CHAPTER 1

AN ISLAND SHATTERED

An Earthquake Strikes

Another hot, humid, dusty day in the streets of a Caribbean capital. Flies crowd the markets and aged motorbikes and cars bounce through the potholes, coughing emissions and dodging pedestrians. Azure waves lap against the docks while street dogs and pigs scrounge for morsels in the trash heaps dotting the hill neighbourhoods. Just the typical sights, sounds, odours, and haze of life playing out as it has thousands of times before, with the shimmering heat starting to dissipate as the sun droops towards evening.

Today, though, is far from typical. It is 4.53 p.m. on Tuesday 12th January 2010 in Port-au-Prince, Haiti. Twenty-five kilometres west-south-west of the city, just thirteen kilometres below the surface, the earth jolts, fracturing rock, heaving soil, and radiating waves of motion with an intensity technically described as moment magnitude 7.0. This is high on the scale with which earthquakes are measured; just one or two earthquakes at this level or stronger occur in any month somewhere in the world,

although often much deeper below the surface than Haiti experiences on this day.

The earthquake's first set of waves, the primary waves, travel twenty times faster than most passenger jets, giving premonitions of the coming destruction. Port-au-Prince has the misfortune of being so close to the rupture's centre that most people have only seconds before the secondary set of waves, the shear waves travelling half as fast, arrive. The devastation begins.

The arrondissement (district) of Léogâne, almost on the earthquake's epicentre, witnesses over 80 per cent of its buildings badly damaged or destroyed. Many rural areas lose the little infrastructure they have, with dirt roads cut by landslips and schools entombing pupils and staff. Around the capital, thirty kilometres away, the shaking lasts for between thirty and sixty seconds. Thousands of buildings crumble, especially the shoddily built, ramshackle dwellings inhabited by people with no choice but to live there. Some buildings collapse in on themselves or tip over. Others slide down the hills into the ravines. The stories of the people who live in these homes are rarely told: people who scrape by day to day, ambling along the unpaved roads, living without running water, electricity, or sewage systems, and then dying in the ruins of their small, dilapidated shelter.

As one lives poor, one dies poor. The immediate aftermath could not bring ambulances and fire trucks wailing through the streets, with hard-hatted rescuers ready to haul out unconscious survivors, stabilize them right there, and then whisk them away to advanced life support in hospitals. Instead, roads are impassable to cars, vans, and trucks—as many were before the earthquake, with these vehicles stymied by the steep slopes, the inadequate infrastructure, and the difficulty of driving after dark. Rescue and

medical services do not exist to respond, and this too is a situation long predating the earthquake. As the sun sets, the survivors wonder what to do about water, food, toilets, and sleeping—questions many of them asked every day.

Except that today, the earthquake has happened. The first task is finding family and neighbours under the rubble. Throughout the dusty area, people scramble onto and into partially standing structures, despite the danger of aftershocks. They dig with shovels, makeshift tools, and their bare hands, carrying blood-covered casualties outside.

The destruction seems arbitrary. A pile of masonry which was once a house sits sandwiched between two others that still stand; a collapsed roof is surrounded by others that remain intact. Other blocks, which were crowded neighbourhoods earlier in the day, now resemble derelict construction sites. As the dead are recovered and the injured rescued, makeshift medical centres—never with enough personnel or gauze or room or antiseptic—shelter child and adult amputees. Soon, tent cities spring up proffering small rooms under flimsy sheets for extended families that have lost half their members.

The quagmire of poverty perseveres. Before 12th January, how could Haitians in the informal settlements begin to think of earthquakes? Even where their abodes were not constructed from masonry, sometimes making them safer during earthquakes, daily life meant struggling for food and water, navigating the open sewage and the violence, and being denied education and healthcare. Not much changes after 12th January, except that their rickety residences exist no more.

Higher-profile structures of the well-to-do fare no better and the losses are just as calamitous, but they garner international

attention and international rescue resources. Parts of the Presidential Palace crumble, leaving it like a smashed and smeared wedding cake. One section of the country's United Nations (UN) headquarters pancakes, six storeys becoming one. UN employees die, 102 in all, the largest single-day loss of life in the organization's sixty-four-year history and a tragedy involving staff from every inhabited continent. The dead include the top UN official for Haiti, his deputy, and the acting police commissioner—all well deserving of the praise and memorials they received, as are the tens of thousands of ordinary Haitians who were provided with neither.

Many other UN employees and Haitians survive, only to reach home to discover that their spouses and children did not. A Danish man who had been working in the UN building is rescued five days later. He describes how he heard others trapped but alive, their noises ceasing thirty-six to forty-eight hours before he was pulled out. Dust clouds lift above the luxury seven-storey Hotel Montana, renowned among foreigners and once hosting dignitaries, celebrities, and country leaders. Over four dozen bodies are eventually recovered, including staff, tourists, and business travellers.

As the earthquake runs its course, at least 150,000 people and possibly up to double this number, the vast majority of them poor Haitians, are dead or dying. Disaster casualties are notoriously hard to tally, especially when the number of people living in an affected place is not known. The true death toll, and the true toll of suffering, in southern Haiti, can never be known.

The Haitian disaster mobilized the world. Aid soon poured in, along with journalists. Taking over from locals using their bare hands and basic tools to dig for survivors, international rescue teams crawled through collapsed structures time and again.

Many tearful reunions made it worthwhile, but the joy was marred by the growing piles of corpses. Locating all the bodies took weeks. When it was deemed that no one remained underneath a wrecked building or that they were not recoverable, a major logistics operation cleared and dumped the masses of rubble.

Governments and organizations pledged around US$13 billion of aid and delivered perhaps half. Remittances and individual donations are harder to track and they provided support to people who had lost everything except their own lives. The people's continuing desperation did not stop the political shenanigans. Days after the earthquake, the US military took over airport operations at Port-au-Prince, sparking a backlash from countries and agencies whose aircraft were unable to land. As the political fights brewed, Haitians were left needing the basics.

Flimsy tents were erected on mud-prone slopes only to be blown away by moderate winds. Privacy, security, dignity, and safety were not always significant considerations in setting up the temporary settlements, leading to continual rape and assault with little recourse for catching and punishing the perpetrators. Even allowing for the fact that attacks are under-reported because many fear that they will be stigmatized or abused for documenting what happened to them, by the end of a year after the earthquake, at least one-tenth of households in the temporary settlements had reported that a member had gone through some form of sexual assault.

As the post-earthquake months dragged on without promised housing being built, tens of thousands of Haitians were forcibly evicted from these temporary settlements. In many cases, they went from squalor to nothing. Once again, so many people were left without safety, without jobs, without healthcare, and without

schools for their children, despite the world's attention and the promises to 'build back better'.

The troubles did not stop there, as UN soldiers tasked with helping post-earthquake reconstruction made the situation even worse. On 21st October 2010, the Haitian government declared an outbreak of cholera, a disease not seen in the country for over a century, and over 10,000 people have died from it since. The UN soldiers had introduced cholera, which spread swiftly due to the extremely poor quality of water, sanitation, and hygiene across Haiti, not helped by the earthquake disaster.

