Green Business AB
Richard Almgren

richard.almgren@greenbusiness.se
+46705688112

Our Environment 1930-2030 -

The long-term view

Richard Almgren

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Author: Richard Almgren
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Preface

Is the environment getting better or worse? It is certainly an urgent question we ask ourselves after all the conflicting reports in recent years. The complete answer will not be delivered in this report. However, the reader will get a brief overview of six key environmental areas. The answer is highly complex, because the Swedish environment is heavily influenced by activities in other countries. The focus of this report is on the extent to which Sweden pollutes the environment. With respect to that area of focus, the answer is clear; the environment is getting better!

The purpose of this report is to provide perspective on major environmental issues. The report can also be seen as a contribution to the larger discussion on finding the necessary international solutions. The time-span for this report is a period of one hundred years, 1930-2030. In other words, we start before the Second World War and look to a few decades into the future.

The following issues are highlighted in this report:

Climate change
Ozone depletion
Acidification
Human toxicity
Eutrophication ("Overfertilization")
Eco-toxicity

The data for the diagrams in this report are taken primarily from existing literature, the majority of which has been published previously. In a few cases it has been necessary to extrapolate the calculations. The basis for all calculations is referenced within this report.

From the point of view of Swedish Enterprise, we hope that the findings of this report will contribute to constructive dialogue on the design of environmental policies for tomorrow. To date, environmental policies have largely focused on national counter-measures. Yet, if we take into account the transnational nature of environmental issues and our dependence on activities beyond national borders for solutions, environmental policy needs a new agenda. One clear conclusion of this report is clear; Successful environmental policy requires international solutions.

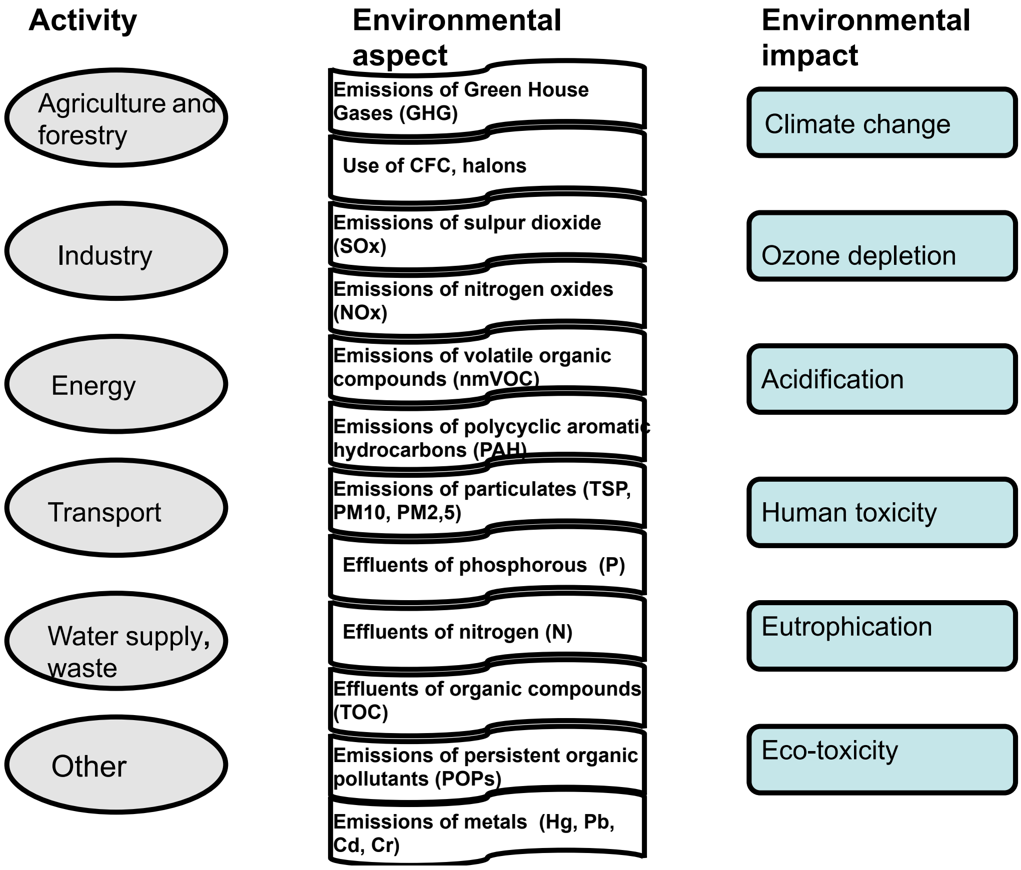
This report was prepared by Richard Almgren, Green Business AB on behalf of Swedish Enterprise. A more complete version of this report is available from: www.swedishenterprise.se.

Stockholm in May 2013

Inger Strömdahl
Responsible for environmental policies
Swedish Enterprise
inger.stromdahl @ swedishenterprise.se

Environmental issues

The *environmental issues* covered in this report are highlighted on the right part of the first figure (Figure 1).



Climate change

Our *problem* is that climate is changing at a rapid pace. Average temperature on earth has risen by 0.74 degrees in 100 years. It can be measured with high levels of reliability (Figure 2). The levels of so-called greenhouse gases, or GHG, GreenHouse Gases (namely carbon dioxide, nitrous oxide, methane, F-gases and water vapour), in the atmosphere has also increased by over 30 percent during the same period. That is also possible to measure with good reliability (figure 3). The international climate panel, Intergovernmental Panel on Climate Change (IPCC), has in its fourth report in 2007 collated our existing knowledge with regard to climate change. There is no doubt ("very high confidence"), the IPCC says, climate change is occurring.

The *cause* of the problem is considered to be the use of energy by burning fossil-fuels (coal, oil, natural gas). Energy supply in the world today is largely (80%) based on the combustion of fossil- fuels. Unlike many other countries, Swedish energy supply is mainly based on non-fossil sources (hydro, nuclear, bio-fuels). The reason for using fossil-fuels as a major source of energy in the world is simple. Coal, oil and natural gas have a common feature in that they are rich in energy. On the other side of the coin, however, burning of these fossil-fuels releases carbon that was bound-up in the fuel several hundred million years ago. This implies that the burning produces a surplus of carbon compounds as nature cannot re-absorb it at the rate at which it is produced. Global emissions of greenhouse gases have approximately doubled over the last 40-50 years (Figure 4), emissions which govern the state of the environment. Corresponding emissions in Sweden have roughly halved over the same period (Figure 5). It should also be noted that there is a "natural greenhouse effect" on Earth. It is one of the prerequisites for life on Earth. The question now is whether the increased concentrations of greenhouse gases also cause an increase in temperature which result in climate change.

Actions taken occur primarily through an international convention, the United Nation's Framework Convention on Climate Change (UNFCCC). More concrete commitments to the UNFCCC are set out in Protocols. The first of these is the Kyoto Protocol from 1997. The commitments in this protocol are now coming to an end (2012). A new protocol covering the coming years is expected to be signed in Copenhagen in 2009, anticipated to be known as The Copenhagen Protocol. Price mechanisms of various types have also been established for driving the reduction of emissions. One such emissions-trading system has already been introduced within the EU. Furthermore, in Sweden, one of the sixteen environmental-quality objectives deals with the reduction of greenhouse gases, "Reduced Climate Impact". It is also reasonable to assume that many of the companies that have voluntarily implemented an environmental management system in line with the international environmental management standard ISO 14001 have established objectives for reducing greenhouse gas emissions. Another voluntary effort worth mentioning is the Carbon Disclosure Project. A number of measures have been taken in Sweden; replacing oil primarily with bio-fuels after the oil crises of the early 1970s, improvements to the efficiency of energy use, and measures resulting from a special carbon tax in 1991. The Swedish carbon (dioxide) tax is significantly higher than the global carbon tax proposed by the IPCC, and advocated by economists i.e € 40 per tonne carbon dioxide. The Swedish tax on heavy oil corresponds to € 150 per tonne carbon dioxide.

Discussions are ongoing on *environmental policy* for the years to come, in Sweden, the EU, and at international level. At present, EU member countries appear to have consensus on a 20 percent reduction of GHGs by 2020. Due to the rate at which *Nature responds,* any positive effects of the measures already taken however have yet to be observed (Figure 6). There is still a great need for *further action,* but it is possible to stop climate change. The technology is, for the most part, already available, and its evolution is only just beginning. Regarding costs, the most thorough assessment has been conducted by the British economist Nicholas Stern in the "Stern Review ". In this report necessary measures were assessed to cost equivalent to 1 percent per year of global GDP.

