MONTSERRAT – A CASE STUDY IN THE APPLICATION OF MULTIPLE METHODS TO MEET A POST DISASTER HOUSING SHORTAGE

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Abstract

Following the violent eruptions of the Soufriere Hills volcano in 1995 the Island of Montserrat suffered extensive damage and loss to its housing stock.

The post disaster reconstruction programme involved the provision of new housing to meet both the immediate emergency need and the longer term need for the resettlement of the population.

The re-housing programme drew heavily on both local and international resources and incorporated a range of solutions from low-cost prefabricated units, traditional timber framed units, masonry construction (upgraded to meet revised building code requirements) and high quality modular units.

This paper will set out the challenges faced in the implementation of this programme, which included the logistical complications presented by an Island with very few natural resources, a need to maximise local employment and a desire to conform with accepted notions of best practice.

The paper will also compare and contrast the effectiveness of the alternative methods in meeting both the above mentioned challenges and, more importantly, the needs of the Island population.

In conclusion this paper will suggest ways in which lessons learned can lead to improvements of best practice.

Merging local and imported technologies, imported prefabrication, self-help programmes, inadequate prevention, hazard prone area development, natural catastrophes, improved strategies

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INTRODUCTION

In 1995 the Soufriere Hills volcano on Montserrat began erupting for the first time since European settlers arrived almost 400 years ago.

The calamitous damage inflicted upon the Island destroyed most of the economy and forced the evacuation or relocation of 90% of the population.

Plymouth by permission: Doug Darby

With the volcano continuing to exhibit signs of activity the choices facing officials responsible for redeveloping the Island are at best difficult.

This being said, the Island population has grown in recent years from a low of 3000+ in 1997 to just over 5000 in 2001. This population increase drives the need for reconstruction and keeps alive the hopes of displaced Montserratians as they look forward to the day when their return may also be facilitated.

HISTORY OF MONTSERRAT

Montserrat is a small island nation situated in the Eastern Caribbean at Latitude $16^{o}45$”N, Longitude $62^{o}10$”W, and approximately 25 miles due West of Antigua.

The island is mountainous and measures $102km^2$ of which only $33km^2$ at the northern tip are now safely habitable following the recent volcanic eruptions.

Socio-economic history

The Island was first colonised by European settlers in the 1600s and due to the high proportion of Irish immigrants to the Island at this time, Montserrat became known as the Emerald Isle of the Caribbean.

Throughout its history, Montserrat's economic development mirrored many of the other regional Island States. Primary exports have included Tobacco, Indigo, Cotton, Sugar and Limes (Government of Montserrat, 2001).

However, environmental hazards (described below) affecting the Island did much to damage economic conditions and since the 1940's the Island population has been in decline.

In recent decades the Island's economy has relied mainly on Government services, Construction and Residential Tourism. Some manufacturing capacity was developed throughout the early 1990's with the introduction of electronic assembly and rice processing industries.

The volcanic eruptions turned a modest annual budget surplus to a significant annual deficit. The effects were twofold, firstly requiring the expenditure of significant government funds to meet the needs of the crisis and secondly losing significant revenue following the collapse of the industrial, tourism and financial sectors.

Estimates of the damage to the building stock as reported in the Sustainable Development Plan (Government of Montserrat, 1998) are:

▪ Agricultural	EC$47,308
▪ Residential	EC$82,959,063
▪ Business	EC$33,039,441
▪ Institutional	EC$9,168,712
Total	EC$125,214,524
	(US$1: EC$2.6)

The scale of this devastation is fully appreciated when considered in relation to the average GDP for the country between 1997 and 1999 of EC$88.75 million (Montserrat investors guide, 2001).

The Government of Montserrat (GoM) faces considerable difficulties in implementing an effective reconstruction programme as long as the volcano remains active. The balance of payment deficit for the country rose to EC$53 million in 1999 and was set to grow for 2000 and beyond.

Within this context and by virtue that Montserrat remains a British Overseas Territory, the British Government (HMG) has taken a lead role in securing both the financial requirements of the Island and assisting in the development of emergency and redevelopment plans (DFID, 2000).

Natural hazards history

Before considering the housing issues facing the Island it is worth putting into perspective the nature of the natural hazards faced by developers.