The UN first tried to avoid responsibility for the outbreak, but then commissioned an independent report which concluded in May 2011 that the methods for handling and disposing of the UN soldiers' human waste were not sufficient to prevent cholera contamination. Claims for compensation from the UN by those affected by cholera were met with intransigence up to the level of Secretary-General. In February 2013, a formal UN statement effectively denied the need to provide compensation by not accepting legal responsibility for the cholera outbreak due to diplomatic immunity.[1]

It took until August 2016 for the UN to admit formally the role its troops played in bringing cholera to the country and it was December of that year when UN Secretary-General Ban Ki-moon, in his last month holding his position, finally issued an apology.[2] In between, in October 2016, the UN offered 'material assistance' (which some take as a code word for 'compensation') to those affected by cholera as part of a US$400 million initiative, which also involved eradicating the bacteria and improving Haiti's water and sanitation infrastructure. Without a specific funding or allocation

plan for this initiative, it was unsurprising that, over two years later, little had happened and cholera still plagues Haitians.

From flimsy shelters to disease to sexual violence, how could so much go so disastrously wrong during the relief, recovery, and reconstruction? There is no lack of experience in humanitarian aid and no shortage of guidelines and manuals gracing the shelves. All the heartaches identified in post-earthquake Haiti had multiple precedents registered in reports from past disasters.

More to the point, why did the world have to wait for the earthquake to mobilize so much help for Haiti? As with humanitarian aid, there is plenty of experience side by side with guidelines, manuals, and texts on building to withstand earthquakes and other hazards—and developing a society which can deal with an earthquake and other hazards. Little of this accumulated insight had been applied to Haiti. The promised US$13 billion, or even half of that, would have gone a long way towards preventing the disaster in the first place.

Before and After the Earthquake

It is hard to predict exactly when earthquakes will hit, as there are few reliable warning signs beforehand. In the long term, statistical analysis can provide some indication of the time frame within which a geological fault will move. For now, so many assumptions are needed, and the ways in which a fault can shift are so varied, that confidence in the predictions is low. In the short term, hours or days before a tremor, a variety of proposed indicators has been examined, from radon gas to groundwater levels and from animal behaviour to electricity in the air. No single sign has proved itself

sufficiently to be accepted. This doesn't, of course, stop some individuals popping up after a major earthquake claiming they foresaw it, neglecting all the previous times they predicted an earthquake which did not happen, and so making scientists rightly leery about such claims.

Despite not knowing when an earthquake will occur, many major tremors can generally be forecast by location, in terms of mapping known faults, most notably along the boundaries of tectonic plates. This method is not 100 per cent reliable and earthquakes still occur far from major tectonic plate boundaries, as witnessed on 25th December 1989 when northern Québec, in the middle of a tectonic plate, experienced surface ruptures during the Ungava earthquake. Even at known tectonic plate boundaries, previously unknown faults can slip, which is what occurred in Northridge, California on 17th January 1994, with damage killing about fifty-eight people. We certainly know that Dushanbe, Istanbul, Jakarta, Kingston (Jamaica), Mexico City, Quito, San Francisco, Skopje, Tehran, Tokyo, Vienna, and Wellington among many others will be rattled at some point. Port-au-Prince was also on this list.

Knowledge of Haitian earthquakes extends back centuries. In 1842, a quake about ten times as powerful as that of 2010 rocked the country's north coast. Hesketh Prichard, a British explorer and then a First World War sniper, referred to it in a scientific article of 1900, describing his journey across Haiti.[3] Another research piece from 1912 mentions 1842 alongside the major damage around Port-au-Prince from shakings in 1751 and 1770.[4]

Yet despite this knowledge of seismicity, little was done. Why was the infrastructure in the capital city so poorly constructed? Why were so many people poor, leaving them with no choice but

to live in these buildings without hope of improving them? Why did even the affluent parties, from the country's president to the UN to the developers of Hotel Montana, not enact basic earthquake safety principles? These questions were being asked in 2010: a meeting on tackling disasters in Haiti, highlighting seismic safety, was concluding on 12th January when the earthquake rumbled through.

The overwhelming inequities, underdevelopment, and marginalization precluded a quick fix. Haiti, as a country, is not especially poor or under-resourced, but the scale of inequality is horrifying. Centuries in the making, all these problems could not be easily solved. It takes time to put up tens of thousands of buildings which lasted barely a minute on 12th January. It takes time to create a city rife with informal settlements, without basic services, and lacking planning regulations, building codes, and institutions to monitor and enforce such laws. It takes time to produce a culture of day-to-day bustle across exposed electric wires, through haphazard doorways, and around informal structures.

For Haiti in 2010, this time period might have been precisely 206 years. Before 1804, France had been the ruling colonial power, exploiting slaves to plant and harvest coffee, sugar cane, and tobacco. In treating human beings as commoditized objects, France's costs were low and profits were high, a wealth built on the back of inhumanity. At the time, a colonizer would not care much about saving the lives of the colonized, especially since slaves could easily be imported from elsewhere.

In 1791, in the wake of the American War of Independence (1775–83) and the French Revolution of 1789, Haitian slaves rebelled. Twelve years later, as the Napoleonic Wars gripped Europe, the Haitians won. A year after that, on 1st January 1804,

Haiti declared independence, so that the first free Caribbean state was born, only to remain everywhere in chains.

Colonial powers refused to accept this freedom. France exacted a heavy toll through a demand for reparations, finally paid off by Haiti in 1947. The USA, with its own colonial experience apparently forgotten, joined in the exploitation. In 1868, American President Andrew Johnson suggested annexing the island, but it never happened. US warships were a common sight around Hispaniola until in 1914 US President Woodrow Wilson sent in the marines to move the foreign cash reserves of Haiti to New York. In 1915, the marines arrived again as an occupation force, staying until 1934.

This pattern of control persisted over the next decades through Haitian leaders. François ('Papa Doc') Duvalier retained an iron grip over the country from 1957 to 1971 after which his son Jean-Claude ('Baby Doc') Duvalier continued in the same vein. They subjugated, tormented, and pillaged Haiti as much as France and the USA had done before them. Although the former colonial powers were not wholly enamoured with the Duvalier regimes, they more often than not took advantage of the leaders' absolute power while the Haitian people suffered. Baby Doc fled to France during a popular uprising in 1986, paving the way for elections and coups in Haiti.

Jean-Bertrand Aristide became the on-again, off-again elected president of Haiti. A convoluted American foreign policy remained uncertain exactly where the White House and American troops stood with respect to Port-au-Prince. In 2004, the UN took over and was working at reconstructing the country with evidence of some progress.

After a steady increase between 2004 and 2008, Haiti's population growth rate dipped slightly in 2009. Infant, child, and

maternal death rates continued their steady decline, each dropping by more than 10 per cent from 2004 to 2009. Numbers and rates of undernourishment decreased during the same time period.