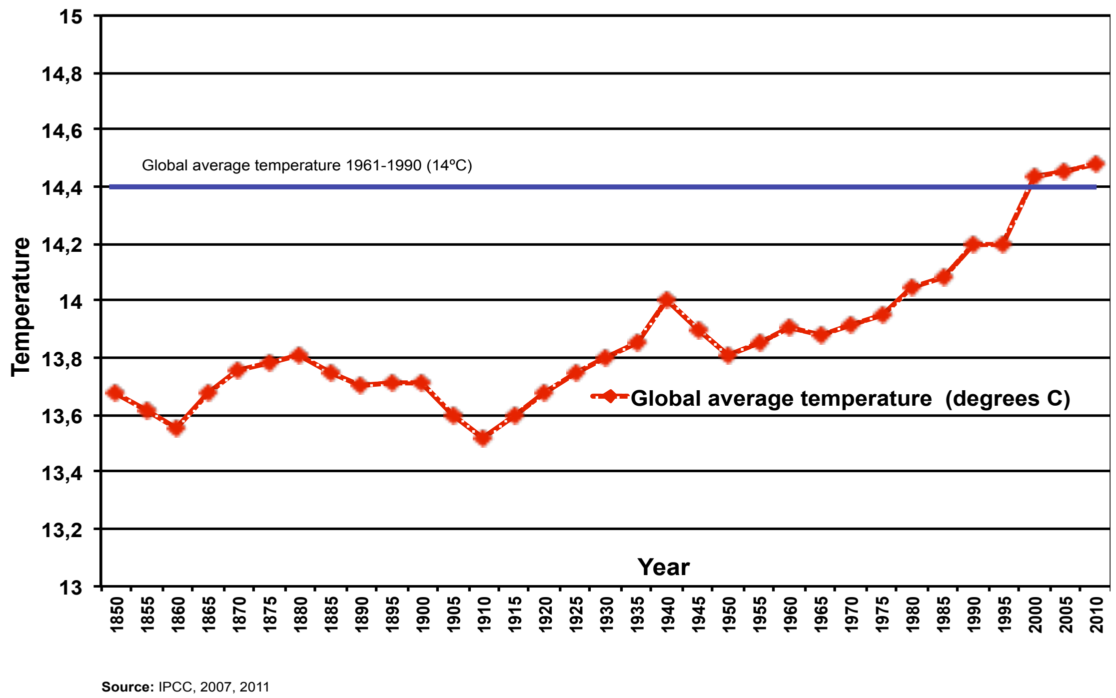


Figure 2: Average tempearature on earth 1850-2010

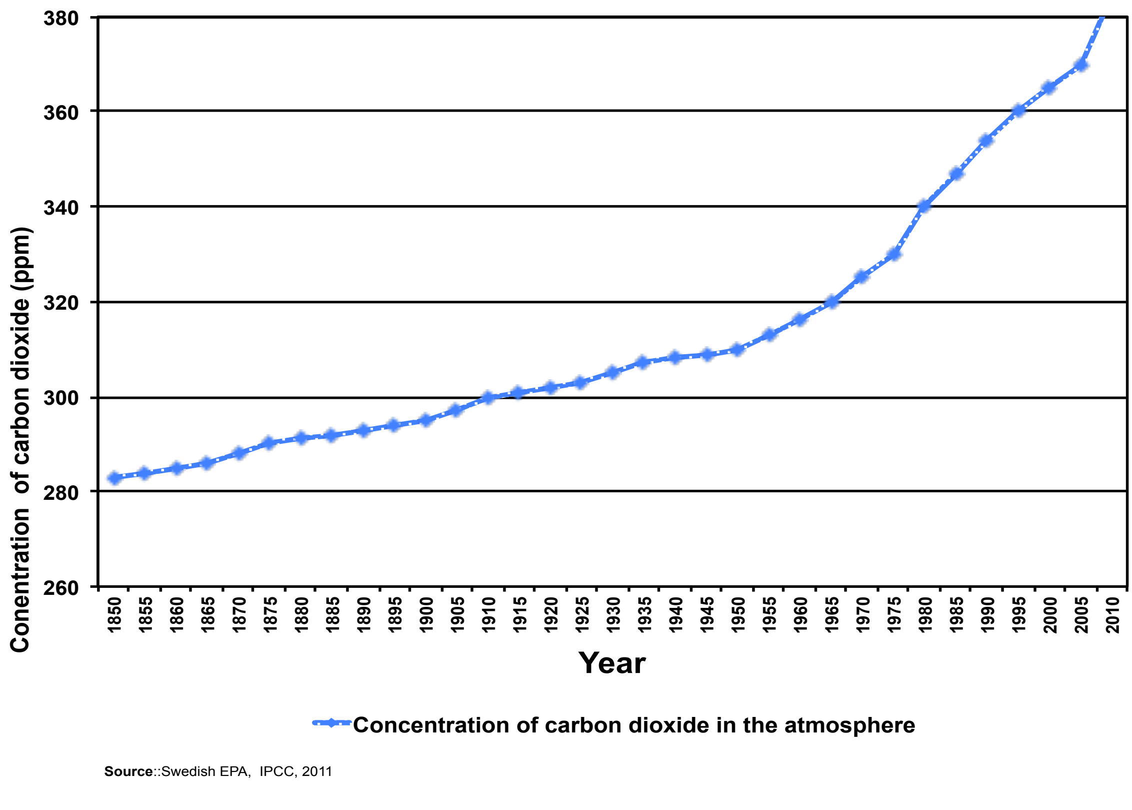
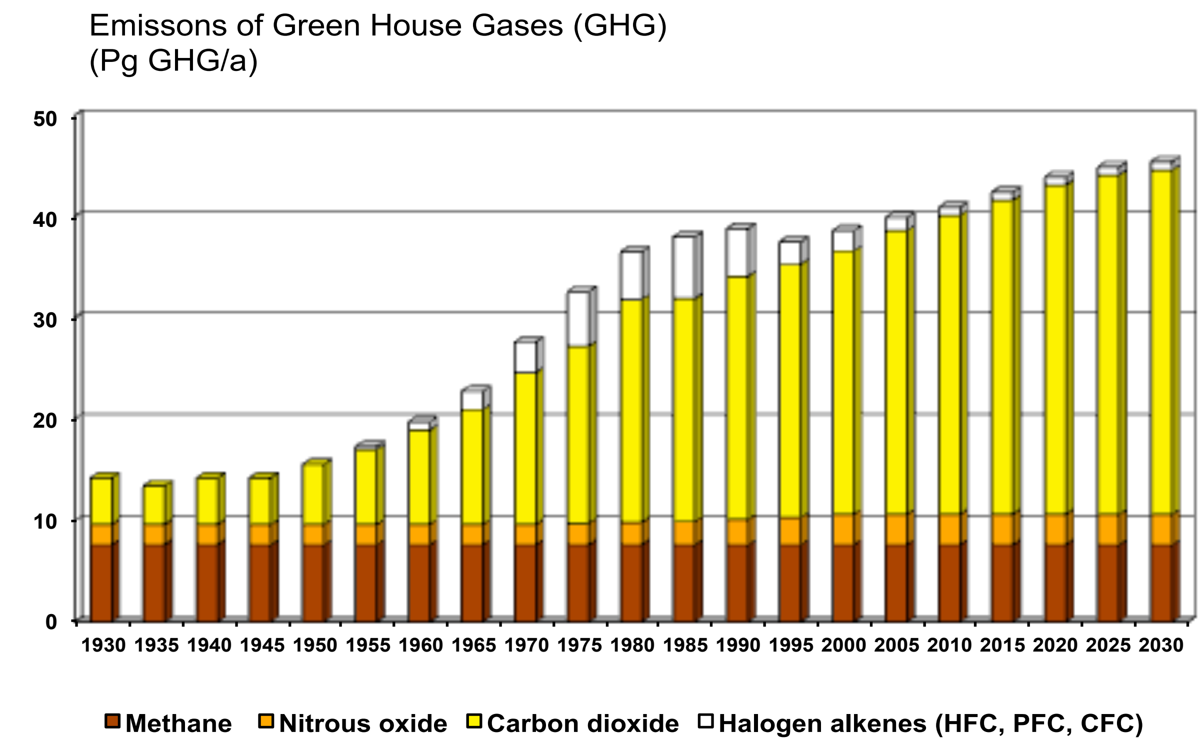
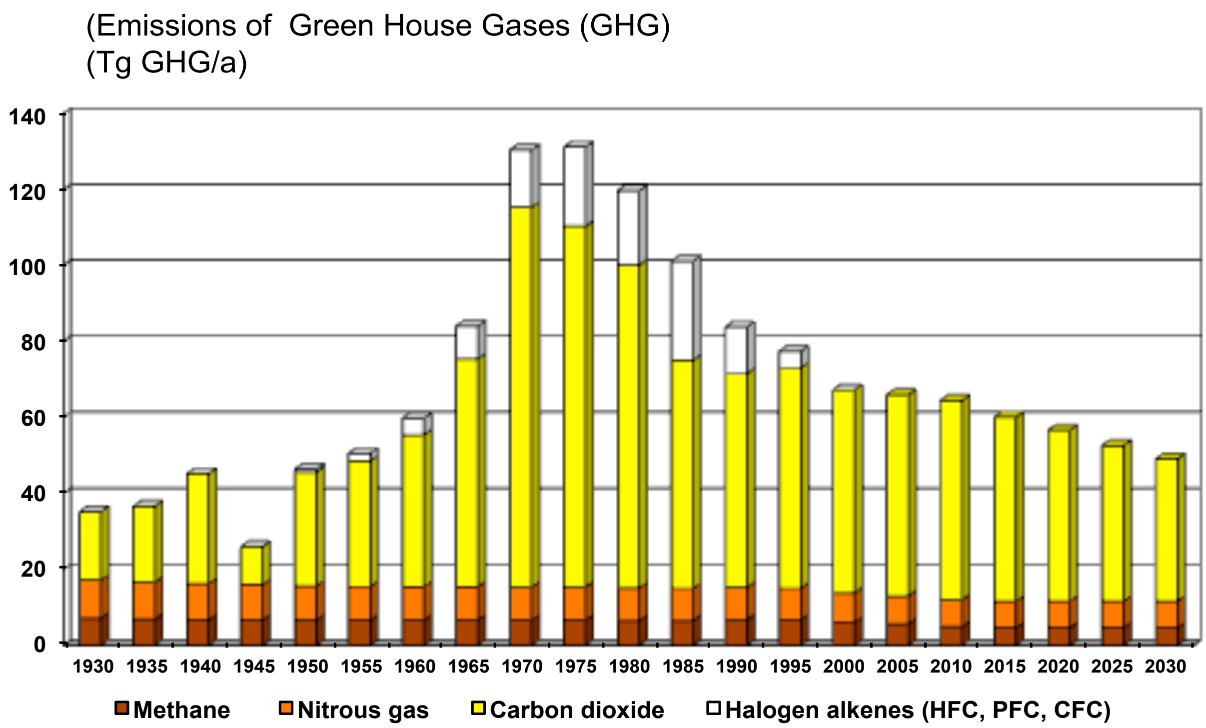


Figure 3: Concentration of carbon dioxide in the atmosphere 1850-2010



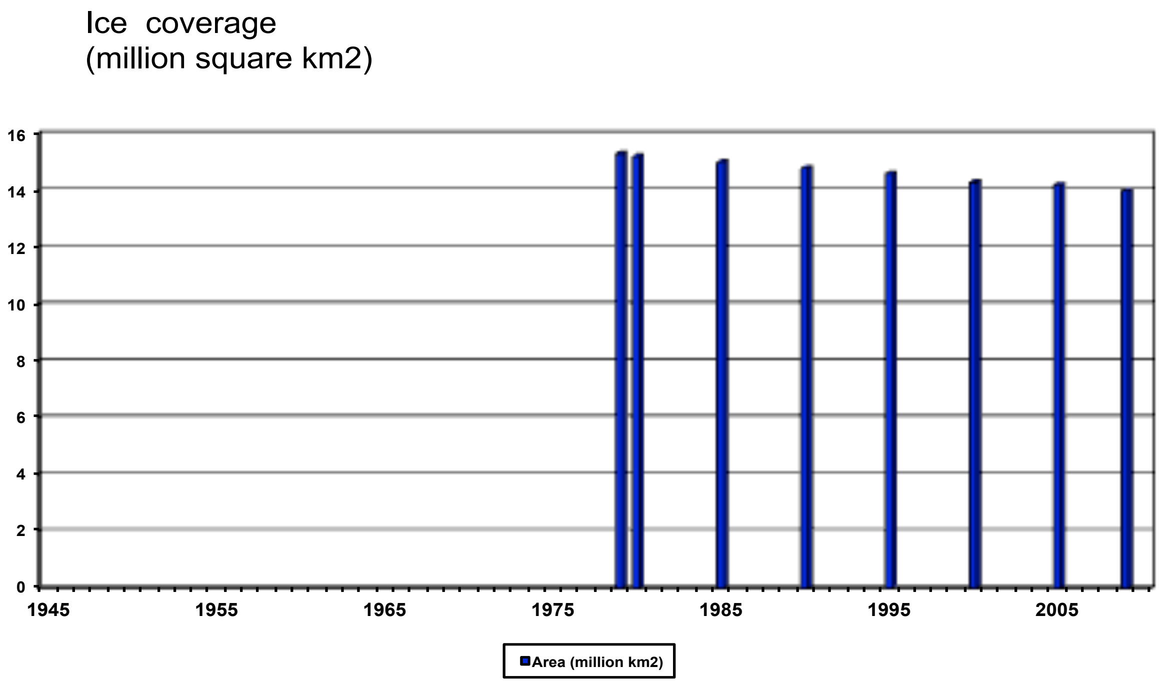
Sources: Richard Almgren (2009), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: 1930-1945 Keeling, 1973; 1950-1965 Keeling, 1973; Delvis egen bedömning utifrån produktionsdata, UNEP, 2006; 1970-1975 WWI; Delvis egen bedömning utifrån produktionsdata, UNEP, 2006; 1980-2005 UNEP, 2005; 2010-2030 IPPC, 2007: Synthesis Report, scenario B1 “Rapid changes”

Figure 4: Emissions of GHGs from sources globally 1930-2030



Källor: Richard Almgren (2009), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: ***Koldioxid*** 1930-1985 SOU 2001:2; 1990-2005 Naturvårdsverket, 2009; 2010-2030 Prognos baserad på minskning med 20% till 2020, räknat från 1990, och fortsatta minskningar i samma takt därefter. ***CFC*** 1930-1980 Lindmark, 1998; 1985-2005 UNEP, 2005; IPCC, 2001; ***Metan*** 1930-1980 Egen beräkning

Figure 5: Emissions of GHGs from sources in Sweden 1930-2030



Source: The National Snow and Ice Data Centre, University of Colorado

Figure 6: The coverage of ice on Arctic 1979-2009

Depletion of stratospheric ozone

The ozone layer protects us from the sun's strongest rays, ultraviolet radiation. The ozone layer is a prerequisite for life on Earth. The ozone layer protects life on earth by filtering out some of the harmful UV rays from the sun. Our *problems* are stemming from the fact that substantial reduction in the ozone layer in Antarctica is occurring each spring, and to some extent over the Arctic (Figure 7).

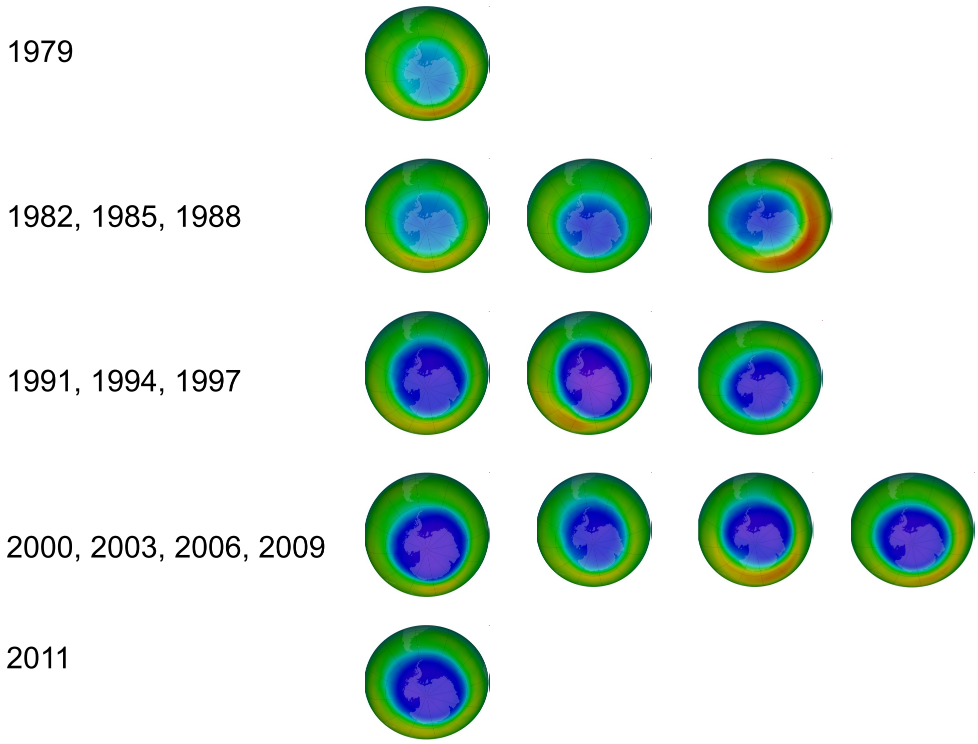
The *cause* of ozone depletion has been shown to be due to the use of certain chemical products. Substances that deplete the ozone layer include certain chlorinated solvents, chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). CFCs and HCFCs have multi-applications, such as in refrigerators, air-conditioning plants and foam. *Action taken* have been decisive. Measurements of the ozone layer have been performed since it was discovered. All manufacturing of the above products has largely ceased, and any new use is in principle prohibited (Figure 8).

Environmental policy is again set out in an international convention, the Vienna Convention (Vienna Convention for the Protection of the Ozone Layer, 1985), and its Protocol, the Montreal Protocol of 1987 (the Montreal Protocol on Substances that deplete the Ozone Layer). These international agreements regulate emissions of ozone-depleting substances. In principle, most substances defined within the Montreal Protocol should be phased out by 2010.

Nature's response to actions taken has lead to the recovery of the ozone layer (Figure 4). That has been confirmed by the various monitoring systems that have been put in place. Although no major improvements have taken place, current monitoring results are important early-indications that the decisions made on the phasing-out of CFCs etc were the right-ones. Around the middle of this century the concentrations of key substances are expected to be below 1970- levels, and to return to normal levels by the turn of the next century. This is an important example of the time-delay between the actions taken today, and nature's response to these actions in the future.