Montserrat is a volcanic Island with evidence suggesting at least five major eruptions in the last 30,000 years. Prior to the recent activity, the volcano had been dormant for approximately 400 years, although there was evidence to suggest a 30 years life cycle of activity.

Volcanic activity on the island has been evident in the form of Fumarolic venting in 1897-98, 1933-37, and 1966-67. Evidence of the latest activity was first registered in 1992 as earthquake swarms of increasing intensity shook the country.

Full Phreatic eruption, ash venting and Lahars (Mudflows) began in 1995. In 1997 pyroclastic flows spread out on all sides of the volcano engulfing the capital city of Plymouth and destroying most of the industry and agriculture (Montserrat Volcano Observatory, 1997a).

Ash Cloud by permission: Doug Darby

In mid 2001 the Montserrat Volcano Observatory (MVO) reported that dome growth on the volcano was on-going and volcanic activity was expected to continue for at least two more years and possibly for several decades (Norton, 2001).

Developers need also to be aware that Montserrat lies within an area of significant earthquake activity. Evidence suggests that earthquakes of magnitude 8 on the Richter scale have occurred within a 50km radius of the Island in 1692 and 1843 (Montserrat Volcano Observatory, 1997b).

Montserrat is also subject to the annual onslaught of Atlantic hurricanes with the most severe recent impact occurring in 1989 when a category 5 hurricane, “Hugo”, passed directly over the Island causing severe damage (Ruzdilsky, 1999).

POST DISASTER HOUSING PROGRAMME

The official evaluation report into HMG’s response to the emergency on Montserrat (DFID. 1999a) points out that complex institutional arrangements, unclear responsibility and fragmented authority hampered progress in the resettlement and reconstruction programme.

On-going differences of opinion between HMG and GoM delayed decision-making and confused project implementing agencies by insisting on divergent specifications and standards throughout the implementation period.

Abandoned House by permission: Doug Darby

Emergency temporary housing

In the early stages of the emergency, temporary shelter was found by utilising Churches, Schools and other public facilities. Although these represent traditional forms of shelter in the event of hurricanes, their use is generally restricted to short duration occupancy lasting a few days at most.

The volcano disaster forced longer-term occupation and placed residents under intolerable strain due to the poor sanitation arrangements, overcrowded conditions and lack of privacy.

The initial situation was eased as it became evident to many Montserratians that the disaster held long-term implications and many left the Island.

In efforts to ease pressures on remaining inhabitants, HMG procured American ex-army tents. These proved inappropriate for the hot humid conditions on Montserrat and fell out of use.

Next GoM procured steel framed, aluminium clad prefabricated structures. These demonstrated the difficulties in procuring technologically advanced structures in emergency situations. Confusion in the specified requirements led to protracted construction operations and cost increases as additional components were purchased to complete the structures.

The aluminium structures suffered the same defect as the ex-army tents with a lack of insulation to prevent heat build-up and a lack of ventilation. As a result they too fell out of use.

Finally HMG purchased plastic clad structures but these were rejected by GoM and never utilised for living accommodation purposes.

Emergency prefabricated housing

The first attempt at providing a reasonable standard, medium term emergency accommodation came from the GoM Public Works Department (PWD). The unit was a demountable timber framed building with plywood floor, T1-11 (ribbed plywood) wall sheeting and steel corrugated sheet roofing.

The design was compatible with local building traditions and locally available materials. The units were low cost, quick to erect and housed up to 20 people and despite the poor infrastructure provisions serving the units, residents found them to be acceptable.

Two years after the onset of volcanic activity HMG took a further initiative to commission the procurement and construction of 55 prefabricated housing units (DFID 2000).

The contract introduced the expertise of an International Project Management contractor, Brown and Root (B&R) who were able to mobilise men, materials and equipment rapidly onto the Island.

Davy Hill by permission: Doug Darby

HMG priorities at this time were to reduce population numbers in the temporary shelters as speedily as possible. With this in mind, B&R procured an American prefabricated housing unit and was able to co-ordinate the majority of the logistical complexities of design, procurement, shipping and construction of the housing units complete with infrastructure provisions – roads, electrical reticulation, water supply, drainage and sanitation within a three month period.

