Emergent disaster response during the June 2007 floods in Kingston upon Hull, UK

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Abstract
There is a growing body of research that suggests much of the behaviour that occurs during a disaster response effort is emergent, meaning it is produced as a result of complex non-linear factors at work both within and between the affected communities, responding organisations, and the environment. This paper uses the pluvial floods of June 2007 in Kingston upon Hull as a case study to investigate to what extent emergence was apparent during the disaster response effort, as well as identifying certain systemic features that facilitate or inhibit this emergence. Results show that emergent behaviours corresponding to each of the types identified in the literature (emergent groups, networks, and activities) were present in the response to the June 2007 floods; and that these behaviours contributed positively to Hull's community resilience. Both altruism and the relative rate of information transfer were key drivers for emergent actions.

Key words
complexity; disaster response; emergence; Hull; social impacts

Introduction

Over recent years there has been an increasing interest in what are termed non-structural or 'soft' engineering solutions to flood risk (and indeed hazard management in general). Of these non-structural methods, preparedness strategies are of particular interest, as these outline the overall organisational strategy during times of hazard, the protocols that attempt to regulate the actions of the various actors involved, and the levels of authority they are imbued with. However, it has been observed that given that disaster management plans operate at times of unreliable information, acute time pressures and inadequate communication systems (Smith and Ward 1998) no preparedness strategy can account for the multitude of unexpected events precipitated by a major flood event. It has therefore been suggested that planning should seek to enhance the adaptive capacity of the community and ideas emerging from complex system theory have been proposed as a means to produce such a strategy (Comfort 1999; Hilhorst 2004; Johnson 2006; Smith and Fischbacher 2009; Stallings and Quarantelli 1985; Tierney and Trainor 2003).

In disaster circumstances the usual processes and structures of emergency response are often overwhelmed (Tierney and Trainor 2003) and consequently a linear, hierarchical response is generally the exception rather than the rule. The consequent assertion that some degree of non-linear, emergent behaviour is both inevitable and natural (Stallings and Quarantelli 1985) is supported by a number of case studies across a range of disaster scenarios and levels of development (Comfort 1999; Tierney and Trainor 2003). Consequently these emergent behaviours have been the subject of considerable research interest (NRC 2006), not least because response networks that display greater proportions of emergent organisational behaviours are more successful in limiting the impact of hazards (Comfort 1999).

The purpose of this paper is to determine to what extent emergent behaviours were evident in the response effort during the Hull floods of June 2007. The relative prevalence of different forms of emergent behaviour will also be examined,

Hull floods, 2007

Hull is located in the north east of England on the banks of both the River Humber estuary and the River Hull. It is a particularly low-lying area, with over 90% of its area below high tide level (Environment Agency, 2008a), indeed some parts of the city are below sea level (Coulthard *et. al.*, 2007a). Because much of the land on which Hull stands is reclaimed marshland, it has limited natural drainage, and this combined with its low-lying position means it is particularly vulnerable to flooding (Environment Agency, 2008a) as shown in Figure 1.

Figure 1: Map of the Hull area showing important hydrological features, infrastructure, and flood vulnerability (*Source: Environment Agency (2008b)*).

Areas to the west of the city are located on higher ground than the majority of the city, and so water falling here drains eastward toward the city (Coulthard *et. al.*, 2007a). There are also slightly higher areas to the east of the city, and so at times of high tide when sluice gates to the Humber are closed, the area around Hull acts like a large bowl (Pratt, 2008). The presence of a chalk aquifer beneath the western part of the city also contributes to flood risk, as it can lead to a high water table and saturated ground during periods of heavy rain (Yorkshire Water, 2008). In total the Environment Agency (2008b) estimates there are 57,000 properties at risk of flood in the Hull catchment.

June 2007 was the wettest month in Yorkshire since 1882. The rainfall for the UK during this period is shown in Figure 2. Hull received over 400% of its monthly average rainfall during June 2007. On June 25th 2007 Hull experienced a storm of magnitude greater than 1 in 150 years (Coulthard *et. al.* 2007b), with over 100mm of rain falling on the city over a period of 24-hours (Environment Agency 2008a). This volume of rainfall overwhelmed the drainage network of the city, resulting in surface water flooding. While many parts of the city were affected, flooding was more extensive and severe in western parts of the city.