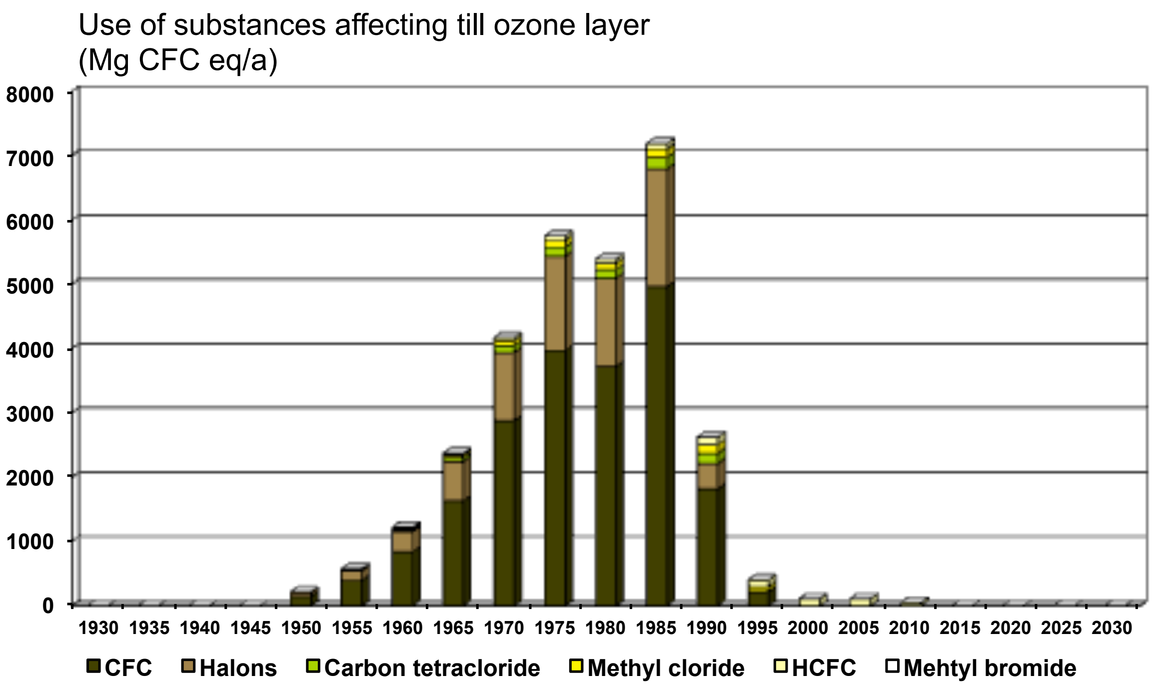
Further action essentially needs to focus on the continued implementation of actions that have already been initiated. The majority of substances that are likely to have an impact on the ozone layer have already been phased out. There are however a number of CFCs still being used in existing products.

As a final *comment,* it is worth mentioning that the international community acted promptly, and positively to indications that the ozone layer at high altitude was at stake.



Source: NASA, Ozone Hole Watch, 2011 (Average values in September in Antarktis)

Figure 7: Depletion of the ozone layer over Antarctic 1979-2011



Källor: Richard Almgren (2009), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: 1950-1990 Lindmark, 1998; Naturvårdsverket Miljömålsportalen; UNEP

Figure 8: The use of CFCs (Halogen alkenes) in Sweden 1930-2030

Acidification

Acidification of soil and water is a complex *problem*. Essentially it is a natural phenomenon. Some acidification of soil and water has been going on since the Ice Age. In the 1960s, the Swedish scientist Svante Odén discovered that the acidification process was accelerating.

The consequences of acidification include impoverishment of flora and fauna, through heavy metals gaining access to biological processes, enhanced corrosion of metals, as well as negative impacts on the respiratory tract of humans. Anyone who can recall their chemistry lessons in school will know that a drop of acid can speed up chemical reactions. The same occurs in Nature; acid rain increases the speed of biological processes.

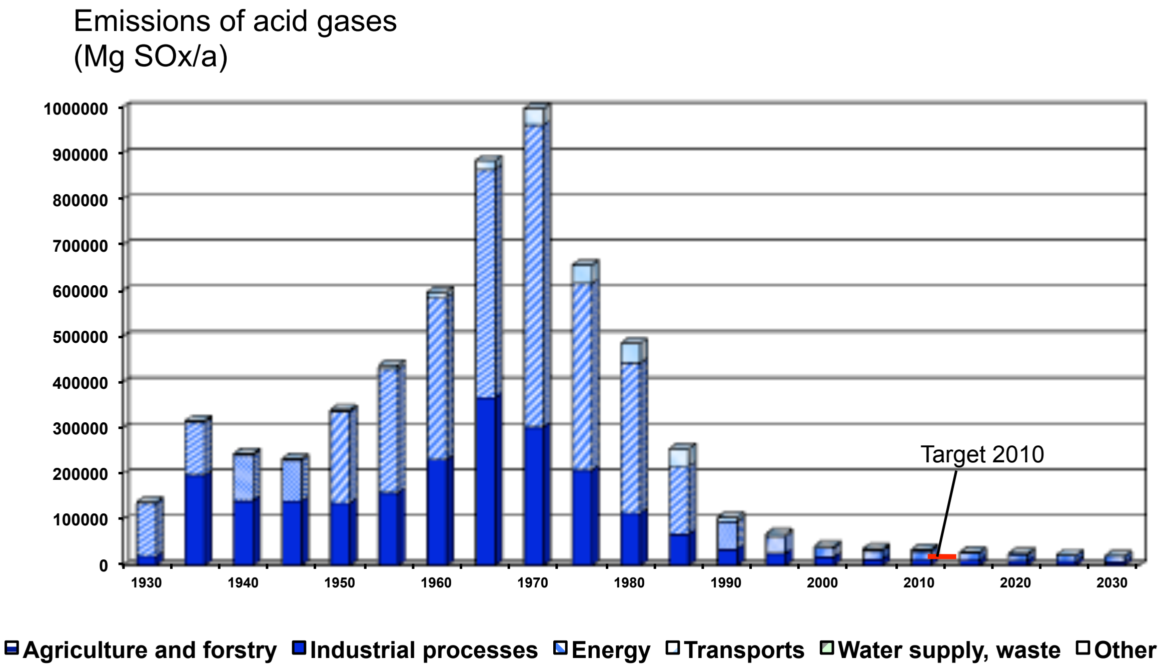
Emissions of sulphur dioxide in the European countries have been the principal *cause* of decades of acidification of soil and water in Sweden. These emissions are generated primarily through the burning of sulphur-containing fuels, such as coal and fuel-oil. Emissions also arise from certain industrial processes (Figure 9,10). Fossil-fuels generally contain a certain amount of sulphur. At present, around 10 percent of the precipitation in Sweden stem from Swedish sources, the remaining 90 percent from foreign sources. Emissions from continental Europe has declined significantly, but not as fast as they have in Sweden and thus lag 10-20 years behind (Figure 11).

Actions taken have resulted in Swedish annual emissions of sulphur oxides being substantially reduced over recent decades, more than 95%.

Environmental policy has to-date been focused on the 1979 International Convention on Long-Range Transport of Air Pollutants, CLRTAP, and its different protocols.

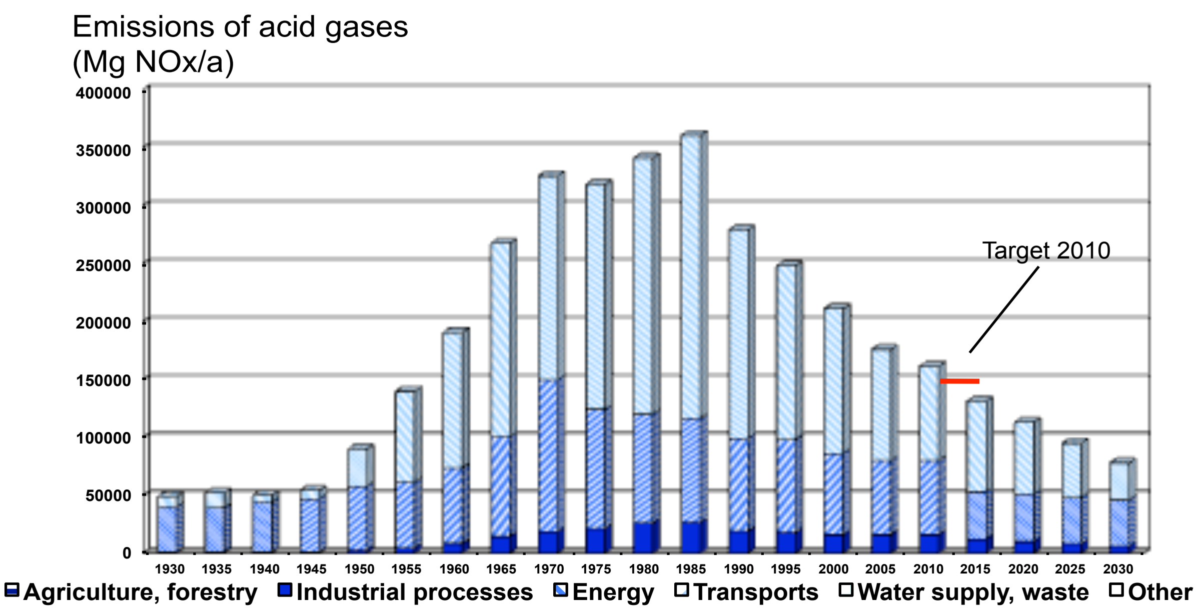
Nature's response to the *actions taken* has been positive. The sharp reduction in the burden on land and water from acidic substances has led to similar reductions in the acidification of our soil and water. One can say that this change reflects the changing pattern of emissions across Europe given the extent of foreign sources of emissions in Sweden (Figure 12,13).

As a final *comment* it needs to be reinforced that the problem of acidification must be tackled at an international level. Acidification is another example of the fact that air pollution does not respect national boundaries.



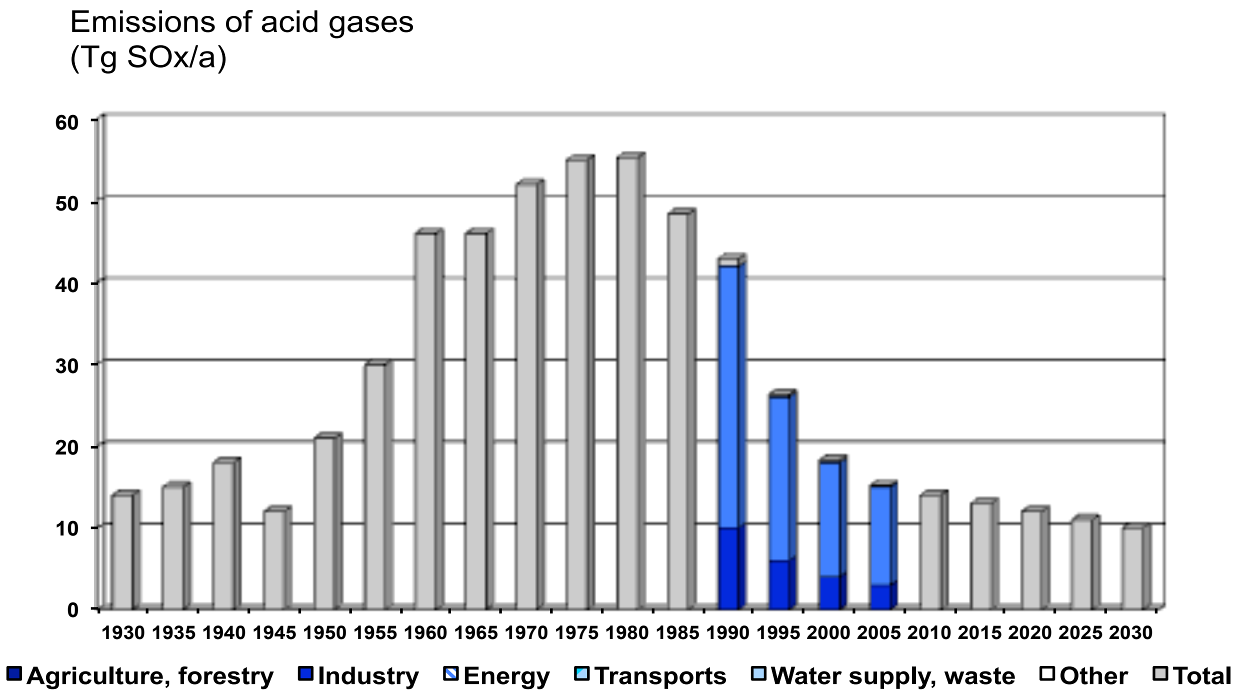
Sources: Richard Almgren (2012) Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: 1930-1985 Naturvårdsverket, 2003, 1984, 1993, 1995 (Monitor 18, 1862, 4206, 4234, 4461); Kindbom, 1993 (IVL B1109); Skogsindustrierna; SOU 1966:65; SOU 1974:101; Facht, 1976; SOU 1975:98; 1990-2005 CLRTAP-rapport , 2009, 2012; Naturvårdsverket, 2010; 2010-2030 Prognos baserad på Miljömålsrådets bedömning (2008) och Oljekommisionens bedömningar om möjlig oljeersättning till år 2020 och samma takt därefter