The housing units were of a timber frame construction with fibre cement board/polystyrene/medium density fibreboard (MDF) sandwich wall panels, timber roof trusses and corrugated steel roof sheets. Floors were plywood with vinyl covering (George Pinder, International Building Systems, IBS).

IBS houses by permission: Doug Darby

The housing units were sited on individual plots and comprised 2 bedrooms, a shower room and a combined kitchen/dining/living area and a small veranda.

As an additional requirement for the Montserrat project, each housing unit was fitted with hurricane holding-down straps that were bolted to the concrete strip footings.

Permanent masonry housing

Alongside the 50 prefabricated units, B&R were commissioned to construct 100 permanent houses using masonry construction.

The units were to be built in 2 phases of 50 houses each. For this project B&R worked closely with local architects and GoM planning officials.

Lookout Yard by permission: Doug Darby

The first phase of housing consisted of 3-bedroom villa style houses with dual 110/220 voltage, fitted kitchens and wardrobes, beam and rafter ceilings, corrugated alloy roof sheeting, verandas and fully tiled floors.

The second phase of development followed similar specifications but involved a mix of 2, 3 and 4 bed units in semidetached or individual blocks depending on local topography.

Variations were introduced to the second phase units in the form of sash windows, which performed better than louvered windows in the exposed conditions of the development site.

Lookout Yard by permission: Doug Darby

Permanent modular housing

In an effort to speed up the housing programme, B&R investigated alternative housing systems. An international tender was issued and a system chosen that showed superior quality characteristics acceptable to GoM and potential for speedy delivery and erection suitable to HMG.

The housing system was a modular steel framed system, used in the Caribbean region but sourced from Australia (Force 10). The system comprised fibre cement board and polyurethane sandwiched wall panels, a steel trussed roof with corrugated alloy roof sheeting and integral rainwater guttering system.

Force10 house by permission: Force10

The units procured were 2, 3 and 4 bedroom styles in semidetached and individual blocks. The internal finishes matched the specifications of the masonry units with the exception that single 220v electrical systems were installed.

Approximately 50% of the units were built on concrete raft foundations/floor slabs. Where the terrain was too steep to create a level pad, the units had suspended steel framed floors with dense fibre cement floor boarding. The suspended floors sat on braced steel columns set into concrete strip footings.

CHALLENGES IN IMPLEMENTATION

The whole process of dealing with the post disaster accommodation was one of the most controversial aspects of the entire emergency response.

Montserrat enjoyed a standard of living comparable to most industrialised nations with high levels of education and literacy amongst the general population.

The loss of school buildings to use as emergency shelters for prolonged periods had a negative impact on the mood of the people. At the same time, the poor living standards in the emergency shelters were unbearable for many and upwards of 70% of the population left the Island.

By the time an effective housing programme was approved those remaining in the shelters were mostly single persons or small family units at the poorest end of the economic spectrum.

To complicate matters further, by the time the house-building programme got underway much of the Island's resources had been lost.

Logistical complications

When B&R mobilised for the emergency housing project, air services to the Island had been reduced to a twice-daily helicopter service. The main port facility in the city of Plymouth had been lost and an emergency jetty at the north end of the Island (Little Bay) had just been completed.

Seaport deliveries were restricted. Small items of cargo arrived via a daily passenger ferry from Antigua. Larger cargo arrived via weekly or bi-weekly ships from Puerto Rico or St Maarten.

Docking facilities at the new seaport were also restricted to smaller vessels with shallow draft and during the hurricane season (September, October and November) the port often had to close due to high sea swells.

B&R's operation utilised the full capacity of the Island's customs and clearing agents, and local purchases through the few Builders merchants had to be carefully co-ordinated.

All building materials had to be imported. More importantly, aggregates for concrete and filling also had to be imported as there was no operational quarry on the Island.

Local plant was fully utilised by GoM so plant for construction projects had to be brought onto the Island together with all necessary spares for breakdowns and routine maintenance.

On the whole the logistical operations worked effectively with only occasional confusion arising with customs officials over the appropriate categorisation of items of imports.

