons from disruptions is applicable to the transport sector as well (Marsden and Docherty, 2013).

The concept of mobility disruption is broad and addresses a virtually infinite number of possible situations and events. Indeed, mobility disruptions can be associated with volcanic ash clouds interrupting air travelling (Birtchnell and Büscher, 2011; Guiver and Jain, 2011), with domestic fuel crises (Chatterjee and Lyons, 2002) and with reallocation of road space (Cairns et al., 2002). The list extends to include earthquakes, floods, nuclear accidents, major traffic accidents, and military attacks. The list comprises a series of large area or system wide events which affect significant numbers of people. We also stress the importance of seeing the range of events as a continuum from a global issue to a highly localised issue. At this stage in the research we therefore also incorporate events that happen at an individual or household scale such as giving up or taking up a car, moving house or changing job.

There is a growing evidence base of the importance of the significant and on-going changes in personal, household and familial circumstances, which provide an opportunity to defrost, break or consciously re-evaluate habits (Schwanen et al., 2012; Verplanken et al., 2008). Goodwin (2008) refers to this as churn, the natural re-evaluation of travel choices as personal circumstances change; Thompson et al. (2011) refer to these as 'moments of change' and Beige and Axhausen (2012) as 'turning points'. It is important to consider the continuum as one of the responses to major disruptive events is to take advantage of 'moments of change' that occur in any case to adapt (or to determine that an adaptive response is not necessary).

The context is typically stable from a policy-makers' perspective. From an individual's perspective there may be contextual information such as a company being in financial difficulties or family members being ill which influence the context for future decisions. The triggers for change are likely to vary substantially across each individual or household but could include the end of a rental period for a house, the loss of a job or a more voluntary driven change such as a decision that a move or new job is simply desirable.

The previous examples suggest that mobility disruptions can be caused by tree different types of triggers. The first is natural events (e.g. a flood, a volcanic eruption). The second is human activities and policies which unexpectedly induce a disruption (e.g. an unpopular policy which leads to a strike in the transport sector). The third is actions and policies promoted by individuals which either are motivated by a desire to induce or by necessity will induce a change (e.g. a government policy such as a congestion charge or tax break on business travel by car, the decision to host a major sporting event such as the Olympics or a terrorist attack). Individual level changes perhaps fall across all three categories. Aging and health issues are typically seen as 'external' factors and certainly have some degree of inevitability. Decisions to change home or employment can be self directed or result from the actions of others (e.g. closing social housing or making employees redundant). Anthropogenic disruptions therefore differ in the extent to which causing a disruption is an unintended or perhaps an even highly undesired result, and the extent to which causing a disruption is actually the objective. This distinction is important as we hypothesise that it affects how any such event is perceived and the extent to which responses are tolerated. Nonetheless, it demands that we consider transport policy and work to change the way we travel as in some way a disruptive policy change (Marsden and Docherty, 2013).

Independently from their triggers and their nature, the results of mobility disruptions can be divided into two broad categories: direct impacts and outcomes. Direct impacts are more immediate in time and space. They result very obviously from the disruption. For example, some of the direct impacts of the 9/11 terrorist attack was the destruction of the Twin Towers in New York City and the tragic death of many people. Among the outcomes we can address the empowerment of a fear culture which has legitimated a significant toll in civil rights (Strossen, 2005). A large number of modifications on air travelling practices and laws resulted from this.

It is important to mention that mobility disruptions can have impacts in the nature of the demand (e.g. in the aftermath of a terrorist attack people may be less willing to fly due to fear of another attack) and in the nature of the supply (e.g. highly reinforced airport policing leading to reduced capacity). Disruptions may be so meaningful that they lead to permanent outcomes both on the characteristics of supply and or demand. It is because of this that one can argue that mobility disruptions can have an important role in shaping the transport systems and mobility practices of the future – see Marsden and Docherty (2013) for further insights.

At an individual or household level moments of change can also result in a range of outcomes but these will not extend into the broader policy realm nor, in isolation or in the short-run lead to wider adoption. Schooling arrangements, after-school activities, sports and recreation venues and access to social networks can all be disrupted to a lesser or greater degree. The types of activity, the location of activities and the mode of transport used to access these activities can all be affected. Such events have a negligible impact on the transport system in isolation. Over time, we suggest that the impacts could be more significant. Dargay and Hanley (2003) analysed the British Household Panel Survey and found that over a nine-year period, more than 50% of commuters change their main mode at least once. Of those who both move house and change employer during two consecutive years, 45% also changed mode. The outcomes are also largely considered to be welfare gains and losses within the household unit.