Figure 9: Emissions of acid gases (sulphur dioxide) in Sweden 1930-2030



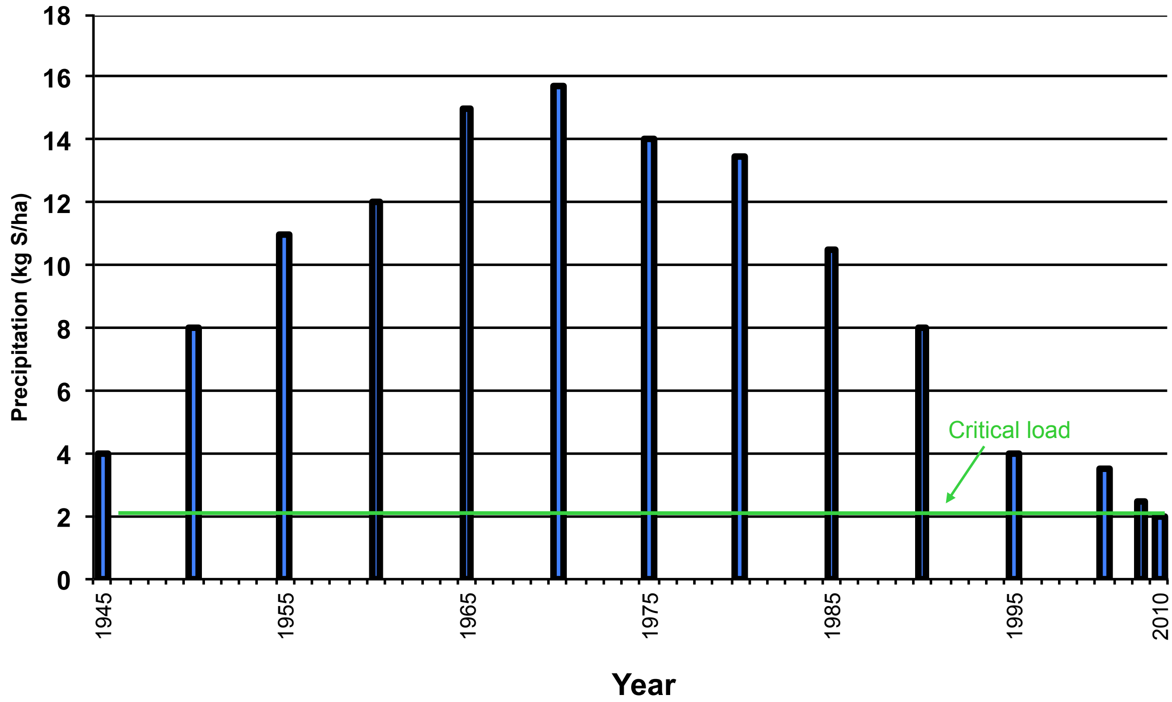
Sources: Richard Almgren (2012) Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: 1930-1990 Kindbom, 1993 (IVL B1109), Naturvårdsverket, 1984 (Monitor); Naturvårdsverket 1984 (1862), IVA, 1990; Naturvårdsverket 1984, 1993 (1862, 4234); 1990-2005 CLRTAP, 2009, 2012; Naturvårdsverket, 2010; 2010-2030 Prognos baserad på Miljömålsrådets bedömning (2008) samt Oljekommissionens bedömningar om möjlig oljeersättning till år 2020 och samma takt därefter

Figure 10: Emissions of acid gases (nitrogen oxides) in Sweden 1930-2030



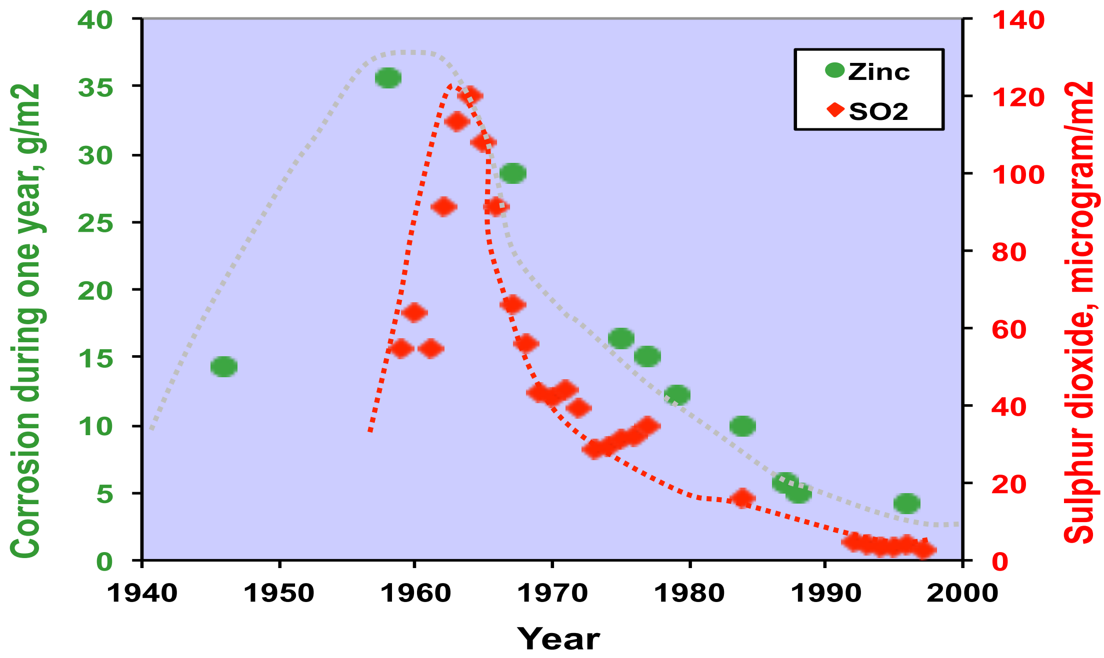
Sources: Richard Almgren (2012), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor:
1930-2005 Verstreng, 2007; 2010-2030 Egen bedömning baserad på motsvarande minskning som EU-målet för GHG

Figure 11: Emissions of acid gases (sulphur dioxide) in Europe 1930-2030



Sources: 1930-1990: S Mylona, EMEP/MSC-W Report 2/93, beräkning av svavelnedfallet över småländska höglandet i södra Sverige; 1995-2010: Naturvårdsverket, IVL Svenska Miljöinstitutet;

Figure 12: Precipitation of acid compounds in Southern Sweden 1945-2000



NOTE: Measurements have been made in central Stockholm (station Vanadis)
Source: Johan Tidblad et al, 2002

Figure 13: Corrosion of zinc and concentrations of sulphur dioxide in ambient air 1940-2000

Human toxicity

This *problem* relates to, amongst other things, local air pollution and noise. Regarding local air pollution, three types of harmful pollutants are considered to be of upmost importance; ground-level ozone, certain organic hydrocarbons and particulate matter (PM10). Ground-level ozone (not to be confused with the ozone-related problem discussed above) can be formed in the presence of hydrocarbons, nitrogen oxides and sunlight. This "smog", as we more commonly know it, was previously quite a regular occurrence in cities like London and Los Angeles.

Polycyclic Aromatic Hydrocarbons (PAHs) constitute a large group of closely related chemical substances within the family of hydrocarbons. Of these, several are known, or suspected to be, carcinogens, benzo(a)pyrene being perhaps the most familiar to us.

There are both natural and anthropogenic (man-made) sources of particles. The smallest particles (PM10) are considered to have the greatest negative impact on human health. The majority of particles in the diagram below are of PM10-type; there is little difference between the total amounts of particles (TSP) and the amount of fine particles (PM10).

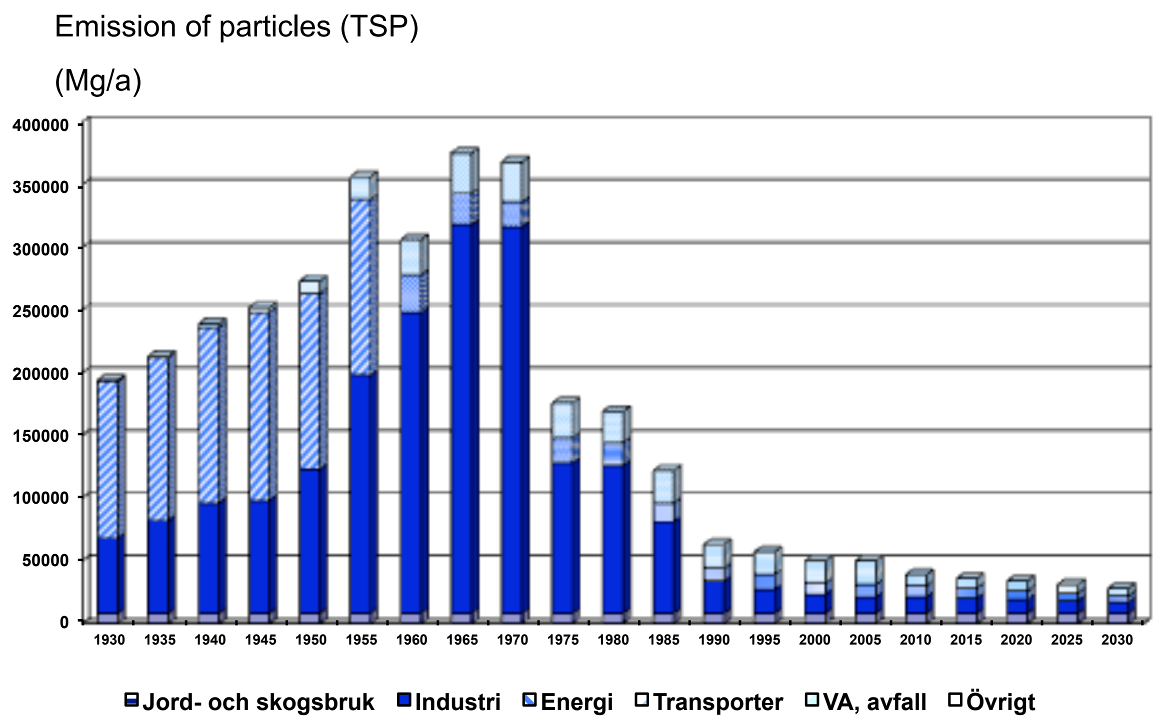
Our focus in this section is upon day-to-day occurrences like transport and heating, also the main *cause* of the type of pollution we are dealing with here.

Improvements to air quality in urban areas can be attributed to *actions* that have been *taken*. Individual boilers for heating homes and offices have largely been replaced by district heating, where emission control is more effective. The fuels are also cleaner. Furthermore, cars have gradually improved from the point of view of emissions. Cars are covered by a system of environmental classification in order to promote the sales of cars with better environmental performance. Emissions of the pollutants addressed in this section is governed by licensing activities under the Swedish Environmental Code (Chapter 9, § 6). The Convention on Long Range Transport of Air Pollution (CLRTAP) has provided an important foundation for international cooperation. Challenges, however, still remain. The combined emissions of hydrocarbons from Sweden has roughly halved since 1970 but not decreased as much as other pollutants have. Emissions of particulate matter from industry and other sources have declined dramatically (Figure 14).

Environment Policy had led to the formulation of specific targets for dealing with the various components of local air pollution, sulphur dioxide, nitrogen dioxide, ozone, volatile organic compounds (VOCs), benzo(a)pyrene), etc. As a result, emissions of such substances has been reduced (Figure 15,16).

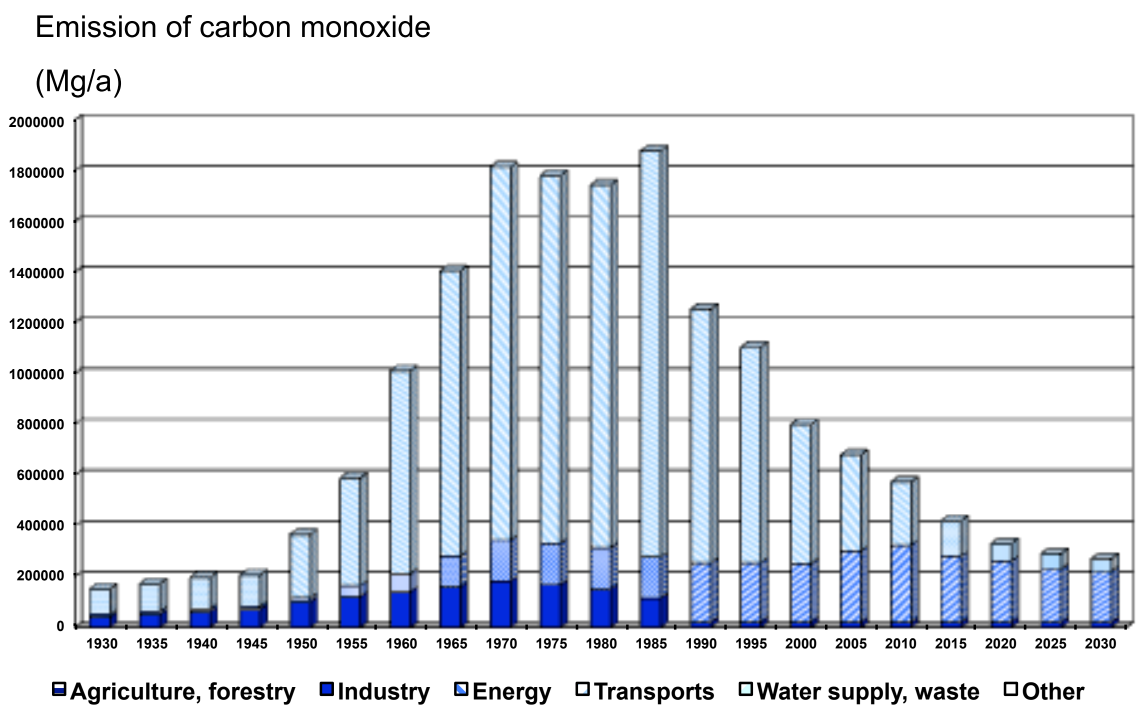
Nature's response to actions taken has resulted in the dramatic decline of sulphur dioxide, nitrogen dioxide and particulate matter in our city environments over recent decades (Figure 17). From a European perspective at least, the quality of our air is relatively good (Figure 18).

As a final *comment,* it is also worth mentioning that the measures taken to decrease emissions of acidic gases (primarily sulphur dioxide) have been successful. Particularly pleasing has been the effect on the levels of sulphur dioxide in outdoor air. Air quality in urban areas is improving from year to year. Existing emissions of nitrogen dioxide stem primarily from transportation. It is hoped that as cars are gradually replaced with newer, friendlier models, these emissions will also gradually be reduced to acceptable levels. The same applies for particles, the current trend for shows that levels of air pollutants in our air is declining.