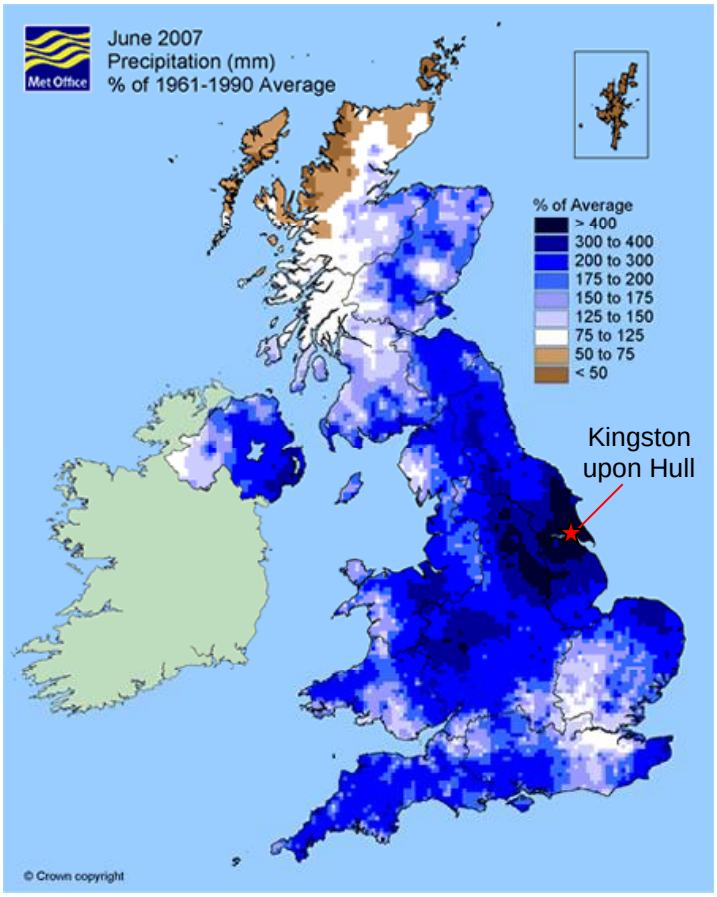

Figure 2: Precipitation (mm) falling on the UK during June 2007 as a % of monthly average (*Source: Met Office, 2007; annotation added*).

Flood preparedness is particularly relevant to the city of Kingston upon Hull, which has 90% of its area below the high tide level (Environment Agency 2008a). Nearly 10,000 properties were flooded during the pluvial floods of June 2007, causing extensive damage and misery to Hull's residents. Damage to Council property alone was estimated at nearly £200 million (Coulthard *et. al.* 2007a). During the floods roads in affected areas became impassable for 2 days and 91 of Hull's 99 schools were forced to close. The flooding affected the communities of Bransholme and Kingswood in East Hull, the low lying areas by East Carr, and large areas of Orchard Park, Newland Avenue, the Avenues, Priory Road/East Ella and Anlaby Park in the west of the city (Coulthard *et. al.* 2007b). The affected communities represented a cross section of the Hull population, with diverse socio-demographic characteristics. The flood itself continued for several days before the waters retreated, and standing water remained in many parks and other open areas for weeks (Environment Agency 2008a). Given the extent of the disaster in Hull, study of the emergency response system provides the opportunity to uncover important information about emergent behaviours in disaster management.

The core data for this study comes from the various official reports (both internal and independent), media reports from the time, as well as from the field, in the form of structured interviews with key figures from various responding agencies, 'shadowing' of certain officials involved in flood recovery activities, and discussions with affected

citizens and responders from the various groups. Organisations of interest were identified by analysing the aforementioned reports and accounts of the floods, and through communications with academics who are either conducting their own studies of the June 2007 floods, or have been heavily involved in published reports (Coulthard 2008 *pers. comm.*). Groups who were involved in the field work and interviews include:

- Hull City Council
- Silver Command
- The Hull Community Wardens
- The Environment Agency
- Flood affected Residents

The account of the flood begins with a description of the roles and responsibilities of key organisations, followed by an account of the unfolding of the disaster and the immediate responses gleaned from interviews and grouped into an analysis of the extent of emergent behaviour during the event.

