# Reducing earthquake risk in urban Europe

South-eastern Europe is awaiting another earthquake. In Romanian living rooms, the population has been horrified to hear scientists announce on TV that a major earthquake can be expected within the next five years. They have reason to fear. The most serious in recent years was in 1977 when a quake measuring 7.2 on the Richter scale left 1,650 people dead and 10,000 injured. Bucharest was worst affected. Other earthquakes followed in 1986, 1990, 1991 and 1996. A large tremor in March last year panicked the population, but thankfully caused no material damage.

Turks share the fear, and shadows of the recent past impact upon their lives. Where 1999's two earthquakes left up to 20,000 people dead and 50,000 injured in north-western Turkey, newspapers have reported many cases of people jumping from windows in panic when tremors occur. In February this year, a quake measuring 6 on the Richter scale killed over 40 people in central Turkey and damaged the homes of up to 60,000 inhabitants.

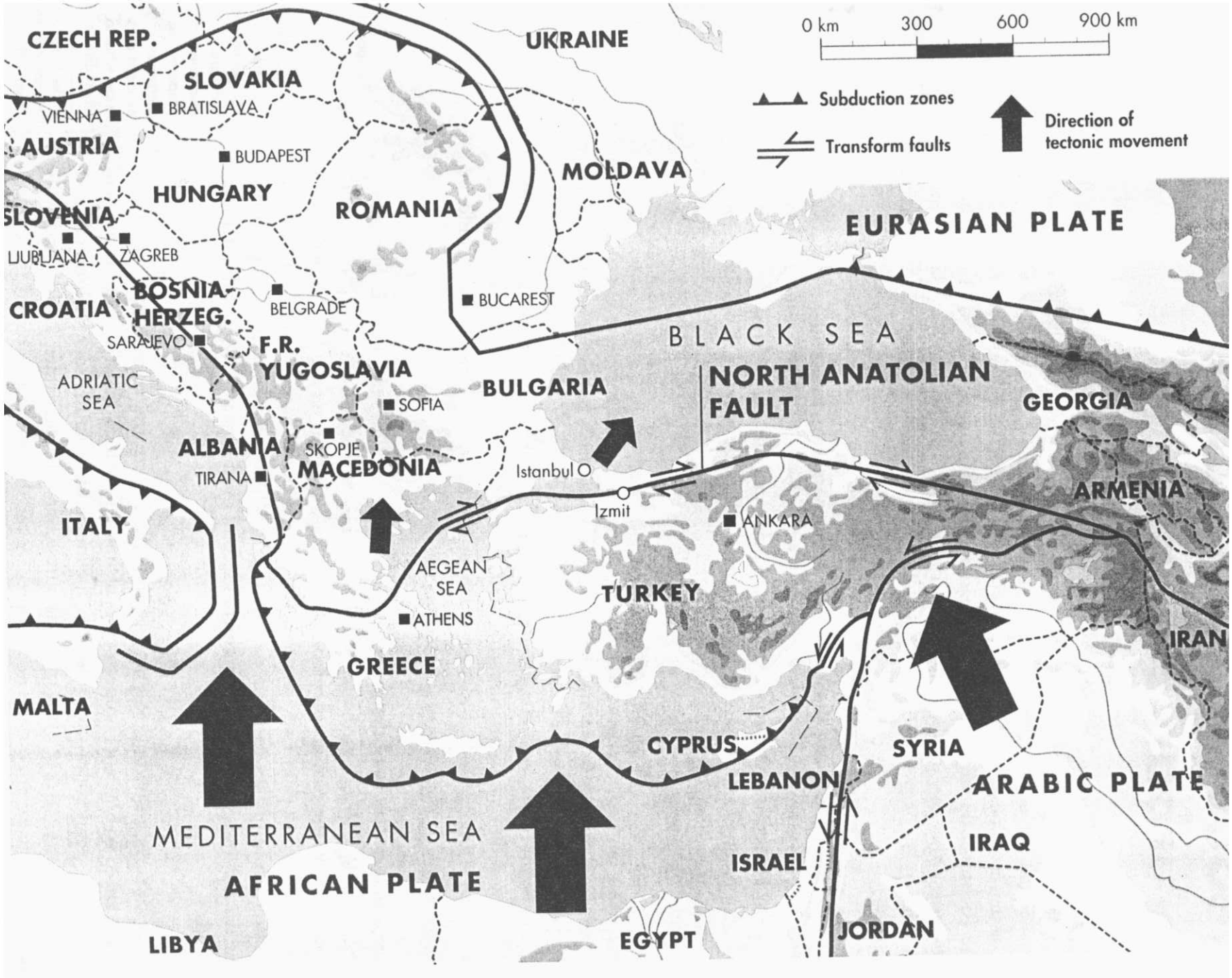
Albanians have social crises and grinding poverty to preoccupy them but the chance of seismic disaster is by no means forgotten. The country's last major earthquake was 20 years ago and a big one tends to come around every 20-25 years. Given the country's problems, the humanitarian consequences of a major quake are unthinkable, just as they are in neighbouring Macedonia. A repeat of the 1963 Skopje quake, in which 1,066 people died and much of the town was demolished, would be devastating.