The relationships between triggers, disruption, direct impacts and outcomes are visually represented in Figure 1. Another important element shown in this figure is the context that frames and provides a backcloth for all the previously described elements. By context it is meant all the social, cultural, geographical, and circumstantial variables that will somehow explain why the trigger was capable of inducing a disruption and why the impacts and outcomes resulting from it were experienced in the way they were.

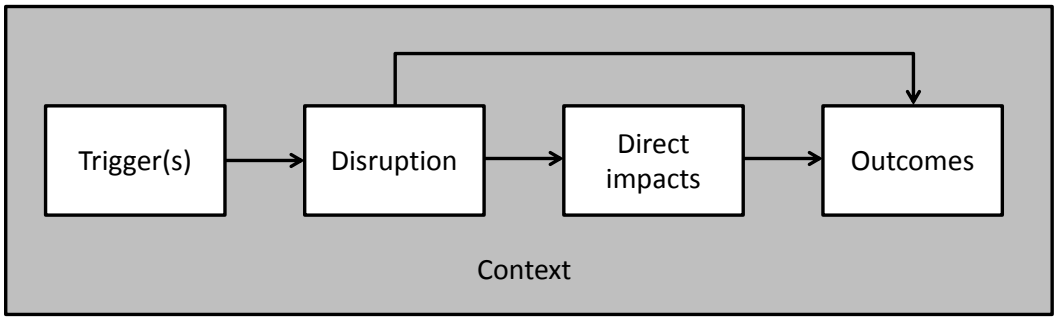

Figure 1: Conceptual scheme – graphical representation

Figure 1 does not integrate yet in the theoretical framework being developed here the agents which are being affected by the disruption while using or operating the (probably damaged) mobility structures in place. In this paper we consider two fundamental types of agents should be considered. The first type is constituted by the individuals and travellers who see their daily lives and travelling patterns being unsettled. These can be road users, pedestrians, air travellers – that will depend on the nature of the disruption. The second is constituted by the decision-makers and policy-makers in charge of the institutions which are supposed to somehow provide either the services or the structures which guarantee normal mobility practices (e.g. local authorities, public transport companies), and the institutions which are supposed to facilitate the return to normality (e.g. local authorities once again, but also rescue and emergency services). These two types of agents will have very different perspectives on the same mobility disruption because their societal roles are quite different. The bidirectional arrow integrated on the top of the table aims at representing the interactions that individuals maintain with decision- and policy-makers. It is important to highlight that these interactions can be more or less problematic and more or less informal. Research on disruptions can therefore focus on the perspective of the individuals, on the perspective of the decision- and policy-makers, and on both perspectives.

It can also focus on the relationships between the two types of agents – these relationships are being represented by the bidirectional arrow on the top. Whilst their introduction in this paper would overcomplicate the principles we are developing, we also recognise the broad range of other stakeholders that could feature here such as transport service providers, supermarkets, insurance companies etc.