With over half the population under the age of 20, opportunities for education and jobs persisted as a major challenge. Riots over food prices in 2008 precipitated the firing of the prime minister. As Haitians had done for decades before, thousands fled in derelict boats, hoping to reach the USA, the Turks and Caicos Islands, or the Bahamas. If they did arrive and could find work, their remittances provided a lifeline for those staying at home. Commonly, the US Coast Guard intercepted and repatriated those in boats, leaving them to try again another day. Many more simply disappeared at sea, slipping below the waves or being devoured by sharks.

This roller-coaster progress characterized Haiti, as it had done since independence, when the earthquake battered over two centuries of social and infrastructural neglect. And earthquakes are not the only hazard facing Haiti. On 14th September 2004, tropical storm Jeanne formed in the ocean near several Caribbean islands. The system tracked west-north-west, becoming a hurricane on 16th September and skipping along the Dominican Republic's north shore as a tropical storm before unleashing its rainfall across northern Haiti.

The city of Gonaïves was worst affected, suffering more than 2,800 of Haiti's 3,000 Jeanne-related fatalities. The same vulnerabilities which led to the 2010 earthquake's devastation created the Jeanne disaster. Lack of opportunities, gross inequities, oppressive dictatorships, and centuries of exploitation by the outside world made people vulnerable.

Part of this equation was environmental degradation, including decades of deforestation. Denuded of trees, the hills sent the rainfall sluicing into low-lying areas. Mud, floods, and landslides marked Jeanne's passage, killing people and blocking roads delivering post-disaster aid. The same was true outside of hurricane season. Four months before Jeanne, along the Haiti–Dominican Republic border, flash flooding from intense rainfall killed more than 1,000 people in Haiti and over 400 in the Dominican Republic.

It would be easy to blame the rainfall for leading to deadly floods and landslides. It would be straightforward to pontificate that Haitians made the decision to cut down the trees. Doing so ignores our understanding of the nature of these unnatural disasters. The real disaster is revealed by the questions which we must raise and answer. Why did people feel they had no choice but to cut down trees? Why was infrastructure so poor that it could not withstand rainfall? Fundamentally, why did people not have the resources, knowledge, options, abilities, and opportunities to prepare for and deal with a storm? The answers to these questions are the same as for the 2010 earthquake.

Then, on 29th September 2016, a tropical storm formed just west of Barbados. As hurricane Matthew, it briefly reached Category 5, the most powerful, on 1st October before shifting between Categories 3 and 4 during its march northwards. Jamaica, Cuba, Haiti, and other countries in the area issued warnings. Many people evacuated locations in Jamaica as Cuba's well-tested civil defence went on standby. But Haiti took the brunt of the storm when it tracked east, cutting across the country from 4th to 5th October. Jamaica escaped a direct hit, with no reported deaths. Cuba and the Dominican Republic each listed four fatalities. Haiti's toll was at least 500 killed.

And there was the continuing cholera epidemic too. Following Jeanne and the May 2004 flooding, at least there had been no need to worry about the spectre of cholera. Society had taken action to deal with cholera long before 2004. It was the same during the 2008 hurricane season. Four storms in a row—Fay, Gustav, Hanna, and Ike, representing two tropical storms and two hurricanes—ripped through different parts of Haiti killing hundreds. No matter how much or where the rain fell, cholera had never been a concern.

By the time hurricane Matthew appeared on the map, Haiti had already reported 29,000 cholera cases for 2016. The disease's death toll around the country since it was introduced after the earthquake in 2010 already matched, if not exceeded, the total number of storm-related deaths within the same time period. As Matthew moved on and the floodwaters subsided, Haiti's cholera cases grew. The humanitarian response was duty-bound to involve cholera prevention, treatment, and vaccination. Human decisions following the 2010 earthquake had created the hazard of cholera for Haiti, which existing vulnerabilities turned into a continuing disaster. This disaster was illuminated by another hazard, a hurricane.

No shaking of the earth, no downpour from the clouds, and no wind from a storm created cholera in Haiti or vulnerability to the disease. The disaster is not natural. Cholera was introduced by people, and it continues to grip the country because of human failures.

Two months after Matthew, an international group of doctors and researchers advising the Minister of Health and Population of Haiti estimated that cholera transmission in Haiti could be stopped within five years for around US$66 million.[5] Considering

cholera's cost of thousands of deaths and hundreds of thousands falling ill, as well as what might transpire should the disease cross the border into the Dominican Republic, this is a bargain. Thus far, no one has given the resources needed to achieve this goal, even though we know that every year, Haiti has the potential for a hurricane, earthquake, or tsunami which would entail the emergency import of cholera treatment and vaccination equipment.

Such decisions are not one-offs. They are systematic and continual, ensuring that the cholera burden on the Haitian population endures. They exemplify a long-term attitude of, in effect, allowing the perpetuation of a long-term problem inside Haiti which was introduced from outside.

And so the disasters continue. They parallel exactly the perpetuation of the long-term problem inside Haiti of entrenched disaster vulnerabilities which were introduced mainly from outside the country. The systematic and continual decisions to oppress most of the Haitian people, to snatch resources from the country, and to sustain the abject poverty all conspire to create the vulnerabilities which in turn create the disasters. The 2010 earthquake exposed the centuries of neglect, brutality, and vulnerabilities foisted on the Haitians who could least afford to challenge their locked-in position.[6] The 2016 hurricane exposed the years of neglect, brutality, and vulnerabilities foisted on the Haitians who are least able to avoid cholera by their own means.

This is the disaster. The disaster is these long-term processes, over years and centuries, not the short-term events, over seconds (earthquakes), minutes/hours (tsunamis), and days (hurricanes). The process of unrolling disaster is based on the long-term choices of people who have the power, resources, knowledge, and abilities to make essential and intrinsic changes—but apparently not the

wisdom, will, or principles to do so. A disaster is not an event and is not the fault of nature. A disaster is a process manufactured and implemented by people and their choices.

How could an oppressed, marginalized, overexploited country forced to remain underdeveloped with the people in poverty ever deal with nature's extremes? Hurricane Matthew provided at least three days of preparation for Haiti. The entire Caribbean knows that any date between June and November (and sometimes outside these months) could bring a storm roaring through. The 2010 earthquake provided barely seconds of preparation time, but Haiti nevertheless knew that it could shake at any time.

Disasters such as those hitting Haiti hit the headlines and capture our attention. They are nothing new, having always happened throughout human history. Did disasters exist before human history? This question is not easy to answer because a disaster is described through effects on humans and society. Neither the earthquake of 2010 nor the rainfall of 2004, 2008, and 2016 would have mattered if they had not killed and injured people, disrupted routines, and damaged infrastructure. It is hard to have a disaster without humanity. Yet nature still produced the earthquake and storms.

Disasters not involving nature—such as chemical explosions, riots, and terrorism—are clearly not natural. When an environmental component—such as earthquakes and hurricanes—is involved, then disasters seem to be caused by the environment and are blamed on nature. Then what exactly is wrong with the phrase 'natural disaster'?