According to data from the Brussels-based Centre for Research in the Epidemiology of Disasters (CRED), earthquakes have proved by far the most deadly of all Europe's disasters over the past decade. From 1992-2001, earthquakes claimed 58 per cent of the 36,000 European lives reported lost due to both "natural" and technological disasters. And quakes cost Europe over US$ 27 billion in estimated damage during the decade, making them the continent's second most expensive type of disaster after floods.

Since collapsing buildings kill most earthquake victims, risk is more concentrated in urban areas. So how are European cities planning to reduce these risks? Enforcing better building codes and strengthening "lifeline" infrastructure, such as hospitals and schools, emerge as key mitigation measures. But this takes time, money and willpower. So what can be done now to prepare for the catastrophe round the corner?

Photo opposite page: Making buildings earthquake-resistant is a crucial long-term strategy. But structura mitigation must be complemented by widespread disaster awareness and preparedness measures, so that exposed communities know what to do when disaster strikes

Mikkel Ostergaard/ International Federation Turkey 1999.


0 km
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Subduction zones
Transform faults
Direction of tectonic movement
CZECH REP.
SLOVAKIA
UKRAINE
VIENNA
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BUDAPEST
HUNGARY
MOLDAVA
ROMANIA
SLOVENIA
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LJUBLJANA
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BOSNIA HERZEG.
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BLACK SEA
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NORTH ANATOLIAN FAULT
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LIBYA
EGYPT
JORDAN

How can structural and non-structural initiatives complement each other in reducing the deadly toll of earthquakes? This chapter will analyse options for:

- **Mitigating earthquake risk.** How to prevent or reduce the risk of an earthquake's disastrous impacts.
- **Preparing for earthquakes.** How authorities and exposed communities can prepare to respond better to disaster.

  **Converting ideas into action.** Advocating for the commitment and resources necessary to make mitigation and preparedness happen.

## Mitigating earthquake risk

The earthquakes which hit the Turkish towns of Izmit and Duzce in 1999, known collectively as the Marmara earthquakes, not only took a terrible human toll. They cost the country around US$ 20 billion in damage alone – equivalent to over 10 per cent of annual gross domestic product (GDP). And that doesn't account for the knock-on effects to the economy. What has been learnt since then, and what has changed? Can Turkey afford not to be ready next time?

The Marmara quakes, with epicentres barely 100 kilometres east of Istanbul, brought widespread criticism of the national state of disaster mitigation and preparedness for response. They changed the way Turkey thought about earthquakes – and certainly focused minds in Istanbul itself. Most experts consider that the city runs a very high risk (between 60 and 70 per cent) of being struck by a major earthquake within the next two to three decades. That may not mean in 30 years. It could mean tomorrow.

Most of Turkey is seismically active territory. Two major fault lines, the south and north Anatolian faults, run the length of the country from east to west. Of the big Turkish cities, only Ankara, the capital, is not seriously earthquake prone. The Marmara quakes were on the north Anatolian fault. Some specialists think the next big one will be further west, almost directly on the southern edge of Istanbul. The palpable sense of urgency makes the city a poignant case study of lessons learned, and what it is possible to do with them.