Roles and responsibilities

Silver Command

When an emergency situation is declared in the UK, a central multi-agency Gold/Silver/Bronze Control is convened by the Police in order to coordinate the response effort, when it is deemed there is a fear or threat to property. Depending on the perceived seriousness of the emergency this team has varying authority and membership; an emergency of only moderate severity precipitates the formation of a "Bronze Command", while the most serious events (such as a major terrorist attack or nuclear accident) would lead to the formation of a "Gold" command. Humberside Police instigated a Silver Control structure on the morning of 25th June that the Hull floods called for the creation of a "Silver" Command. The Police establish the Silver Command and invite responders to that command, and will take advice from other responders. However, Coulthard *et. al.* (2007a) reports that there was a degree of confusion between agencies about whose responsibility it was to instigate a Silver Command, though the extent to which this led to a delay in establishing top-level coordination is unclear.

While Silver Command seems to have been established relatively quickly, it appears to have taken longer for the body to establish a picture of what was occurring and begin allocating resources. Coulthard *et. al.* (2007a) comment on the lack of local knowledge present in Silver Command and note that there was no readily available information highlighting important strategic locations. This appears to have meant that the early phases of Silver Commands response were reactive, and concerned with information gathering.

Initially Silver Command was made up of representatives from Hull City Council, the Police, Fire Brigade, certain National Health Service (NHS) bodies, and the Environment Agency. Yorkshire Water requested a representative early on Monday 25th June, however it was not until Wednesday that they were invited to join the team (Coulthard *et. al.* 2007a; Yorkshire Water 2008). The director of Hull's Community Wardens was also brought into Silver Command on Wednesday. Silver Command was in place for around a week, being dissolved on the Monday following the floods.

Responsibility for coordinating the recovery effort was then handed over to Hull City Council.

Hull City Council
Hull City Council has responsibilities for providing housing and shelter for those affected, emergency planning, working with other category 1 responders during an event to provide emergency assistance, as well as duties in the recovery phase post hazard. Specific responsibilities include warning members of the public of potential threats in the lead-up to an event, traffic management during disasters with emphasis on keeping important routes clear for use by the emergency services (Red Routes), offering assistance and potentially evacuation to elderly and/or vulnerable people, and responsibility for setting-up and maintaining rest and care centres for people to be evacuated to.

The Council is structured with a central coordinating and administrative team at Hull town hall, and seven 'Area Teams' that coordinate Council services within their district. Because of the lack of prior warning, the Council had little time to plan its response, and there was no emergency plan in place specifically for pluvial flooding (emergency plans at the time were based solely on fluvial events), although there were generic protocols for use in all emergencies. A common sentiment present in the comments of all of the Council staff spoken with was that the pluvial flooding took everyone completely by surprise.

Environment Agency
As a category 1 responder the Environment Agency (EA) has duties for a number of aspects of emergency planning and response. They are responsible for providing effective forecasts and warnings for river and sea flooding (Environment Agency, 2008a), and during an emergency they are expected to work closely with the Meterological Office (MET Office) to monitor the probable impact of rainfall on local rivers, and warn the public, local Council, and emergency services of any potential hazards (Coulthard *et. al.* 2007a).

Hull Community Wardens
Hull's Community Wardens are partially funded by the Council, and partially funded through national charitable organisations. They have a number of official duties for which the Council gives them targets, including cleaning up graffiti, patrolling streets, tending to overgrown areas of land, and reporting fly-tipping (NaSA Community Wardens 2008). In addition to this the Wardens undertake a vast array of initiatives generated internally by the Wardens themselves, such as distributing energy saving light bulbs, a service to tag and photograph residents bicycles in order to prove ownership (and ultimately reduce theft), and visiting elderly or vulnerable residents to offer help and support. There are also 12 Warden 'shops' across the city where people can drop in for help and advice on a range of topics including problems with drugs and alcohol, advice on obtaining benefits and aid, and help finding employment.

