Freshwater input

What is the issue?

The large scale balance of freshwater is important through its impact on the thermohaline circulation, but also for riverine inputs from coasts that can strongly affect productivity (through nutrient supply) as well as local currents and pathways (through freshwater effects on buoyancy). On an annual time-scale, the whole of the North Atlantic and its extended system into the shelf seas, high latitudes and Arctic, north of about 50° N benefits from an excess of precipitation over evaporation (P – E > 0 mm/year). P – E is particularly high to the south and west of Norway and over Iceland and south-east Greenland (Serreze *et al*., 2008). This atmospheric flux of freshwater into the region is balanced, with river run-off as an intermediate step, by the oceanic transport of ice and freshened seawater southward into regions where evaporation predominates.

What has happened and how confident?

Winter rainfall has substantially increased over Northern Europe, increasing flooding along river basins and increasing run-off into the North Sea (Struyf *et al*., 2004).

(Peterson *et al*., 2002) concluded that the average annual discharge from six Arctic rivers increased by 7% from 1936 to 1999. The increase is linked both to Arctic warming and to the amplifying NAO/AO (NAO/Arctic Oscillation system) from the 1960s to the 1990s. (Wu *et al*., 2005) reproduced the trend in Arctic river flow using an 'all forcings simulation' of a global coupled climate model (HadCM3 – the UK Met Office Hadley Centre coupled model) in which the model was forced with both anthropogenic (greenhouse gases, sulphate aerosols and ozone) and natural (solar and volcanic) external factors. The simulated change in Arctic river flow shows a consistent upward trend from the 1960s, 'in very good agreement' both in timing and amplitude with the trend reported by Peterson *et al*. (2002) from river monitoring data. The trend is not evident in the set of experiments using only natural forcings. They therefore describe it as likely that the upward trend in circum-Arctic river flow is real, part of an anthropogenic intensification of the global hydrological cycle. (Curry *et al*., 2003) describe evidence of the accelerated water cycle through freshening of the Nordic Seas and upper North Atlantic while sub-tropical seas appear more saline over four decades.

What might happen?

Future projections give an estimated increase of 10–30% in annual river flow to the Arctic Ocean by the end of the 21st century (Walsh *et al*., 2005 in IPCC, 2007b) with additional inputs from the melting of land-based ice, most notably Greenland (Gregory *et al*., 2001; Dowdeswell, 2006).

Confidence in model projections of future precipitation is low, downscaling studies demonstrate that local precipitation changes can vary significantly from those expected from the large-scale hydrological response pattern (IPCC, 2007a).

Are there any OSPAR regional differences?

The IPCC (2007a, see FAQ 11.1) suggests that, while regional prediction of precipitation remains uncertain, Region IV (Bay of Biscay/Iberian Coast) and southern area of Regions III (Celtic Seas) and V (Wider Atlantic) are more likely to experience decreases in precipitation, and reduction in supply of freshwater in summer months, either directly or through changes in local catchments. They also suggest that precipitation is more likely to increase over Region I (Arctic Waters) in summer and over Regions I and II (Greater North Sea) in winter.

➥ *Go to the full QSR assessment report on impacts of climate change (publication number 463/2009)*

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