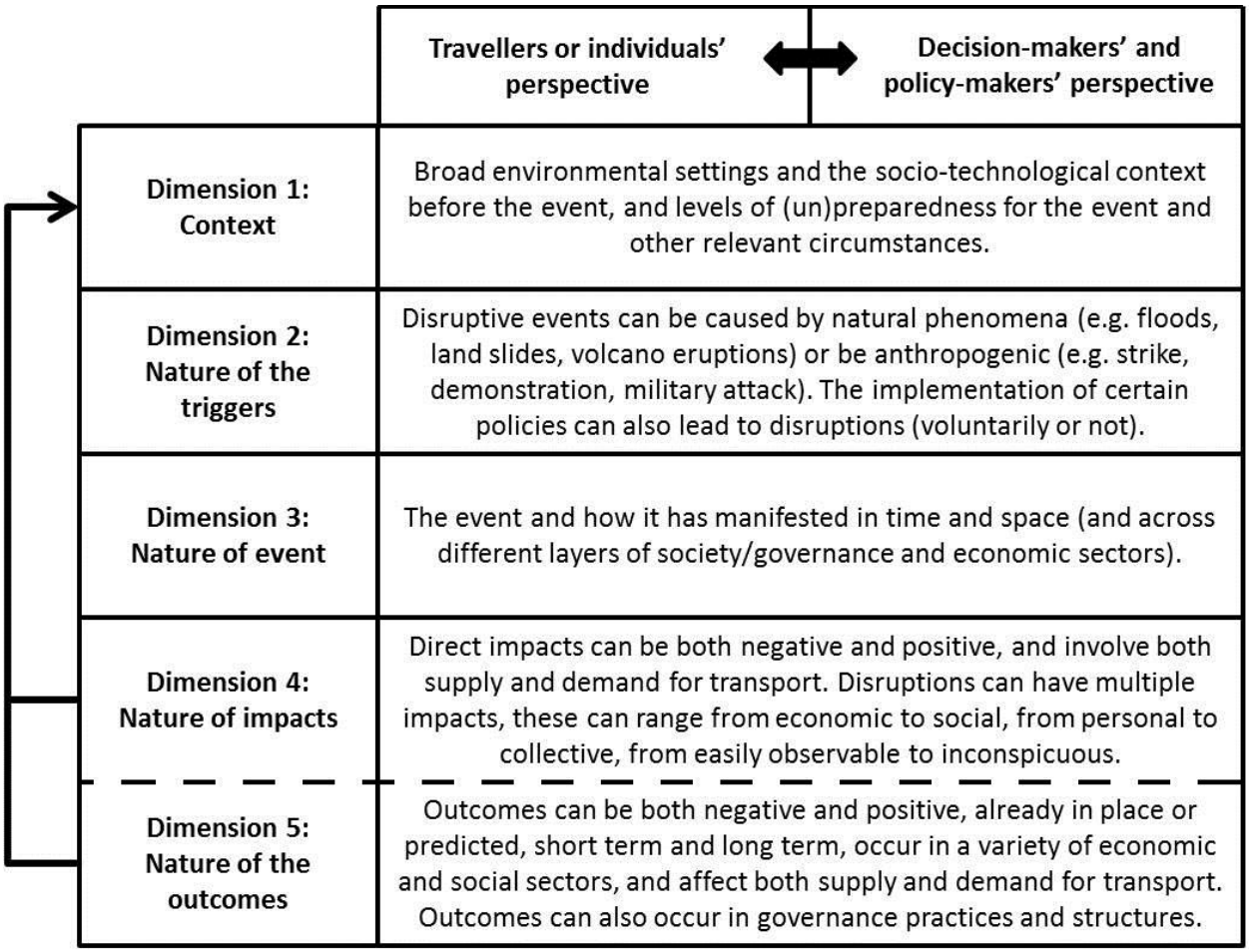

Figure 2: Conceptual scheme of the dimensions of disruptive events

This second scheme presents the five elements introduced in Figure 1 as the 'dimensions of disruption'. The claim being made here is that a careful description of these five dimensions is necessary and sufficient to provide to an uninformed individual a quite clear understanding of the event and its mechanisms. Other elements added to this second scheme are the arrows from Dimensions 4 and 5 (nature of impacts and nature of outcomes, respectively) to Dimension 1 (context). This was added to make it explicit that a disruption can have deep impacts on an entire society or, at least, on the way a certain sector develops. This is how research on mobility disruptions can provide a significant contribution to the development of theoretical understandings on the relationships between disruptions, agents, and social structures.

2. Data/Methodology

In order to support the analysis, data was collected from two real life disruption case studies, as they unfolded, initially in the form of quantitative surveys and qualitative face to face interviews, and subsequently, in the form of focus groups. The two disruptive events were both UK based: (1) The Fuel Supply Shortage (March-April 2012) and (2) The York Flooding Events (September and December, 2012).

This mixed data collection methodology was adopted to help facilitate a broader understanding of the issues and interdependencies of the events by combining different types of data from a number of different sources (Bryman, 2008 and Dillman et al, 2008). In addition a media monitoring process was conducted during both disruptions to enable the production of a database of national/local media reports and official announcements from governmental and relevant national agencies (e.g. the Environment Agency) that could provide useful context and inputs to the data collection. The data collection methodologies for both events are outlined below.

2.1 Fuel Supply Shortage Event

Towards the end of March 2012 fuel tanker drivers at five of the UK's seven fuel distribution depots voted for a mandate to strike. Whilst no strike was actually called the threat of a strike led to widespread fuel shortages amongst the general public as panic buying ensued, fanned by calls from Francis Maude (Minister for the Cabinet Office, (London Evening Standard, 28th March 2012[1]) for people to keep their car tanks full and to stock pile fuel in jerry cans at home.

A postal paper-based questionnaire survey was initially launched to capture public reaction to the fuel shortage across a number of locations within the city boundaries of Leeds and Aberdeen. The initial focus was on public spaces (parks, city centres and out of town shopping centres) with face-to-face distribution of questionnaires along with freepost mail back envelopes. This developed into a much more widespread 'letter box' drop of mail back questionnaires in Leeds, with a number of inner and outer suburbs targeted to ensure a good socio-economic spread amongst potential respondents.