Managing the disaster
The time immediately after a large-scale hazard has struck constitutes a massive managerial task (Smith and Ward 1998). Responses to these events come not just from governmental agencies, but also from the private sector, voluntary and non-governmental organisations, and the general public (Tierney and Trainor 2003). These

groups and individuals need to address diverse and often unplanned-for challenges, under severe pressure in terms of both time and resources. As they do this they may need to incorporate new members and/or adapt their organisational structure as well as identify and utilize new resources (Tierney and Trainor 2003). Essentially they must generate strategies under difficult and pressing circumstances. Stallings and Quarantelli (1985) state that under these conditions there are regularly instances of organisations finding themselves undertaking new, unexpected tasks, or performing familiar tasks using innovative and unplanned methods. A number of authors have therefore concluded that a significant portion of disaster response behaviour is characterised by emergence rather than routine (Comfort 1999; Stallings and Quarantelli 1985; Tierney and Trainor 2003). Stallings and Quarantelli (2003) state that behaviours may be considered emergent if either the relationships among the individuals pursuing collective goals are new, or if the tasks being undertaken in pursuit of these goals are new.

Emergence

Emergence takes place within, and between organisations in the public sector, private sector, and among citizens (Stallings and Quarantelli 1985). Emergence has been described as behaviour that is not explicitly apparent from the parts of the system and when it then arises, is therefore unexpected, unplanned and inevitable in any complex system. An essential element of emergence is that it arises from interaction between agents. Unplanned action by one particular individual would not constitute an emergent behaviour, nor would activity by groups that was pre-planned or centrally directed. Emergence is evident when individuals or groups work together in unplanned or unanticipated ways, or new networks are formed in response to an event that would not have existed otherwise. Emergence may be evident in three general categories or behaviour following a disaster: Emergent Groups, Emergent Networks, and Emergent Activities.

Emergent Groups

Emergent groups are made up of individuals who have informally banded together in order to pursue some common goal or necessary function. Sometimes, they form in terms of occupational roles, but at other times their formation is along social, or geographic lines. Emergent groups made up entirely of public officials, entirely of private citizens, and combinations of the two have been identified, with group compositions varying considerably in terms of age, sex, race and lifestyle. They generally have a relatively flat hierarchy, relatively unspecialised roles within the group, and generally an absence of a designated leader (Stallings and Quarantelli 1985). Emergent groups perform a variety of tasks including damage assessment, search and rescue, distributing aid, and debris clearing. After forming, these groups generally persist for only a short time, hours or perhaps a few days (Stallings and Quarentelli 1985).

There was evidence of Hull's residents forming emergent groups over and beyond what would have been anticipated and expected due to existing emergency contingency plans by the groups involved, and their pre-determined arrangements for working together in such situations (e.g. the pre-ordained arrangements in the levels of gold, silver and bronze commands). Coulthard *et. al.* (2007b) report of residents forming groups to provide emergency medical assistance, though it was not possible to ascertain to what extent those belonging to these groups knew each other prior to

the event, or what factors facilitated their coming together. Clearly though they were performing an essential task, and doing so without any prior planning, responsibilities or authority.

Emergent groups also formed entirely from public officials. The testimony of a number of staff in one Area Team clearly demonstrated that very rapidly after the floods various Council service providers, Council housing groups, Community Wardens, and the Area Team themselves co-located in a single building in order to tackle the task of assessing which residents were in greatest need, and attempting to meet that need. Though this was partially caused by one Council premises being rendered inoperable, the other individuals that worked from the site did so voluntarily.

The team of Council staff and Wardens assembled to carry out the door-to-door flood surveys also constitute an emergent group. At the time of the floods the Wardens appear to have been working relatively autonomously of the Council. The Council would set the targets mentioned previously, but then the Wardens were free to act wherever they perceive a need. The Wardens had no official flood related duties at the time of the floods, nor had they been involved in any Council emergency planning activities. The Wardens continued officially working as part of the Area Teams until November 2007.

The team had both new structure (in that those in the group were unfamiliar working with each other) and new functions (conducting door to door surveys was entirely novel to all those involved). The formation of the group was also not the result of protocol or long term planning; rather it was a decision made in response to a perceived need. The membership of this group also changed significantly over time, with indications from those involved that many staff left after a few days of the work, while others joined. Cited as a feature of emergent groups by Stallings and Quarentelli (1985), this dynamic membership appears to have occurred because the staff available to take part changed on a daily (sometimes hourly) basis due to pressures elsewhere in the system caused either by the dynamic nature of the floods themselves, or other internal or external influences, such as their own personal issues regarding own residence flooding, or existing administrative duties for established local procedures that had to be maintained beyond the additional strain of flood damage duties, to name just a few.

