gen tensions *in vitro*[11,12], we propose that the hypoxia-driven autocrine stimulation of endothelial cells by VEGF in solid tumours helps promote the formation and reorganization of their vascular network. Other molecules present in the tissue microenvironment, such as nitric oxide and carbon monoxide[12], may also affect endothelial VEGF production and angiogenesis *in vivo*.

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Pollution

Chernobyl's legacy in food and water

Radiocaesium (^{137}Cs) from the 1986 Chernobyl accident has persisted in freshwater fish in a Scandinavian lake for much longer than was expected[1]. On the basis of new data generalizing this observation, we propose that the continuing mobility of ^{137}Cs in the environment is due to the so-called 'fixation' process of radiocaesium in the soil tending towards a reversible steady state. Our results enable the contamination of foodstuffs by Chernobyl fallout to be predicted over the coming decades. Restrictions in the United Kingdom, for example, may need to be retained for a further 10–15 years — more than 100 times longer than originally estimated.

We have measured ^{137}Cs activity concentrations (Q_t) in terrestrial vegetation (seven sites, including data from ref. 2), lake water (dissolved phase, two lakes) and mature fish (three species) in Cumbria, UK, over the same period as the Norwegian study[1]. Our results for vegetation and water contamination (examples in Fig. 1) show the same two-component exponential decline ($Q_t = Q_1 e^{-k_1 t} + Q_2 e^{-k_2 t}$) observed for immature fish[1]. The decline in ^{137}Cs in mature fish was influenced by slower biological uptake rates during the initial period after Chernobyl[1,3], so only the second component of the decline is shown for our fish data (Fig. 1).

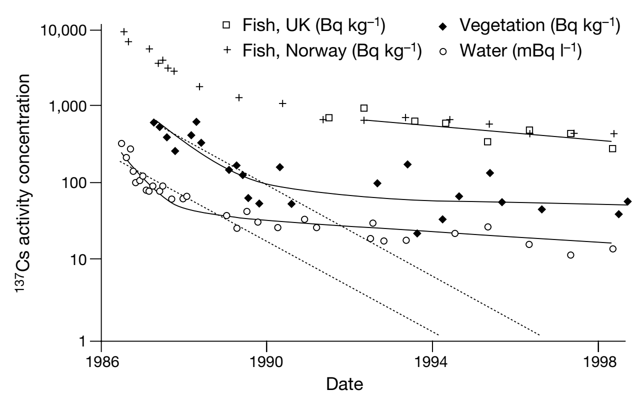

Figure 1 Long-term changes in ^{137}Cs in brown trout in Norway (from ref. 1), and in perch, terrestrial vegetation and water in Cumbria, UK. The decline in ^{137}Cs in immature fish, water and vegetation during the first five years has an effective ecological half-life (T_{eff}) of 1–4 years[1,4] as a result of 'fixation'. Dotted lines indicate the hypothetical continuation of irreversible fixation. Fits of the two-exponential model to our data, indicating the reversibility of 'fixation', are shown as solid lines. Long-term declines in all three Cumbrian systems are similar (T_{eff} range of 6–30 years) and are in quantitative agreement with results from the Norwegian fish study[1].

Our results show that the effective ecological half-life (T_{eff}, the time for the ^{137}Cs concentration to reduce by 50%) in young fish, water and terrestrial vegetation has increased from 1–4 years during the first five years after Chernobyl[1,4] to 6–30 years in recent years. The common rate of decline in ^{137}Cs concentration in lake water, fish and vegetation suggests that it is controlled by the same process in all three pools. This is consistent with a controlling influence of changes in chemical availability of ^{137}Cs in soil (in these lakes, long-term ^{137}Cs in the water originates in catchment runoff[5]).

The decline in ^{137}Cs mobility and bioavailability over the first few years after fallout is believed to be controlled by slow diffusion of ^{137}Cs into the illitic clay mineral lattice[4]. This 'fixation' process controls the amount of radiocaesium in soil water and therefore its availability to terrestrial biota and for transfer to rivers and lakes[4]. Studies of ^{137}Cs in contaminated sediments[6,7], however, indicate that this process may be reversible. From the persisting mobility of radiocaesium, and particularly the increase of T_{eff} towards the physical decay rate of ^{137}Cs ($T_{1/2} = 30.2$ years), we conclude that the sorption–desorption process of radiocaesium in soils and sediments is tending towards a reversible steady state.

The continuing mobility of ^{137}Cs in the environment means that foodstuffs will remain contaminated for much longer than was first expected. In the United Kingdom, restrictions on the sale and slaughter of sheep are currently in place on 389 upland farms (with about 232,000 sheep) on which some sheep have ^{137}Cs activity concentrations above the UK limit for the entry of meat into the food-chain (1,000 Bq kg^{-1}). During our studies on three restricted farms in 1991–93 (ref. 8), the maximum ^{137}Cs level in sheep meat was 1,870 Bq kg^{-1}.

Assuming that this is typical of restricted farms within the UK and using the rates of long-term decline we have estimated, restrictions may need to remain in place on some farms for a total of 30 years after the Chernobyl accident, which is more than 100 times longer than initially expected. In some areas of the former Soviet Union, consumption of forest berries, fungi[9] and fish[10] (present ^{137}Cs content, 10–100 kBq kg^{-1}), which contribute significantly to people's radiation exposure, will need to be restricted for at least a further 50 years.

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