

International Journal of Mass Emergencies and Disasters
March 2016, Vol. 34, No. 1, pp. 113-142.

**Unpacking Long-term Disaster Recovery Processes:
A Case Study of the Healthcare System in Montserrat, West Indies**

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Long-term disaster recovery processes are poorly understood, yet there is a growing imperative to improve knowledge of their complexity and timeframes to inform policy and post-disaster decision-making. This empirical study explores post-disaster change and recovery processes for the healthcare system on the island of Montserrat, West Indies. Taking a systems approach, we adopt a qualitative case study methodology to explore post-disaster changes over an extended timeframe (1995-2012). We identify many different aspects of change, which lends a new perspective on post-disaster change types for complex systems, and an alternative classification for analysis of their recovery. Recovery of the healthcare system is ongoing. We find that recovery is not a uniform process. Different elements of the system show signs of recovery at different times. This exploratory study documents the complex and long-term nature of disaster recovery in this context, which brings new understanding of change and recovery processes and raises important considerations for future studies.

Keywords: relocation, recovery, healthcare, complex systems, Soufrière Hills Volcano

Introduction

Disaster recovery is defined as: ‘The restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors’ (UNISDR 2009, p. 10). Recovery is understood to be a complex process that is non-linear and multi-dimensional, with a lack of consensus on its endpoint and no agreement on the measures of success (Johnson and Hayashi 2012; Rubin 1985). By triggering physical, social, economic, political and environmental changes, disasters create an altered context. Recovery therefore takes place in the new normality that is created in a post-disaster context.

A recent special issue of this journal on disaster recovery reviews current understanding and finds that although much is known about what hinders long-term recovery, there are no unifying theories, underpinned by sound research, to help to inform policy decisions in post-event contexts (Reiss 2012). Longitudinal studies of recovery are needed in order to better understand how disaster recovery processes unfold over a period of years (Chang 2010; Cutter et al. 2006; Reiss 2012; Rossetto et al. 2014; Rubin 2009). Further, the Sendai framework for disaster risk reduction emphasises the need to learn from recovery and reconstruction programs, to build back better, reduce future disaster risk and increase resilience to disasters (UNISDR 2015).

This study addresses a key knowledge gap in gathering empirical data of disaster recovery processes over many years. The island of Montserrat, West Indies, provides a context in which long-term disaster change and recovery processes can be studied in depth, following the onset of the eruption of the Soufrière Hills Volcano (SHV) (ongoing since 1995). The eruption prompted a large-scale relocation of the population further from the volcano, and triggered an unfolding and long-term disaster. Taking a systems approach, bounded by the geographical extent of the island, we adopt a qualitative case study methodology to explore the long-term recovery of the healthcare system in Montserrat through the experiences of its staff.

In this paper we set the context and challenges in understanding disaster recovery. We present a background to the case study and outline our methodological approach. We present an overview of change for the healthcare system and analyse empirical data to reveal the dynamic nature of large-scale relocation. We identify multiple aspects of post-disaster change for this complex system, and present a classification system for unpacking disaster recovery processes and timescales of recovery within the healthcare system in this context. This exploratory analysis provides a long-term empirical case study of the recovery process, which lends new understanding of post-disaster change and recovery and highlights key considerations for future research.

Disaster Recovery

Over the past decade there has been an enhanced focus on recovery research (Chang 2010; Smith and Wenger 2007). Recovery is a social process, with its roots in the pre-

impact period as well as post-impact actions (Nigg 1995; Smith and Wenger 2007). Different groups, organisations, communities, economies and the environment experience different impacts from disasters and differing kinds and rates of recovery afterwards. The recovery process is complex, dynamic and multidimensional. It involves rebuilding lives and livelihoods, as well as buildings and infrastructure (Chang 2010; Olshansky 2005; Phillips 2009; Tierney and Oliver-Smith 2012). There is currently no consensus on how to measure recovery (Johnson and Hayashi 2012). Recovery has no fixed point at which it is considered to have been completed (Rubin 1985; Olshansky 2005; Johnson and Hayashi 2012).

A variety of common terms are used in the literature to mean recovery. They include: reconstruction (post-impact rebuilding); restoration (re-establishing pre-disaster physical and social patterns); rehabilitation (restoration to include more people and things, perhaps to an improved level); restitution (restoration of the rightful claims of owners and implied legal actions); recovery (attempting to bring some level of acceptability to the post-disaster situation) (Quarantelli 1999). Despite the positive phrasing suggested by the terms used for recovery, there is an alternative pessimistic argument that suggests that there will be uncertainty, unforeseen events and a reproduction of social vulnerability. In some cases people do not recover (Nigg 1995; Smith and Wenger 2007; Wisner et al. 2004).

Successful recovery is conceived in different ways. From a social perspective, post-disaster activities should increase community resilience to disaster (Mileti 1999; Phillips 2009; Wisner et al. 2004). From a built environment perspective, repair and development of relationships between parts of the system that enable operation and coping in a new context is a manifestation of recovery (Alesch and Siembieda 2012). A study of urban systems argues that disasters create temporary instability where rates of change exceed pre-disaster rates. Recovery is attained when stability is regained in the altered post-disaster context (Chang 2010).

Changes stimulated by disasters may be slow or rapid, linear or non-linear, planned or unplanned and may manifest themselves in many ways across society (Birkmann et al. 2010). Post-disaster changes may be difficult to identify soon after an event: long-term study is required. Birkmann et al. (2010) propose a classification system for types of change: organisational, environmental, social, economic and legal systems. This system is used to compare case studies of two areas affected by the 2004 Indian Ocean tsunami, revealing that formal interventions such as relocations demonstrate both positive and negative outcomes. This classification allows for comparison of recoveries across geographic contexts, yet may be too broad to analyse change processes for smaller units of analysis, such as organisations or complex systems. Understanding change processes on a different scale may require a more specific framework for analysis.

During critical times, such as disasters or political events, 'policy windows' (windows of opportunity) may open where media and public concern, policies and politics (decision makers) can unite, allowing problems to be coupled with solutions (Kingdon 1995; Longest 2003). A number of key international organisations (United Nations Development Program (UNDP), and the World Bank) have been promoting

the concept ‘Build Back Better’ in disaster recovery (Clinton 2006; Mannakkara and Wilkinson 2013; Monday 2002). There is a need to understand change processes in order to negotiate the post-disaster ‘window of opportunity’ for structural change in society, and to promote positive disaster outcomes (Birkmann et al. 2010).