The questionnaire asked respondents a series of questions that were designed to obtain information on: (1) The impacts (delayed start, postponement, cancellation etc.) on the respondent's activities (commuting, business travel, leisure activities, school drop-off etc.); (2) Whether respondents' had changed or might have changed travel mode in response to the disruption; (3) If respondents' had changed driving habits to be more fuel efficient; (4) General household and socio-economic characteristics; and (5) Any other information that respondents' felt was of relevance. A total of 511 questionnaires were distributed in Aberdeen and 1,600 in Leeds, with 66 completed returns for Aberdeen and 197 for Leeds providing response rates of 13% and 12% respectively.

Recruitment for focus groups commenced at the same time as the survey with 4 locations targeted within both Leeds and Aberdeen, covering urban, suburban and rural areas with

[1] http://www.standard.co.uk/news/london/fuel-strike-francis-maude-fuels-crisis-with-jerry-can-blunder-7594476.html

significantly different socio-economic and cultural differences. The logistics of organising the focus groups meant that there was a two weeks gap between the initial freepost survey and the first focus group taking place. This had the advantage of enabling the initial results of the questionnaire to be taken into account when scripting the focus group interviews but the downside that the disruption had subsided and so reactions from focus group members would be retrospective rather than current.

The themes presented within the focus group were also able to draw upon the ongoing analysis of media reports and government advice bulletins and focussed upon: (1) Whether and how focus group participants had been affected by the fuel disruption; (2) Whether they or family/friends had made changes to their normal behaviour; (3) How participants thought people should have responded to the fuel disruption; and (4) How the government should have responded to the fuel disruption and how they should respond to future disruptions.

2.2 The York Flooding Events

Later that year two periods of sustained localised flooding occurred in York and its surrounding villages. Further detailed information about the events is given in section 3.2 but the events were very different to the fuel shortage disruption in terms of their causes and their very specific geographical nature. The first episode took place during late September 2012 when several days of incessant rain led to severe flood warnings being issued by the Environment Agency. The nature of the flooding (located up river) meant that there were 2-3 days to prepare an online survey and face-to-face interviews with those households and businesses affected.

The online survey was based upon the fuel disruption paper questionnaire that had been used successfully earlier that year and was constructed using the BOS (Bristol Online Surveys[2]) survey software. A large number of organisations (schools, large employers, transport companies and media companies) were contacted to see if they were able to email the survey link to their employees, customers or audiences; and/or if they could put the survey link on their websites or 'push' through their social media channels. The response was mixed with many companies refusing to promote the survey for a variety of reasons: (1) A reluctance to highlight the disruption to services provided by that particular company; (2) Confidentiality issues; and (3) No resources to devote to such an exercise or too busy dealing with the disruption. As a result the online survey resulted in 10 completed responses and highlighted the difficulties of relying upon external organisations for assistance, particularly when in the midst of a disruption themselves.

A much more successful approach was enjoyed by the employment of face-to-face interviews. These targeted households and businesses within areas directly affected by the floods and included York city centre, Fulford (an outlying suburb of York) and several villages (Cawood, Naburn and Acaster Malbis). The interview script covered a number of themes including: (1) What action did you take or contemplate taking in the lead up to the flooding; (2) What impact did the floods have on your normal day to day activities – specifically did you have to change your normal routine and if so how; (3) If you did make any changes did you consider any of them to be positive experiences; (4) What time of activities carried on as normal and why was this the case.

[2] www.survey.bris.ac.uk

A team of eight interviewers were dispatched to conduct the interviews and in total managed 88 interviews (75 household and 13 business) ranging from 5 minute sound bites to 30 minutes in-depth discussions. By their very nature the selection of participants was random and as a result it was not possible to suggest that the sample was representative of the population. Despite this the interviews provided fascinating insights into how the flood disruption had impacted upon peoples' and businesses normal behaviour. They also offered the opportunity for interviewers to probe respondents for further information than would have been the case with a more specific online or paper based questionnaire.

A second flooding event occurred in York and surrounding areas during early December 2012. This presented another opportunity to collect data on how a flood related disruption had impacted upon the normal activities of those affected. A different approach was taken with the emphasis this time placed upon focus groups in an attempt to enrich the width and breadth of the data already collected. Two of the worst affected flood sites were chosen for focus groups (Naburn and Cawood) with recruitment being conducted shortly after the initial flooding. Despite this the focus groups were carried out against a backdrop of continued flood disruption and, given the predisposition of both sites to historical flooding, were a rich source of data from participants who had experience of both short and medium term flooding disruption. The focus group script had similar themes to that explored by the fuel shortage focus groups, but also recognised the flood experience of the participants by exploring additional themes; such as what lessons had been learnt from the September floods and whether the culmination of both the flooding events had led participants to give serious consideration to permanent behavioural change?