When precisely a quake might strike is beyond the scientists. Through studying tectonic plates, fault lines and surface geology, they can predict possible disaster locations fairly accurately. And mathematical models can help to predict probabilities of time scale, but not specific times. Sophisticated equipment has made it possible to identify a very small interval (up to 15 seconds) between warning signs and the moment tremors are felt. It could be long enough to activate a direct cut-out of the main gas distribution or electrical substations, which would diminish the risk of

## Box 5.1 "Grandpa Earthquake" dispels fear of disaster

"The worst possible reaction to an earthquake is panic." This is the message of Ahmet Metin Isikara, director of the Kandili Observatory, situated on a hill high above Istanbul. For thousands of children and their parents, Isikara has become "Grandpa Earthquake". In its campaign against fear, the Kandili Project began with teachers. At least one teacher from each of the city's 3,000 schools has been trained to train other teachers and, ultimately, the children in how to prepare for the day when disaster strikes.

Isikara stars in a series of short animated films which show children and adults exactly how to react in an earthquake. With his shock of white hair and toothbrush moustache, Isikara is stopped on the street by children saying things like, "Hello there, Grandpa Earthquake. Like you told me, I'm not afraid anymore." His blue eyes twinkle and he obviously relishes his star quality. But he turns absolutely serious when he talks about the importance of preparing a population to deal with earthquakes, and of going through the children to reach whole families.

The films are skilfully made and really reflect Turkish culture: the homes where children help Grandpa bolt down the furniture, for example, look like real Turkish interiors, not those of North American soap operas. The enthusiasm at Kandili is infectious. Disaster training has been incorporated into the curriculum of grades 1 to 8 and schools hold disaster preparedness days. Future plans include creating an "earthquake park", an information centre with explanatory exhibits, and even a simulated earthquake room so that children can practice "for real" what they have been taught in theory.

The message is beginning to get across: "It doesn't matter how big it is; what counts is *Are you ready?*" Turkish children are disciplined and good disseminators of information. Earthquake survival kits – including items such as bottled water, torch, radio, photocopies of the family's important papers – are appearing in homes and even offices. However, admits Isikara, the terrible thing with "earthquake education" is that there is no way to tell how well it works until the next one hits.

Isikara, who is well connected within the Turkish establishment, wants to go beyond what he feels are sterile academic quarrels. He lectures incessantly and appeals to a broad cross-section of society. He reminds politicians and economic leaders that Turkey lost around US$ 20 billion because of the 1999 earthquakes and that being prepared means losing less next time. To him, and other astute observers, those earthquakes triggered the serious economic crisis in which the country was still embroiled two years later. If the earthquake had hit the country's economic heart, Istanbul, the situation would have been far worse ■

fires. But it is still insufficient to provide the population with enough warning to evacuate buildings.

The sense of urgency is even greater since, in recent decades, Istanbul has grown almost exponentially – today the population is well over 10 million. Some parts of the

city reach tremendous human density, with more than 40,000 people per square kilometre, increasing the risk of disaster. Some experts believe that, depending on the location and magnitude of a future quake, 30 per cent of Istanbul's 900,000 buildings could collapse completely. With a large proportion of the population living in flats, typically five- or six-storey buildings squashed together along steep and narrow streets, the consequences would be catastrophic.

## Substandard construction costs lives

The Marmara quakes shook up more than the earth in Turkey, and left no illusions. In the first place, the number of deaths would have been dramatically less if the country had enforced its building regulations. It is a common shortcoming in south-eastern Europe and more tragedy will undoubtedly occur elsewhere because of it. Mihail Garevski, from Macedonia's Institute of Earthquake Engineering and Engineering Seismology (IZIIS) in Skopje, was the leader of an expert team that visited Izmit a few days after the 1999 disaster. He is unequivocal: "Failure and damage of structures is inevitable in catastrophic earthquakes. However, such an extensive failure as that in Izmit is not permissible."

Garevski lays the blame on a number of factors. Certainly, locations were wrong. Some buildings were placed over an active fault, some on soil susceptible to liquefaction (so subsidence overturned them) and some were built on unstable coastal sites and disappeared into the sea along with the land. In those circumstances, he says, even the strictest application of seismic regulations and construction codes will not prevent failure. Better land-use guidelines are needed to ensure buildings are put up on solid ground.

But bad locations were not the main cause of the damage in Turkey. The primary reasons, according to Garevski, were a structural system which should not be applied in a high-seismicity region; bad quality concrete; and improper reinforcement. Istanbul does at least stand on solid ground. Polat Gülkan, of the Middle East Technical University in Ankara, points out that much of the city is built on "competent soil" – soil that will not liquefy. But, as in the Marmara region, the building materials typical to Istanbul are reinforced concrete frames with masonry infill. The reinforcement has not always been designed to withstand the special stresses of an earthquake, and both concrete and masonry have all too often been substandard. Newer steel-framed high-rises and, paradoxically, jerry-built shantytown dwellings, are considered less vulnerable.

