Living with Volcanic Risk: The Consequences of, and Response to, Ongoing Volcanic Ashfall from a Social Infrastructure Systems Perspective on Montserrat

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Many parts of the world are at risk from volcanic hazards. Chronic hazards such as volcanic ashfall are wide reaching and may affect large areas for variable periods of time; from a few weeks to many years. Such is the case on Montserrat, where islanders have been living with chronic ashfall hazard since the Soufriere Hills volcano began erupting in 1995. This low impact, frequent event type may be analogous to other hazards such as drought, flooding or even earthquake aftershock sequences. I will discuss the range of consequences observed for living with long term hazards, viewed through the lens of social infrastructure, using an interdisciplinary, exploratory research strategy. A systems-ecology framework is applied to this topic in order develop an holistic methodology for exploring coupled physical-social systems; the physical and social consequences of living with risk, and the process of adaptation to such an environment. This current research seeks to gain new understanding of how societies cope, adapt to risk and develop resilience across physical-social systems in long-term ashfall environments. Preliminary accounts will be presented and indicate apparent adaptations and adjustments to living with risk on Montserrat. I discuss also some responses to living with volcanic risk, and the progress towards the development of community resilience. This research aims to improve our understanding of how adaptation and resilience are developed in an ongoing and long term risk environment, and has applications for improved management and reduction of risk in urban areas.

Introduction

Montserrat is a really interesting case study in the Caribbean. Volcanic activity has been going on for 15 years. It has had constant eruptions since 1995, so this is very much an environment where people are living with risk. This is where the parallels come in with Christchurch, an area that also is living with risk. It has a complicated political situation as well: as a British overseas territory, it has a dual Government which has also created some conflict and problems in the past.

I focus on living with risk day to day. The topics I'm going to cover are listed:

Extensive risk is the widespread low impact, with chronic hazards,

consequences of chronic hazards, and intensive risk happening every now and then. This is analogous to Christchurch, with constant aftershock sequences punctuated by larger events.

I look at some of the tipping points that people have discussed with me, that relate to whether they stay or go in these situations and whether it correlates with the bigger events or whether it correlates with the ongoing difficulty of living in this environment. I'm presenting a series of narratives, so will be presenting quotes for discussion and thought.

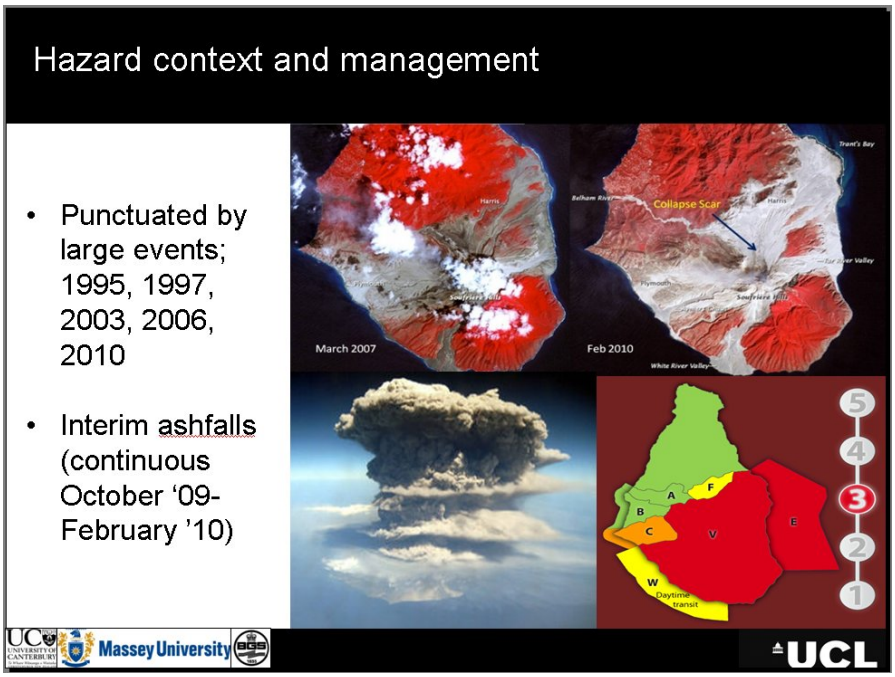
Eruptions have been going on for 15 years, so there have been sponsored behaviours and adaptations over that time. We're not talking about a study that comes in after a disaster and sees how people have done something in response. We're talking about living with it constantly, with permanent change, and behaviour change in mitigation and preparedness as people learn to live with the risk. We also have a couple of future outlooks on Montserrat from the participants' point of view.

