include unprecedented gravitational sensors to find oil and minerals, clocks that deliver next-generation navigation, and secure broadband communication."

Of the £270 million, £190 million is new money; the rest will be drawn from the government's roughly £1-billion annual allocation for science capital funding. Most of the money will be distributed through the Engineering and Physical Sciences Research Council (EPSRC).

"Each hub will cover a carefully selected theme, such as computing or communication, where quantum technologies can provide game-changing advances and benefit from enhanced collaboration between industry, academia and government," then-science minister David Willetts told *Nature*.

Imperial College proposes a hub focused on manipulating the quantum states of ultracold atoms. An Imperial project already under way with funding from the UK Defence Science and Technology Laboratory aims to develop a quantum-based ultra-precise submarine positioning system for the Royal Navy. Submarines face a navigation challenge because they cannot contact positioning satellites without surfacing. "After six months of wandering around under the ocean, you could be way off where you think you are," says Imperial physicist and project leader Edward Hinds. The system promises to be 1,000 times more accurate than today's technology — with no need to surface. And because space is at a premium on submarines, the researchers also want to make the device smaller; their current model is 50 centimetres wide. The team hopes to have a narrower prototype available by 2016.

Other teams are focusing on different applications. The Lancaster University group, for example, aims to develop quantum sensors and metrology tools for use in health care and nuclear power, says Yuri Pashkin, director of Lancaster's Quantum Technology Centre, which opened in May. And University of Oxford physicist Ian Walmsley says that his institution's proposed hub would establish Britain as a global leader in quantum technologies for defence, communications, pharmaceuticals and finance by pursuing powerful computers, simulators, communications networks and sensors.

The goal of the investment is to secure the United Kingdom's strong global position in quantum physics and keep British quantum physicists at home, says Rachel Bishop, theme leader for quantum technologies at the EPSRC in Swindon. "As a scientist, you want to work somewhere exciting where you can explore your ideas in a well-funded research environment — and that's exactly what the government is doing in quantum." ■

Plans are afoot to improve landslide monitoring for the endangered town of Zhangmu in Tibet.

NATURAL HAZARDS

Landslide risks rise up agenda

Forum on deadly natural phenomena discusses use of simulation and hazard-mapping technologies.

BY JANE QIU

The Tibetan town of Zhangmu is on edge — in an emotional and physical sense. Perched precariously on a mountainside, the growing trading and tourist centre lives under the constant threat of landslides, the result of a formidable combination of geological, climatic and developmental factors. The settlement, whose population reaches 40,000 in summer months, is built on the unstable debris of past landslides. As more buildings appear, the risk of a catastrophic collapse increases.

Many settlements across the globe face a similar predicament. With extreme weather events becoming more common, land resources dwindling and urban development spiralling, landslides "are increasing in frequency, scope and destructive capacity", says Sálvano Briceño, chair of the scientific committee at Integrated Research on Disaster Risk, an international research programme headquartered in Beijing.

But the risks are being addressed. At the third World Landslide Forum in Beijing last month, researchers met to discuss ways to improve the monitoring, prevention and management of these lethal phenomena. Presentations included technologies for mapping hazards and providing early warnings, as well as computer models that simulate the effects of rainwater and earthquakes. "With the projected increase in extreme rainfall, communities in landslide-prone regions will be more vulnerable," said Rex Baum, a geologist with the US Geological Survey in Golden, Colorado.

Slope failures are the biggest landslide threat. These occur when a chunk of slope becomes detached from a hillside. As the material descends, shearing forces increase the pressure of water in the gaps between soil and rock particles (the pore-water pressure), causing clumps of slope materials to collapse. This process, called liquefaction, can be a result of rainfall-induced increases in water volume or seismic

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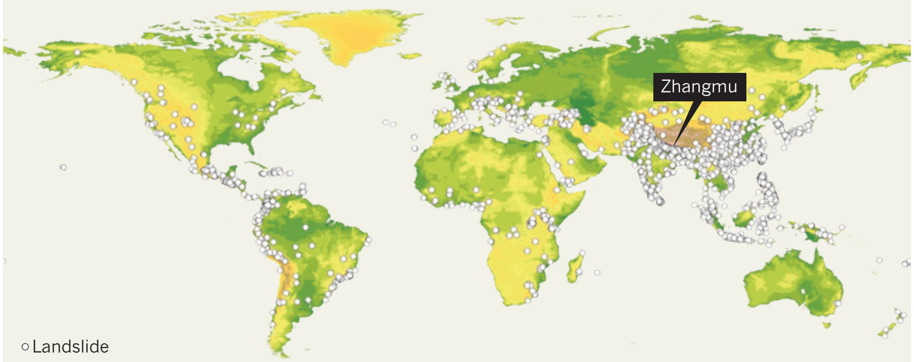
DANGER ZONES