The definition of the term 'disaster' relates to its impacts on humans. At the basic level, trawling through hundreds of pages of academic writing on the definition, dozens of professional

manuals, and several dictionaries, a reasonable definition is 'a situation requiring outside support for coping'. Something happens, we cannot deal with it, and we ask for help. This concept works at the individual level and at the international level, matching UN glossaries, researchers' viewpoints, emergency services' interests, and dictionaries.

These seven words display vagueness—how should 'situation', 'support', and 'coping' be interpreted?—but vagueness can rarely be avoided. The principal power of these words is that they are understandable, somewhat intuitive, and work across many (although certainly not all) languages and cultures. The key is that disasters are defined by their societal impacts, not by the degree or scope of any influence from nature.

We also need to consider why those affected by nature cannot cope with it. The reason lies beyond the natural environment: vulnerability of people, places, infrastructure, and communities. Vulnerability means that people do not have the resources, knowledge, or choices available to stop nature from harming them.

Haiti's earthquake and storms were natural, but its disasters were not. They arose from individuals and society. But this is all for Haiti. Does the same pattern hold elsewhere?

CHAPTER 2

NATURE'S HAZARDS

Change is Natural

Our natural environment changes, as it has done for billions of years. Species evolve, continents drift, and sea levels fluctuate over time periods of hundreds, thousands, and millions of years. Some volcanoes wait millennia or longer between eruptions, as magma from deep underground slowly wends its way to the earth's surface. In the meantime, people build. The last known eruption of Germany's Laacher See volcano near Bonn was nearly 13,000 years ago, when comparatively few people were in the area. Scientists calculate that a similar eruption today would affect over two million people and the damage to housing alone would cost between 18 billion and 27 billion euros.[1]

As the ages wax and wane, the shape of the earth's orbit around the sun varies. So does the direction in which the earth's axis tilts compared to the sun. These variations affect seasonal extremes and lead to ice ages advancing and retreating.

Over human lifetimes, across decades, the climate witnesses further changes. The North Atlantic Ocean, the Pacific Ocean,

and the Indian Ocean each dance through slow oscillations of their properties such as temperature distributions and air pressure, affecting regional and global climates. On land, over decades, forests mature, expand, and shrink while, over slightly longer time frames, soils form underneath the canopies and across grasslands. Land, oceans, and the atmosphere have been shifting over decades from human-induced climate change. As the air warms by fractions of a degree Celsius each year, average sea levels creep up by millimetres per annum and ocean acidity increases. Many glaciers and ice sheets have been steadily shrinking while others expand with increased snowfall due to climate change. In places, erosion of topsoil, coasts, and river banks is easily measured over months and years. Some coastlines around England annually retreat more than a metre. Expanding coastlines elsewhere include some salt marshes of New York, which continue to rise a few millimetres above sea level each year, along with much of Norway's shoreline.

These changes are gradual. All the same, infrastructure which does not adjust to them becomes damaged, for example when the subsidence or rising of land causes buildings to crack and fall apart. Sometimes the drama even plays out on live TV. In June 1993, the four-star Holbeck Hall Hotel built in 1879 near Scarborough, England was videoed tumbling over a cliff as a landslide glided into the sea over several hours.

Hurricanes, wildfires, temperature extremes, and river floods can last days. Tsunamis and thunderstorms rarely endure longer than hours. Earthquakes typically complete their shaking in seconds. Consequent damage makes these creeping or rapid changes hazardous to our infrastructure and disrupts our lives. When we have not planned or prepared for it, nature's hazards over any time period lead to damage and losses, to life, livelihood,

and infrastructure—in effect, a disaster. The key is 'when we have not planned or prepared for it'. In none of these cases is nature intent on being malicious.

Walt Disney's 1942 movie *Bambi* reflects our view of nature. Who could forget, it is suggested, the forest fire that endangered Bambi's life?[2] He and his father bounded through the woodland with sparks showering around them and trees in fiery explosions barring their way. Yes, 'Man' had entered the forest and 'his' campfire had set the woods aflame, forcing the animals to gather in the safety of a lake island.

Characters from Bambi soon fronted forest fire prevention campaigns. The bear Smokey supplanted them in 1944, morphing into Smokey the Bear in a 1952 song. In folksy style, 'the fire preventin' bear' lamented 'what you'll be missing' if all trees 'went up in smoke'. Thus was born the phrase 'Only you can prevent forest fires'. All fire is bad, so stop all fire. To be fair, Bambi and his friends were pursued by unnatural flames, from human carelessness. In any case, forest fire prevention in the USA long precedes Disney fans' favourite fawn. Does Bambi really bear the blame for American post-Second World War policies which aimed to suppress what are now called wildfires?

After all (spoiler alert), a hunter felled Bambi's mother. Bambi's plaintive cries as he fruitlessly searches for her in the falling snow under darkening skies have left the USA's hunting and gun cultures intact. The deer-child's single teardrop did not even impede hunters from expressing offence at their portrayal in the movie. Somehow, bullets against nature are acceptable, it seems, while fire is not. But preventing fire from human mistakes, or deliberate setting, should not shift to obstructing all wildfire. Nature is full of change, and fire is part of nature.

Wildfires are nevertheless terrifying. They can advance at more than ten kilometres per hour in forests, faster than most people can walk, or double that speed across non-forested land. The air preceding a wildfire can exceed 800°C as flames leap dozens of metres upwards, cresting the tallest tree crowns. Sparks and debris drift along or are fanned by the wind, igniting land and property far from the main front of the fire. Initial triggers might be lightning, sparks from power lines or motorcycle engines, vehicle fires, cigarette butts, neglected campfires, or, worst of all, arson. It is unsurprising that significant efforts are put into controlling and stopping wildfires.

The morning of 30th January 2009 dawned hot and dry over the state of Victoria in Australia. Melbourne recorded a peak of 45.1°C, one of the highest formally measured temperatures in the city. Similar conditions had persisted for the previous two months, leaving vegetation around the state parched. As the lack of humidity and high temperatures endured over the next week, the premier of Victoria warned on Friday 6th February that the following day would bring Victoria's worst-ever recorded conditions for vegetation fires.

Australia has good reason to fear the flames. The incongruously named Ash Wednesday fires of 16th February 1983 killed seventy-five people across two states in twelve hours. Tasmania lost sixty-two people to the Black Tuesday fires of 7th February 1967. Forty-two years later to the day, their Victorian compatriots waited to see whether or not their fire warning would anticipate a disaster.

Saturday 7th February 2009 brought near-hurricane-force dry winds sweeping across Victoria. At around 11:45 a.m., a power line failed, partly due to an incorrect installation which had been

missed during an inspection the previous year. Electric arcing from the failure ignited the vegetation, which was, in the premier's words, 'tinder-dry'. A few minutes later, an observer in a fire tower reported smoke. Fire crews were alerted within three minutes and were on-site before noon. But the fire was already out of control. It jumped roads and advanced through the bush along multiple paths. Sparks fanned by gusts ignited new fires up to forty kilometres ahead of the main front. Flames leapt over fifty metres high.