So this is Montserrat, the island is 10 by 16km. It's in the Caribbean island arc. Here is a risk map – a hazard map. There is a lot of confusion about the terminology, such as of 'risk' and 'hazard' and 'vulnerability' in this field. Risk is likelihood of consequence, hazard is the hazard itself.

This is the volcano. The red zone is an exclusion zone. The numbers are risk ratings. As the risk goes up, the boundary of the exclusion zone changes and zones that were outside then become incorporated in part of the exclusion zone. So people have to move occasionally and adjust as the risk changes.

This happened early in February 2010, in the photo. You can see some of the outline of the island. It was a dome collapse, but it was a small one of about 15% of the volume of the volcano collapsing. Imagine what happened if 100% went.

These are satellite images of the island in 2007 and 2010. You can see how the hazard is changing. You can see how the area has become inundated between the two time periods. And the larger events that are listed on the left hand side: intensive hazard periods in 1995, 1997, 2003, 2006, 2010 – the bigger events.



I want to talk about the interim continuous activity—how the ashfalls affect the rest of the island, and the islanders who are not living in the exclusion zone. That's the constant living with risk in this environment.

The Context: Extensive Hazard

So the context: extensive hazard. This is a photograph I took of a pyroclastic flow. These happen all the time. This is normal in this environment. Boiling clouds of ash and gas roll down the hill. Ash goes up into the atmosphere, gets blown across and falls on the inhabited areas in the north and causes issues for the people living there.

Day to day, people describe the island in general in their narratives as quiet, very safe, very low crime and beautiful. They're really attached to Montserrat, to the greenness, to the beauty of the island.

But the one thing they really complain about is the ash. They said it's really fine, it gets into every part of the house, every fabric you can imagine, into your beds, into cupboards, into your food source, it gets everywhere. So there is a lot of work involved in keeping your clothes clean. It's quite demoralising. That's what people are living with.

The way people talk about ash is interesting. They say things like "We're fine." "We're living with ash." "We've been living with it for a couple of years." "We're okay." "We're alive." "We're still here."

This is what it looked like in 2003, after one of the largest ashfalls. As you can see all the green has turned grey. They liken this, in their own words, to SAD — seasonal affective disorder. Montserrat looks like this on the ground almost everywhere after an ashfall.

Methods of Examining Living with Risk

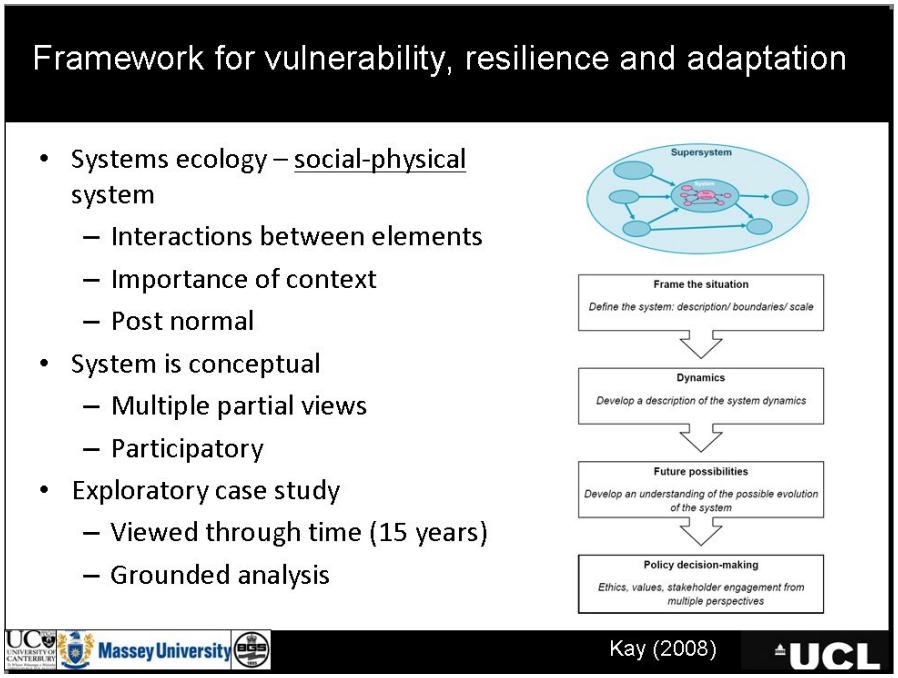
I'm examining living with risk. We need infrastructure. We need basic services to meet our needs. So I'm looking at living with risk through an infrastructure context, interviewing infrastructure managers and maintenance people to find out how it affects basic services and service provision on the island.