Many challenges and gaps remain in understanding long-term disaster recovery. The recovery process can last decades, yet most studies are of limited duration or represent single points in time across the disaster recovery continuum (Smith and Birkland 2012). Studies of recovery must be viewed over a much longer time-scale in order to understand the processes at work, and the outcomes of in-crisis and post-crisis decision-making, as well as the timescales of the recovery process and the factors influencing it (Mitchell 1996; Reiss 2012; Smith and Birkland 2012). There is a need to learn from past case studies. Holistic and longitudinal studies of recovery are important research gaps in this field.

Methodology and Case Study Context

This study takes a long-term view of post-disaster change and recovery in Montserrat, West Indies. We take a systems thinking approach, focussing on the healthcare system as a critical and complex system with key roles in disaster response as well as the long-term well-being of society (Achour and Price 2010). Disruption of the healthcare system has a direct impact on the community. We adopt a case study methodology and qualitative methods to gather empirical data of change over time for the healthcare system, using semi-structured interviews, focus groups, and secondary data sources, as well as an inductive timeline tool. Data collection for the study was undertaken in 2010-2012.

A systems thinking approach focusses on the interactions between multiple parts of a system, which account for its emergent properties and dynamic behaviour (Checkland 1999; Simonović 2011). Healthcare systems are complex adaptive systems, comprising interacting elements, including: governance, financing, information, health workforce, medical products and technologies, and service delivery (WHO 2007). Dynamic relationships between these elements are self-learning; consequently their behaviour in response to change is characterised by a degree of unpredictability (Kay 2008).

A systems approach provides a flexible and dynamic framework that takes all aspects of a system into account in order to explore a problem holistically (Checkland 1999). The interactions of systems are not only within the system itself (the interrelated elements of its construction), but also between the system and its context. In systems approaches the scale and the boundaries of the system under study need to be defined.

Case Study Context

Montserrat is a small British Overseas Territory in the West Indies, with a colonial history and a complex dual government system shared between the British Governor (appointed by the UK Government) and the locally elected Government of Montserrat

(GoM). The sudden onset eruption of the Soufrière Hills Volcano (SHV) began on 18 July 1995 (Sparks and Young 2002). Large-scale evacuations from inhabited areas closest to the volcano ensued. In 1996 the majority of the population, including the capital of Plymouth, were permanently relocated further from the volcano (Aspinall et al. 2002). Much housing and most of the island's infrastructure had to be relocated and re-established in the under-developed north of the island (Clay et al. 1999). Real GDP declined by 44% between 1994 and 1997 and by early 1998 the population had fallen by about 70%, from 10,639 recorded in the official census of 1991, to around 3,000 people (Clay et al. 1999; GoM 1991; Kokelaar 2002). By 2001 the population increased to 4,491 (GoM 2001).

The eruption, which is ongoing, has triggered a protracted disaster that has been exacerbated by a complicated dual governance system, large-scale population emigration, and significant economic decline (Clay et al. 1999; Druitt and Kokelaar 2002; Haynes 2005; Haynes 2006; Sword-Daniels et al. 2014; Wisner et al. 2004). Today, ashfalls, acid rain and gases from the ongoing eruption intermittently affect the relocated population in the north of the island. The British Government currently supports Montserrat's economy through the Department for International Development (DFID), providing around 60% of the recurrent budget (Clay et al. 1999; Sword-Daniels 2014). DFID provided more than £350 million to support Montserrat during the period 1995-2012 (DFID 2012a).

The large-scale relocation, economic and social change, and the protracted nature of the eruption create a complex context in which recovery must take place. To date there are no studies of long-term change or recovery on Montserrat, raising questions about the nature and outcomes of the relocation, the dimensions of recovery and change processes, and how far Montserrat has recovered from this disaster.

Data Collection

The healthcare system consists of one 30-bed hospital (secondary care), two elderly care homes (one public, one private), four clinics (primary care) and a headquarters. The hospital can perform limited secondary care services. Tertiary care is available via an overseas referral system in Barbados, Jamaica or Antigua, and between 2006 and 2010 a total of 58 people were referred overseas (mainly to Antigua and Barbuda) (PAHO 2012). There is a resident surgeon, anaesthesiologist and physician on the island, as well as visiting specialists from other islands. In 2012 there were 134 employees in secondary healthcare, and a total of around 200 employees in all levels of healthcare on the island (Sword-Daniels 2014). Overall there is a shortage of trained health personnel, particularly in primary care, where three of four clinics are staffed by only one nurse (PAHO 2008).

A purposive sample of experienced healthcare employees was selected to gain participant-centred perspectives of change through time, as well as detailed understanding of the consequences of volcanic activity for the healthcare system. A total of 47 staff participated, from different levels and parts of the healthcare system:

healthcare managers (including senior management in headquarters), healthcare professionals (doctors, nurses, other technical staff and specialists), and maintenance and cleaning staff (see Table 1). The high proportion of female participants is representative of the composition of healthcare workers on the island (for example, all clinic staff are female).

Using a Timeline to Construct a Chronology of Change

Timelines allow documentation and recording of participants' past experiences through time, while simultaneously extending and deepening understanding of the context (Sheridan, Chamberlain, and Dupuis 2011). Drawing on timeline methods (Bagnoli 2009; Sheridan et al. 2011), we gathered longitudinal retrospective data using an inductive timeline tool, developed for use within a focus group setting. The method and application of this tool is described in detail elsewhere (Sword-Daniels et al. 2015).

Challenges in using retrospective methods over long periods of time include participant recall, where lapses of memory, simplification of events, and also rationalisation, self-presentation and attribution are possible (Wolfe and Jackson 1987). Yet retrospective reports serve to gather rich detail on changes as perceived, framed and expressed by expert informants (Glick et al. 1990). Multiple informants create improved internal validity by checking accounts against others, resolving discrepancies in face to face discussions among informants (Wolfe and Jackson 1987). In Montserrat eliciting empirical data from retrospective recall is essential, as there is little documentation of the longitudinal effects of the ongoing eruption (Sword-Daniels 2014). In this context timeline tools are valuable for generating empirical data of changes over time.