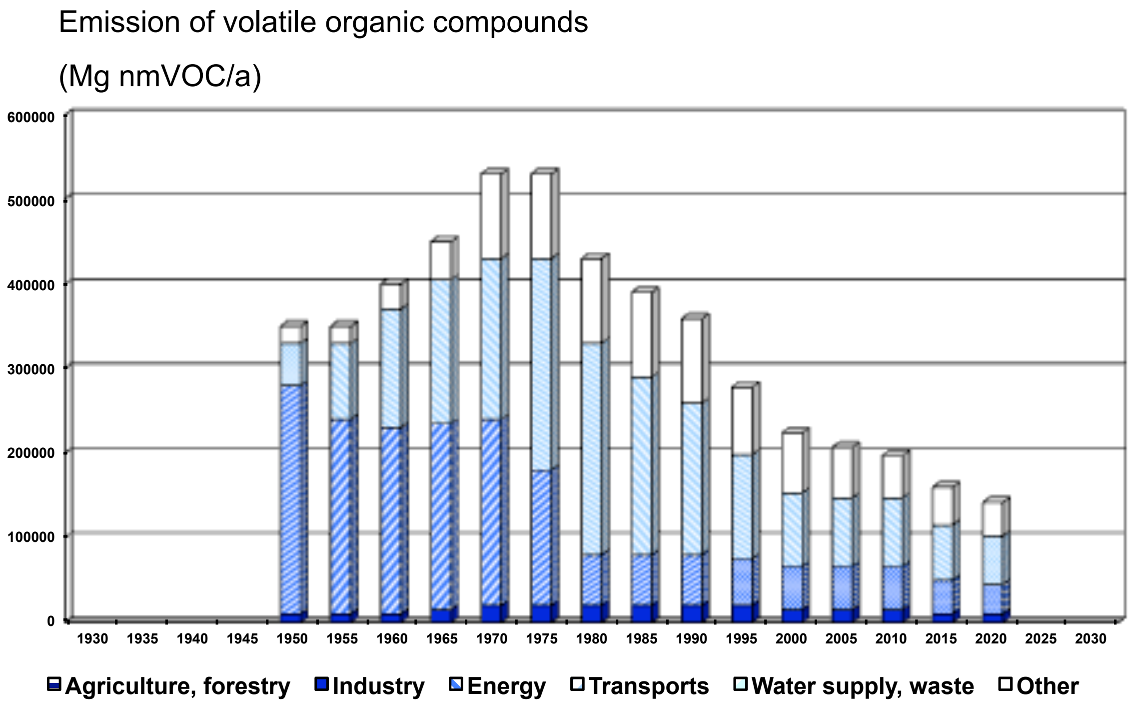
Sources: Richard Almgren (2012), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor:
1930-1975 Facht, 1976; SMED 4/07 (Jordbruk oförändrat som 1980-2000); Jernkontoret, 1987; SOU 1966:65 (Extrapolerade värden från 1960 och 1970 efter stål- resp industriproduktion); 1980-1985 Interpolerade värden för industri; CLRTAP, 2009, 2011; 1990-2005 CLRTAP, 2009, 2012; 2010-2030 Naturvårdsverket, 2003 (5318); Egen bedömning

Figure 14: Emissions of particles to air in Sweden 1930-2030



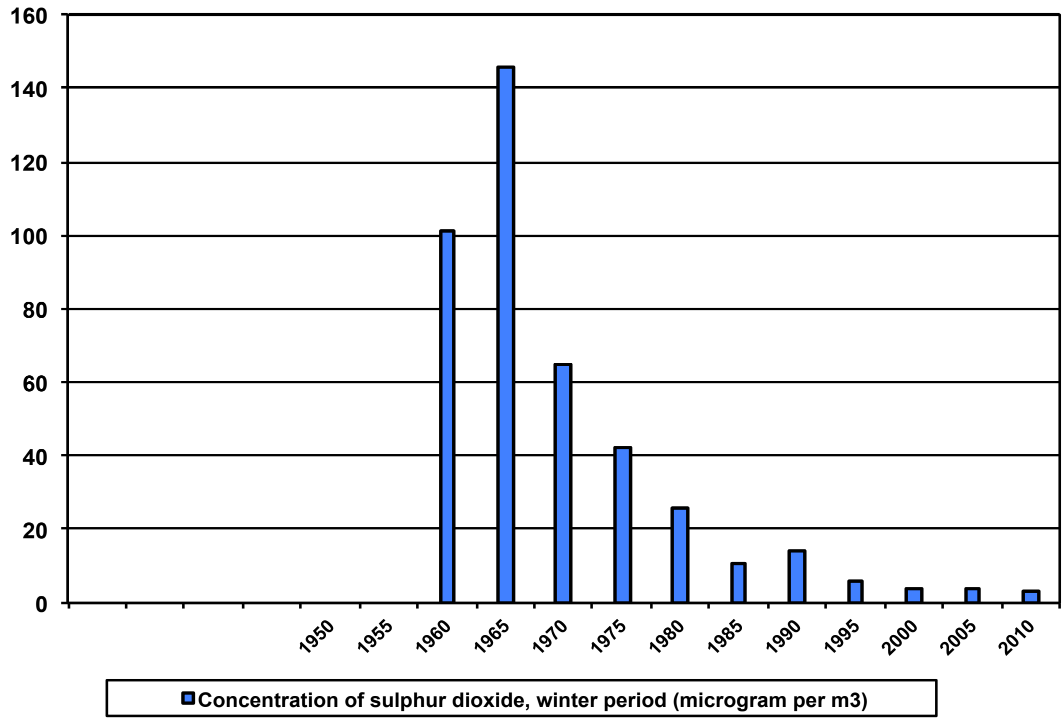
Sources: Richard Almgren (2012), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor:
1930-1950 Lindmark, 1998; IVA, 1990; utsläpp från industri efter produktionsnivå; 1950-1985 Naturvårdsverket, 1984 (1862), SOU1975:98; 1990-2005 Naturvårdsverket, 1995 (4459); 2010-2020; 2025-2030 Naturvårdsverket, 2010, 2011; Samma minskningstakt som 2010-2020

Figure 15: Emissions of carbon monoxide in Sweden 1930-2030



Sources: Richard Almgren (2012), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: 1930-1950 1950-1985 Lindmark, 1998; Energimixen; 1990-2020 Naturvårdsverket, 2009, 2012; Energimixen;

Figure 16: Emissions of volatile organic compounds (nmVOC) in Sweden 1930-2030



Source IVL Svenska Miljöinstitutet; Göteborgs stad Miljö R 2011:10

Figure 17: Concentrations of sulphur dioxide in ambient air in Gothenburg 1960-2010

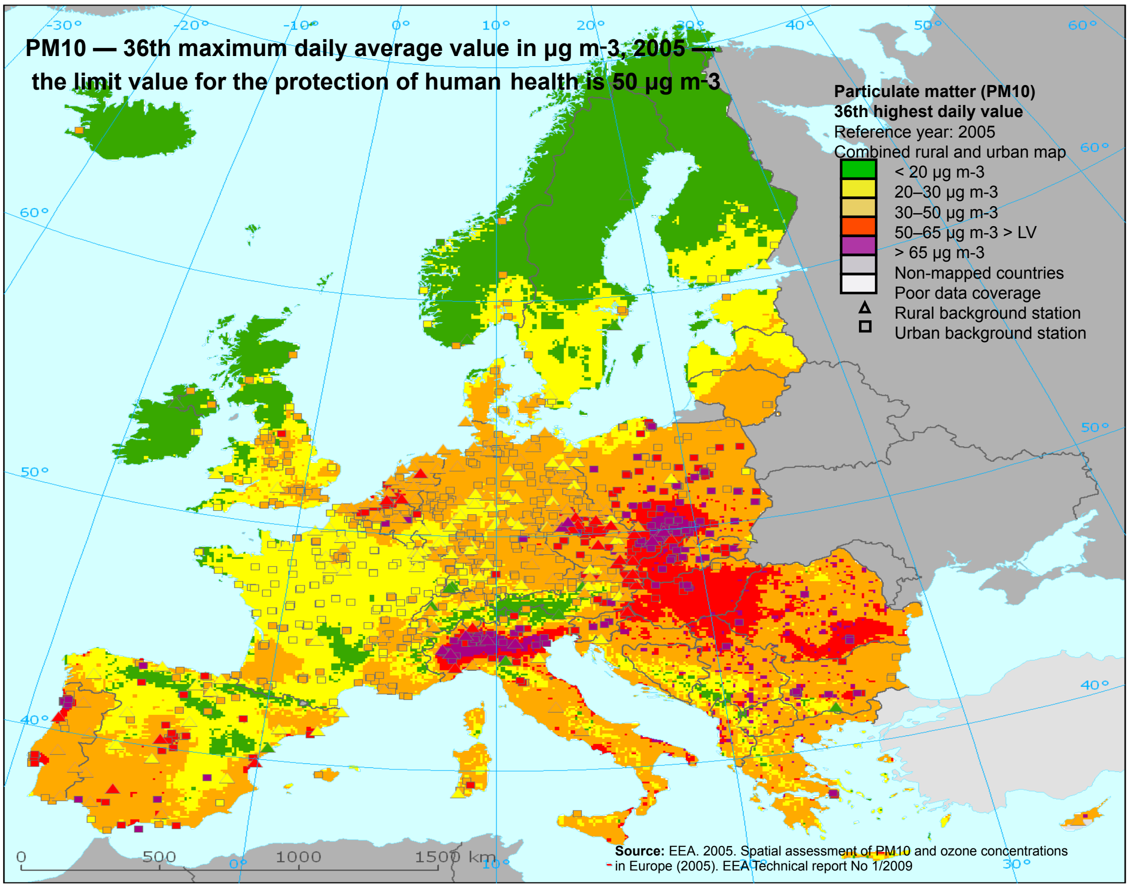


Figure 18: Concentrations of particles in ambient air in Europe 2005

Eutrophication

Two *problems* illustrate this issue, eutrophication of lakes and seas, and general pollution. “Over-fertilisation” (what we scientifically refer to as eutrophication) of the marine environment is one of the greatest threats. The Baltic Sea has long shown the symptoms that are characteristic of eutrophication. Measurements show that hypoxia situations have occurred for several hundred years. Although oxygen deficiencies in bottom-waters of the Baltic Sea have occurred naturally from time to time, the frequency and size of deficiency-events has increased since 1950. Many lakes and rivers are heavily fertilized. About 800 of the 60,000 lakes in Sweden are deemed to be fertilized, about 50 of these heavily fertilized. General contamination of waterways was a bigger problem than it is today but is nonetheless included here as such pollution that has been monitored for decades.

The *cause* of eutrophication stems from excessive levels of nutrients such as phosphorus and nitrogen in the soil or water. The sources of emissions of these substances are mainly agricultural and urban areas (Figures 19, 20, 21, 22). The availability of nutrients, such as phosphorus and nitrogen, is often the limiting factor for growth in the aquatic environment; small amounts generally resulting in restricted growth and clear water, too much leading to drastic overgrowth (algal blooms).

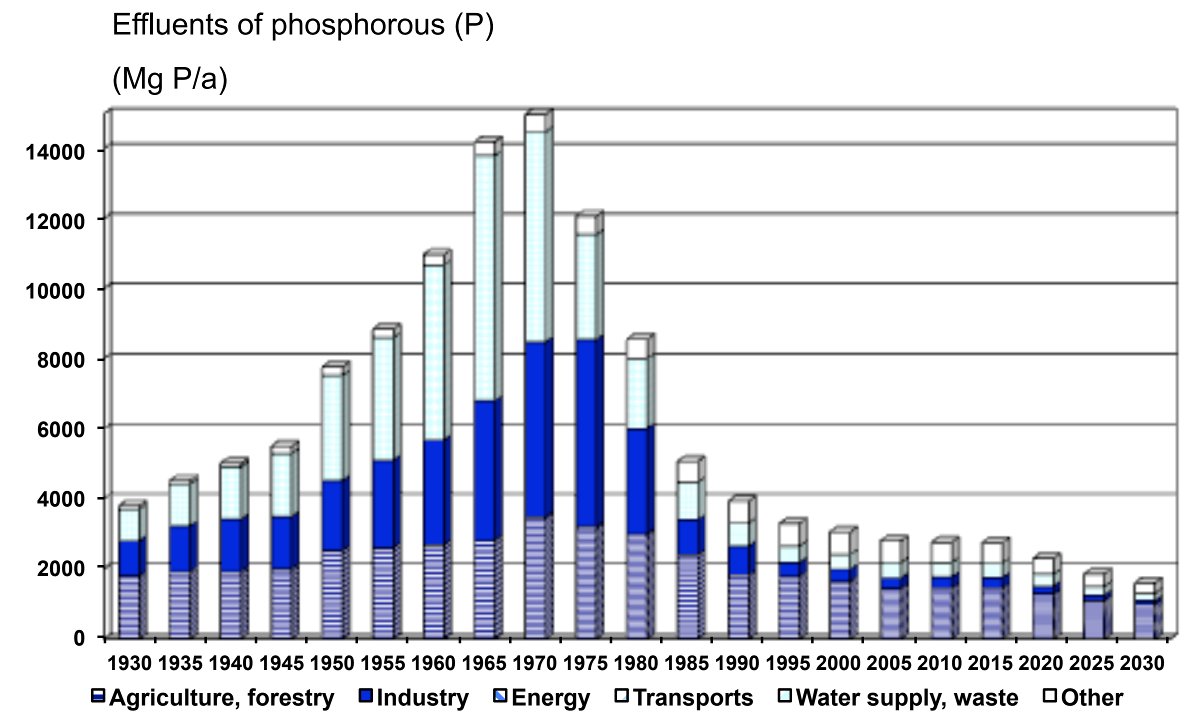
Actions taken to limit the problem generally include one or more of the following; Purification (removal) of phosphorus in sewage treatment plants, a ban on phosphates in detergents, better dissemination methodologies in agriculture, reduced fertilizer-use and wastewater discharges from industry, and fertilizer taxes (1984, 1994).

Environmental policy has focused on several international conventions including the Helsinki Convention, HELCOM, which regulates member countries' commitments. In this, member countries have agreed on an action plan for the Baltic Sea, the Baltic Sea Action Plan. The objective of this plan is for the Baltic Sea to reach good ecological status by 2021.

Nature's response has been mixed to action already taken. Water quality in Sweden’s largest lake, Vänern, deteriorated throughout the 1900s until around 1970 when the trend reversed (Figure 23). In contrast, no improvement has been noted for the Baltic Sea with regard to eutrophication. Heavy algal blooms frequently occur in the Baltic Sea, especially in summer when it is hot, sunny and still, and high pressure dominates.