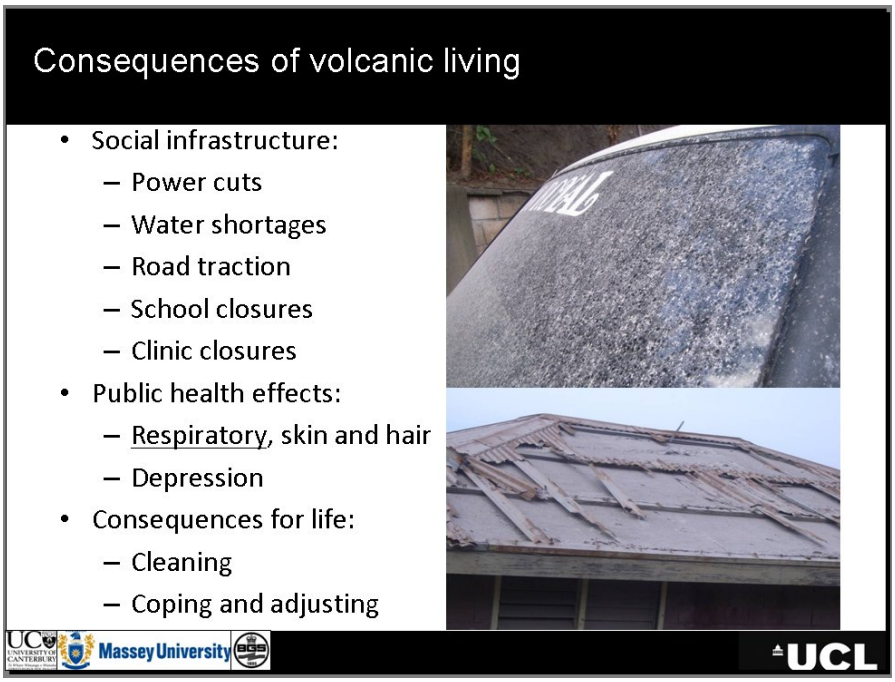
Systems ecology is a framework that allows you to look at the interactions between elements like this, so I'm looking at staff, the uses of the general community, and also the physical elements within the infrastructure system. It's 'post normal.' In normal science, you drill down into a problem and try and find something measurable. With 'post normal,' we ask 'What is the bigger context or frame in this situation?" In a way, we're looking up and we're not looking down.

It's participatory in concept as well, very much in the eye of the beholder. If you ask an engineer what a health care system looks like, they might say to you it's a series of buildings connected together with a bunch of roads with some electricity and some water pipes going in. If you ask a community nurse, what a health care system looks like, she'll say paediatrics, dental clinic, all these other kind of things that go on in there. Everybody has a different view of the system. I'm trying to gather these multiple partial views and create a view of the problems and the ways that people have adapted and developed resilience in these systems over 15 years. It's very much an exploratory case study.

I'm using semi-structured interviews with infrastructure employees; managers and maintenance (18 interviews across 12 departments) and further focus groups, interviews and participant observation in 2011, to look at the consequences of living in this environment and how people live with risk:

- What are the *consequences* of long-terms volcanic activity for social infrastructure systems?
- Have infrastructure systems *adapted*, and has *resilience been developed* over time?
- What *factors influence* the development of *resilience and adaptive behaviour* in long-term





volcanic environments?