Using the timeline tool, the participants chronicled detailed aspects of change within the healthcare system, from before the onset of the eruption until the present day, focussing on three main aspects of change: resources and training, physical changes to buildings, and actions to reduce the effects of volcanic activity. The recalled changes were triangulated with interview data and the following secondary documents: Government of Montserrat (GoM) budget speeches (GoM 2004; 2005; 2007; 2008; 2009; 2010; 2013), Department for International Development (DFID) records (DFID 2012a; 2012b; 2012c), technical literature (PAHO 2007; Wason 1994), and books chronicling events at the time (Buffonge 1998; 1999; 2000). Triangulation revealed just four discrepancies in timeframes (by one year) between group recall and the secondary data sources across the multiple aspects of change recalled.

Data were used to construct a chronology of changes to the healthcare system (Appendix 1). Qualitative data collection enabled deeper explanation of the observed changes, helped to delineate background trends, and to qualify the completeness of the data. For example, staff contextualised their responses to eruptions (actions to reduce impacts), saying that these had not significantly changed over time. They also confirmed that in general healthcare staff training had increased since the onset of the eruption.

Table 1: Information about the Participants in This Study.

	No. Healthcare participants	Male	Female	Living on Montserrat pre-1995	Moved to Montserrat after 1995	Montserratian	Non-Montserratian
Interview	23	7	16	20 (87%)	3 (13%)	17	6
Focus Group	28	1	27	12 (43%)	16 (57%)	17	11
Total	47	8 (17%)	39 (83%)	28 (60%)	19 (40%)	32 (68%)	15 (32%)

Note: Four focus group participants were also interviewed for further insights from their experience of the eruption. These participants are subtracted from the final total, to avoid double-counting. All four of these participants were living on Montserrat before 1995: two are Montserratian and two are non-Montserratian.

Table 2: Information about the Participants in This Study.

	No. Healthcare participants	Male	Female	Living on Montserrat pre-1995	Moved to Montserrat after 1995	Montserratian	Non-Montserratian
Interview	23	7	16	20 (87%)	3 (13%)	17	6
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Empirical data were analysed chronologically and thematically (Gibson and Brown 2009). Themes derived from the data were developed into a classification of post-disaster change types for analysis. The classification was used to delineate and plot qualitative patterns of change over time by counting the number of changes in each category. The chronology of changes relates to background trends as well as direct post-disaster change. Post-disaster processes may also be inferred from reduced instability in the rate of change over time as a new normality is reached (Chang 2010).

Results: Delineating Aspects of Change and Recovery Over Time

The healthcare system has undergone significant change since the onset of the eruption. Formerly the majority of essential services on the island were centred on Plymouth, the capital, located just 4 km from the volcano. There were 12 primary care clinics distributed in villages around the island, and a large hospital complex located in Plymouth. The Glendon hospital was being upgraded at the time of the eruption and had a 67-bed capacity. The onset of the eruption, enforcement of the exclusion zone, and permanent relocation to the north of the island, prompted changes to the healthcare system. These included: closure of healthcare facilities (including eight primary care clinics); changes in staffing levels (for example the number of registered nurses fell from 40 in 1994, to 13 in 1998) (PAHO 1998); staff out-migration and retraining of new employees; re-organisation of some services that became incorporated within remaining clinics or were stopped (for example some hospital services including laparoscopy and peritoneal dialysis were no longer tenable due to equipment shortages or issues of supply reliability); a change in healthcare financing; a need to address new public healthcare needs (including housing for the elderly and mental health patients); a change in community nursing structure (formerly nurses lived in nurses' homes on the premises of the district clinics, rather than elsewhere on the island); and relocations and physical modifications of healthcare facilities on the island (including upgrading the St John's school into a hospital facility, and renovation of the islands remaining clinics) (Appendix 1). Figures 1 and 2 show the number and location of healthcare facilities in 1995 and 2012. Overall the reduction in population number, and the increased proximity of the population to the hospital after the relocation has mediated the impact of health facility closures. Yet the hospital lacks space and facilities, and the loss of skills and staff experience as well as economic constraints create challenges for the function and development of the healthcare system today (Sword-Daniels 2014).

Relocations of Healthcare Departments

Following the large-scale relocation in 1996, many of the healthcare departments have moved a number of times across the north of the island. The relocations of healthcare departments over time are shown in Figure 3. Some of the relocation sites were temporary and others permanent. Most departments have moved location more than once. For example the health promotion department moved three times after the