3. Results/Findings

This section presents findings from three different types of case study that allow an exploration of the dimensions of disruption set out in Figure 1. The first draws from a developing literature on moments of change whilst the final two (flooding and fuel shortages) draw directly from the events described in Section 2. The events are first classified using the categories developed in Figure 2. The mixed methods data collection methodology from Section 2 is used to draw out some insights which demonstrate the analytic potential (and limitations) that result from the study of disruptive events.

3.1 Flooding Event

This case study considers a flooding event in the City of York in the UK in September 2012. The City of York sits at the junction of two rivers (the Foss and the Ouse) and further downstream another river joins (the Wharfe). These rivers drain a large hilly national park area. In addition, the river Ouse is tidal up to five miles outside of York. Very heavy periods of rainfall can lead to flooding within the city and the areas adjacent to the river. Such events are not annual but are relatively frequent and the context is therefore one in which there is a general level of preparedness and an expectation that, from time to time, some flooding will occur. There is a level of vigilance and monitoring that sets the context for the event. The triggers are very substantial periods of intensive rainfall which swell the rivers. The nature of the terrain means

that it typically takes 24 to 48 hours for the severe rainfall to drain from the hills to the rivers and to reach York so flood warnings are in operation and measures are put in place to protect public safety.

The event is localized in that it affects York and series of villages along the Ouse. Even within York the impacts are relatively localized although the media reporting tends to sensationalize the impacts and this may affect potential visitor perceptions. The start time and peak for the flooding are generally well known and predicted although it is not always obvious to residents exactly how they will be affected. It is anticipated that such an event can have an impact of a week or more for some areas allowing for the clean up operation. Residents had some appreciation of how the event would unfold and reacted to this:

"*I had to leave for Denmark on Thursday morning [flood was expected Wednesday PM] so I cycled home... since the water was rising, rising and it was obvious that no taxi would be able to get through on the Thursday morning, I caught the train at 8.10 I think and had to spend the night in Manchester Airport cramped... so I stayed overnight there and caught the flight in the morning*" (male)

Whilst the city has good flood defences flooding events still lead to the closure of a major route into the city (A19 to the South), a series of roads and car parks in part of the city centre and riverside cycle routes as well as leading to road closures and a bridge closure in the villages to the South of York. Cawood Bridge was closed for over a week. The impacts of even relatively small scale infrastructure losses were quite significant. For the three day period where the A19 into York was closed between the ring road and the city centre, bus services were suspended or re-routed. The bus services through the local villages between York and Selby which would have used the Cawood Bridge were stopped for a week. The closure of the A19 also had a significant knock on impact elsewhere in the city. York is a historic city and has a series of single lane access routes off an outer ring road. These typically operate at or over capacity in the peak and therefore when the A19 was closed even small volumes of diversion led to extreme delays on all routes.

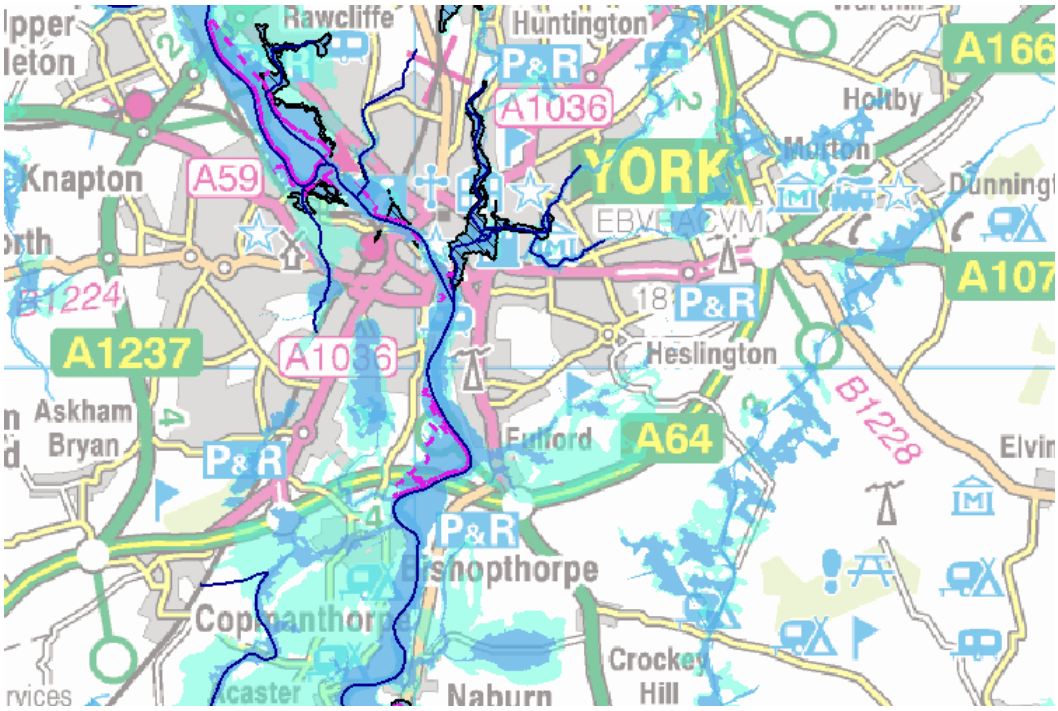

Figure 3: Map of York Flood Risk Areas (© Environment Agency)

