Scarce resource

Freshwater availability is likely to change in many regions. Humans must adapt — or move.

There is no shortage of water on the blue planet. But sea water — which covers more than two-thirds of the Earth's surface — is too salty for human consumption or irrigation, and too corrosive to be useful in many technical applications. Humans therefore critically depend on the abundance of freshwater. Yet its availability, or its distribution around the globe, may well change as the planet becomes warmer, more crowded and increasingly developed.

As noted in a Review on page 853 that will be part of a joint web focus by *Nature Geoscience* and *Nature Climate Change* (to be published on 3 December 2012), the vast majority of freshwater on Earth circulates in aquifers below the surface as groundwater. Typically free from the biological pathogens that often pollute water in rivers and lakes, groundwater is a key resource for human consumption and irrigation. Climate change has been considered a potential threat to the sustainability of groundwater reserves. However, excessive extraction of groundwater — mainly for agriculture — is a far more important factor in depletion (page 853; Grafton, R. Q. *et al. Nature Clim. Change* http://dx.doi.org/10.1038/nclimate1746; 2012). With rising pressures on extraction both from an expanding population and rising per-head consumption, groundwater depletion is spreading.

Water stored as snow and ice in mountain glaciers is of no immediate use for humans, industry or agriculture. But mountain glaciers are sizeable, natural reservoirs that can store freshwater over long periods of time and — depending on location — release meltwater in the dry season when it is most needed. Mountain glaciers can thus regionally and seasonally contribute a significant fraction of river flow, with implications for agriculture as well as energy production. Mountain glaciers and the rivers that originate from them, for example in the Himalaya (page 841) and in the South American Andes (*Nature* **491,** 180–182; 2012), are vulnerable to climate-change-induced alterations in rainfall and temperature. Determining how exactly melting glaciers will affect river flow in the short, medium and long term is not straightforward. But at some point, a new equilibrium will be reached, with a much smaller volume of water locked at mountain tops.

Crucially, water is difficult to transfer across catchment basins and aquifers: transporting worthwhile quantities of water usually requires large amounts of energy (*Nature Geosci*. **1,** 283–286; 2008). Transport of so-called virtual water — that is, crops whose production requires large amounts of precipitation or irrigation — is more efficient by several orders of magnitude. For example, it takes about 1,650 m^3 of water to produce a tonne of cereal (*Ecosystems* **15,** 401–415; 2012). So instead of growing wheat, for example, a country with a water shortage could simply import. But only few water-poor regions are sufficiently affluent to pay for substantial crop imports. Virtual water transport is unlikely to become a viable global solution.

Precipitation patterns are set to change in a warming climate, making the future distribution of freshwater on the planet uncertain. In the long run, humans and their cities, farms and factories will probably follow the water. But for the medium term, we must find solutions to any threats of water scarcity — and they are likely to be different for each river basin. ❐

Rare Earth scientists

Not enough young people enter the geosciences. A passion for the subject should be sparked early on.

The supply of food, water, energy and mineral resources, along with environmental degradation and climate change, are among the most pressing problems of humankind today. To meet these challenges will require a significant amount of Earth science expertise. Yet the community of geoscientists is small. What's more, rapid growth is not apparent — not least because the geosciences hardly feature in schools. It is high time for children to be encouraged early on to learn more about our planet.

The demand for geoscientists continues to grow, despite the economic downturn. Fossil fuels remain a necessity, and Earth scientists are needed to find new hydrocarbon deposits and help extract them from the ground. And as many countries are shifting their focus towards renewable energy resources, more geoscientists are needed; for example, to assess winds and waves as well as geohazards and environmental impacts. Global demand for metals and minerals is at an all-time high, too.

As a result of these emerging job opportunities for geoscientists, the US Bureau of Labor Statistics predicts that employment of geoscientists in the US will grow disproportionately, by 21% between 2010 and 2020. An expanding job market is not just a North American phenomenon: worldwide, the number of qualified scientists is unlikely to meet demand (*Nature* **473,** 243–244; 2011). University enrolment rates are simply too low.

Compared with other science subjects — physics, chemistry and biology — there are only a small number of Earth-science graduates. Registrations for undergraduate courses at US institutions are on the rise (http://www.agiweb.org/workforce/reports.html), but the job market globally is expanding even faster. It is no wonder that few young people choose to study the geosciences, given that in schools Earth science subjects are often not taken very seriously. High-school teachers of geoscience subjects do not necessarily hold a relevant degree, and in times of austerity and budget cuts, the Earth sciences are easily sacrificed to preserve the more traditional science subjects.

On an increasingly vulnerable planet, governments need to teach the young people of their country an understanding of the Earth's basic make-up and dynamics, along with inspiring a fascination for its age and beauty. How else can we expect humanity to survive the Anthropocene? ❐