The rapid, erratic spread and the continuing, multiple ignitions—including from arson—coupled with the wind's change of direction earlier that evening left many people little time to prepare or flee. Several firefighters found themselves caught in the fire but survived. Risking their lives, they saved hundreds of others. Sadly, the flames trapped dozens more. By the time this bushfire had completed its run, 119 people had perished and 232 were injured, some with horrific burns.

Overall, 7th February, or Black Saturday, realized an even higher toll. All the day's bushfires around Victoria together killed 173 people and injured 414. Over one million animals were killed and 3,500 buildings destroyed. It is Australia's worst bushfire disaster so far.[3]

How could such vulnerability to a known hazard arise?

Indigenous Australians managed fires for tens of thousands of years. They set controlled blazes to alter the environment for maintaining tracks, trapping animals, and avoiding the build-up of burnable fuel which could lead to large conflagrations. Over time, indigenous practices adapted the ecosystems to support plant species which could survive low-intensity bushfires, actually using fire to propagate. Fire was part of land use and

land management, integrated into human needs among other environmental adjustments, although we do not really know how many fire disasters the indigenous Australians might have caused nor how many of them perished in the flames.

Europeans imported and imposed a different perspective of bushfires. Flames were presumed always to be dangerous and damaging, so they were suppressed and fought. As settlements expanded into the bush, fires indeed became highly destructive and lethal, reinforcing the combat mode.

The same is true across North America. Wildfire is part of the ecosystem and it is a needed ecosystem process. Californian and Coloradan forests, meadows, and scrubland would not exist today without occasional burning. Suburbia has sprawled into these areas of vegetation and their fires. How could we help ourselves and nature by living with natural fire rather than harming both by manipulating it?

The theory is that preventing wildfires delays the inevitable. Ecosystems expecting frequent, lower-intensity fires might have trouble with the changed regime of less regular flames. Leaves, plant litter, and dead trees build up, providing large swathes of combustible fuel during dry spells. Then, a rare fire rages as a high-intensity, hard-to-control inferno destroying plants, animals, people, and infrastructure.

As we entered the twenty-first century, debates on vegetated lands and wildfire management continued from North America to Australia. Prescribed burns to reduce fuel loads appeared to reduce the intensity of fires, but remained controversial, particularly when properties could be at risk. Some evidence countered the notion that human fire prevention strategies undermine natural fire cycles and lead to worse fires. Survival strategies for people in

fire's way came under question, as did the role of climate change in affecting heat, humidity, and winds.

What persisted unquestionably was urban expansion into fire-prone locations. From Calgary to Canberra, dwellers at the city–wildland interface enjoy the quality-of-life benefits of leafy green surroundings, less air pollution, and nature-based activities right beside them. They sit in the middle of areas which are not only flammable but which also require periodic burning for ecosystem health.

Since periodic burning is not healthy for houses or people, a balance is still sought between healthy ecosystems with wildfires and not placing people and properties at risk. Much of the advice must centre around the assumption that fires will happen. Sparks, embers, and flames must eventually envelop properties that infringe on locales which were previously used to being burned.

Warning, preparedness, and responsiveness are essential. We can plan to stay and defend our homes, but extensive preparation and care are needed, as well as being psychologically and physically ready. One small mistake could end our lives. Other strategies are keeping surrounding land clear of burnable vegetation, applying proper landscaping, being attuned to environmental conditions and information sources, and using fire-resistant roofs, walls, doors, and windows. To survive an evacuation, strategies incorporate practising and implementing an escape plan, protecting irreplaceable valuables, having insurance, and being psychologically and financially ready to rebuild. And, especially, leaving long before the flames approach. No strategy is foolproof. All reduce vulnerability to some degree, especially keeping options open and deciding quickly once a threat is palpable—and preferably before

the situation is urgent. No matter what, planning and preparedness must begin long in advance and must never stop.

At two and a half kilometres above sea level, people used to living close to sea level quickly end up short of breath when they exercise. Those who grow up or have lived for a long time in Colorado's Rocky Mountains, a more than two-hour jet flight from the nearest salty shorelines, have adjusted. They rarely notice the reduced atmospheric pressure, which means less oxygen, revelling in the alpine air, culture, wildlife, and woodlands. With the forests come all parts of forest ecosystems, including wildfire, which is never too distant.

Houses in the woods surrounding Nederland, Colorado sit about as high as one can live in this area. Some residents were born in the town and never left. Others are transplanted, mainly from around the USA. Everyone deals with the quirks of Nederland, noted for its annual March festival called Frozen Dead Guy Days. Centred around a cryogenically frozen Norwegian who was shipped out to Nederland by his family, the festivities include coffin races, a polar plunge into freezing water, and human 'foosball' (which is life-size table soccer, so people play the game themselves rather than controlling plastic effigies attached to bars).

Nederland's foibles are not just cultural, but also arise from nature. To live there, you need to learn about the blizzards and winds buffeting the canyons and about the moose which can suddenly step out in front of your vehicle as you drive. You need to be aware of the squelching downpours that cause lethal flash floods, especially because a cloudburst upstream means that the flood can swiftly sweep through a sunny location. In any case, the scorching summer days demand continual hydration, as the lack

of humidity sucks you dry. Among all these hazards, you must certainly learn about wildfires—and what to do about them.

The 9th of July 2016 was yet another toasty, dry summer day on the lee side of the mountains and foothills around Nederland and down the canyon to the city of Boulder, which extends out onto the plains. Residents and visitors expect such weather. The myth of 300 sunshine days per year and the vast tracts of accessible, scenic parkland beckon nature lovers from ambling tourists to serious climbers. As we stroll along, we may see a deer bounding through the grassland at sunset or prairie dogs perched on their hind legs twitching their noses and waggling their tails at us. Bouldering and cycling routes entice recreationalists who cool off afterwards by tubing down the creek chilled by snow and glacier melt. Birdwatching binoculars train on the varied raptors while their owners hope a bear does not ramble into view.

Some people head out for a few hours for a relaxing picnic by emerald lakes. Others camp for a few days, trekking deep into the backwoods and scrambling over the scree. Two men and a woman from Alabama chose July 2016 to camp around the woods of Nederland. On 8th July, the two men did not properly extinguish their campfire. Twenty-four hours later, the flames lit up the forest in what became known as the Cold Springs Fire. It burned a swathe through the tinder of trees, forcing nearly 2,000 people to evacuate, killing numerous animals, and destroying eight homes along with several other buildings. Fortunately, no one died.

The campfire trio were soon arrested, and trespassing, arson, and other charges followed. The two men had been responsible for the campfire, so the woman plea bargained, receiving community service and probation. The men pleaded guilty and, after four

months in jail, were sentenced to a programme permitting them to be employed provided that they return to prison after work. It will take them the rest of their lives to pay for damages awarded against them.

As this drama was unfolding in a Boulder District courtroom, some residents in the fire zone were cleaning up from the blaze—but they were not rebuilding their properties. The flames had swept through their land sparing the houses. Not 'miraculously sparing the houses', because there was no miracle. Foresight, initiative, planning, and actions had saved these homeowners from ruin.