The project explored how residents responded through surveys as described in Section 3. A few interesting examples of responses that emerged from the interviews are shown below. They demonstrate a variety of responses. Some respondents struggled on with journeys despite the additional time cost that this often incurred.

One parent with a child at senior school in the centre of York which was physically unaffected reported that the school had carried on as usual although she had been unable to take her child "*he's just one of 400 kids and they come from all over the place so... but I understand from some of the people who did make it in they were kind of two hours in and two hours back because of the flooding in the centre of town*." Reflecting on what she would have done had her car not been trapped by the flood water "*I think I probably would have still set out and sat in the traffic jam and moral high ground of sort of saying to the school, "Well I tried and here I am*."

Other responses included cancelling attendance or events, postponing or rescheduling over short time periods, relocating activities (changing shopping habits or working from home in particular), condensing activities (working harder or longer at specific points), re-allocation (getting other people to fulfil a role) or re-evaluation (whether a particular task was actually necessary). These are classified and examples provided in Table 1.

Table 1: Responses to disruption

Response	Example
Cancel	I was supposed to be at an AGM meeting with the firm that I work for but because I couldn't get out of the village, I had to cancel that. Again, we were on holiday so we did plan to go away a few days but we couldn't, we couldn't

	leave the property, we couldn't get out of the village.
Reschedule	we probably didn't go shopping on the days we would normally do because Naburn School was closed, we then had to cancel a governor's meeting there so I had to contact everyone. And we're having to arrange that now; we're trying to juggle that and rearrange it. I can't just drop a day or two, it's just "Well, make the hours up then". That's what I have to do. So I have to find fourteen hours extra in the next couple of weeks to get everything done, so it doesn't just go away. It kind of follows on now
Relocate	Example 1: Work relocation on Thursday I was trying to do face-time videoing conferencing for a meeting I should have been at and couldn't get to, so that's not a problem Example 2: Shopping relocation A respondent felt it not worth accessing the usual supermarket in York and "went down to Riccall [3 miles] to the Costcutter [local convenience store] down in Riccall, and just picked up some pieces down there because we can access it quite easily"
Condense	Example 1: A farmer changing processes It's a battle to try and get everything, you can do it, but it just makes everything harder work next year. It'll throw your harvest later and then your days are getting shorter and it just makes everything hard, hard work really. Example 2: Catching up on work I've lost pretty much two days' work time, which is why I'm having to work over the weekend to make that time up.
Reallocate	Example 1: Across family members Well, I would have gone to my mother's, gone to see my brother, that sort of thing in, sort of, Pocklington… Interviewer "And in terms of, say, for example, going to visit your mother, did other people go instead of you, or was that…?" Oh yes, yes. There's a family and we sort it all out between us. Example 2: Tasks over time I work as a Health Visitor so it meant visits had to be changed but I was able to do teaching preparation and stuff like that from home instead.
Re-evaluate	Example 1: Realisation of dependency and taken for granted resources it also makes you more aware of what provisions you've got…it makes you think, well, that we should be more aware really

	Example 2: Realisation of lack of spare adaptive capacity there's so little here there's not much infrastructure that's helpfully close we are reliant on being able to get about, being able to get up and down these little key roads. Obviously just to get to school for Jethro it's complicated; as soon as there's a little bit of water on the road it's difficult. And there's no shop. So yeah, I'm really reliant on the car… So it makes you realise how tight the margins are that you're living life by. That's kind of modern life, isn't it? It's not very sustainable and sensible, is it, in a lot of ways. Yeah. It easily starts to fall apart.

It also became apparent that social norms were also changed during the flooding period. Of not attending a meeting one respondent said *"It didn't feel like I was making a particularly dramatic excuse. A lot of people weren't driving into work, so a lot of people didn't turn up for this*."