The biggest hazards were climatic. The closures of the port during prolonged periods of bad weather had inevitable impacts on the fast moving construction programme. When hurricane "Georges" passed by Montserrat in 1998 damage on the Island was slight but Puerto Rico suffered severe disruption and many important deliveries were delayed significantly.

Maximising local employment

The Volcanic eruptions caused an exodus of population of such great proportion that many of those that remained on Island were either obliged to stay as a result of their jobs in essential services – Utilities, Communication, Government, Law and Order, or they were too poor, elderly or infirm to leave.

Local labour resources for the housing programme were scarce and skilled trades were practically non-existent.

B&R utilised most of the willing labour on the Island and imported skills from other regional Islands. In this respect GoM was very effective in processing entry permits and allowing the import of labour to facilitate the programme.

As work moved from the emergency phase to reconstruction, GoM put pressure on B&R to relinquish its foreign workforce. B&R then contracted with a number of local Building companies for the supply of labour to the building projects.

The move to supply labour through local Contractors ultimately led to disruption of the construction programme as Contractors formed a group or cartel and collectively demanded increased financial remuneration and often dictated completion times for projects.

Underlying the context of the labour arrangements on the reconstruction programme was the endemic disagreement between GoM and HMG on issues of Standards and Cost. GoM were pressing for maximising standards while HMG was focussed on minimising cost.

At some point along the process, all parties lost focus on the main aims of the project, which was to alleviate suffering amongst the Public Shelter residents; disputes erupted over minor financial and technical details.

Conforming to best practice

The obligation to conform with notions of best practice was addressed to different extents by different parties at different times during the crisis.

At the outset, HMG was conscientious in fulfilling its role as co-administrator of the disaster response together with GoM. Although hampered by its organisational complexities and at times frustrated at delays in reaching decisions, the fact that fatalities throughout the crisis had numbered in the low twenties is evidence that the response was at least effective if not an example of best practice.

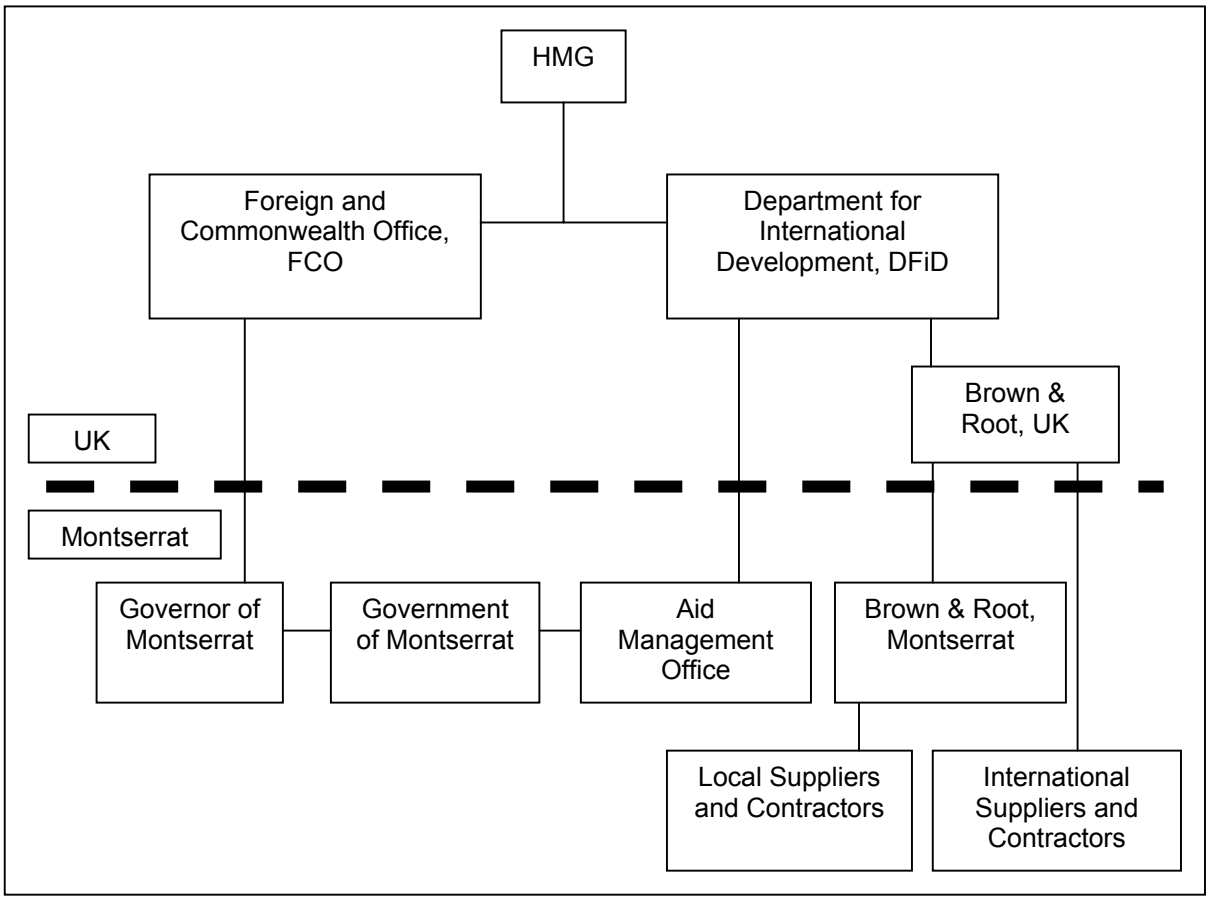
The disaster highlighted shortcomings in the levels of preparedness of GoM in dealing with the event. Risk assessments undertaken in the 1980's raised awareness of the potential for a volcanic eruption and despite knowledge of the 30