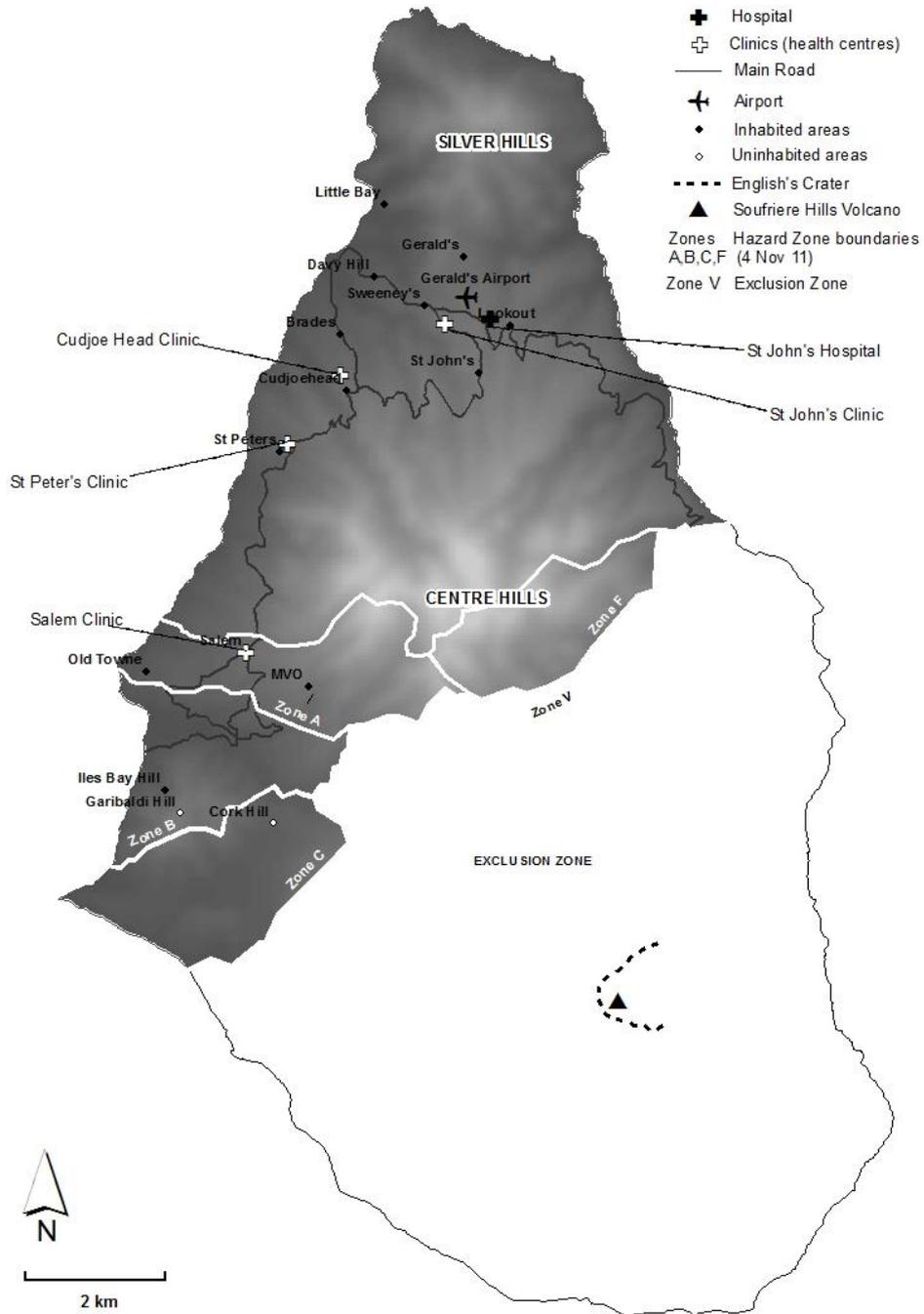


Figure 2. Healthcare Facility Locations in 2012.

The relocation from Plymouth and the south in 1996 was not a static occurrence. Relocations prevailed over a very long time period. No primary or secondary healthcare department has remained in one place throughout the relocation process. Relocations continued into 2009 for secondary care, and into 2012 for primary care. For example, dental, sexual health and health promotion departments all moved to alternative (and permanent) buildings in 2012.

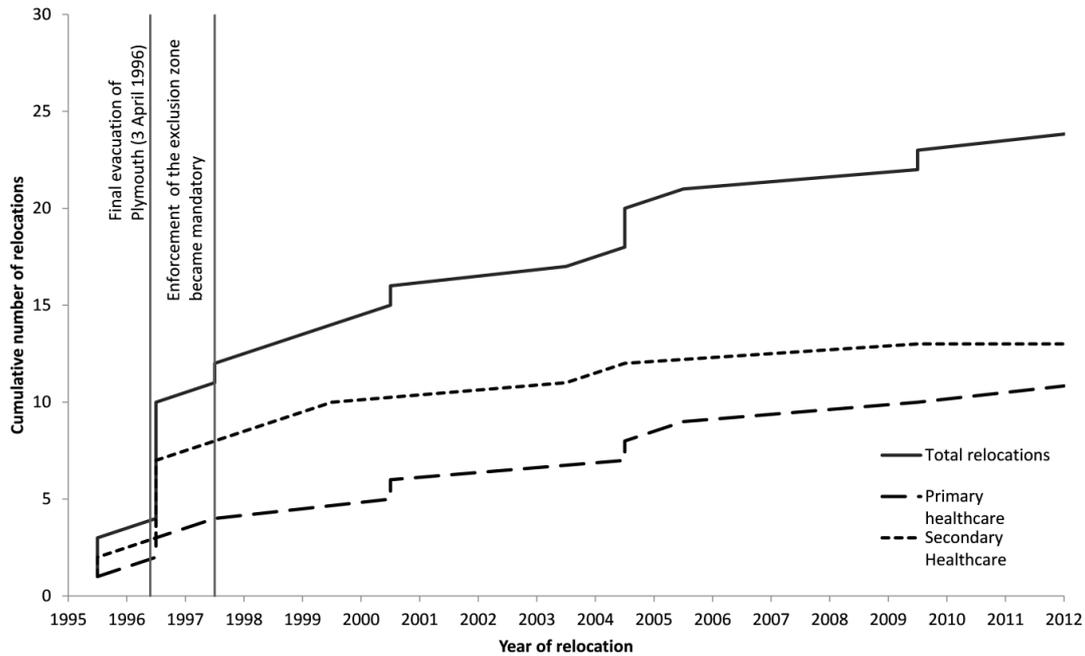


Figure 3. Relocations of Healthcare Departments Over Time. Relocations of both primary and secondary care facilities and departments are delineated. The overall profile of relocations for the healthcare system is also shown. Two significant events are shown: the final evacuation of Plymouth on 3 April 1996, and the mandatory enforcement of the exclusion zone after 19 people lost their lives on 25 June 1997 (Loughlin et al. 2002).

Classification of the Multiple Dimensions of Recovery

Many aspects of change within the healthcare system were evident from the empirical data (Appendix 1). These were grouped thematically into five types of post-disaster change: response actions for risk reduction, policies, training, resources and services, relocations and structural changes. These change types are specific to this complex system, and differ from those used to compare geographic areas affected by other disasters (Birkmann 2010). Further, this is an ongoing eruption context, which affords opportunities to explore processes of adaptation to living and working in a context of continual change, where the system is intermittently affected by volcanic ashfalls. Unique insights are gained for risk reduction approaches and the adjustment of services over time within this context, where change and recovery processes take place alongside ongoing hazards. As such, this exploratory analysis lends a new perspective and an alternative classification of post-disaster change types for the healthcare system, which provides a framework for analysis of change and recovery processes in this context. The classification of change types and their definitions are shown in Table 2.

Table 3: Empirically-derived Classification of Post-disaster Change Types for the Healthcare System in Montserrat.