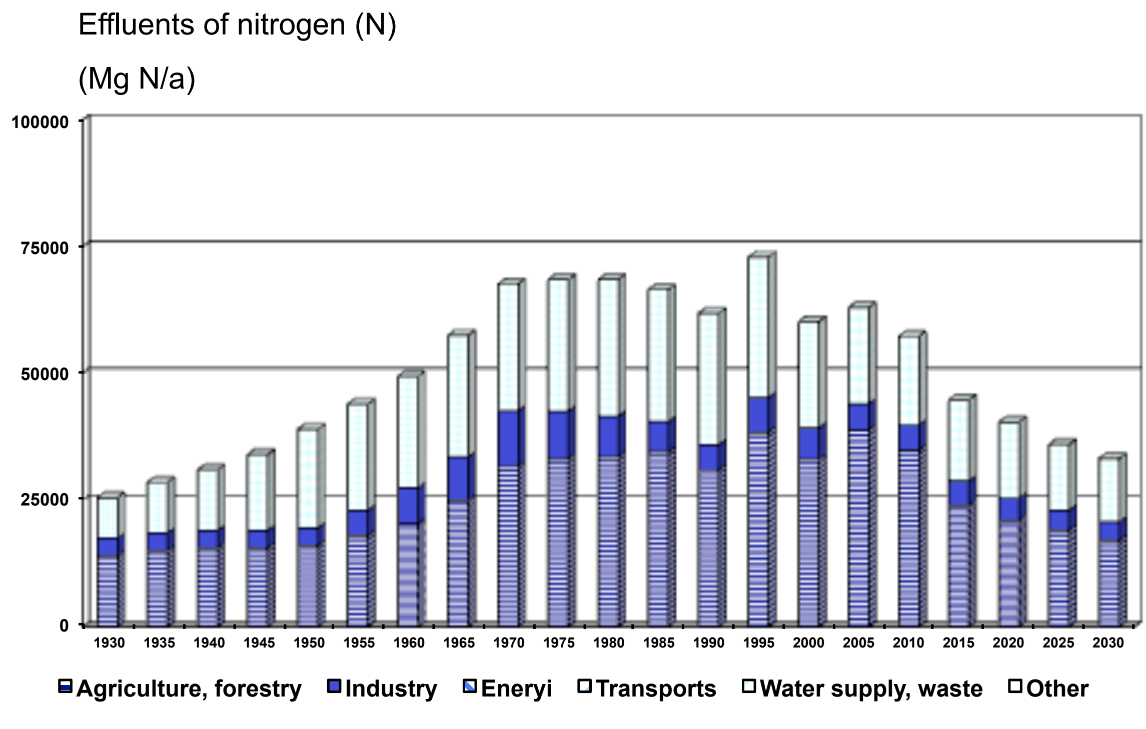
As a concluding *comment* it should be mentioned that eutrophication of lakes is also to an extent a natural phenomenon. Emissions of nutrients, such as phosphorus and nitrogen, to lakes and seas have however led to an acceleration of this process. The reductions achieved so far are, therefore, not sufficient for allowing our waterways to recover.

The degree of eutrophication of the Baltic Sea has also accelerated, so much so that oxygen deficiency occurs, unnaturally, more often in the bottom waters. This results in even more nutrients being released from bottom-sediments into the water column, creating a self-perpetuating "vicious circle" of over-fertilisation (Figure 24).



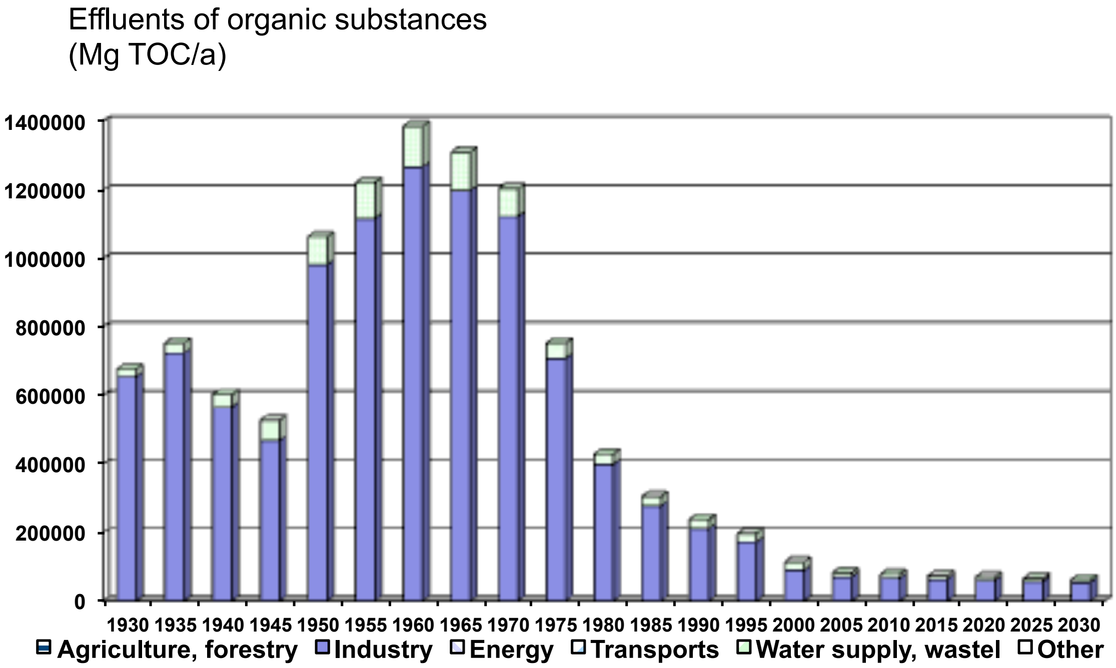
Sources: Richard Almgren (2012), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: 1930-1945 Egenberäkning efter vattenanvändning; Naturvårdsverket, 2006 (5587); Svenskt Vatten, 2005; 1950-1990 Naturvårdsverket, 1993 (4134, 4234); Naturvårdsverket, 2004 (5364); Naturvårdsverket, 2006 (5587); Svenskt Vatten, 2005; 1995-2010 Naturvårdsverket, 2004 (5364); Naturvårdsverket, 2006 (5587); Svenskt Vatten, 2005; SMED 7/2007; 2015-2030 Egen tolkning av Miljömålsrådet, 2008;

Figure 19: Effluents of nutrients (P) to water bodies in Sweden 1930-2030



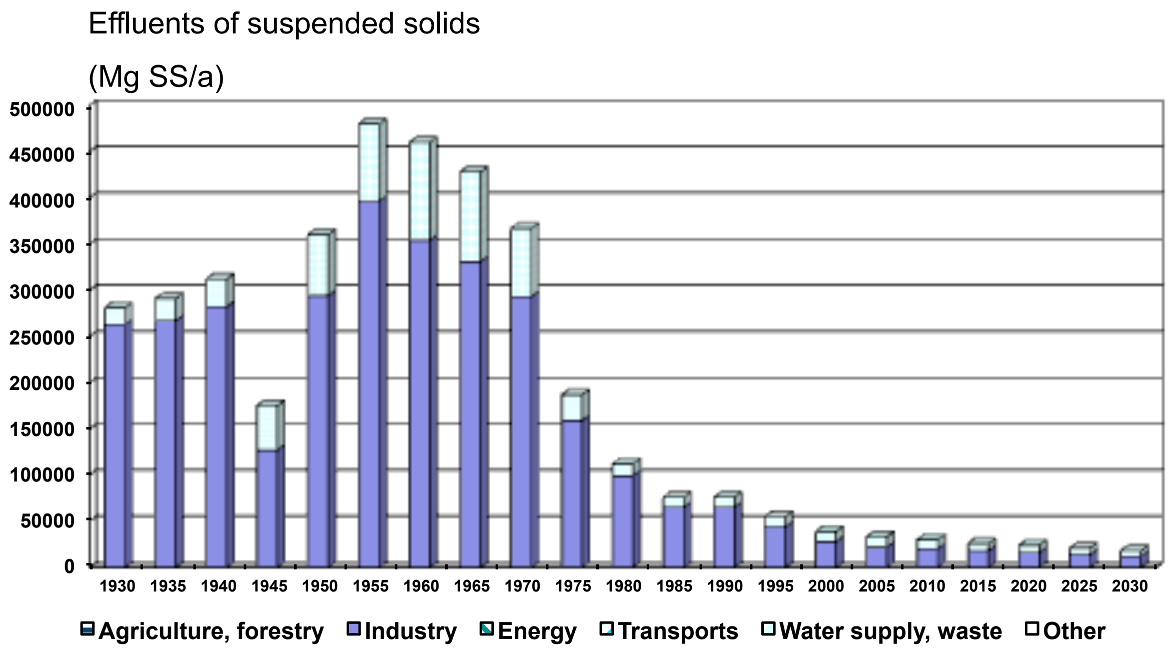
Sources: Richard Almgren (2012), Vår miljö 1930-2030, med bearbetning av följande källor: 1930-2005 SOU 1974:35; Naturvårdsverket, 1984 (1862); Naturvårdsverket 1993 (4134); Naturvårdsverket 2004 (5364); Naturvårdsverket 2006 (5587); Naturvårdsverket 2008 (5815); Svenskt Vatten, 2005; SMED7/2007; SCB, 2007; Monitor 21; 2010-2030 Egen tolkning av Miljömålsrådet, 2008;

Figure 20: Effluents of nutrients (N) to water bodies in Sweden 1930-2030



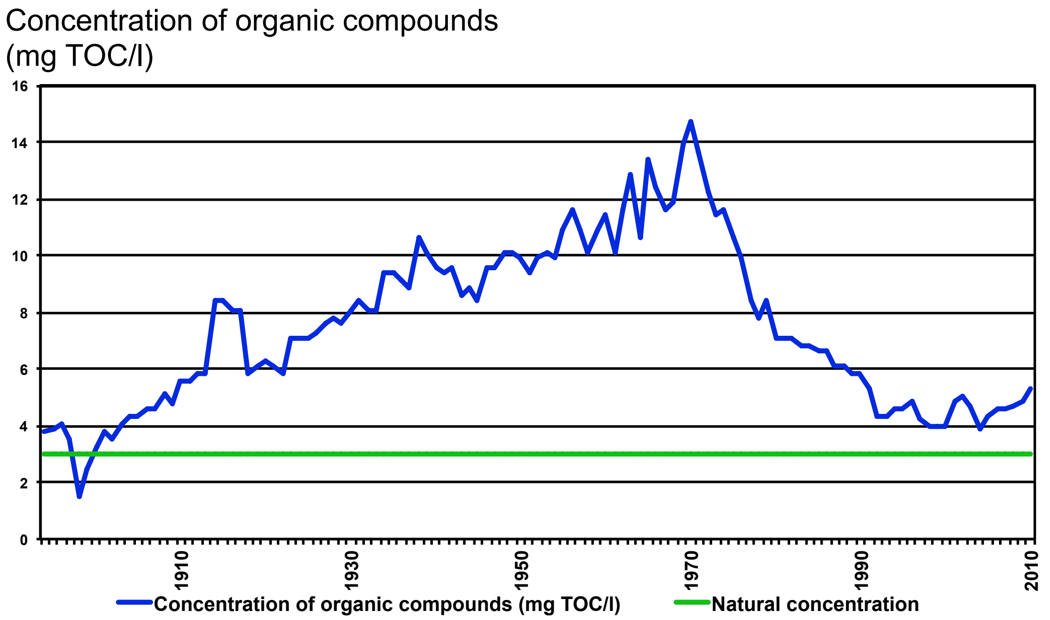
Källor: Richard Almgren (2009), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: 1930-1935 Lindmark, 1998; Svenskt Vatten (extrapolerat från 1940 med uppgift om vattenanvändning i tätorter); 1940-1990 Lindmark,1998; Svenskt Vatten, Naturvårdsverket, 1993 (4234); SOU1967:43; Facht, 1976; SOU 1975:98 1995-2005 Svenskt Vatten, Naturvårdsverket, 1993 (4234); Skogsindustrierna; (1 COD=2,7 TOC; 1 TOC=1,5 BOD; 1 COD=4 BOD); 2010-2030 Bedömning baserad på målet för reduktion av P till 2016 och samma takt därefter

Figure 21: Effluents of organic compounds (TOC) to water bodies in Sweden 1930-2030



Källor: Richard Almgren (2009), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: 1930-2005 Skogsindustrierna, Jernkontoret; Naturvårdsverket; Facht, 1976; SOU 1975:98; VA: Egen beräkning, baserad på tätortbefolkning, anslutning och reningskapacitet resp år; 2010-2030

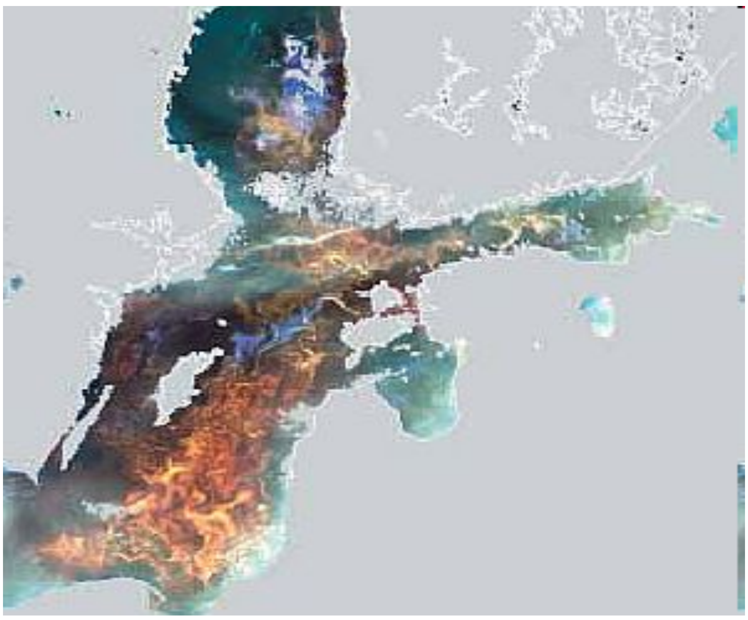
Figure 22: Effluents of suspended solids (SS) to water bodies in Sweden 1930-2030



NOTE: The measurements have been made in accordance with the KMnO4-metthod 1894-1999, thereafter the TOC-method. The early data has been recalculated with a factor, 1 KMnO4=3,95 TOC

Sources: Göteborgs VA-verk, Nationella miljöövervakningen i Vänern

Figure 23: Water quality in the lake Vänern 1896-2005



Source: SYKE, Finland

Figure 24: Algae bloom in the Baltic

Eco-toxicity

The *problem of ecotoxicity*, essentially the depletion of flora and fauna, is caused through a combination of the other environmental issues already discussed. This section focuses therefore more specifically on the impact of chemical products due to its inherent properties. The nature of the problem will be addressed by using a few examples, being aware that it is only a question of a few examples.

