Safe as houses?

Clever construction can help mitigate tragedy in a natural disaster, writes Madeleine Johnson.

As the 2008 hurricane season winds down, you might be wondering whether you’ve seen more images of families huddled on rooftops or assessing sudden piles of belongings this year than you did, say, two decades ago. The answer is yes.

According to statisticians such as insurer Munich Re and the Centre for Research on the Epidemiology of Disasters, numbers of “extreme events” such as this summer’s storms, hurricane Katrina in 2005 and the 2004 tsunami in south-east Asia have quadrupled since the 1970s as a result of climate change, increased settlement in risky areas and urbanisation in the developing world. Combinations of disasters – earthquakes followed by fires or windstorms and water surges – are typical, with the after-effects often wreaking as much havoc as the main events.

On the bright side, the total death toll has gone down. But economic losses have increased 14-fold, with houses and household possessions the primary victims. Some properties, especially the ones we see on the television news, are simply flattened. But others might be damaged in smaller ways: strong winds comprise structural envelopes; pebbles blown from gravel roofs break windows; deck umbrellas and items of loose trim become wall-piercing missiles. And problems such as mould only appear after the wind has stopped and the water receded. Munich Re reports that in Thailand after the 2004 tsunami many buildings stayed standing but the “main losses involved damage to contents”.

Even for those with insurance to cover repair costs, seeing one’s house destroyed is a wrenching experience. For most people houses are not only a big financial asset but also expressions of taste, cultural or family heritage and identity. In poor countries stable shelter also means improved health and education opportunities.

But there are ways of improving the situation. Architects and builders can help by designing and constructing houses that are better able to withstand natural disasters. One example is the “X House” developed by architect Zaha Hadid. The building, which includes a school for children and a market hall, can withstand strong winds and earthquakes. It’s being built in the Philippines and is expected to provide shelter for 200 people in case of future disasters.

Another example is the use of traditional building materials such as bamboo, which is lightweight and flexible but strong enough to withstand strong winds. Such materials can be used to build houses that are more resistant to natural disasters.

Overall, it’s clear that better construction techniques and materials can help protect people from the effects of natural disasters. As the saying goes, an ounce of prevention is worth a pound of cure.
Once hurricanes, earthquakes and tsunamis happen, relief money for rebuilding does typically flow in. But disaster experts agree that it is much better to pre-empt the problems - by investing in buildings that can withstand rain, flood and fire and that lessen the overall impact that such events have on a community. A roof that doesn't fly off, for example, works twice, not only the people and things underneath it but also the other buildings it doesn't hit. Post-disaster, viable shelter speeds recovery by reducing economic losses, the spread of disease and social disarray. "Having a house is the most important thing for getting society back on track," says Domenico Re, an engineer with Risk Management Solutions.

Experts say it is neither possible nor cost effective to build houses that laymen would describe as "disaster-proof". We can't live in bomb shelters. But there are effective "disaster mitigation" techniques, such as installing specially designed windows or steel roof anchors, raising buildings above expected flood levels and enforcing rigorous building code standards. "You can never be 100 per cent safe, so do what you can," says Andrew Sachs, whose title - vice-president of crisis and consequence management at "emergency preparedness" consultancy James Lee Witt - conveys the seriousness of his mission. "Many studies have found that the return for every single dollar spent on mitigation is at least four dollars."

This strategy includes adapting innovative or unconventional construction techniques as well as re-evaluating traditional practices with good survival records and making simple modifications. Sometimes it means creative destruction.

Buildings that survive disasters seem to lie at extreme ends of the cost and sophistication scale. At one end are highly engineered structures constructed by well-trained, experienced professionals using the latest technology. At the other are indigenous forms and materials employed by amateurs equipped with simple skills. The poorest-performing homes are in the middle range, where not-so-new technologies or materials are applied by not-so-skilled professionals. The most common and most tragic example is reinforced concrete used in developing countries.

Some of the most advanced disaster mitigation tools, such as base isolation systems for earthquakes, are usually reserved for big or critical projects, such as bridges, hospitals or large apartment complexes - or individual homes in the $30m range. But other new technologies are accessible to all homeowners. Sips, or stress-skin panels, which are sandwiches of structural board - wood composite or cement - and foam filling, perform well in high winds and floods. Quick and inexpensive to put together, Sips panels can be trimmed and shaped to blend with local architectural styles. And after a flood a cement-board Sips house can be stripped, hosed down and reconditioned in days.

Monolithic domes are another example. For these, inflated forms - often made by hot-air balloon manufacturers - are reinforced with steel, then sprayed with specially formulated concrete. Deceptively delicate, they can withstand 300mph winds and are blast- and earthquake-resistant. With no wood or porous materials, they also resist fire, floods, mildew and rot. The dome of the Sigler house in Pensacola, Florida, was, after hurricane Ivan in 2004, "the only thing still standing" according to David Barrett, a colleague of the late architect Jonathan Zimmerman, who designed it with a Federal Emergency Management Agency grant. "Journalists staying in the house slept through the hurricane."

Another newer construction system with proven extreme-event credentials is insulated concrete form (ICF). Concrete is poured into large-panel forms made of closed-cell insulation, such as polyurethane. The foam remains after curing, providing a nailing surface and vapour barrier. Homes constructed in this way performed well in hurricanes, such as Ivan, as well as floods and tornadoes, and their styles can be adapted for varied tastes.

At the other end of the spectrum, many old construction systems do just fine and can be built by non-specialist builders (usually the homeowner) with accessible and affordable materials. From yurts in Kyrgyzstan to 18th-century apartment buildings in Lisbon to single-wall wood-board buildings in Hawaii, there are many vernacular architectural forms that incorporate millennia of first-hand disaster mitigation research. One excellent case in point is "masonry infill" or "confined masonry" construction, in which structural elements of wood, reinforced concrete or steel surround rocks, bricks or concrete blocks. Britons know the wood version as "half timber" and there are other types in Portugal, Italy, Turkey, India and Pakistan.

"It seems counter-intuitive that simple, unsophisticated, non-engineered timber-and-masonry structures associated with the medieval rather than the modern world might be safer in large earthquakes than new structures of reinforced concrete," says Randolph Langenbach, an architect, scholar and United Nations Education, Scientific and Cultural Organisation (Unesco) consultant. But over decades of researching earthquakes' effects, he has seen the evidence first-hand.

In Turkey's 1999 earthquakes, for example, row upon row of modern, reinforced-concrete apartment houses collapsed while their traditionally constructed neighbours survived with little apparent damage. The 2005 earthquake in the Kashmir region of Pakistan and India also saw some centuries-old vernacular wood-and-masonry buildings outperform new concrete ones.

Working with Unesco, Langenbach and conservation consultant Rohit Jigyasu are now collaborating on projects to promote traditional Kashmiri building techniques. Conferences and publications encourage local residents to appreciate the advantages and then a disaster is not a tragedy.