Classification of Change Type	Description
<i>Relocations and structural</i>	Relocations include temporary and permanent moves of facilities and departments after the onset of the eruption. Structural changes include newly constructed buildings, buildings modified for purpose (renovated or converted) and structural modifications (e.g. installation of Plexiglas in windows, which, coupled with air conditioning, acts to reduce ash ingress into buildings). Relocations often involved some refurbishment (structural change) to make the facility suitable for use, and the construction of new buildings also involves relocations as departments move into them. Relocations and structural changes form one classification comprising all of the physical changes to healthcare infrastructure.
<i>Response actions for risk reduction</i>	Response actions for risk reduction include staff-enacted (collective or individual) responses within the healthcare system (e.g. covering equipment for protection from ash), and organisational responses of other sectors to reduce the effects of hazards at healthcare facilities (e.g. ash clean-up of health facilities by the Fire Department).
<i>Policy changes</i>	These include policies to address the new needs of the population (e.g. policies for housing the elderly and mentally challenged); the new environmental context (e.g. mass casualty response plans); new operating standards and protocols for healthcare; as well as updating and amending existing healthcare policies (e.g. maternal child health) (GoM 2009).
<i>Training</i>	Training includes individual training (there are many ‘single-trained’ specialists in healthcare on the island), and group training in specialities (e.g. eye care, midwifery, and geriatric care), as well as mass casualty simulations, information technology training, and nurse training programmes at the community college in Montserrat.
<i>Resources and services</i>	Resources and services include changes to staffing levels, changes in the specialities offered and frequencies of visits by specialists to the island, changes in physical resources (e.g. medical equipment, computers, air conditioning systems, power wash) the availability of new services (ultrasound, physiotherapy, HIV/AIDS and high risk antenatal clinics), as well as changes in the hours of operation for healthcare facilities.

Different types of change are delineated and their cumulative number over time is shown in Figure 4. The chart depicts patterns of change, together with approximate phases of volcanic dome growth activity (phases 1 to 5) as an indicator of periods of heightened volcanic activity.

Each classification type shows variation in the number of changes, the points when they began to change, and the rate of changes over time. Each has a different profile. The multi-faceted nature of change processes is evident.

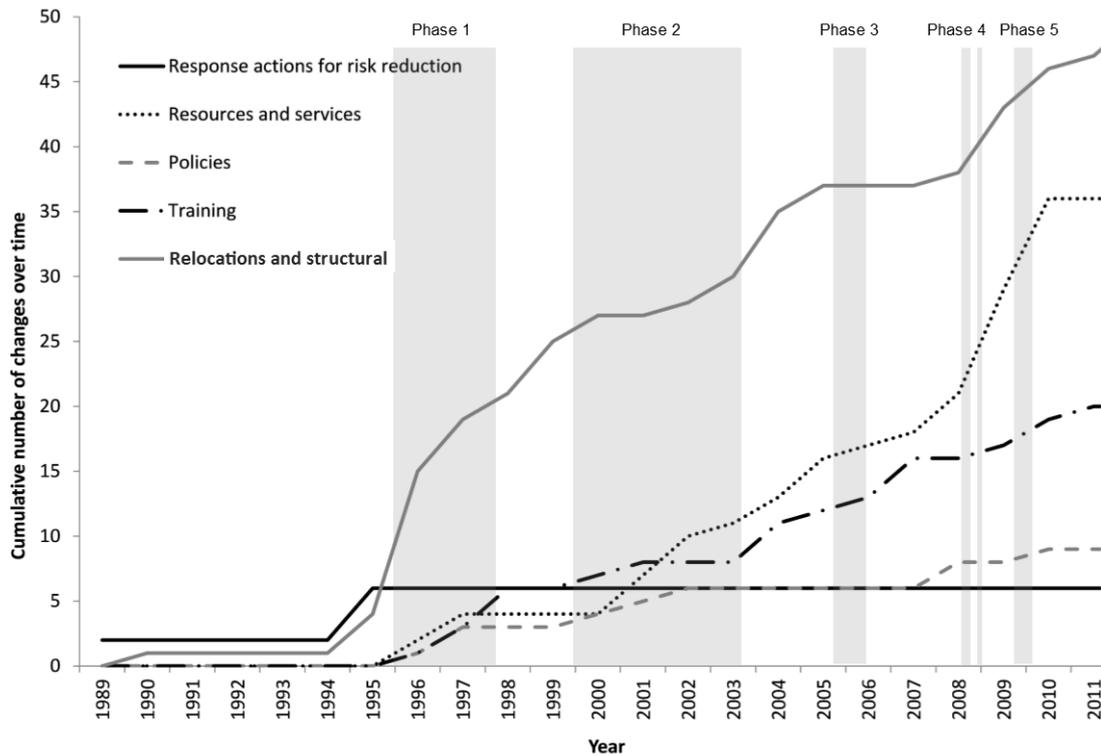


Figure 4. Changes Over Time to The Healthcare System (1989-2012). Phases of dome growth are shaded (Cole et al. 2010; MVO 2013). The timeline of response actions for risk reduction and structural change starts from 1989, because the participants attributed these to Hurricane Hugo in 1989 (these include ongoing structural repair work, and responses for risk reduction that were learned from the hurricane experience). The timelines for other aspects of change start from 1995, when eruption began.

Response actions for risk reduction were implemented quickly and changed little from 1995 onwards. However, some responses to reduce the effects of volcanic activity (mainly ashfalls) were adopted from lessons learned from Hurricane Hugo in 1989 about water damage and protection of equipment: participants said that these responses had not substantially changed to adapt to a volcanic context. Other identified response actions were adopted swiftly after the onset of the eruption.

Structural changes were underway at the hospital in Plymouth at the time that the eruption began. These included renovations and major upgrading works as a result of the damage sustained from Hurricane Hugo (Sword-Daniels 2014). Between 1996 and 2000, relocations and structural changes dominate the change types, and few other changes were implemented. Relocation and structural changes were more numerous than other types of change. The trajectory of change slowed in two periods (2000-2003, and 2005-2008). Although there appears to be a correlation between Phase 2 of volcanic dome growth and slowed physical change, healthcare projects were initiated during this period (Appendix 1). Relocations and structural changes were ongoing in 2012.

Resources and services, and training began to change from around 1997. These change types do not appear to correlate with volcanic dome growth activity. Changes in resources and services increased rapidly, with new equipment, specialities and staff

brought into the healthcare system: these were ongoing in 2012. There was a fairly steady rate of change in training from 1998 onwards. Yet the specific training undertaken between 2004 and 2007 was necessary in order to manage specialist healthcare services. This relates to filling key skills gaps left as a result of large-scale staff emigration. The new community college, which opened in 2007, has allowed basic nurse training to be carried out on the island. This re-established background levels of nurse training on Montserrat.

Policy changes in the first few years after the onset of the eruption correspond to times of critical social need: for example, regulations introduced for refuse collection and disposal in 1996 (in response to the population living in shelters), policy for institutional care of the elderly in 1997 (in response to the development of elderly care homes, marking a significant change from family-centred elderly care), and provision of social welfare in 2000 (in response to the changed financial circumstances of many people resulting from losses to livelihoods and homes). After 2002, policy change appears to reflect a return to non-disaster policy development processes.