Just briefly, here are some consequences of volcanic living: this is ash on the window screen of my car after I woke up one morning—there had been an eruption overnight and I had no idea. The image below is of corrosion—ash causes extensive corrosion and completely destroys corrugated iron roofing. Ashfall causes power cuts—it falls on insulators and causes arcing, temporary tripping the power system. Water shortages occur because people clean up their houses from the ash. There are problems with road traction, so everyone has to drive very slowly and take care not to skid off the road. It causes schools to close, because there is a perceived high risk of respiratory problems from ashfall.

People are very concerned about children in this environment. So when there is a lot of ashfall, they close all the windows and doors. It's a tropical environment so it gets really hot. Air-conditioning doesn't work because the power is off, so all these children are cooped up in this dark little room getting very hot and bothered. They can't go outside because of the ash and so school closes. This has a knock-on effect on all other infrastructure because everybody needs to go and pick up their kids. It knocks-on across the community. Clinics face very similar issues, closing because of the amount of ash or because of the perceived risk increasing at the volcano.

Respiratory health has been mentioned. People also talk about getting depressed

Other consequences for life include extensive cleaning and people learning to cope and adjust in their environment.

So people are pushed to their individual tipping points. Two-thirds of the population had left the island by 1998. There were originally around 12,000 people on the island. There are now 5,000. Half of those are new immigrants, so only 2,500 are Montserratians.

Decisions About Leaving Montserrat

There are many reasons why people left the island: British incentives, deaths, respiratory health, lack of shelter, economic decline, education interruptions, continued eruptions. Some quotes to exemplify what people told me their reasons were.

Montserratians are very independent and prefer living alone, "living comfortable." Ashfall related damage has brought many to the point where they have to share shelter, and the privacy is diminished.

"…very independent, and living alone, living comfortable, to a point where you have to share a shelter, and the privacy is deprived…so I could understand why most people had to migrate to the UK…so we lost a lot of our people, how you call, brain drain, and there was a few that's left because they have no choice, they have to leave their parents, and some parents choose to go because of their children's education. So there's a lot of reason why a lot of people moved…education-wise, their children's future, and probably health-wise cos some persons asthmatic…some person like myself stayed back to keep it going..." (Fireman)

Complex social factors contributed to decisions to leave Montserrat. Concerns about shelter and education are predominant, raising a hypothesis that keeping education going, may prevent some emigration.

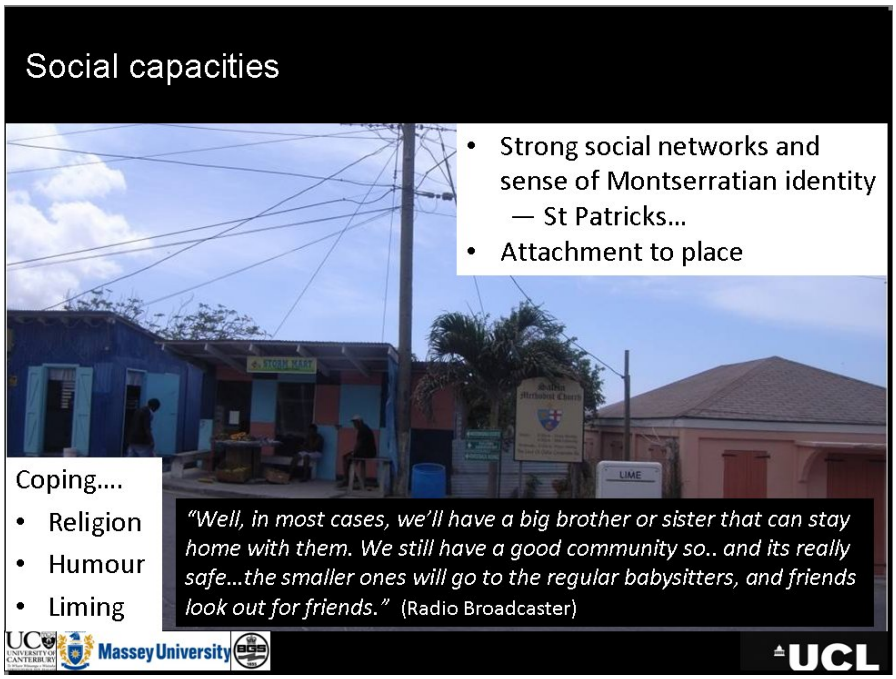
Personal factors also make a difference:

"When my children were small the reason I didn't leave was that they were young…the opportunity to go to England and a Caribbean island or America, I didn't want them to go there because you have to be there for them when they come from school, like in Montserrat they can come from school they can go home on their own. A neighbour would look out for them, when you move to another country it's different, so I was afraid of adapting to change." (Nursing manager)

This response indicates that strong social networks outweigh change. The interviewee was able to leave, but didn't. Strong social networks helped and this participant values community support. Benefits of staying outweighed the advantages of change.

Two of fourteen interviewees revealed that the continuous ashfall in 2009-10 had made them seriously consider leaving Montserrat. Stage of life is a factor in staying, with obligations yet to meet and a different mix of things to lose:

"I'm getting pretty old now, I can't leave to go find a job



anywhere…the kids want to go…they're pretty much said they don't want to live here no more. And my son is, I believe he's gonna leave, when he leaves school...So he's had enough of ash! I, I'm pretty much rooted here with other obligations…things to pay back for…I can't just uproot. Even though I may want to, It's not too easy to just leave…I'll be hanging around going nowhere, I got 13 years to retirement, which is not alarming. So, stick it out again" (Infrastructure manager)

Social Capacities Involved in Living with Risk

Decisions to leave appear to be affected by 'unusual' hazard events:

"So, generally its pretty easier to deal with, if you only have to face it one or twice a year, but I don't think what we've experienced here, if it continues for another 3 months, we will have reached that point of just throwing the towel in and going." (Infrastructure manager)

It's not necessarily the poorest and the most vulnerable who get left behind: some people chose to stay, producing a different mix in society. For Christchurch, there are complex social factors contributing to the leaving and staying. But as in Montserrat, there is also a lot of understanding: there is tolerance for people leaving which is interesting. If strong social networks delay change, Christchurch has a lot going on in rebuilding and reinforcing social networks, so that's something that may reduce departures.

The continuous extensive hazard is ongoing in Montserrat, very much like the aftershocks in Christchurch. So decisions to leave may be prompted by unusual hazard events, not necessarily the biggest ones, but a period of particular difficulty like the continuous ashfall or frequent tremors.

Like Christchurch, Montserrat has got a lot of social capacities, which support reasons people are able to stay. Humour is a way of coping.

Montserrat also has hurricanes; in 1989 Hurricane Hugo wiped out 90% of buildings on the island. Earlier in the volcanic crisis, they had Hurricanes Louie and George destroy parts of infrastructure and buildings.

Some people responded by building the shop in this picture is called "Storm Mart." When a storm happens, the building will collapse and they just rebuild.

There are strong religious beliefs in Montserrat – there's a Methodist church beside Storm Mart.

There is also a helpful cultural sense of time. In Caribbean culture, these men are behaving in a typical way: sitting around at the shop chilling out, chatting. This frequent community gathering enables information exchange, supports friendships and reinforces coping ability.

Very strong, old social networks are present. Montserratians originated from Irish plantation owners and African slaves, and they celebrate St Patrick's Day, possibly more than the Irish. But the reason they celebrate it is different. There was going to be a slave rebellion against the Irish landowners, planned for St Patrick's Day when the Irish landowners would be drunk. Unfortunately, a Montserratian felt allegiance to one of her slave owners and the plan was foiled. They still celebrate it.

Strong social networks provide very practical support during extensive periods of living with risk.

