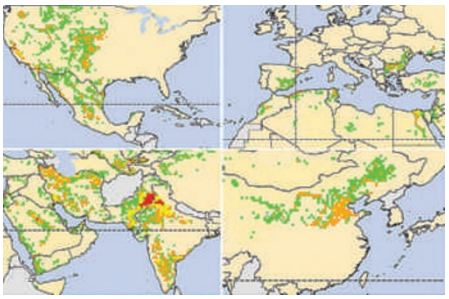
Groundwater loss

Geophys. Res. Lett. **37,** L20402 (2010)



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In regions with frequent water stress and large aquifers, groundwater is often used as a water source. Hydrological modelling suggests that total global groundwater depletion has more than doubled between 1960 and 2000.

Marc Bierkens of Utrecht University and colleagues compared the rates of groundwater extraction in regions ranging from semihumid to arid with estimates of aquifer recharge derived from a hydrological model. The model was forced with daily estimates of precipitation, temperature and crop cover spanning 1958 to 2001. Hotspots of groundwater overuse were found to occur in Yemen, southeast Spain, northeast China, northeast Pakistan, and the central and western United States. Rates of depletion in these regions ranged from 20 to 1,000 mm yr^{-1}. The total global groundwater depletion in 2000 was estimated to be about 283 km^3 yr^{-1}, much of which went to irrigation.

About 97% of the extracted groundwater is ultimately thought to enter the ocean, where it may be contributing close to 0.8 mm to the sea-level rise per year.

Diversity decline

Glob. Change Biol. doi:10.1111/j.1365-2486.2010.02345.x (2010)

Field surveys of species-rich grasslands in the UK suggest that the management of such habitats to maintain species diversity does not protect against the adverse impacts of excess nitrogen, which threatens the biodiversity of terrestrial ecosystems.

Leon van den Berg of York University and colleagues examined the impact of nitrogen deposition on the species composition of calcareous grasslands across the UK over the past two decades. The areas surveyed are some of the most species-rich communities in northwestern Europe, and are subject to management aimed at reducing the number of aggressive species to maintain diversity. The researchers found that species diversity was reduced under high levels of nitrogen deposition. In particular, the number of rare and scarce species present declined by a factor of five in communities exposed to the highest rates of deposition.

The researchers' statistical modelling suggests that the decline in species diversity resulted from a combination of nutrient enrichment and a nitrogen-induced increase in soil acidity.

Repeat ridge jumps

J. Geophys. Res. doi:10.1029/2010JB007504 (2010)

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The Mid-Atlantic Ridge is progressively migrating to the northeast, but segments of the ridge have periodically become abandoned, as new rifts formed above the Iceland plume. Simulations suggest that abandonment of rift segments, which cause the migrating tectonic plate boundary to jump back towards the plume, can occur only under a narrow range of conditions.

Iceland was formed by a hotspot mantle plume that is located beneath the Mid-Atlantic Ridge at present; the plume provides extra heat to the ridge, causing the rock above to melt and penetrate the rigid crust. Numerical simulations performed by Eric Mittelstaedt at the University of Hawaii, Honolulu, and colleagues indicate that if the heating from the plume is relatively low, the hotspot has little influence and the mid-ocean ridge freely migrates away. At higher rates of heating, however, the plume captures the mid-ocean ridge, holding the plate boundary steady and preventing it from migrating.

Over the past 16 million years, the Mid-Atlantic Ridge has repeatedly jumped towards the Iceland plume, movement that can in part be explained by a moderate flux of heat supplied by the plume.

Carbon at depth

Earth Planet. Sci. Lett. doi:10.1016/j.epsl.2010.09.022 (2010)

The amount of dissolved carbon dioxide in the deep waters of the equatorial Pacific Ocean was higher during the last glacial period than during the present interglacial, suggests an analysis of marine sediments. Increased carbon storage at depth could help to explain the reduced atmospheric carbon dioxide levels observed during glacial periods.

Louisa Bradtmiller of Macalester College, Minnesota, and colleagues assessed the amount of oxygen in the deep water of the equatorial Pacific Ocean over the past 30,000 years. They found that oxygen levels were markedly lower during the glacial period, which implies that carbon dioxide concentrations were elevated. Sedimentary indicators of primary production in the ocean surface show no concomitant increase in surface productivity, suggesting that the elevated carbon dioxide concentration at depth was acquired during the formation of the deep water mass.

A similar trend in oxygenation seen in the deep North Pacific Ocean indicates that a shift to more oxygen-depleted, carbon-dioxide-rich deep waters occurred throughout the ocean basin.

Corrected online: 10 January 2011

Sulphur from below

Icarus doi:10.1016/j.icarus.2010.10.016 (2010)

Volcanic eruptions on Io — Jupiter's innermost large moon — spew large volumes of silicates and sulphurous material across the moon's surface, which over time are buried deep in Io's cold outer shell. Numerical calculations suggest that these deposits give an explosive push to subsequent volcanism.

Giovanni Leone at Lancaster University and colleagues calculated the rates of heat transfer through Io's rigid outer shell. Away from the active volcanic centres, the shell is relatively cold, and remains so to great depths. Sulphur deposits erupted at the surface and buried over time can therefore remain solid to depths of up to 26 km, but may form large stores of molten sulphur at greater depths. If molten rock rising from below intersects either the solid or molten deposits, the sulphur may mix with the magma and make it less dense.

The researchers conclude that magmas that would ordinarily have been too dense to move upwards through the crust are given a buoyant kick by the addition of sulphur volatiles, allowing them to erupt at the surface.

Correction

In the Research Highlight 'Groundwater loss' (*Nature Geosci.* **3,** 818; 2010), the article number should have been 'L20402'. This error was corrected online in the HTML and PDF versions on 10 January 2011.