Turkey is among a dozen countries included in a 2001 risk analysis for the Stability Pact for South Eastern Europe. Its Disaster Preparedness and Prevention Initiative (DPPI), a Stability Pact effort to help develop a cohesive regional strategy, underlines "the significant role that proper construction can play" in reducing quake damage. But its operational team – drawn from the United Nations Development Programme (UNDP), the

North Atlantic Treaty Organization (NATO), the United States Agency for International Development (USAID), the International Federation, the Swedish Rescue Services Agency, and Italian, Bulgarian and Croatian governmental bodies – concludes that enforcement programmes have been neglected or abandoned, resulting in another generation of housing and industrial facilities being built without minimum protection.

In south-eastern Europe, part of this may relate to the transition from communism, from command to free-market economies in some states. The change does bring some benefits. Disaster preparedness is no longer the exclusive preserve of the military, and better trained, better equipped civilian units are now involved. But economic reform and structural adjustment have stretched economies and capacities, and will continue to for some time. Health and social welfare have suffered as a consequence, so it's hardly surprising that the enforcement of building regulations – not the easiest operation at the best of times – should also feel the pinch. Observers say widespread bribery and corruption throughout the region exacerbate the situation.

Macedonia is a country that may be in the process of coming full circle. While strict enforcement of regulations existed under socialism, particularly after the horrific 1963 Skopje earthquake, the dissolution of the former Yugoslavia allowed rules to be ignored. "There was no one to ensure there were controls," says Sune Follin, the International Federation's regional disaster preparedness delegate and DPPI team leader. "There was no follow up. Nothing was happening. House building today may be no problem, but in the early 1990s who knows? Construction was worse then than anything that had come before."

## Initiatives needed to enforce building codes

Turkey's building regulations are fine. Its construction code has been on the statute books since the catastrophic Erzincan earthquake of 1939 and revised several times, the last in 1997. It prescribes an impressive chain of inspections from the planning phase onwards. Unfortunately these are often quite simply ignored. There are too few trained inspectors, and shoddy building practices and corner-cutting remain common. Some lessons have been taken to heart. In the Marmara region, the International Federation has constructed or renovated five schools and five hospitals to earthquake-resistant standards. But how do you ensure such practice becomes commonplace?

Improving building practice will require both sanctions and encouragement. Here, says Follin, there is an important role for the insurance industry, working with national authorities to provide incentives for adherence to building codes – some carrots to accompany the legal sticks. They could also share some of the risks. New Zealand, for example, has used both insurance and tax policies to encourage better building practices. In Turkey neither has played an active role. Swedish development analyst Ian

## Box 5.2 Iceland – model of efficient disaster preparedness

*What you expect, you can prepare for.*
Icelandic saga

At the north-western corner of Europe, far out in the Atlantic Ocean, directly on the fault line where the American and European continents meet, lies the volcanic island of Iceland, one of the most disaster-ridden places on earth. Tremors are almost daily events, and few years go by without a sizable earthquake. Volcanic activity is almost constant: the last major explosion was just offshore in 1973. Vulcanologists expect another almost any day. To complete the picture, Iceland is also subject to avalanches and extremely violent storms.

This disaster-prone country has, however, learned to deal with its natural hazards remarkably well. Iceland lacks an army, but has a well-integrated system of response, comprising the civil defence, the Icelandic Red Cross, police, firefighters, the independent search-and-rescue association and special auxiliaries including the scouts. All across the island, even in sparsely populated areas, disaster relief centres have been designated with trained leaders, often teachers. The goal is to have at least eight people fully trained for emergency response in each centre. Both the Red Cross (represented in 51 districts) and the search-and-rescue (S&R) association are entirely made up of volunteers. S&R members are trained in the use of heavy equipment. Psychological preparedness has become a priority for the Red Cross, which is teaching its volunteers informal counselling techniques.