Emergent groups also formed from combinations of public officials, residents and the emergency services. There were a number of examples of residents ‘lending a hand’ to the fire brigade or police as they evacuated vulnerable residents. The same was true for Council staff; as outlined previously, once senior member of the Council Area Team worked with firemen to evacuate a number of elderly residents.

Emergent Networks

A network is an organisational form distinct from others such as bureaucracies, markets and hierarchies (Tierney and Trainor 2003), and have been defined by Podolny and Page (2003) as consisting of “a set of entities that pursue repeated enduring exchange relations with one another and, at the same time, lack a legitimate organisational authority to arbitrate and resolve disputes that may arise during the exchange”. Rather than formal procedures such as contracts or policies, exchanges within a network are regulated by trust and reciprocity (Podolny and Page 2003). In

the context of a disaster response scenario, networks form because there is often not a pre-defined method of coordination between certain organisations, or these methods are too slow to be responsive in a crisis milieu.

There was evidence that networks emerged during the flood response at all levels of organisations. Testimony from those involved in various organisational incident rooms consistently shows that there were regular communications with agencies in order to coordinate action and gain information about the ongoing situation. As observed by Podolny and Page (2003), the groups rely on altruism, reciprocity as well as a sense of 'manners'. Descriptions such as 'to help them out', 'courtesy' and 'informal' were regularly used by those interviewed when discussing the reasons why contact was made with different organisations during the flood response.

Networks also emerged at a local level, specifically from the Council's Area Team. As discussed above the Area Team grouped with a number of other service providers, it also formed network links with others. These included charities, housing associations, and social care groups. Again the reasoning behind forming the communication links was to coordinate actions, and gather information; generally in order to identify vulnerable residents.

A pattern that appeared during discussions with the Wardens and Council Area Team was that it was often easier to communicate laterally with other agencies in the same location, than it was to communicate vertically within an organisation. There were a number of examples where there were long delays in receiving feedback or instructions from superiors (such as those in incident rooms or Silver Command), while staff could speak with their opposite numbers in other agencies or groups much more rapidly and reach joint decisions. This appears to be due to the fact that because the senior management sections of organisations act as central information processing nodes they were much more prone to 'information overload' during the early stages of the event; they simply did not have the capacity to take in all the required information from various sources and at the same time coordinate their numerous resources. Teams at lower organisational levels seemed to experience this to a much lesser degree, and this seems to be a key driver in the formation of emergent network links. These observations imply that the centrality of an organisational network, defined by Janssen *et. al.* (2006) as the degree to which only few nodes in a system possess high structural importance and connectedness, may be an important factor in the speed and efficacy of a hazard response.

An exception to this situation was the coordination between the EA and the Fire Brigade, who had requested a presence within the EA's incident room from its point of inception, a situation also noted by Coulthard *et. al.* (2007a). In this case high-level strategic coordination appears to have been in place almost immediately, with the Fire Brigade deferring to the EA on matters of where to place pumps, and which infrastructure to protect.

Emergent Activities

Emergent Activities are those activities which actors engage in that are novel or unusual for them in some way, particularly when these activities differ from those laid out in disaster plans (Tierney and Trainor 2003). They may be undertaken by emergent or pre-existing groups, organisations or by individual citizens acting

autonomously. In this context emergent activities include both those activities which are entirely new to an actor, and those where performing the function itself may be familiar, but the methods or equipment used or the context of the activity are novel. As with the other forms of emergence the impetus to undertake these activities is due to a recognition on behalf of the actors that there is an urgent need for some form of action, and simultaneously recognition that official action will not be forthcoming in the necessary timeframe (Stallings and Quarantelli 1985).

A range of emergent activities can be identified from the evidence gathered, with residents and officials of all levels engaging in novel activities beyond the scope of their role; many of these activities were highly beneficial to the response effort. Table 1 lists a number of activities identified as being emergent, together with who performed them, and an indication of the agency that holds responsibility for undertaking such actions.

It is clear that emergent activities cover a large range of different types of actions including administrative and social tasks, provision of emergency aid, and advice giving. Emergent activities were carried out by individuals (such as single local residents), emergent groups (as outlined in a previous section), and organisations (such as the Community Wardens).

Emergent activities fell into two groups, those novel activities that were undertaken voluntarily, and those where a group was 'tasked' with a novel activity. The activities of the Community Wardens provide example of both of these, with their evacuation of vulnerable residents and provision of care packages to residents an example of the former group, while their involvement in traffic control duties and door –to-door surveying examples of the later.