Wildfire Partners is a local and state government funded programme inspiring and supporting residents to implement measures countering wildfire damage to their properties. They provide assessments, detailed advice, progress checks, and occasionally some financial assistance to enact recommendations. In the Cold Springs Fire of 2016, eight houses participating in the Wildfire Partners programme were in the burned area. All survived and were habitable immediately afterwards.

To avoid embers drifting inside, gaps and holes in walls and roofs must be covered or closed while skylights and solar panels are kept clear of debris and litter. Vents, doors, and windows can all use improved materials and construction to reduce the chance of the building catching alight. Fences, porches, and decks require non-combustible material and should be free of other combustibles on or under them. Woodpiles are placed away from the house on a non-combustible surface.

Changes go beyond the buildings and land, such as purchasing insurance while preparing and testing an evacuation plan. How will we receive emergency alerts? Do we understand what they mean and how to respond? Do we know when to leave, how to

travel, where to go, and what to take? How will we contact family members who are elsewhere when we evacuate? Have we considered taking irreplaceable and sentimental items, essential documents, and enough hygiene products, medications, and medical aids? Finally, is our address marked clearly on a non-combustible pole and reflective surface visible from both directions along the road through smoke so that emergency services can quickly locate our property?

These actions mean taking personal responsibility, with every family actively pursuing their plan, implementing it themselves for themselves. But nothing can happen in complete isolation, so another Wildfire Partners' principle is to work with neighbours, to compare notes, to exchange advice, and to collaborate on changes needed along property borders or roads. Wildfire Partners encourages participants to organize local meetings and to get their neighbours involved.

In the mountains, neighbours are not side by side and might not even be within shouting distance. They can be a ten-minute walk down the avenue or sited on the next ridge, distances which wildfires leapfrog in an instant. After the Cold Springs Fire, some of the neighbours of those with houses following the Wildfire Partners programme returned post-evacuation to find ashes where their homes had stood. For months afterwards, with the scars of burned trees barely starting to be covered up by nature's renewal, hammering and sawing could be heard across the landscape as the neighbours rebuilt, living elsewhere until their new homes were complete.

Wildfire Partners participants never let down their guard. Fires can spark at any minute of any day, especially in the summer. Too often, there is barely enough time to leap into a car to escape.

During the Cold Springs Fire, one lucky resident dodged the flames on a horse, emerging uninjured. When evacuation means skedaddling immediately by any means possible, once we smell smoke, it is far too late to consider fire-resistance measures around our land and buildings.

Instead, overlooked by the skeletons of scorched trees guarding hillocks around their houses, home owners who do not want their possessions to ignite clear brush and debris, clean their gutters and eaves, trim the grass, thin limbs and branches from trees, maintain aspen which burns less than the lodgepole pine they remove, and rip out vegetation that encroaches close to the house. Some are self-employed, running businesses they founded, and the time they spend on avoiding wildfire destruction detracts from time spent with their clients. Nevertheless, in the end, the fire-related endeavours cost far less than losing everything in a few, sizzling minutes. Accepting the quality of life of living in the airy forests among the snow-capped peaks means the continual effort that comes of living in a burn area. Even so, as Wildfire Partners repeats: 'There are no guarantees'.

Wildfire hazards exist around the world. The triggers, intensities, and spreads can be forced as much by vegetation management, people management, and land use decisions as by the environment delivering lightning, wind, air temperature, and humidity. These points on reducing wildfire vulnerability neither condemn nor condone the choice to manage forests and fire. They emphasize that hazard modification techniques always yield advantages and disadvantages—as does avoiding changes in hazards. Addressing vulnerability, no matter what the wildfire hazard, must always be the focus of action to avert wildfire disasters.

Fire can be quenched by water. Water, too, has a role to play in nature and in destruction. Standing on Singapore's Marina Barrage, where five rivers meet in a bay that flows out to sea, gives a sense of the lengths (literally and figuratively) to which we are willing to go to try to control nature. At 350 metres long, it is just shy of the world's longest cruise liners, forming an imposing, concrete end to a stroll through the Gardens of the Bay park in the lustrous heat and humidity.

In desalinating Marina Bay behind it, the barrage provides a water supply for the city state. It stops many high tides from flooding low-lying areas of the city and drains excess rainwater from these same locations during deluges. The entire area has become a tourist and recreation attraction, for walking along coastal paths, boating in the bay, or relaxing in the shade of the adjoining garden's trees or the barrage's visitor centre.

The grassy rooftop above the visitor centre provides magnificent vistas of the barrage and Singapore's eclectic downtown architecture. The scale of engineering in Singapore city becomes conspicuous, from the coasts, up the rivers, and around the centre. This engineering and urban development placed people and buildings in the way of floods, and exacerbated those floods, so the city has now sought to alleviate these hazards through the barrage.

Around the world, river and coastal engineering dictates where the water goes, how fast it flows, and the power of the waves and currents. Human interventions to influence areas of flooding can be in the form of embankments or walls as well as dredging, building groynes, tailoring coastlines, and re-forming the bends of a river. Whether the water falls from the sky, melts from mountain peaks, or encroaches from the sea, we have spent millennia separating ourselves from it.

These endeavours make sense. Daily life would not be easy if we were continually flooded. Many peoples around the world, from Guyana to Myanmar, thrive in houses on stilts or on boats. In a different context, London and Cambridge in England have flourishing groups of boat dwellers, enjoying life on their canal or river. But not everyone desires this lifestyle. Plenty of infrastructure functions best when not immersed every so often. There is nothing inherently wrong with reshaping our environment to try to stay dry with the added advantage of channelling water for irrigation and drinking. The question is: how much does it really reduce flood risk over the long term?

Imagine that we live near a river which floods every few years. We get to know the water's cycles and we learn the signs of the river's highs and lows. We are cautious about storing valuables on our ground floor. We refurbish it so that it is easier to dry and clean after a flood, plus we make the electrics and plumbing water resistant. We even chat with our insurance company. We let them know where we live and ensure that we are covered for floods above the ground floor and for non-river floods, such as a pipe bursting, a bathtub overflowing, or rainwater pelting through open or broken windows. As part of the deal, we agree not to claim for any ground floor inundation from the river. In short, we learn to live with the regular floods. We accept that we gain from living beside the river, with the cost of making some adjustments to our property and life alongside a bit of disruption. We are ready to deal with the typical river water ourselves while having backup for other types of flooding or unusual river extremes reaching above our ground floor.

Now imagine that we construct an embankment along the river, halting the regular flooding. We look forward to staying

entirely dry while enjoying the river's amenities, the view, and the walking path atop the embankment. We need to repaint our house, but now we do not need to worry about water-resistant, easy-to-clean finishes, or about maintaining the water resistance of the electrics and plumbing. We start to use the ground floor exactly as the rest of the house, displaying artwork and filing the family's passports and wills in our ground floor study. We delay renewing our flood insurance, balking at yet one more bill to pay, eventually leaving it buried beneath a stack of paperwork.