With the exception of developing response actions for risk reduction, each of the change types remains dynamic through time. This is expected for most aspects of change, as the healthcare system continues to adapt to public health needs and evolve with new technologies and training. Different elements in the healthcare system are seen to show signs of recovery at different times. Changes in response actions show signs of recovery after 1995, policies after 2002, relocations from 2005, and training from 2007. Both resources and services, and structural changes have not stabilised. Recovery in these aspects is not yet achieved.

Discussion: The Process of Recovery

The disaster created both negative and positive outcomes for the healthcare system in Montserrat. The continual change to facility locations over the duration of the eruption (ongoing in 2012) indicates that conditions after the initial large-scale relocation and reconstruction did not adequately meet the healthcare system's needs. It took years to find or to build appropriate facilities. Further, the continued relocation of departments lends a sense of impermanence to some sites. For example, the relocation has stalled development of some other essential services facilities on the island, such as the Ministry of Agriculture buildings and a secondary school, because there is a reluctance to invest in facilities that may be temporary (Sword-Daniels et al. 2014). Within the healthcare system specific contingency plans have been developed for Salem Clinic (related to swift nurse relocation and housing, patient note transfer arrangements, and storage of furniture at a clinic further north). The village of Salem was affected by a year-long evacuation between 1997 and 1998 and plans are in place in case this facility should close again (Sword-Daniels et al. 2014).

This highlights the uncertainty felt by staff concerning the future of the location, and a reluctance to consider the clinic to be a fully-operational site. Salem was also the last clinic to be upgraded, with works undertaken in 2009 (after Cudjoe Head in 2000, St John's in 2002 and St Peter's in 2004). Yet the disaster also created opportunities for

healthcare development. Policy changes since the onset of the eruption corresponded to times of critical social need. These created windows of opportunity for formal change within society (Kingdon 1995; Birkmann et al. 2010).

Further opportunities for healthcare development included improvements in mental healthcare services, elderly care facilities and nutritional services (Sword-Daniels 2014). For example after the onset of the eruption there was a new need for elderly care homes to care for large numbers of elderly people, as family members migrated overseas (reducing extended family networks), or when families relocated to shelters where they were unable to care for the elderly. Housing was coupled with a new elderly care policy and training for geriatric aides in the healthcare system. Similarly new housing and increased services for mental healthcare patients were required. A new mental health unit was opened at St Peter's Clinic in 1996, psychiatrist visits to the island increased from 2002, and staffing and training in mental health increased.

Mental healthcare client housing projects were completed in 2009 and 2010. Non-Communicable Diseases (NCD's) are leading causes of death in Montserrat, and prevalence is increasing among younger people. Some changes to lifestyle were prompted by the eruption, for example loss of property and land in which to cultivate back-yard gardens, and reduced recreational facilities (Sword-Daniels 2014). Realising the importance of managing NCD's through diet and exercise led to increases in staffing and services for nutritional health. These are positive outcomes of the recovery process.

From 1995 to 1999, reconstruction activities were prevalent in the chronology of changes. There was some restoration as facilities were upgraded, services were restructured and training focused on filling the skills-gaps left following staff emigration. From 2000 restoration continued, and some level of rehabilitation began as training and resources increased. Policies, services and facilities were also improved in order to capitalise on new opportunities for healthcare development.

Rehabilitation was more prevalent in the recovery process from around 2007-2008. This is evident from the new operating standards, new services and equipment, and purpose-built facilities or facility extensions. Recovery on Montserrat has been a non-linear process, while some aspects of reconstruction, restoration and rehabilitation have occurred concurrently. Overall, signs of recovery were more prevalent after 2007-2008. This is around 11-12 years after the large-scale relocation of the population. Considering the healthcare system as a whole, recovery is ongoing. This demonstrates the prolonged timeframes of disaster recovery processes.

Looking to the future, there are plans for continuing healthcare development. Funding for a new hospital was approved by DFID in 2012 (GoM 2013), in an agreement that also addresses changes to the way in which the healthcare system operates and is financed (The Montserrat Reporter 2011). These changes are planned to take place over the next few years, transforming the site of the current hospital in St John's in a phased development programme over four years (2012-2016) (DFID 2014). Facilities are to be upgraded and built around existing structures on the St John's site. These include a new minor theatre for day surgery, obstetric and paediatric wards (currently patients are treated on the main adult female ward), an expanded diagnostics facility and pharmacy. The hospital will have a 38-bed capacity.

The changes will improve space and facilities, allow increased services to be carried out on the island and modernise aspects of the system including electronic ordering systems for supplies. Yet some physical modifications to enable coping with the challenges of volcanic ashfall (e.g. changes in roofing style and material for improved longevity, and alternative drainage systems) are not being made (Sword-Daniels 2014). The reason for this is unknown. As a result of the planned changes, the healthcare system will continue towards reaching stability within the new context at some point in the future.

In addition to changes in the physical infrastructure (following relocation and re-establishment) and the environment (ongoing volcanic eruption), the wider social and economic context shows some indications of reaching a new normality, which constitutes a significant change. The population appears to have stabilised at roughly half of the pre-eruption level, official census data show a population of 4,922 in 2011 (GoM 2012). As a small island, Montserrat's economy is dependent on foreign economic circumstances (Briguglio 1995; Clay et al. 1999). The economy has not recovered from the volcanic eruption and remains reliant on DFID for funding.

Conclusions

This research offers three main contributions to our understanding of disaster recovery processes. First, the large-scale relocation to the north of the island was far from a static process. Ongoing relocations, modifications and completion of new healthcare facilities have continued since the onset of the volcanic eruption to the present time. These processes are dynamic and long-lasting. Dynamic change lends a sense of impermanence to relocation sites that may delay the recovery process. The link between ongoing relocations and development processes makes the dynamic nature of relocation an important element of long-term recovery that requires further study.

Second, a classification of post-disaster change types is developed from empirical data that provides a framework for unpacking recovery processes within a complex system. This framework has been developed within an ongoing volcanic eruption environment, but may be applicable to complex systems in other hazard contexts. Additional case studies of complex systems in other disaster contexts and triggered by single-event hazards, would advance knowledge of these change types and of their recovery processes. This could help recovery actors to negotiate the post-disaster window of opportunity and promote positive development outcomes.