Table 1. Illustrative list of emergent activities identified during the response to the 2007 floods

Activity	Actor	Agency usually responsible
Evacuations	Numerous, including: Community Wardens, local Area Team staff, emergency services, volunteer lifeguards, local residents, army	Emergency services
Provision of 'Care Packs' (Food etc.)	Community Wardens, charities	N/A
Traffic Control	Police, Community Wardens, local Area Team staff	Police
Door to Door Flood Surveys	City Council staff, Community Wardens, local Area Team staff	N/A
Care and Support for Neighbours	Local residents, charities	N/A (possibly voluntary organisations or charities)
Emergency Medical Assistance	Local residents, emergency services	Emergency services
Building Sandbag Walls	Local residents, EA, Fire Brigade, Community Wardens	EA, possibly emergency services
Assessing flood damage to properties	City Council staff, Community Wardens, local Area Team staff	Building surveyors
Advising on obtaining benefits / talking to insurance companies	Local residents, Community Wardens, local Area Team staff, city Council staff	Citizens advice bureau, certain Council departments

The types of emergent activities engaged in changed as time progressed. In the early stages of the flooding they focused on ensuring that the most vulnerable residents were looked after, and the prevention of damage to property. Once the floods began to recede and it became clear that there was no immediate danger to life or health, actions became more focused on recovery; activities such as surveying and assessing flood damage and dispensing advice became more prevalent. It is also interesting to note that the emergent activities carried out during the recovery phase were often coordinated as part of a city wide effort by Silver Command or senior management; coordination that was absent during the response phase.

While most of the activities outlined in Table 1 were largely constructive, there were examples of emergent activities creating difficulties or dangers. Most tragically, the man who died during the floods was attempting to clear a weed screen on a storm drain; a consistent opinion garnered from interviewees was that he should not have been engaged in this activity, as he did not have the skills, experience or equipment to perform such a hazardous task.

Discussion

The trigger for emergent behaviours almost always seems to be a desire to help alleviate human misery or 'help out'. A consistent sentiment across all the organisations and individuals was 'we did what we could'. The evidence from Hull shows that once a need is identified, and there is a perception among those 'on hand' that action through 'usual' channels cannot meet this need, emergent action is instigated. A common sentiment from the ground was that 'something had to be done', and people took action even if they were aware that there actions were only of minimal benefit. This seems to be related to the community spirit displayed in Hull over the course of the floods, with most people feeling a need to be seen to be 'contributing to the cause'. When the perceived need is not so urgent, i.e. in the days following the flooding, there were more frequent examples of people withdrawing from emergent activities. This was most obvious in the observations of several of those involved in carrying out door–to-door surveying. This observation appears to support Comfort (1999) who proposed that 'identification of a common threat' was a key prerequisite, indeed once the perception of a hazard begins to diminish, and peripheral actors begin leaving the response.

Emergent behaviours of the types discussed above have been cited as a major source of resilience within disaster networks (Comfort 1999; Tierney and Trainor 2003). Emergent behaviour has the capacity to bring in a greater diversity of actors to the response system as well as capitalise on more diverse information sources and resource pools (Tierney and Trainor 2003). This happens because relationships are more informal, and new actors can rapidly be brought into the network when needed. Beunza and Stark (2003, in Tierney and Trainor 2003) also note that this diversity enhances the flexibility of the system by increasing the possibility that interactions will yield unpredictable solutions or unpredicted resources, referring to this capacity as 'generative redundancy'. This situation can be contrasted with a rigid hierarchically structured response system, where due to the centralisation of control of the system, there is less diversity in terms of information exchange because all nodes receive the same information from the central node (Janssen *et. al.* 2006)

The flow of information also seems to be important in facilitating emergence. Because during the early stages of the flooding information and instruction was not forthcoming from senior levels of organisation, actors on the ground appear to have acted upon information available to them, including their local knowledge and that provided by residents. In essence in the absence of organisational directives coming down from above, people and groups self-organised according to the information available. With regard to the overall picture of the Council's flood response, a senior official involved with Silver Command commented:

> A lot of what we did just evolved, and it was due to the people involved in those processes. What we realised was that there wasn't the basic understanding of how the whole process was supposed to work. A lot of what we did was fine and we'd want to see it again, you'd just get things moving. What we didn't have was an understanding of the protocols and who could action decisions.