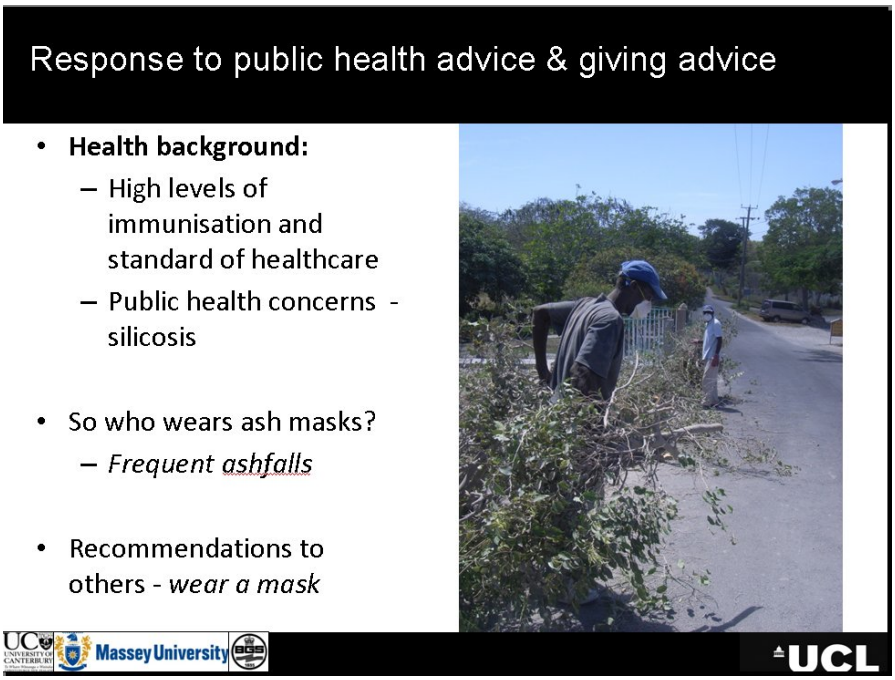
"Well, in most cases, we'll have a big brother or sister that can stay home with them. We still have a good community so.. and its really safe…the smaller ones will go to the regular babysitters, and friends look out for friends." (Radio Broadcaster)

It keeps the vulnerable in the community safe: the smaller ones will go to regular babysitters and friends look out for friends. This has been very true also of Christchurch.

Health Care Advice Received and Given

In the next picture, the men are wearing ash masks – the only guys I saw in the entire time I was on the island that wore ash masks. Montserratians have a high level of public health awareness. It is really important for them culturally and socially. At a time when the UK was struggling to immunise children, everybody on Montserrat was immunised.

Montserratians are very aware that public health problems may occur, such as silicosis which happens in miners, from material getting into their lungs. There has been research into this in Montserrat so they are



aware of the public health risk. The standard protection in an ashfall is to wear a mask.

So who wears a mask? Only a couple of men dragging ashy trees!

How do you get people to adopt preventative behaviours when they're dealing with the risk all the time?

- If the risk event happens just once, it's more obvious.
- If it happens for a period every now and then, people can put ash masks on until the event ends then remove them.
- But if it's happening daily?

Can you live in an ash mask? These people say it's not realistic. How do we get people to reduce the risk of silicosis? Incidentally, when asked what they would recommend to other people, these men said "Wear a mask."

"…we are able to provide ash masks to the population. The challenge however has been getting people to actually use them, as they should…people for varying reasons they would use it for a little bit and then they would …take it off, expose themselves to the ash particles again. So, it's a matter of re-educating, educating, re-educating you know, people to the dangers of ash..." (Emergency manager)

We talked about this earlier that this issue of "we must tell you what to do" and then the public saying "well hang on a minute what about us" is the public response.

"If all ashfall, we know we need to use mask, sometimes you don't even bother with mask, because you thought eh, you have an immune system now, we are part of it now so hey. Most people don't use the mask because they think it's stifling, they say more like they can't breathe properly. Erm, and you have to live with the hazard, with all the ash, this dust. You inhale it, it goes to your lungs, and settles there for a while, it may cause problems in the future, we know that, but sometimes we just being, that its alright, we accustomed to it so, probably, we probably erm, immune to the ash" (Fireman)

So they know the risk. It's not education that will help change the mask-wearing behaviour. How do we deal that what has become a normalised cultural hazard?