It is clear that the majority of people interviewed were affected in some way. For some the experience was negative as they missed valued activities or had to incur significant additional journey time penalties to fulfil obligations. For many, there was considerable adaptive capacity such as shopping less frequently, working from home and asking other people to help out. Although perhaps a feature specific to this case study, a number of participants were able to carry on as usual as they could use their bikes and access York via a cycle network that was largely unaffected. This is interesting in so far as the cycle network, although affected, includes all roads and journey time increases were therefore marginal compared with the gridlock described by car drivers. Cyclists also had their key activities within reach by bike whereas car drivers often reported extensive distances to drive. Distance or separation between activities is clearly a source of vulnerability to a range of disruptions. Proximity by contrast was often identified as part of the solution even if choice was reduced. Location decisions are underpinned by a series of long-term assumptions about price and availability of transport and they are not easily unwound. However, it may be possible to make use of 'moments of change' to channel people to housing choices which make them less vulnerable to disruption.

3.2 Fuel Supply Shortage

In the past decade there have been two fuel supply shortages in the UK, both stimulated by some form of industrial unrest. In 2000, set against a governmental policy of an annual significant rise in fuel duty, hauliers and farmers blockaded a series of refineries in the UK, almost completely cutting off the supply of fuel to petrol stations (Chatterjee and Lyons, 2002). In 2012, the fuel tanker drivers union passed a vote on strike action but did not declare a strike, the basis of the dispute being unsafe working conditions. The UK government responded by advising drivers to fill up their tanks and also to store extra fuel at home. The consumer response to this led to a shortage although the actual distribution network was unaffected (Ferreira et al., 2013).

The context in both is one of a heavily car dependent society and in both cases the generally stable system of fuel provision was disrupted at relatively short notice catching the government and consumers unprepared. The nature of the triggers was different. The former being a dispute which was aimed at government to stimulate a change in government policy whilst the latter was

a dispute with the fuel distribution companies which escalated into a disruption as a result of, arguably, poor government intervention. After all, no strike had actually been declared and a period of seven days notice of such a strike would be required by law.

Both events unfolded over several days although the 2002 event was longer and had more significant impacts on behaviour as many more people ran short of fuel. Nonetheless, during the period of the disruption the actual duration was unknown to all protagonists and the situation was highly uncertain. A shortage of fuel had impacts across the country although it is worth noting that even within this there are local variations (for example depending on the number of filling stations and when they last received their deliveries). There are also differential levels of impacts. 25% of households do not have access to a car and therefore are only indirectly affected by disruptions to broader systems such as food supply or friends and relatives not being able to visit. Of those households with cars, the number of cars and the extent to which they are fuelled at the time an event occurs has a significant impact on their response capability.

The nature of the impacts, as with the flooding, demands a broad interpretation. From the 2002 survey, a sample of 1600 mail back questionnaire surveys provides the most in-depth understanding of how people adapted (Ibid.), with Chatterjee and Lyons finding that “12 to 16% of car users made fewer trips for commuting, business and grocery shopping and 51% of people made fewer trips for other travel” (p136). There was more car sharing and joining together of trips. 25% of respondents made no change to travel purposes whereas 42% made at least two changes (Ibid.). Whilst some had previous experience of a change in travel mode or the decision to work at home, this was true for less than 19% of respondents (Chatterjee and Lyons, 2002).

There were also some important broader changes to the normal ways in which activities were conducted as reported in Marsden and Beecroft (2002). For example, the way people shopped changed, with evidence of grocery shopping becoming more localised and a decline in supermarket trips. A major national telecoms supplier reported a 33% increase in phone traffic and a surge in internet usage as well as bookings for teleconferencing facilities. More professional and managerial grade staff were able to work from home and organisations adapted their working practices through increased flexi-time or the approval of ad-hoc teleworking. Summarising the apparent changes in behaviour prompted by the crisis, Chatterjee and Lyons (2002) concluded that such events can “not only reveal insight in behaviour but can trigger change” (p156).

The focus groups in 2012 provided further insight, in particular in a rural community. There were a number of small businesses that operated and raised concerns because visitors would not come (where a discretionary journey can be postponed or leisure consumed more locally) and also where they had commitments elsewhere such as in mobile trade fairs – where considerable expense had already been made in booking space for exhibits. Other groups also experienced a range of impacts with the types of responses suggested in the flooding also featuring, although to a lesser degree as many people had enough fuel to get through. However, people chose to work from home, to defer activities or to put them together in bundles. Whilst some trips were cancelled the time was put to other use and the extent to which this was an inconvenience linked to the financial implications or the special nature of the event that was missed.

