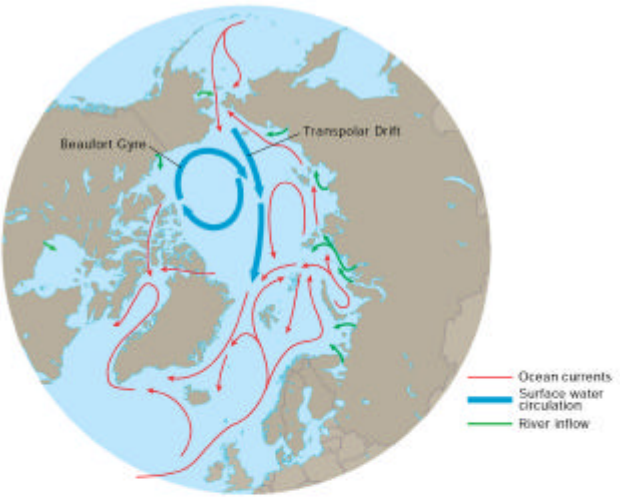
Transport of contaminants to the Arctic and their fate

Over the past 10 years, the Arctic Monitoring Programme (AMAP) has conducted two major assessments of the pollution status of the Arctic, documenting the sources, levels and trends, and effects of a wide range of contaminants, including persistent organic pollutants (POPs), heavy metals, radionuclides, acidifying substances, and petroleum hydrocarbons. The main conclusions of these assessments are that: *"In comparison with most other areas of the world, the Arctic remains a clean environment. However, for some pollutants, combinations of different factors give rise to concern in certain ecosystems and for some human populations. These circumstances sometimes occur on a local scale, but in some cases may be regional or circumpolar in extent."*

Contaminants have been measured in all compartments of the Arctic environment and its ecosystems – in air, soils and sediments, snow and ice; in seawater and freshwater; in birds and animals; and, not least, in humans.

SOURCES: Most of these contaminants come from source areas outside of the Arctic, in particular the industrialised areas of Europe, North America, and Asia. Some volatile and semi-volatile contaminants, including mercury from coal burning sources, and pesticides used in agriculture in the mid-latitudes and for pest control in the tropics, reach the Arctic from as far away as Southeast Asia. Some additional sources exist within the Arctic, however, with the exception of large smelter complexes on the Kola Peninsula and at Norilsk in Russia, these mainly give rise to only local pollution. For POPs in particular, the contamination found in the Arctic cannot be related to any known use and/or releases in the region, and can only be explained by long-range transport from lower latitudes. This transport may involve a series of 'hops' as POPs are deposited to surfaces and then revolatilize when, for example temperature increases, the Arctic acting as a 'cold trap' for such contaminants.

PATHWAYS: Contaminants are transported to the Arctic by the air and by oceans and rivers. Within the Arctic, they are redistributed, also by ice transport pathways. The air provides a fast transport route – bringing contaminants from Europe to the Arctic within a matter of days. Air transport is particularly important in winter when air masses from Europe travel up into the Arctic, where they are trapped by the stable conditions that prevail during the long Arctic winter, or move down into northern North America - with their contaminant load being deposited along the route. Ocean transport is slower, but more important for contaminants that partition into water and sediments rather than air and aerosols. Releases of radionuclides, such as caesium and technetium, from the European reprocessing plants at Sellafield (UK) and Cap de la Hague (France) can be traced as they follow the currents flowing north from the Atlantic into the Barents Sea and the Arctic Ocean, exiting again via the Fram Strait after a period of some years. Several of the worlds largest rivers flow into the Arctic Ocean, transporting contaminants from agricultural and industrial areas within their basins.



FATE: Once in the Arctic, contaminants can be taken up in the lipid rich food chains of the Arctic, in particular the marine food chains – many POPs have an affinity for lipids and concentrate in fatty tissues and organs. Some are also biomagnified in food webs, as predators consume the contaminant loads taken up by their prey. In this manner, concentrations in top predators such as polar bears – and man – can be 7 or 8 orders of magnitude higher than in water.

INFLUENCE of CLIMATE CHANGE: Climate change and variability can and will have profound affects on contaminant pathways to the Arctic, both in response to physical and biological factors. The current situation could alter radically as climate-related phenomena change over the coming decades. Contamination of the Arctic could worsen or improve as a result – and we should expect some surprises – In the long-run, anthropogenic emissions that affect climate may become as important as emissions of the contaminants themselves in determining the extent to which they pollute the Arctic.