One day, a bathroom pipe bursts when we are at work, pouring water into the ground floor for hours. Or a 'reduce taxes' government is elected, so their first budget cuts all monitoring and maintenance of the embankment. Perhaps, during a storm, a river boat collides with and breaches the embankment outside our home. An extreme storm could overtop or undermine the protective barrier, with a rush of water slamming into our property as the embankment crumbles.

In the final scenario, we would have been flooded even without the embankment. But if it had never been built, we would have been ready for the flood hazard and we would have reduced our vulnerability. The embankment's presence lulled us into losing our flood risk knowledge, permitting vulnerability reduction measures to lapse. We see the embankment, we are told that it separates us from the river, and we assume that we are protected from floods. This false sense of security increases flood vulnerability over the long term by eliminating some small-scale flood hazards in the short term. Without other actions to tackle flood vulnerability, we create a higher flood risk. The absence of an embankment would also curtail fast-flowing floods smashing into our walls. The water would typically rise slowly as the river

swells and spreads out. The collapsing embankment could add a significantly dangerous component to any flood.

The important point here is to admit that we can do something about our vulnerability and stop disasters, no matter what the hazard or what we do to the hazard. But we must make the decision to do so. A mindset of prevention accepts the advantages and limitations of the river embankment. We still need a flood-resistant ground floor, flood insurance, and action plans in case of different flood types. We also need to understand how the embankment might have changed the flood regime, outdating our knowledge.

These points on reducing flood vulnerability neither condemn nor condone the choice to construct the embankment or to otherwise engineer the river. As in the case of wildfire, they emphasize that hazard modification techniques always yield advantages and disadvantages—as does avoiding changes in hazards. Addressing vulnerability, no matter what the flood hazard, must always be the focus of action to avert flood disasters.

Managing Ourselves

Canvey Island sits downstream from London, England, in the middle of the Thames Estuary leading out to the North Sea. Today, its population is nearly 40,000, and they are so proud of their island that an independence party has been born—demanding independence from its mainland borough council that is, rather than from the United Kingdom.

Canvey Island is artificial. Remnants of both Celtic and Roman habitation have been unearthed, but shifting land and sea over the centuries slowly reduced the island's habitability. During medieval times, it was marshland, frequently flooded with saltwater, and

grazed by livestock. In the seventeenth century, Dutch engineers led by Cornelius Vermuyden drained the island, with the first sea walls built in 1623. The modern era's first Canvey communities came from Dutch settlers.

Rapid population expansion did not take place until the 1920s. A population of 1,795 and about 300 buildings are indicated in statistics from 1921, while by 1927, more than 6,000 people and nearly 2,000 buildings are listed.[4] This period marked Canvey Island becoming a retreat from London, particularly from the East End, for taking seaside holidays and spa breaks. Today, Canvey offers a getaway from London property prices as well as being a quiet retirement locale.

Building in a floodplain brings consequences. Draining water from soil compacts the land and the weight of buildings pushes it down further. Starting at sea level as a marsh before it was drained, much of Canvey's land soon descended below the mean high water mark of the River Thames. The night of 31st January/1st February 1953 brought the Thames and North Sea to Canvey. A tempest blew off the Atlantic, rounded Ireland, and headed across Scotland. The Irish Sea ferry *Princess Victoria* sank, killing at least 130 people. Around nineteen other deaths occurred on the waters around Scotland before the storm barrelled south across the North Sea.

A storm surge is coastal flooding that combines two phenomena. First, low atmospheric pressure in the centre of a storm pulls the sea surface upwards. Second, strong winds pile up sea water at the shore. The stronger the wind and the greater the distance over which it blows (the 'fetch'), the more water ends up at the coast, raising sea levels. Storm surges can inundate coastal properties with several metres of water.

Some tidal ranges exceed the storm surge height. If the storm surge arrives at low tide, it might look as if the tide fails to retreat. If the storm surge looms at high tide, then the tide appears exceptionally high. Tides display monthly and annual cycles. It was the misfortune of North Sea settlements that the 1953 storm surge swept along England's east coast when the tide there was near a maximum of the daily, monthly, and yearly cycles. Over 300 people died on land in England. Perhaps another 100 or more perished on boats across the North Sea while Belgium's official death toll reached up to twenty-two. The storm surge's full fury was saved for the Netherlands, where large areas lie below the high tide mark. There, 1,836 people succumbed to the cold and the water during that bitter night.

In England, the worst-hit area also rested below the high tide mark: fifty-nine are now said to have died on Canvey Island, although fifty-eight was the traditionally reported death toll for decades. The waves breached walls and engulfed streets up to bungalow rooftops. Just a bit higher and the water would have washed away dozens of people sheltering on top of their homes.

The UK government's response to this disaster involved a thorough evaluation and reworking of the strategy for stopping a North Sea storm surge from becoming a flood disaster.[5] Unwillingness to move away from floodplains, which would have meant abandoning most of Canvey, led to a focus on engineering coastlines. Separating land from water was accepted as protecting people and property in the Thames inundation zone, in which large expanses of London are sited. An eventual outcome of the government's review was the construction of the Thames Barrier, alongside raising and strengthening walls where the Thames runs

through the city. The expectation that London is now immune from storm surge and Thames flood disasters is one factor driving expensive riverside developments. The high-rises of the financial centre of Canary Wharf ascend from the revealing place names of Mudchute and Marsh Wall.

Signs of the original ecosystem are not limited to place names. Across the river, on the Greenwich peninsula, an ecology park presents a wetland to educate locals and visitors about the nature which should be there. Wet areas which would previously have adjoined the river, soaking up rainwater and providing room for a storm surge, have now been drained for high-rise flats with prices exceeding £1 million. The Thames in London has nowhere to spread out except into the infrastructure.

The evidence of the changes made to the river remains. The Thames Path is a walking trail that goes right through London, allowing people to wander along the banks of the river cutting the megacity in two. Dodging the crowds leads us past landmarks such as the Houses of Parliament and the London Eye. Trashy novels and second-hand books can be picked up from the open air market at South Bank while Prime Meridian Walk marks its namesake of Prime Meridian with mosaics in the pavement as it angles north from the river banks.

Walk past the current site (close to the original) of Shakespeare's Globe Theatre near the Tate Modern art gallery in Southwark and it becomes evident how much the river is controlled in central London. Sheer walls confine the flow, with the tide revealing and immersing scattered, pebble-strewn 'beaches' that can trap people as the water rises. The Royal National Lifeboat Institution's busiest station sits in the shadow of Waterloo Bridge with a rescue crew

on-site and ready to go 24/7, because the cold, fast-flowing Thames gives people only minutes to live if they fall in and few ways to climb up the slippery walls.