Third, this exploratory study shows that for complex systems, recovery takes different forms, with its multiple aspects changing and adapting to a new context in different ways and at different times. Each aspect of post-disaster change shows signs of recovery at different points in time. In Montserrat, recovery has taken anywhere from one year to in excess of 17 years, depending upon the type of change under study. Yet, when considering the healthcare system as a whole, integrating all of its elements, it is clear that recovery is ongoing. The multiple aspects and decadal timescales involved demonstrate the complex and protracted nature of disaster recovery processes.

We conclude that further studies of disaster recovery should be conducted holistically, and cover decadal timescales in order to more-fully understand recovery processes. Additional case studies of recovery over similar or extended timeframes will serve to better-understand post-disaster change and recovery processes within a range of specific contexts. This would help to inform policy and post-disaster decision-making.

Acknowledgements

We would like to thank EPSRC for funding this research through the Centre for Urban Sustainability and Resilience at University College London, the British Geological Survey BUFI fund for funding the fieldwork to undertake this research and the New Zealand Ministry of Science and Innovation Natural Hazard Platform Grant C05X0804. We are indebted to all of the people who participated in this research in Montserrat; both interviewees and others who interacted with the researcher in the field, and who gave generously of their time and contributed to this research. The support of the Montserrat Volcano Observatory was also invaluable during fieldwork. We would also like to thank Dr Thomas Wilson, Dr Sue Loughlin and Dr Susanne Sargeant for intellectual guidance during the research process. We are grateful to the British Geological Survey and the Strengthening Resilience in Volcanic Areas (STREVA) project for support during the writing of this paper. Finally, we would like to thank Dr Carina Fearnley for comments on an early draft of this manuscript, and two anonymous reviewers for their constructive comments in the review process, which have improved this paper.

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Appendix 1 Changes made to the healthcare system from 1989-2012³

Year	Description	Status of change ¹	Classification of change ²
1989	Covering equipment and files for protection (at clinics)	New	Response action
1989	Placing ice packs in vaccine fridges during power outages (at clinics)	New	Response action
1990	Reconstruction after the hurricane (including roofing at Glendon Hospital (Wason 1994)	Modification	Structural
1995	Hospital moved to St John's School (inpatients), St John's	Temporary (became permanent)	Relocation
1995	Margetson Memorial moved to St Peter's school (Buffonge 1999), St Peter's	Temporary	Relocation
1995	Dental moved to St John's School, St John's	Temporary	Relocation
1995	Fire Search and Rescue (Fire SAR) and Public Works Department (PWD) began washing healthcare facilities of ash (including Plymouth)	New	Response action
1995	Covering equipment and files for protection (at clinics)	Modification	Response action
1995	Placing ice packs in vaccine fridges during power outages (at clinics)	Modification	Response action
1995	Radio information for clinic clients	New	Response action
1996	Final evacuation of Glendon Hospital, Plymouth	Permanent	Structural
1996	Final evacuation of seven clinics in the southern areas (five clinics remain open on island)	Permanent	Structural
1996	Regulations for the collection and disposal of refuse (GoM 2009)	New	Policy
1996	Margetson Memorial moved to St John's school (Buffonge 1999), St John's	Temporary (became permanent)	Relocation

Year	Description	Status of change ¹	Classification of change ²
1996	Operating theatre moved to St John's Clinic, St John's	Temporary	Relocation
1996	Casualty and X-Ray moved to St John's nursery school, St John's (Buffonge 1999)	Temporary	Relocation
1996	St John's Clinic moved to St John's nursery school, St John's (Buffonge 1999)	Temporary	Relocation
1996	Laboratory, pharmacy, medical records, outpatients moved to St John's School, St John's	Temporary (became permanent)	Relocation
1996	Mental health unit at St Peter's Clinic, St Peter's	Temporary	Relocation
1996	Medical stores located at: St John's School, a house in Gerald's and the Defence Force Barracks, Davy Hill	Temporary	Relocation
1996	Decrease in nursing staff (island-wide)	Modification	Resource
1996	Distribution of ash masks at Clinics	New	Resource
1996	St John's School upgraded to house the Hospital, St John's (Buffonge 1999)	Modification	Structural
1996	School of Nursing discontinued, Plymouth	Permanent	Structural
1996	Mass casualty simulations (Buffonge 1999)	New	Training
1997	Mass casualty plan finalised (Buffonge 1999)	New	Policy
1997	Policy for institutional care of the elderly (Golden Years Foundation care of the elderly act 1997) (GoM 2009)	New	Policy
1997	Mental health unit moved to St John's Clinic grounds, St John's	Temporary (became permanent)	Relocation
1997	Closure of Family Life Services (FLS had moved from Plymouth originally, but became part of the extended exclusion zone in August 1997) (Buffonge 1998)	Permanent (although the service was incorporated into clinics)	Resource
1997	Cork Hill Clinic closed	Permanent	Structural
1997	Salem Clinic closed, furniture stored at Gerald's	Temporary	Structural
1997	Hill View home opened (below hospital at St John's). Official opening 1998 (Buffonge 2000)	Temporary	Structural and relocation
1997	Decrease in nursing staff continues	Modification	Resource
1997	Midwifery training (individual)	New	Training
1997	Training in health information (individual)	New	Training
1998	Nursing training (individual)	New	Training
1998	Registered Nurse training (individual)	New	Training
1998	Golden Years Home built in Brades. Golden Years Home was handed over to the Golden Years Foundation by the Red Cross. The home was completed on 21 August 1998 and	New	Structural and relocation

Year	Description	Status of change ¹	Classification of change ²
	housed residents from the two Red Cross shelters: 'scraps memorial' (in St Peter's) and Cavalla Hill (Buffonge 2000)		
1998	Upgrading of St John's school into hospital. Wards completed in 1998 (male, female and obstetrics wards with paediatrics provision included in the female ward), St John's (Buffonge 2000)	Modification	Structural
1998	University of the West Indies (UWI) care of the elderly course for geriatric aides	New	Training
1999	Upgrading of St John's school into hospital (Medical records, laboratory, pharmacy, 1999), St John's (Buffonge 2000)	Modification	Structural
1999	Upgrading of St John's school into hospital (Kitchen, 1999), St John's (Buffonge 2000)	Modification	Structural
1999	Upgrading of St John's school into hospital (casualty, X-Ray and Nursing Administration, 1999), St John's (Buffonge 2000)	Modification	Structural and relocation
1999	Salem clinic re-opened. Salem	Modification	Structural
2000	Means tested Social Welfare System (PAHO 2007)	New	Policy
2000	St John's Clinic moved to the nurse's home (St John's)	Temporary	Relocation
2000	Cudjoe Head Clinic moved to Cudjoehead police station basement for six months during renovation	Temporary	Structural and relocation
2000	Training in post-basic psychiatry (individual)	New	Training
2001	Nutritional policy (<i>estimated date</i>)	New	Policy
2001	Computer obtained for St John's clinic	New	Resource
2001	Private gynaecologist started working on island	New	Resource
2001	New epidemiologist/health planner post	New	Resource
2001	Staff training in information technology	New	Training
2002	Maternal Child Health policy (amendment in the Public Health Act (GoM 2009))	Modification	Policy
2002	Power wash installed at the hospital, St John's	New	Resource
2002	Increase in psychiatrists visits	Modification	Service
2002	Turning point project moved into St John's nurse's home, St John's	Temporary (ran from 2002-2005)	Service
2002	Renovation of St John's Clinic. Completed 2002. Officially opened 2003, St John's (GoM 2004)	Modification (permanent)	Structural
2003	Medical stores all moved into Theatre basement purpose-built	New	Relocation