Again these events expose interesting insights into the assumptions around which the mobility system is based and also how people conceptualise their rights and responsibilities and those of the state. For example, the events showed that the fuelling infrastructure that typically works

uninterrupted is constructed around a normality of refueling practices which was not understood by government. Second, in a period of potential shortage there is a clear consumer focus on acting in their own interests to minimize the probability of significant loss. This is recognized and seen to be sub-optimal. There was a strong preference expressed in focus groups held after the 2013 event for the government to consider rationing fuel and setting priority access for people such as healthcare professionals (Ferreira et al., 2013). Whilst rationing is seen as a policy of last recourse (Harman, 2002), it is interesting to note that it was also a feature of the post-disaster response to Hurricane Sandy (Kaufmann et al., 2012).

4. Implications for Research/Policy

Whilst there is a tendency to focus on notions of habit and stability and for the data collection tools which are deployed to also reinforce this focus (Marsden and Docherty, 2013; Schlich and Axhausen, 2003) it is important to recognise that major events, planned and unplanned, can significantly impact on the transport system. Such events are a threat. Poorly planned responses and knee jerk reactions may result in the reinforcement of car dependency (e.g. during a fuel shortage the public transport network is not equipped to take large additional volumes of passengers and a negative experience can reinforce the car as the mode of choice). They are also an opportunity. They are an opportunity to learn about what activities people hold most dear and the different resources that can be brought to bear to maintain participation whilst radically changing mobility (albeit typically for short periods).They also lead to innovations in working practices, changing social norms and the application of technology and policy solutions in different ways. Such experiments may only survive the short term but they raise the question as to whether other policy approaches would be possible if a different context and framing of the transport problem were possible (Tennøy, 2010).

Underlying these larger events is an on-going level of churn or change in housing and work location, household roles, income and technology. This creates a raw material of change which can be used to assist with what, in one step might be seen to be radical transitions but which, taken over time might be seen to be acceptable and capable of being absorbed within the flux of change that would happen in any case.

We observe within the data analysed to date a much broader range of responses from travellers than are typically looked for and/or therefore observed in the data we collect as shown in Table 2. Whilst the majority of the findings reported here focus on the individual responses it is apparent that the relationship between structure and agency is an important feature worthy of further development. People's choices on activities were dependent not just on their own preferences but the actions of employers, schools, the state and family and friends. The fuel shortages and flood were also interesting in showing the extent to which this may be specific to individuals in time (as events unfold) and space (dependent on where they are and where they need to be). Vulnerability to these events was well understood by the participants but the solutions were certainly a negotiated mix of individual, group and organizational in nature.

Table 2: Behavioural Responses

Remode	Typically well captured in behavioural models and in data collection where marginal changes in price, quality, supply etc. Occur
Reschedule	A more limited literature supports the mechanisms behind decisions to reschedule (which can relate to cultures of work and household constraints as much as journey times in different periods). Represented to a degree in current models
Cancel	Understood with respect to journey time or price increases and some differentiation made between the extent to which work and non-work trips may be sacrificed but decision process unclear.
Relocate	Relative accessibility of competing sites is a well established feature of land-use transport interaction models. However, this presupposes that the individual has flexibility to exercise choice and the flexibility of work decisions seems divorced from accessibility of the home and work location so would not be captured
Condense	Although measures such as trip chaining might be categorised as 'condensing' this goes well beyond such notions with effort as a work input for example being a response variable for individuals
Reallocate	Although household decision-making is a growing area of interest for the transport community, the reallocation of tasks between household members and communities over time and space is poorly reflected.
Re-evaluate	The occurrence of disruptive events has been shown to lead to longer-term evaluation of the set of activities people participate in and the extent to which they rely on transport and infrastructure to support their decisions. This is poorly reflected in understandings of 'demand matrices'

The project is currently 50% complete and we expect to provide further empirically grounded insight into each of these behaviours and how they relate to the choices of individuals, organisations and the interplay between the two. We see this as unlocking a critical research agenda for the field which explores a broader range of responses and therefore policy options which could lead to lower carbon transport in the future. The implications for research are therefore potentially significant. It is argued (here and by others) that too much effort is dedicated to cross-sectional data collection and theoretical approaches dominated by stability and equilibrium. Other theoretical approaches which encapsulate the uncertain dynamics of everyday life may be more appropriate. To fully explore this there is a need to change the type of data we collect.

We also see wide ranging potential impacts for policy makers. Marsden and Docherty (2013) suggest that "If change is conceived as only possible at the margins, then it is axiomatic that it is politically acceptable to plan only for marginal change. And so the structures and processes that deliver incremental policy change are reproduced as a result." If however, one accepts the underlying adaptability of the population and the potential for systems to adapt to significant

changes then more significant policy change becomes imaginable. It is interesting to reflect, for example, on the broader implications of the success that was observed in managing the additional transport demands from the London Olympics (Parkes, 2013). If together businesses, individuals and transport system providers can change the way they interact over a two month period then can this be sustained beyond if the imperative for change really exists?

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