year cyclic volcanic activity, GoM still failed to develop effective emergency plans to deal with the potential threat.

More specifically, the response in the provision of emergency temporary shelter fell far short of best practice. As early as 1997 an HMG enquiry criticised the response and in the final evaluation report at the end of 1999 conditions for shelter victims had improved little.

With the introduction of B&R, HMG and GoM were buying in internationally recognised expertise. B&R's credentials for undertaking the work on Montserrat were impressive but in practice the large commercial organisation was only as strong as the man on the ground that was making the decisions.

B&R failed to make the best of their potential to achieve best practice by failing to fully utilise their in-house labour pool of expertise. Conditions on the Island were not made any simpler by contractual arrangements that required decisions to be channelled though B&R's UK office to the HMG's UK office; with no HMG representative present on Island with delegated authority to oversee and manage B&R's contract, lapses in performance were slow to be addressed (see organisation structure below).



Organisational Structure for Reconstruction Programme

At the initial stages B&R fell into the trap that both HMG and GoM encountered when procuring for emergency operations. Failure to specify properly in procurement led to delays, cost overruns and failure to achieve desired outcomes.

Designs in the emergency response were not completely thought through; speed of delivery was given priority, thus building in inherent defects, which proved costly to rectify at later dates. Often the speedy delivery, which might have justified the oversight, was also not realised.

With the move into permanent redevelopment, GoM planning officials took a greater interest in specifications and standards. Between the first phase of 50 masonry units and the second phase, GoM adopted a revised Building Code. The designs of the second phase and of the Modular units were then amended to conform to the requirements of the new code.

The introduction of the Australian modular housing units was considered appropriate on the grounds that their popularity within the Caribbean and Pacific Island regions was growing. Their proven effectiveness in coping with the major environmental hazards of Hurricanes and Earthquakes pointed to the fact that these units would in fact represent advances in the notions of best practice in housing development in hazard prone regions.

COMPARATIVE EFFECTIVENESS

When comparing the effectiveness of the various methods used to address the accommodation requirements of the population, after the disaster, it is important to bear in mind that decisions taken in an emergency are often taken in the context of pressing need, inadequate information and a seeming lack of alternatives.

Decisions analysed after the event can often seem inadequate but were often considered best in the circumstance at the time of making the decision.

Temporary public shelters

The utilisation of public buildings was an effective response at the earliest stages of the disaster when evacuations of the Plymouth area were thought to be only temporary and of short duration. Once the evacuation became long term, these facilities were highly unsuitable.

Initial use of tents and other temporary shelter could have proved an effective short/medium term measure if closer attention had been paid to the specification requirements for such shelters in the hot humid climate of Montserrat.

Timber Housing

The PWD timber shelter structures stand out as a good and effective emergency response.