Once communication from senior levels became forthcoming, groups re-organised according to this new source of information, and began undertaking activities that were a part of a more citywide coordinated response. This illustrates the adaptability of emergent behaviours, as well as the evolution of the response system over time; an observation which supports the assertions of Comfort (1999).

Stallings and Quarantelli (1985) argue that the looseness and informality of emergent behaviour is one of their real strengths. Because of the lack of formal mechanisms or rules regulating behaviour, emergent groups are much more able to alter their activities rapidly and undertake necessary, possibly novel, tasks (Stallings and Quarantelli 1985; Tierney and Trainor 2003). A further adaptive benefit of emergent behaviours is that, generally, they give rise to less centrality in the response network. This means they are less dependent on a few central hubs (such as command centres or executive personnel), and therefore less vulnerable to the loss or incapacitation of these hubs (Janssen *et. al.* 2006). For example, a highly centralised system may cease to function almost entirely if a command centre is removed, because it is located in an area effected by the disaster.

It should also be noted that while emergent behaviours have a number of beneficial effects they can also have detrimental effects. The lack of clear 'leaders' within emergent groups, and to a certain extent emergent networks also, means that external groups and agencies can find it difficult to develop relationships with it, which can in turn cause logistical issues with delivering aid and support (Stallings and Quarantelli 1985). Research has also shown that the ability to operate in a network is a skill that must be learned (Podolny and Page 1998), therefore the success of an emergent network may be related to the experience of the actors involved.

The immediate response to the 2007 Hull Floods shows the value of emergent groups, networks and activities in conjunction with formal disaster response plans. Emergent behaviours by and large functioned positively to fill the gaps in information flow and actions that the formal emergency response structures could not fill. Emergence was especially evident during the early phase of the disaster whilst the Silver Command was still being established. Emergent behaviours and local self-organisation also helped in dealing with the sheer number of individual incidence requiring immediate attention, such as the safe evacuation of vulnerable residents.

The evidence for emergence in the response to the Hull Floods does not undermine the valuable role played by formal emergency planning and response measures. However, the Hull experience shows that such plans are necessary but not sufficient in responding to disasters. In any disaster there will inevitably be a time lag between the initiation of the event and the formal response of the authorities. Hierarchical co-ordination is very important, but will inevitably result in some inefficiencies in communication and decision making under rapidly changing and dangerous conditions.

Emergent structures and functions serve to provide rapid feedback and response to changing environmental conditions during a disaster. In addition to formal emergency planning, disaster resilience requires that local communities exhibit the conditions necessary for emergence to occur. This is exemplified by the role that was played by the Hull Community Wardens. These community based workers did not have any formal role in Hull emergency plans but their local knowledge and existing community networks were extremely valuable during the disaster. Informal relationships between individuals working for Hull City Council and the Environment Agency were also essential in the identification of the disaster and the early response. Such relationships and skills will never be entirely or effectively captured in formal emergency plans. The significance if this for civic leaders is that disaster resilience is enhanced by stronger community networks and relationships, which may be facilitated by grass roots community workers who are able to act on local knowledge and experience despite being outside formal disaster plans and services.

Conclusions

The purpose of this investigation was to determine to what extent emergent behaviours were evident in the response effort during the Hull floods of June 2007. An attempt was also made to determine the relative prevalence of different forms of emergent behaviour, together with an attempt to identify certain systemic features that facilitate or inhibit emergence.

As the preceding discussion shows there were examples of each type of emergent behaviour predicted in the literature; emergent groups, networks, and activities. Overall these emergent behaviours were largely constructive. This was especially noticeable in the provision of timely assistance to Hull's most vulnerable residents. A common thread through all emergent behaviours identified was altruism, which was most often expressed in a desire to help or sense of 'courtesy'. There was however some evidence where certain unplanned activities were not constructive, even though these were universally undertaken with a strong desire to help.

What is clear however is that emergence played an important role in Hull's response to the June 2007 floods, and without these behaviours the misery and suffering experienced by Hull's residents would likely have been far greater. In the wider context of disaster management these results imply that a better understanding of the contextual factors that give rise to emergence, together with knowledge of how

emergent behaviours interact with more traditional organisational forms, is of great importance to ensure the resilience in the face of uncertain future hazards.

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