Teachers, many of whom are involved in disaster preparedness programmes, are at the heart of effective disaster education. Even nursery-school children are taught how to behave in an earthquake: for example, to seek shelter under the nearest solid table. It becomes second nature. Can other countries emulate what Iceland has done? There are cultural factors at work here, which are not necessarily present in other earthquake zones. Iceland is a rich and small society. Like the other Nordic countries, Iceland enjoys almost 100 per cent literacy, which makes education programmes easier. It is also a disciplined society. It has been able to institute a strict building code which is largely adhered to. And a culture of civic responsibility underpins its extensive network of volunteers. ■

Christoplos points out that "an ambiguity emerges when one shifts from total control to a free market. Officials and politicians are unsure where they should intervene in market mechanisms, for example, how to mesh regulation with commercial pressures from insurers".

Before 1999, the Turkish government paid, more or less, for all earthquake damage, and until a few years ago private earthquake insurance was forbidden. After the very costly 1992 Adana quakes, the World Bank persuaded the government to reverse its policy and insurance became mandatory for housing. The law, however, is not applied until a property is sold, when insurance becomes obligatory for the new owner. Moreover, premiums are calculated purely on location, by earthquake zone, and are

not differentiated to provide incentives for better building practices. The government did decide to hold contractors responsible for the quality of new buildings and imposed a ten-year liability. Unfortunately that decision was reversed by the High Court and never became law.

The insurance industry would seem to be relieved. The deputy director of the Turkish catastrophe insurance pool, Barboros Yalcin, is candid: "As compulsory earthquake insurance managers," he says, "we don't want to write many more policies in Istanbul" – where 40 per cent of all Turkish policies are already based.

Perhaps the greatest inducement to good practice is better understanding among those who actually do the designing and building. With leading research centres like Turkey's Middle East Technical University, Macedonia's IZIIS and the National Building Research Institute in Romania, there is no shortage of knowledge in south-eastern Europe. But the knowledge is insufficiently shared.

IZIIS, a recognized international training centre, says earthquake engineering has not been adequately included in any faculty programme anywhere in the region. Semih Tezcan, professor of civil engineering at Bosphorus University, deplores the fact that many architects and civil engineers can practise without having had a single earthquake-related course in their university training. He would like to see the national curriculum modified to change that.

## Strengthen "lifeline" infrastructure

For buildings already at risk, the best mitigation option is known as "seismic repair" or "retrofitting" – reinforcing the structure to make it more earthquake-resistant. The big question here is economic, and many governments are either unable or unwilling to foot the bill. Some argue that it isn't the task of government to pay for retrofitting, but to enforce regulations so that those who own buildings are forced to foot the bill. Either way, retrofitting is expensive and a cost/benefit calculation is essential.

In Istanbul, it's highly unlikely that all its buildings could be made earthquake-resistant, although that does not mean there is nothing to be done. One mitigation option is to identify, assess and reinforce "lifeline" infrastructure essential for public safety, such as schools, hospitals and indoor sports centres – the latter not for sports but to serve as better public shelter than tents, especially in a cold and rainy Turkish winter. Tezcan has calculated that assessment would cost US$ 3 per square metre. Retrofitting costs more, but assessment should help to decide what is worth working on and what is not.

The need to regulate the retrofitting of existing buildings is well illustrated by assessments in Turkey and Greece. These show that an enormous number of structures,

which appear to have come through tremors unscathed, are nonetheless below legal standards. In some cases they may have been weakened and left more vulnerable to future quakes. Macedonia is another example: a great number of its old buildings risk severe damage in future earthquakes. Prompted by these concerns, a large joint seismic assessment and rehabilitation project is now getting under way in all three countries, financed by NATO. The knowledge acquired should help establish regulations for retrofitting throughout the region.

Retrofitting private dwellings, however, can prove very complicated. A large proportion of flats in Istanbul, for example, are condominiums. For any major work of strengthening, or even repair, all the owners must agree to it. Even if they do, it is often difficult to find either financing or alternative housing while the work is being done. Landlords are no keener.

Polat Gülkan argues that: "Careful policies for encouraging building upgrades, bundled with tax breaks, cheap loans and other incentives are needed, even for demonstration-size programmes." But, he adds, "an average building in Turkey has a lifespan of 50 years, [so] there is a strong likelihood that many may reach the end of their lifetimes without being tested." The most realistic way forward, suggests Gülkan, would be to replace substandard housing once its design lifespan has ended, as long as building codes are adhered to.

Of the 50,000 people pulled from the rubble of Turkey's Marmara quakes, 98 per cent were rescued by locals. Investing in municipal-level disaster preparedness will save more lives.

Mikkel Ostergaard/ International Federation, Turkey 1999.