Designed with local environmental conditions in mind, they used local materials and technology and matched criteria of both HMG and GoM in terms of quality, speed of delivery and cost. These units proved their worth by virtue of the fact that residents managed to live in them for years rather than the months for which they were initially planned.

Prefabricated Housing

The emergency prefabricated houses matched the purchase criteria for delivery, cost and speed of erection. The units however were of suspect quality, and lack of detail in ordering resulted in under-measure of certain elements, which needed additional procurement and hence cost.

Durability of some of the fixtures and fittings was raised as an issue shortly after occupation and shortcomings in the design of infrastructure elements led to many on-going problems.

However, the housing units were effective in addressing their primary objective in alleviating conditions in the temporary public shelters.

Masonry Housing

The effectiveness of the masonry housing units is variable depending on the viewpoint of the respective party.

On the whole GoM viewed the units as of acceptable quality. HMG considered the investment as marginal in that it failed to address the main aim of alleviating pressure on the temporary public shelters in a timely manner.

B&R viewed the units as successful in achieving the aims of maximising use of local resources.

Modular Housing

The modular housing units matched final quality expectations. However significant difficulties were encountered which raised questions about their overall effectiveness.

A manufacturing defect not apparent until the units arrived on the Island resulted in the need to replace the entire stock of wall panels. This highlighted the risks inherent in utilising imported high technology systems.

On arrival, quality inspections also revealed inadequate levels of corrosion protection to elements of the suspended flooring system. This highlighted the risk of relying on quality control procedures being carried out at such remote locations that verification of compliance was very difficult prior to shipment.

Finally, one of the potential advantages of the system was the speed of erection. This could only be achieved by utilising a system building technique, which was unknown to local contractors. By the time local contractors had mastered the building technique all advantage of speed had been lost.

LESSONS LEARNED

Before examining the lessons to be learned from this it is worth highlighting that alongside the direct build programme, HMG funded two housing finance projects, which GoM administered.

The first project provided grants for self-build materials and also to meet the material costs required to complete partially finished homes.

The scheme was judged a success in view of the high demand for grants and the fact that the scheme benefited residents of the temporary public shelters directly (DFID, 1999b).

The second scheme aimed at providing soft mortgage loans. The scheme never got started but it still remains in place and is expected to commence lending over coming years (DFID, 2000).

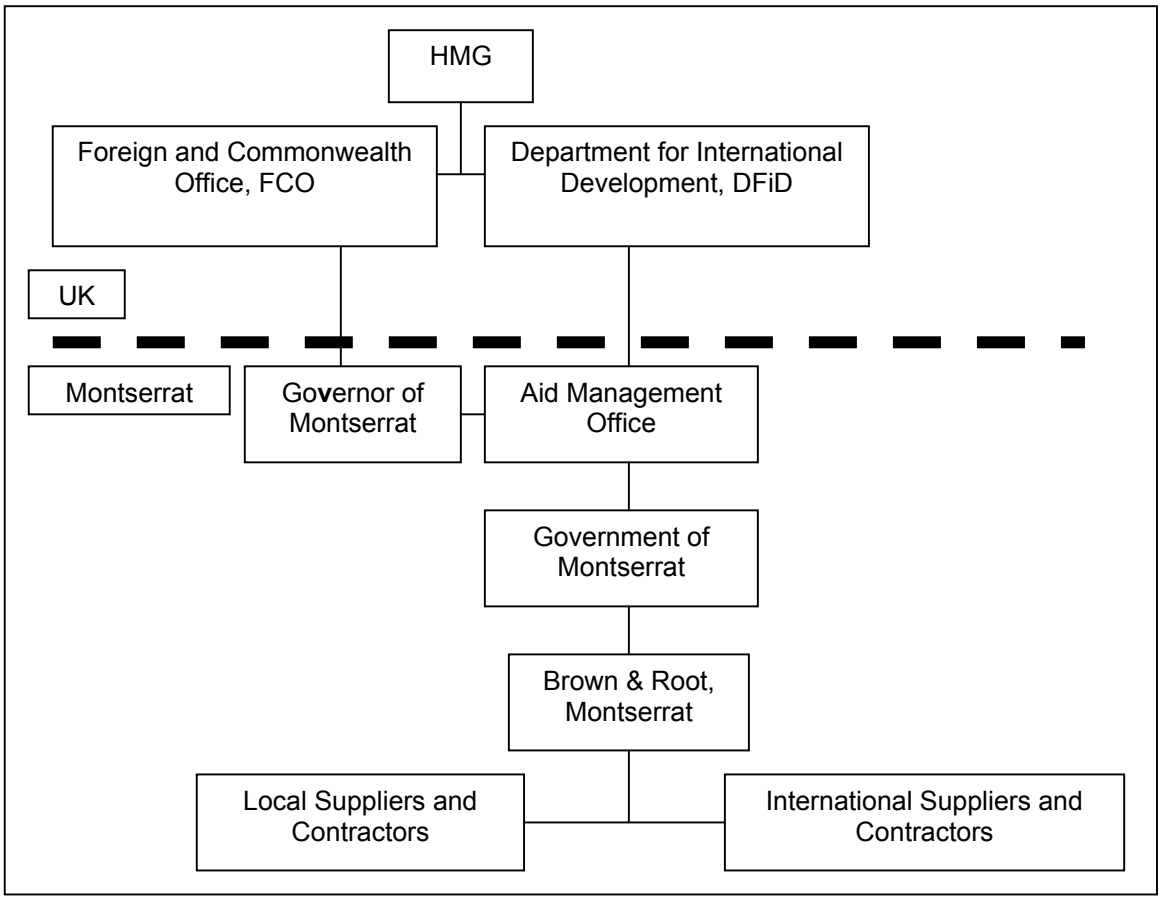
There are many lessons to be learned form this case study:

- In order to implement a speedy and effective response to a disaster administrator must establish clear operating procedures, lines of communication and delegated authority as early as possible.

- Control of technical development and construction activities should lie with established local agencies. These agencies best understand local conditions, resources, practices and technology.

- Rather than replace local capacity it is more effective to use funds to reinforce and build on local capacity. This would avoid repetition of costly mistakes.

In the Montserrat case the three above lessons could have been addressed by changing the organisational structure.



Suggested Organisational Structure for Reconstruction Programme

- Multiple methods can be effective in meeting the demands of a complex emergency situation. Attention to the levels of available detail and acknowledgment of the levels of risk must be accepted however, prior to making investment decisions.

- Investment decisions and programme management must be reviewed regularly with a focus on project aims and objectives. In this way, changes can be made in line with the developing crisis scenario.

- Evaluation and lessons learned should be incorporated into an effective emergency plan, tested and regularly reviewed to ensure it remains valid and integrates new research findings as they occur.

REFERENCES

DFID. (2000). "*Montserrat: Country Policy Plan 1999/2000 – 2001/2002*". London.

DFID. (1999a). "*An Evaluation of HMG's Response to the Montserrat Volcanic Emergency",* Vol. 1. London.
DFID. (1999b). "*An Evaluation of HMG's Response to the Montserrat Volcanic Emergency,"* Vol. 2. London.
Force 10, www.force-10.com
Government of Montserrat. (1998). "*Sustainable Development Plan*". Brades, Montserrat.
Government of Montserrat. (2001). "*Montserrat Investors Guide*", Brades, Montserrat.
Montserrat Volcano Observatory. (1997a). "*Chronology of the Eruption of Sufriere Hills Volcano from January 1992 to Early July 1997*". Montserrat
Montserrat Volcano Observatory. (1997b). "*Assessment of the Status of the Sufriere Hills Volcano and its Hazards*", Montserrat: 18 December.
Montserrat Volcano Observatory. (1998). "*Preliminary Assessment of Volcanic Risk on Montserrat*", Montserrat: January.
Norton, Gill. (2001). "Monitoring Sufriere Hills Volcano, Montserrat". *Earthworks Journal*, Issue 12. British Geological Survey
Pinder, George Jn., International Building Systems, www.internationalbuildings.com
Rozdilsky Jack L. (1999). "Disaster Recovery in an On-going Hazard Situation on Montserrat: The July 20, 1999, Volcanic Dome Collapse". *Natural Hazards Observer*: Quick Response Report #121, Colorado.