Organic substances form the building blocks of all life. There are also some organic compounds however, especially those which humans have learnt to produce, which pose a risk to all living things even at low levels. Of greatest detriment is that such substances are persistent, have the ability to accumulate, are carcinogenic, affecting our genomes and fertility (toxic). POPs, such as PCBs and DDT, are examples of substances of this kind. The American author Rachel Carson first drew attention to the issue of pesticides like DDT, those containing mercury and other substances in her book Silent Spring (1962). None of the pesticides that Carson mentioned in this book are longer in use in Sweden (Figures 25, 26, 27, 28).

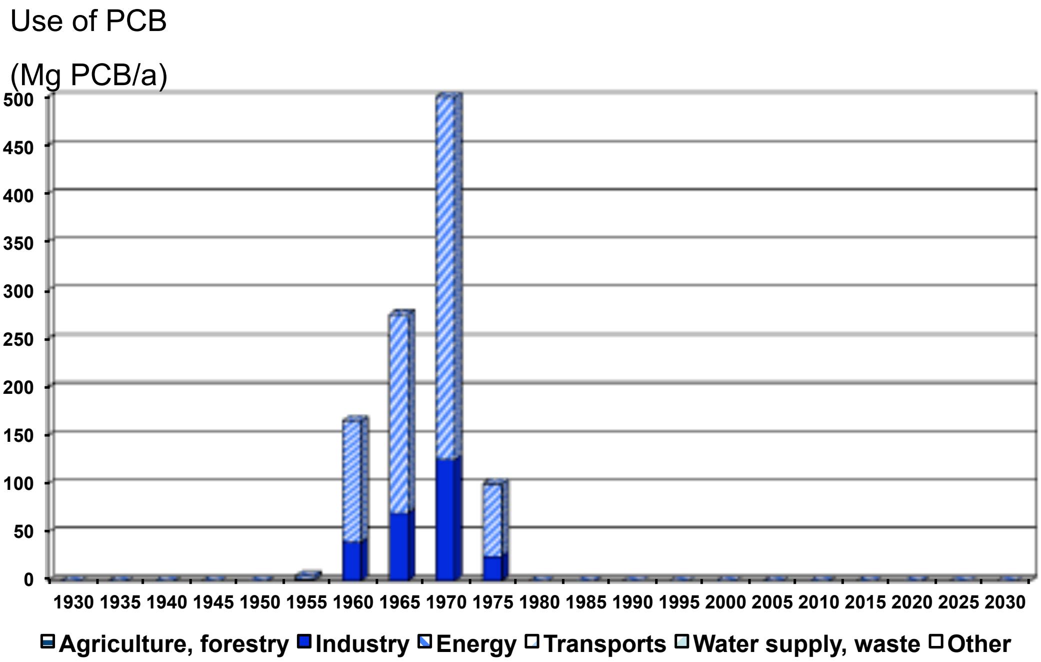
Metals have many good qualities and are therefore used in many applications. They are elements and thus do not break down. In industrial applications that is a good feature. In nature however this allows their accumulation in living organisms with the result that the levels increase further up the food chain. Several metals also have toxic properties.

The *cause* of the problem of eco-toxicity occurs when chemical products are produced, used and finally disposed of, and the chemical substances enter into the environment. Substances used only in industrial processes, and never intended to be disseminated in the environment, are nonetheless often found in nature (Figures 29, 30, 31, 32).

Actions taken to-date have focused on individual chemicals. The use of PCBs was severely restricted in 1971 and was banned in 1994, from existing products as well. The use in new products has long been banned in Sweden and much of the rest of the world. The use of DDT was banned in Sweden 1974. The EU chemicals legislation, REACH, is expected to address many of our current deficiencies in knowledge about chemicals. Furthermore, safety, in the field of major accidents involving the kind of substances mentioned above, has been strengthened considerably.

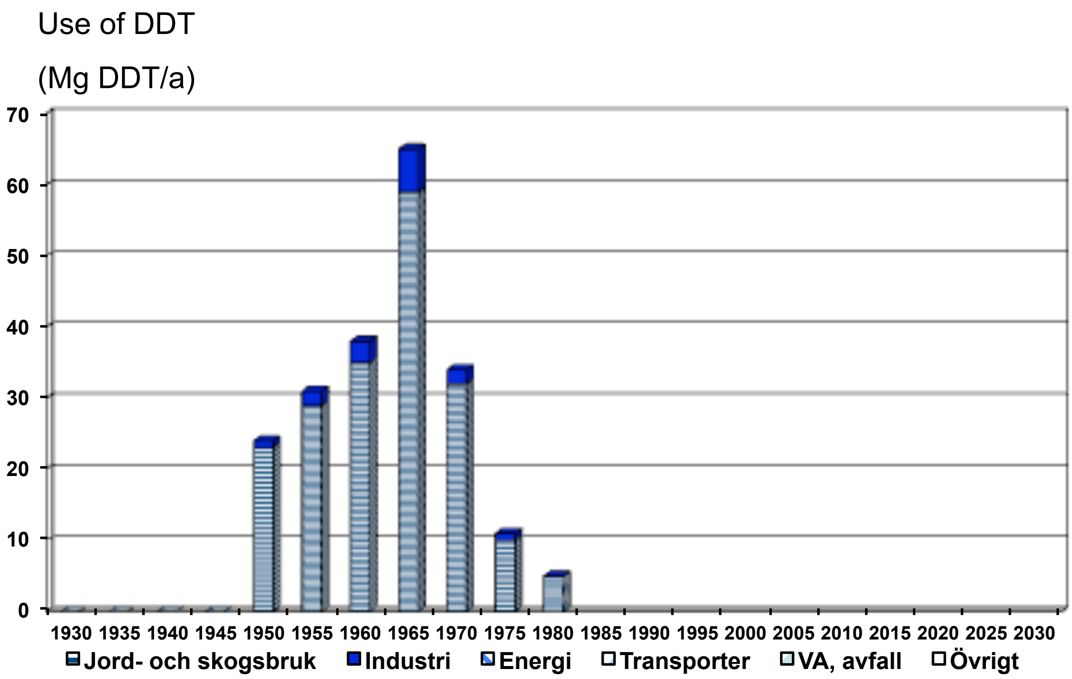
Environmental policy exists in the form of a global convention, the Stockholm Convention on Persistent Organic Pollutants ("the POPs Convention"). Work is focused on taking the first steps needed to remove the most dangerous substances (including DDT and PCBs) from the environment. Within the framework of the EU, several other directives address the topic from different perspectives, including the EU chemicals legislation, REACH, the RoHS and the WEEE Directives. The three metals mercury, lead and cadmium are given priority in several international protocols, including the one to the Convention on Long Range Transport of Air Pollution (CLRTAP).

Nature's response to the measures taken has been positive. The concentrations of organic pollutants such as PCBs in herring in the Baltic Sea have fallen over a number of years. Pollution by metals is decreasing. Measures to restrict the dissemination of particular metals in Sweden have given positive results. That has been made clear by systematic measurements of metal concentration in moss since early 1970s. Moss is a plant that takes up falling metals from the atmosphere and therefore is a useful indicator of metal deposition. It is the metal content in the upper layers that are accessible to the biological processes in nature. This does not mean that the metals are gone - they still exist in the deeper layers as kind of archaeological specimens from the 1900s (Figures 33, 34, 35, 36).



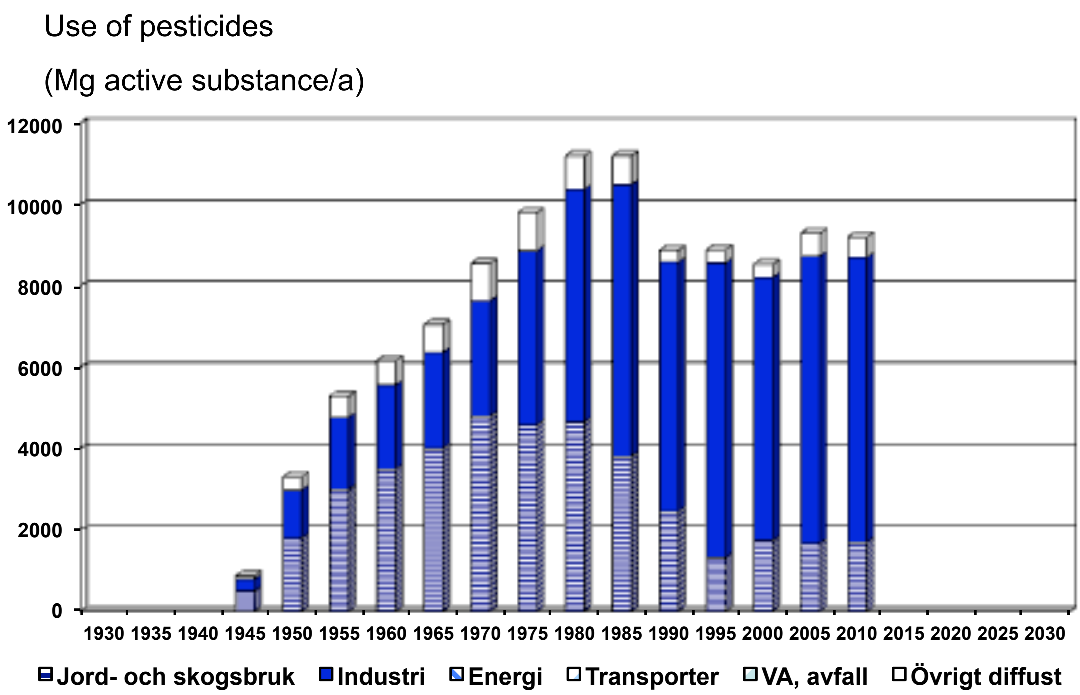
Sources: Richard Almgren (2012), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: KemI, 2007; Lika stor andel av användningen beräknas ha exporterats som importerats i färdiga produkter

Figure 25: The use of PCB in Sweden 1930-2030



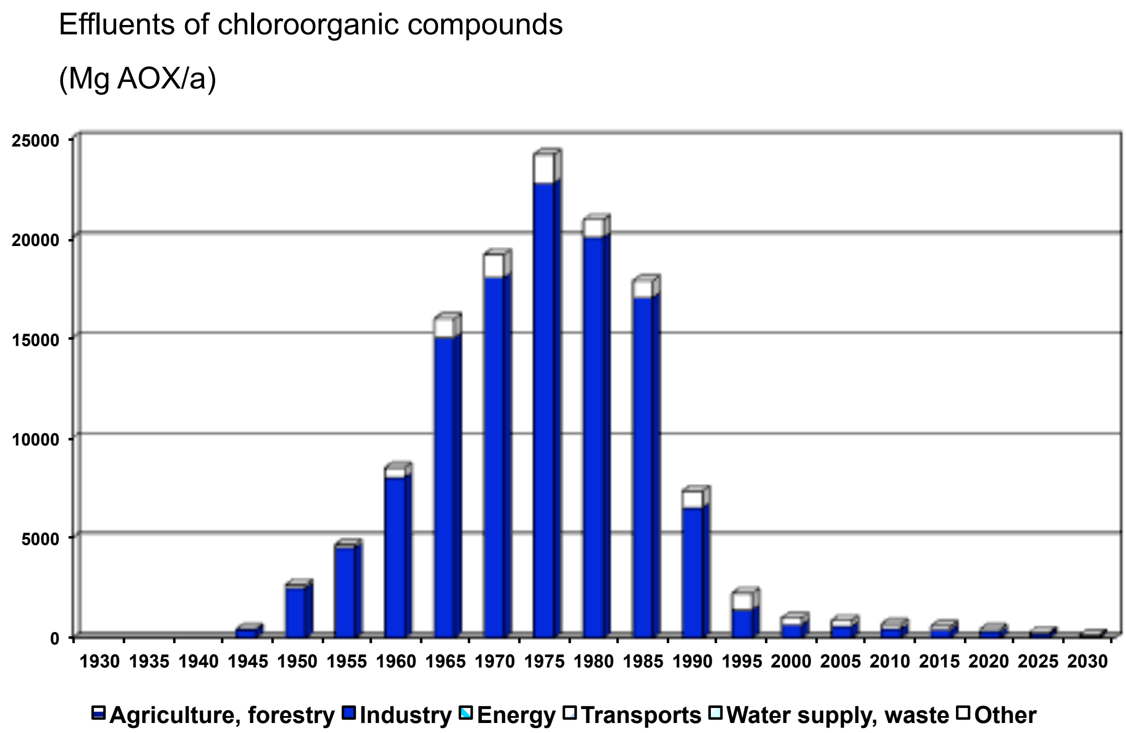
Sources: Richard Almgren (2012), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: SOU1967:43; SOU 1972:31; Skogsstyrelsen statistik 1969-1980