Personal judgments of risk

"We had a lot of disasters before the volcano, like Hurricane Hugo…come out and stop us and we have to pause for a while…Disaster come again hit us again, you know, its natural! I mean that's what we can't control. So we become more crisis managers …Having to manage all this crisis and trying to, to still live, live happily." (Fireman)

Having to live happily in this environment is really important. Somebody else says, referring to the volcano:

"…it is the bigger player in the game. You know, we cope with it, but we can't control it, we…just accept it, just accept that it causes the problem, and then soon as its willing to er, allow us to work then we can work and deal with it as best we can." (Infrastructure manager)

The volcano is in charge. And each person assesses in his or her way, against a personally constructed tipping point. So as the hazard changes:

"I figure if I, I will be my own scientist and if it gets to a certain level, or a certain place, I have to go." (Teacher)

A maladaptive example comes from a member of the ex-pat community. This resident lives in an area frequently affected by the exclusion zone changing with increases in volcanic activity. When the risk rises, they are supposed to sleep out of the evacuation zone but may be allowed to visit by day. When officials ask where they are sleeping, they say "*We were staying with friends.*" Although they are among the richer part of society, they're vulnerable and their maladaptation increases their vulnerability.

There are many examples of developing adaptive behaviours in normal life, taking action to protect equipment and other things and to respond after ashfall. People develop rituals of dealing with it preventatively:

"…because it costs so much to replace or repair…so the first thing we do in an ashfall, is to secure our equipments. We have little sheets, we have plastic bags, we've got, we get the large garbage bags that can be

pulled over filing cabinets, pulled over computers…we actually advise everyone at the end of every day, because we're not sure what we're going to find when we come back in the morning, we cover up, everyday." (Nursing manager)

Other adaptations communicate the short-term changes in the situation, helping others adapt:

"I find that over the years we've developed a sort of a way of dealing with it, so you find the person on the radio start -once there's ash - somebody calls the radio station and say 'erm, there's some ash in Salem', the person on the radio start advising drivers to you know take your time, drive if you're heading into this area there's ash, so we have all our advisories come out and you'll find people themselves doing their own bit of erm, communication so informing other drivers who are heading in the opposite direction…" (Scientist)

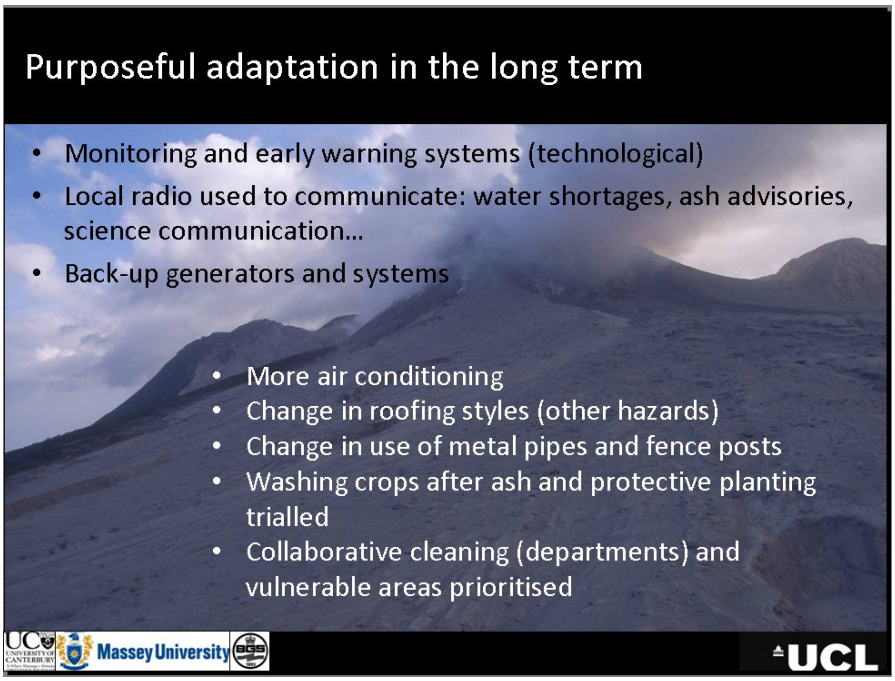
Purposeful Adaptation in the Long Term

We've got a series of physical adaptations, and permanent changes to buildings and other structures.