Between 2004 and 2010 there were 2,620 fatal landslides worldwide, causing 32,322 deaths. Most occurred in Asia and other developing parts of the world. China and the Himalayan region were particularly badly affected.



DAVE PETLEY

waves, and greatly accelerates the landslide because the water acts as a lubricant.

Catastrophic slides are frequent. In 2010, heavy rains in Zhouqu in northwestern China unleashed a torrent of mud and rocks that engulfed 550 houses and killed nearly 1,800 people. And in May this year, a rain-drenched scarp in northeastern Afghanistan gave way, sweeping away the village of Ab Barak and killing more than 2,000 inhabitants.

Developing countries are worst hit (see 'Danger zones'). A study by geologist Dave Petley at Durham University, UK, shows that, of the 32,322 landslide fatalities between 2004 and 2010, most occurred in Asia, especially in the Himalayas and China (D. Petley *Geology* **40,** 927–930; 2012).

But advances in remote-sensing technologies are making hazards easier to detect. Satellite and airborne laser and radar instruments, such as LiDAR and InSAR, can be used to monitor ground movements, enabling accurate mapping of potential landslide sites.

"We are getting pretty good at spotting areas susceptible to landslides," says Baum. "But we still can't quite predict, if a slope fails, how big it will be or how far it's going to go." The landslide that struck in Washington state on 22 March, killing 41 people, took many by surprise. "We didn't really expect that a slope coming off a block that was only 200 metres high could have flowed over one kilometre," Baum says.

A big unknown is how rainfall, which triggers two-thirds of landslides, can change groundwater dynamics and the strength of soil and rock particles, says Kyoji Sassa, a geologist at Kyoto University in Japan. At the forum, his team presented a lab-based landslide simulator that tests how pore-water pressure and the strength of slope materials change with increasing rain. By feeding the data into a computer model designed to reproduce both the initiation and movement of a slide — a first for a landslide model — they have been able to replicate past events.

In a US$5-million project funded by the Japanese government, Sassa and his colleagues are testing the approach on a notoriously unstable slope in southern Vietnam, where annual precipitation is more than 4,000 millimetres. They will combine rainfall records and weather forecasts to see if the simulator and model can predict how the slope will react to further rain. The ultimate goal, says Sassa, is "to develop a model that could be applied in all monsoonal regions".

In the meantime, Zhangmu, which is prone to earthquakes and heavy rainfall, needs a contingency plan. A survey led by Wei Fangqiang, deputy director of the Chinese Academy of Sciences' Institute of Mountain Hazards and Environment in Chengdu, found that the 49–78-metre-deep layer of previous landslide debris below the city is already moving, albeit slowly. It identified 21 potentially dangerous sites, some of which could produce several million cubic metres of debris (the Washington slide generated about 7.6 million cubic metres).

Last month, the Chinese government approved a $483-million project to improve monitoring in the Zhangmu region. Engineers will install sensors to determine pore-water pressure and implement measures to stabilize slopes, drain rainwater and block debris flow.

Critics warn that many governments tend to invest much more in disaster mitigation and relief than in reducing exposure to hazards.

"What kills people are not natural phenomena, but poorly built or wrongly located houses."

"Many mountainous regions are being developed rapidly without proper planning or risk assessment," says Briceño. "What kills people are not natural phenomena, but poorly built or wrongly located houses."

The second phase of the United Nations' Hyogo Framework for Action, a ten-year plan aimed at reducing the impact of natural disasters, including landslides, should help to address such problems, he adds. Its latest incarnation, which is expected to tackle the challenges of extreme climate events and land-use changes, is due to be adopted next March. "Risk reduction is the key," says Briceño. "It should go hand in hand with climate-change adaptation and sustainable development." ■