The Thames Path in London reveals the waterway's history of continual control and narrowing as the city expanded. Just south of Whitehall Gardens, between the Embankment and Westminster stops on the London Underground, a weatherworn plaque describes 'Queen Mary's steps'. Excavations in 1939 uncovered steps designed by Christopher Wren in 1691 for Queen Mary II, who used them to descend to a river terrace. Today, the steps sit over fifty metres from the bank of the Thames. To get between the two, you need to traverse a wide pavement, the two-way bicycle superhighway, the two-way traffic of Victoria Embankment, and a grassy expanse. This much of the River Thames has been filled in since the end of the seventeenth century.

Limiting the width of the river means that, for the same amount of water, the depth and speed will increase. Evidence for this appears further downstream, underneath Southwark Bridge. Pedestrians rush through the tunnel on the south side, enjoying or seeking to avoid music from the buskers making good use of the acoustics. Engraved in the tunnel is a description of frost fairs, carnivals held on the ice when the Thames froze. The last one was in 1814, after which new bridge designs and sustained river engineering quickened the tidal flow, inhibiting freezing.

We humans have shaped and altered the river, which means that we have made London's floods by constricting the river's water between walls. In other words, human actions have made London vulnerable to floods. While a storm surge driving up the River Thames or rainwater coursing down it has its origin in nature, the flood which central London would go through and the

damage it would wreak would be of human construction, by putting extensive, expensive property on land which would otherwise have taken these floodwaters.

Back on Canvey after the 1953 disaster, a concrete wall sprang up around most of the island. Rising more than three storeys above ground level, it is supposed to stop Canvey from being flooded by a storm surge beyond the level of that in 1953. Once any wall is built, the work does not stop, since walls must be maintained. Canvey's walls display signs of deterioration with deep cracks emerging. The seals between wall slabs are starting to disintegrate, with small plants growing out of some of them. Along Canvey Island's south shore, leaving access gates ajar allows people to enjoy a riverside walk at their leisure. Closing a gate means that someone must align metal bolts attached to the gate with holes along the wall. Some of these holes are clogged by debris and some rubber seals underneath the gates do not fully close the gap between the gate and the wall. Some of the locks appear to be rusted.

Encircling the island with walls is an attempt to manage nature by keeping the water out. For low-level storm surges or storm surges occurring with low tides, the walls largely succeed: Canvey has not had a big flood since 1953. But no wall can be 100 per cent safe. If one of the walls collapses, breaches, is undermined, or is overtopped, then the flooding could be devastating. Few will be prepared for it, because they believe in the safety of the walls, as well as the right to occupy land that was previously part of the sea.

So how much should we try to manage nature's waters? The baseline is that no one wishes to see a disaster. Letting a North Sea storm surge trap people in their homes must be avoided, and that can be done by balancing measures to keep

people safe. Walls are currently the main part of this plan: manage nature by controlling where the water goes and by separating the people from the water. People are kept entirely dry—until a storm surge arrives that is larger than expected, or the supposedly protective measures founder.

Another option, especially given the expectations of higher sea levels under climate change, is to return parts of Canvey Island to the sea. Marshland breaks the force of waves and gives room for the water to spread out. It also reduces the space in which people could live without guaranteeing that the inhabited areas will always remain dry. Another possible though large undertaking would be to raise the land, so that all infrastructure sits above the expected storm surge level. This is expensive, disruptive, changes the character of a community, and also has no guarantee of working. Wave, tide, and current action could gradually erode the raised land, although maintenance can assist as long as money is available. And a decision is needed for how high to go.

Leaving for the mainland in the wake of a storm surge warning is another option. Until the first bridge between Canvey Island and the mainland opened on 21st May 1931, ferries were the main route on and off the island. Two public roads now form the main connections with the mainland. They intersect at a roundabout, making it effectively one-route unless traffic flow measures applied during an evacuation force the roads to operate as a one-way system. Narrow lanes across non-public land potentially provide a third way off the island to the west, if the gates en route are left open and if a large number of vehicles would not damage the passages. But evacuation means leaving behind house and home. As with wildfires, evacuees must take with them irreplaceable items and be ready to rebuild immediately afterwards.

In the absence of a major storm surge disaster, retaining a high level of readiness is not easy. It means managing ourselves much more than nature. Thus far for Canvey and London, the decision has been almost exclusively to manage nature by separating water and land, rather than also managing ourselves. Others, though, have taken a different approach.

One homeowner along England's Essex coast has long known about the chances of floods and the damage which water does to an unprepared building. Rather than trying to reconstruct nature to avoid flooding, he renovated his house to make it easy to deal with water. He raised all the electric wires and sockets on the ground floor and installed drains. The water can flow in up to a certain height without knocking out the electricity, and then can easily flow out. To facilitate cleaning and reduce damage to his contents, the owner removed all carpets from the ground floor and coated the walls and floors with a water-resistant plaster used in swimming pools.

Would this work for everyone? Some people like carpets or prefer to have electric sockets near the floor. Finishes such as paints and plasters need to be selected carefully to avoid health hazards from off-gassing. Many would consider floor drains to be aesthetically displeasing. In the end, it is about managing ourselves in terms of knowing the options available and accepting the consequences of our decisions. A property owner could accept that, every time it floods, all carpets and electrics will need to be replaced, with alternative accommodation found for the months needed for cleaning and drying. Or only some flood resistance measures could be taken in order to balance flood-related disruption and recovery. Options exist, each with advantages and disadvantages.

Much of the hazard, then, is shaped by humans—as much as, or more than, by nature. This does not stop us cursing nature's malevolence when a flood inundates shops or a wildfire razes a school. The environmental events and processes originate in nature and so we call them 'natural hazards'.

The balance and integration of the processes of managing nature and managing ourselves to deal with hazards depends on values and preferences. In both London and Singapore, a particular approach was taken regarding floods, and changing it would be expensive and time-consuming. It might not even be politically and culturally acceptable. It is clear that, as with the early European efforts to deal with Australian bushfires, a focus on managing nature deals with the hazard without doing much to understand and tackle vulnerability.

Characterizing nature as dangerous and malfeasant, and hence needing to be tamed, typically creates an emphasis on hazards. Disaster vulnerability and risk then tend to increase. Hazards, though, are not inherent to nature, being regular and typical environmental processes and events; they become hazardous only when faced by an unprepared society. The potential damage which these 'hazards' can do is partly created by human design and management of the environment and our society. We permit, actively and passively, much of this damage to occur.

This manufactured hazardousness of nature masks many of the resources and opportunities brought by 'natural hazards'. Many people settle in floodplains and around volcanoes because the floods and volcanic ash enrich the soil with nutrients, yielding productive farming. Faults associated with earthquakes permit deep groundwater to percolate up to the surface, providing a lifeline in arid regions.[6] Many desert cities developed over faults, in

locations which now seem far too hazardous for the infrastructure which we have chosen to construct there.

Nature has resources which we can use and manage, but inadequate or inappropriate approaches can make nature hazardous. Nature doesn't mind either way, as it is neither good nor evil. It is up to us to manage nature and, far more importantly, to manage ourselves to avoid exacerbating or creating hazards and hazardousness. We can live with and use nature's events and processes as resources without disasters happening, although it requires planning and preparation. To do so, we must admit and tackle vulnerability.