Systems which have changed include

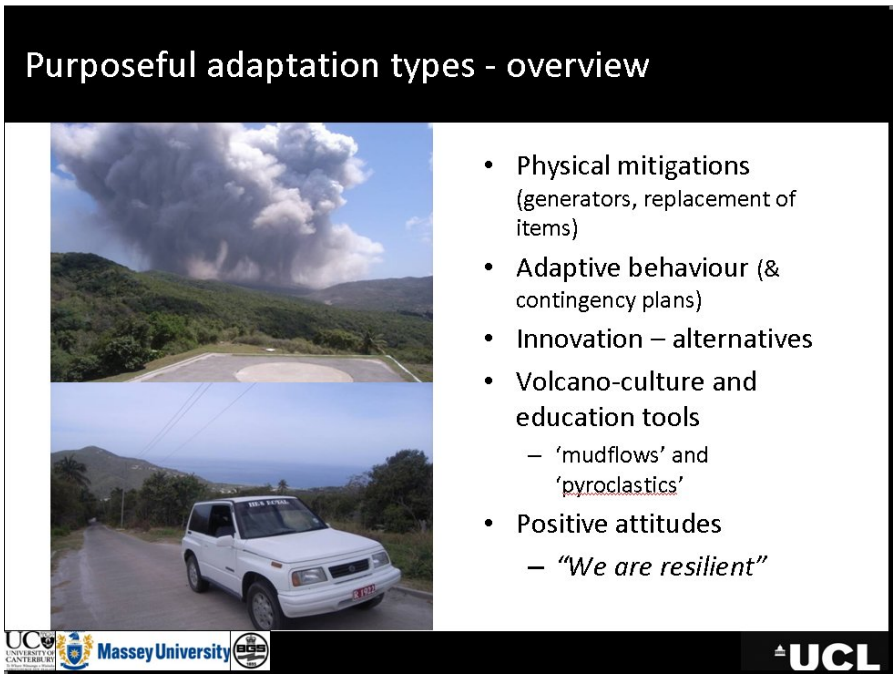
- Monitoring and early warning systems
- Local radio: water and ash news
- Electricity back-up

Building changes include air conditioning, reduced use of metal which corrodes, vegetation,



While neighbours might have arguments over whose ash it is, Montserratians very much prioritise collaboration to protect the vulnerable areas.

The response to the long term risk has been a series of changes of physical, behavioural, imaginative and social natures.



If you are engaging people, their opinions must be taken into account. Gradually and organically, people made changes to the way things had 'always' been.

Montserratians incorporate these into their culture and they have very positive outlooks on life despite the loss and disruption. The school sports teams are called the Mudflows and the Pyroclastics. A steel-pan music group is called the Volcanics

Most importantly, they say "*We are resilient!*"

Future Outlook on Montserrat

Keeping a lot of people staying on Montserrat means there are enough to maintain critical mass for infrastructure and social systems.

"So I think that, we've learned that, not to put all our eggs in one basket, and we've got supermarkets up there now, and supermarkets over here, rather than all being within 100 yards of each other." (Government officer)

Decentralisation is an important lesson from Montserrat.

"Now they're developing the town centre. We know that that area…can have water coming in. One of the mitigation measures that we proposed

at the time was to build further inland and to elevate to a certain level…very little heed was paid to it, you know, so we are still waiting to see what will happen…a lot of people saying here is a chance to build from scratch how you get it right, but not much has been done." (Emergency manager)

As they develop the town centre—this is the new capital, the old capital was destroyed—they are doing so in an area that can be flooded. Although the last fifteen years have seen many things rebuilt, not much has been done on *how* you get it right. This seems to be another lesson: you've got to move quickly. These people have been waiting for 15 years for a new capital. They've been engaged but nothing's been done with the ideas put in.

Future directions for this research include exploring some of the drivers of adaptations and resilience, looking at their political, economic and socio-cultural contexts. Factors which enable and limit are also important, as these promote adaptation and resilience in other areas and for other hazards. As I'm not a psychologist, I'm just presenting where the data's lead me and I'd be really interested to hear about coping, behaviour drivers, normalisation and adjustment to risk to enable exploring some of these aspects.

Author Note

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