Year	Description	Status of change ¹	Classification of change ²
	storage area, at the hospital in St John's		
2003	Distribution of ash masks at police stations (to relieve pressure on clinics)	Modification	Resource
2003	Hospital operating theatre built, St John's (GoM 2004)	New	Structural
2004	Training in medical records (individual)	Modification	Training
2004	Training in Public Health Nursing (individual)	Modification	Training
2004	Specialist nurse training in Intensive Care Unit (ICU) gerontology (individual)	New	Training
2004	Operating theatre moved into new building 2004, St John's	Modification (permanent)	Relocation
2004	Sexual Health housed at Old St Peter's Clinic, St Peter's	Temporary	Relocation
2004	Development of a Patient Information System ('PUTTY') at the hospital, St John's	New	Resource
2004	Full-time physiotherapist employed (GoM 2004). Physiotherapy in Post Office Building, St Peter's	New	Service
2004	Plexiglas added to new operating theatre (post-build), St John's	Modification	Structural
2004	Renovation and opening of St Peter's clinic and eye clinic at St Peter's (GoM 2005)	Modification	Structural and relocation
2004	Hospital mortuary built, St John's (GoM 2005)	New	Structural
2005	Dental building (moved from wooden building, into basement of St John's Clinic), St John's	Modification	Relocation
2005	Added air conditioning to St Peter's Clinic, St Peter's	Modification	Resource
2005	Assistant radiographer hired	New	Resource
2005	Training as a radiographer (returned 2009) (individual)	New	Training
2005	Free gynaecology service started	Temporary	Service
2005	Upgrading Hill View Home, on the hospital site, St John's	Modification	Structural
2006	Gynaecology service reduced	Temporary	Service
2006	Training in Public Health Nursing (individual)	Modification	Training
2007	Added air conditioning at St John's clinic, St John's	Modification	Resource
2007	Training in mental health (individual)	Modification	Training
2007	Training in Housekeeping (individual)	New	Training
2007	Nurse training began at Community College, Salem (GoM 2007)	New	Training
2008	New laboratory standards and operating guidelines for the hospital, St John's	New	Policy

Year	Description	Status of change ¹	Classification of change ²
2008	Policies for housing and care of the mentally challenged (GoM 2009)		Policy
2008	Computers in all clinics	New	Resource
2008	New ultrasound machine installed in a sealed room in the hospital, St John's	New	Resource
2008	Re-start of microbiology department at the hospital, St John's	New	Service
2008	Hill view and Margetson Memorial merged and moved into new building (same site), St John's	New	Structural
2009	Health Promotion moved into Cudjoe Head (originally above St John's Day care centre [since 2007])	Modification	Relocation
2009	New bio-chemistry equipment at the hospital, St John's	New	Resource
2009	Ultrasound being offered privately (unknown location)	New	Service
2009	Additional person trained in Ultrasound (individual)	New	Training
2009	New mental health staff member, St John's Clinic	New	Resource
2009	Air conditioning in maternity ward, hospital, St John's	Modification	Resource
2009	HIV/AIDS Unit started, St Peter's	New	Service
2009	Start of paediatric clinic (clinics)	New	Service
2009	Women's health clinic started (clinics)	New	Service
2009	Extended hours at St John's clinic	Modification	Service
2009	New physiotherapy building, hospital site, St John's	New	Structural and relocation
2009	Warden-supported housing at Sweeney's and Lookout, and new duplexes (GoM 2010)	New	Structural
2009	Extension of Salem clinic and refurbishment of nurse's home (air conditioning installed in doctor's office), Salem	Modification	Structural
2009	Minor operating room (GoM 2008) - C-Minor renovation, and nurses' station added onto casualty, hospital site, St John's	New	Structural
2010	New blood bank protocol (component separation of blood)	New	Policy
2010	Fire Department shares a single ambulance with the hospital (previously two ambulances), St John's and Brades	Modification	Resource
2010	New laboratory staff, hospital, St John's	New	Resource
2010	New Health Promotion Coordinator	New	Resource
2010	'Enhancing your Mental Health' radio programme started	New	Service
2010	Distribution of ash masks responsibility of Disaster Management Coordination Agency (DMCA) (not Ministry of Health)	Modification	Resource

Year	Description	Status of change¹	Classification of change²
2010	Visiting gynaecology service increased	Modification	Service
2010	High Risk Antenatal Clinic (primary care, but run at hospital due to space issues)	New	Service
2010	Nutrition office built at St John's (unoccupied in 2012)	Modification	Structural
2010	Official opening of Oriole Villa (clients moved in 2009), St John's	New	Structural
2010	Painting and renovation of Cudjoe Head Clinic (and new steriliser), Cudjoehead	Modification	Structural
2010	Training in eye care	New	Training
2010	Training of midwives	New	Training
2011	Mental health housing continued	New	Structural
2011	Mass casualty simulation funded by the Pan American Health Organisation (PAHO)	Modification	Training
2012	Sexual Health and Health Promotion merged and due to move into basement of St John's clinic	Modification	Relocation
2012	Dental moved into new building adjacent to St John's Clinic (above St John's Day care centre) designed for purpose	Modification	Structural and relocation

Notes

¹Changes that constitute clear declines are shaded in grey.

²Status of change includes: modifications or new additions to existing services or structures, as well as temporary and permanent changes.

³Classification of changes include: relocation, structural, resource, service, response action, and policy.