Figure 26: The use of DDT in Sweden 1930-2030



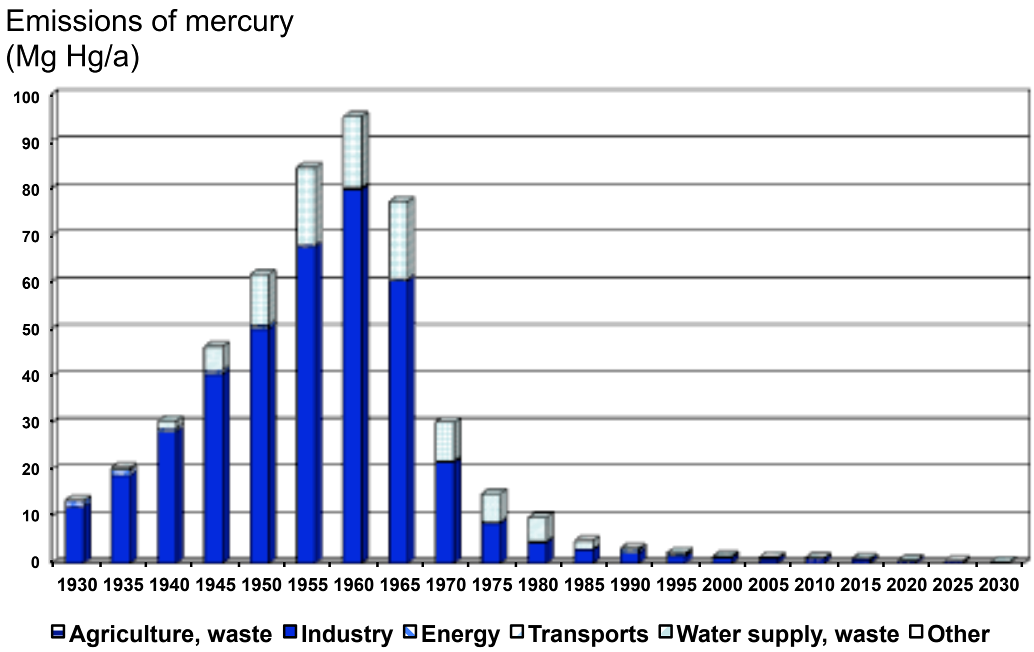
Sources: Richard Almgren (2012), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: 1945-1975: Lindmark, 1998; 1980-2010: KemI

Figure 27: The use of pesticides in Sweden 1945-2010



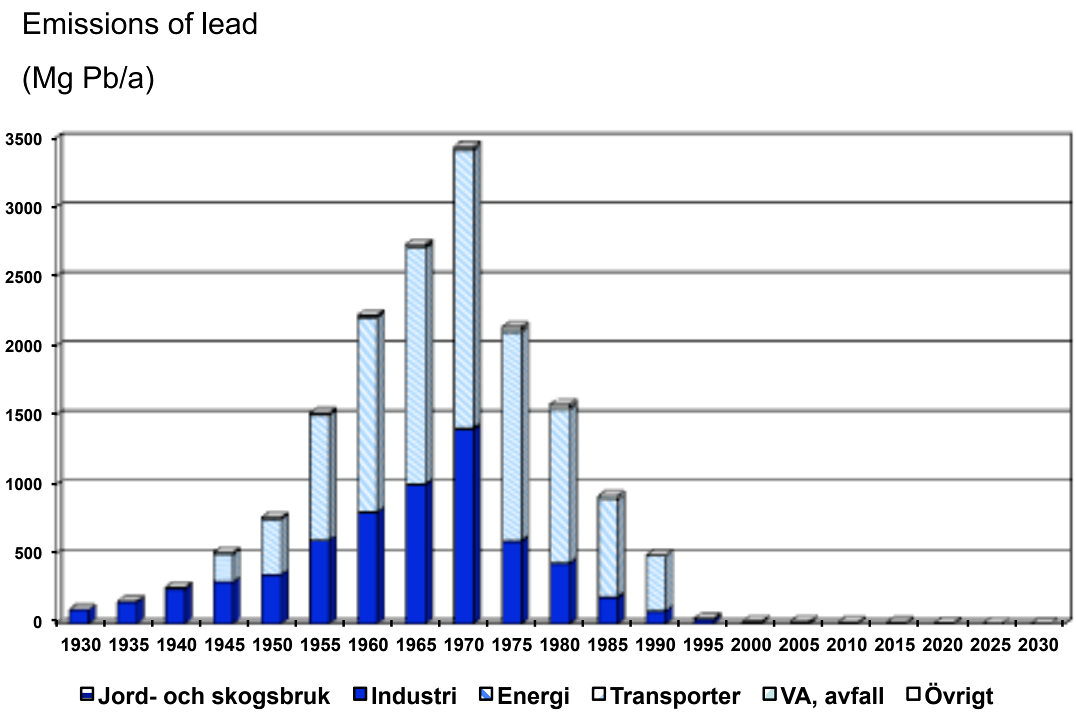
Sources: Richard Almgren (2012) Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: 1945-1970 Egenberäkning baserad på massatillverkning och utsläpp per ton massa (10 kg AOX/ton massa); Naturvårdsverket , 1998 (Monitor); 1975-1990 Naturvårdsverket, 1993, 1995 (4206, 4234); 1995-2010: Skogsindustrierna; 2010-2030 Bedömning baserad på att utsläpp av POPs förväntas vara utfasade under de närmaste decennierna, ofullständigt

Figure 28: Effluents of chloroorganic compounds in Sweden 1930-2030



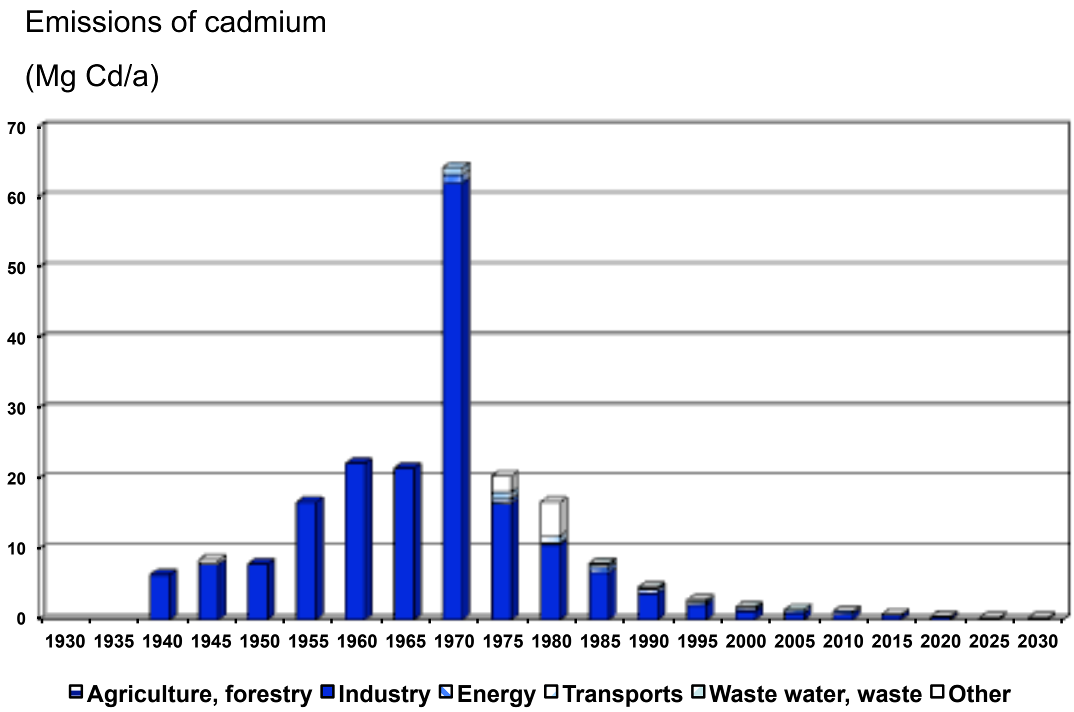
Sources: Richard Almgren (2012), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: 1930-1975 Levander, 1989; Lindqvist, 1991;Naturvårdsverket, 1973 (421), 1984 (Monitor); Bouveng, 1967; Naturvårdsverket, 1981 (1390); 1980-2005 Naturvårdsverket, 1993 (4139), 1987 (Monitor), 1993 (4234), 2005 (Monitor); Levander, 1989; CLRTAP, 2009, 2012; SMED 7/04; 2010-2030 Bedömning baserad på att metallutsläpp förväntas vara utfasade inom de närmaste decennierna

Figure 29: Emissions and effluents of mercury in Sweden 1930-2030



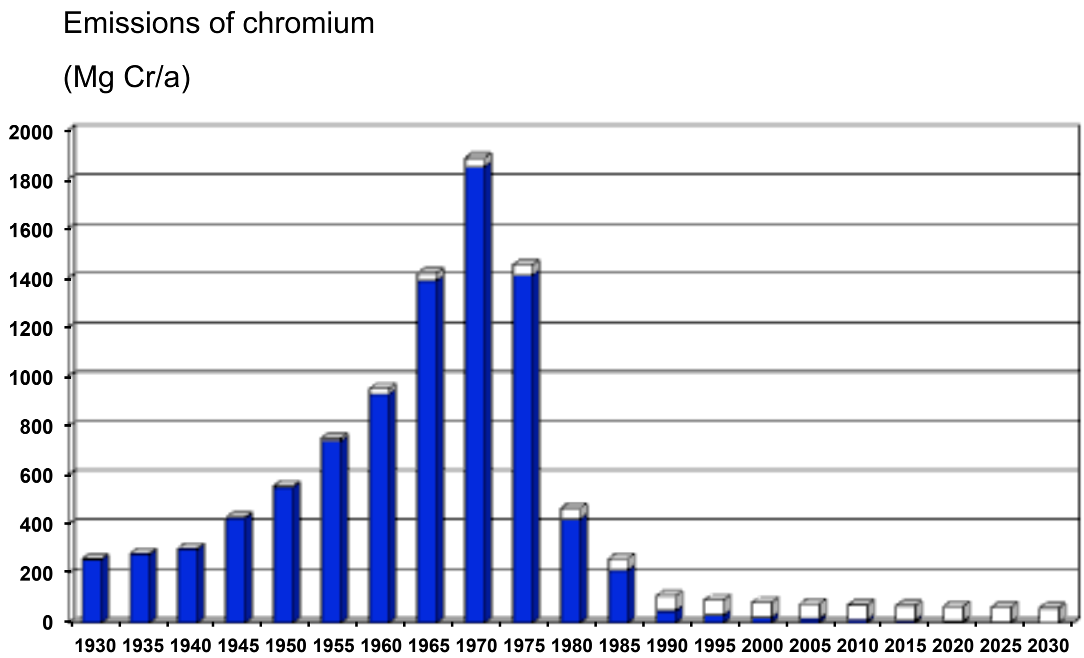
Sources: Richard Almgren (2012), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: 1930-1995 Bergbäck, 1992; Boliden; Naturvårdsverket, 1984 (Monitor); 2000-2005 Kemikalieutsläppsregistret; CLRTAP, 2009, 2012; 2010-2030 Bedömning baserad på att metallutsläpp förväntas vara utfasade inom de närmaste decennierna

Figure 30: Emissions and effluents of lead in Sweden 1930-2030



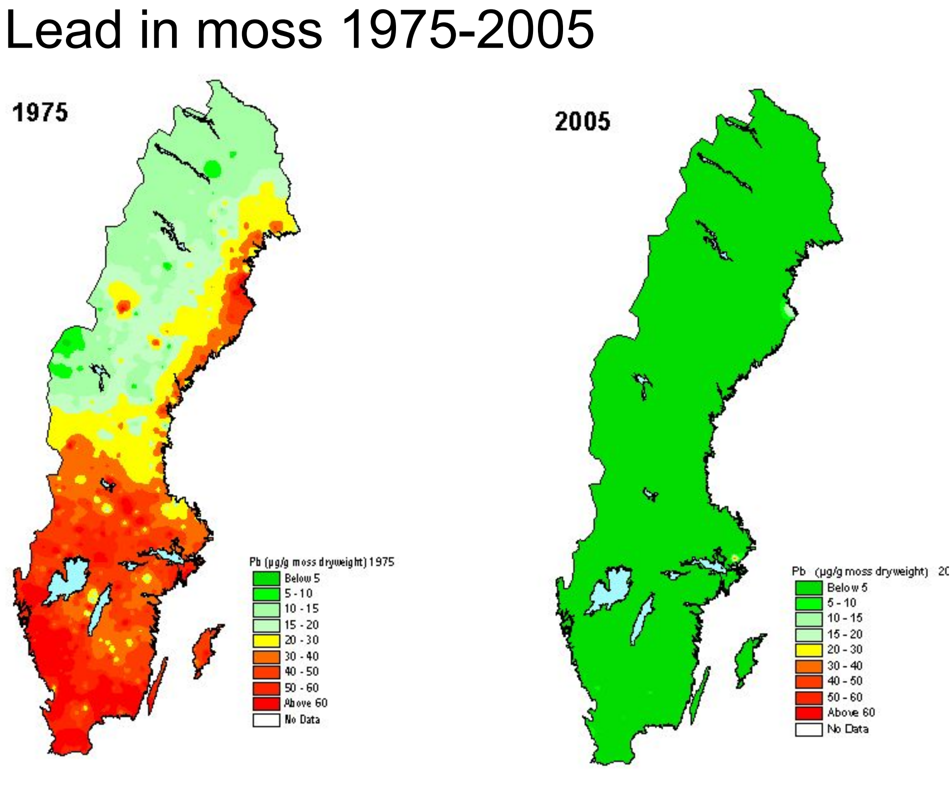
Sources: Richard Almgren (2012), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: 1930-1985 Bergbäck, 1994; Naturvårdsverket, 1987 (Monitor), 2005 (Monitor), 1976, 1884 (Monitor); 1990-2005 CLRTAP, 2009, 2011; Bergbäck, 1994; Naturvårdsverket, 1993; Naturvårdsverkets webbplats; SMED 7/04; 2010-2030 Bedömning baserad på att metallutsläpp förväntas vara utfasade inom de närmaste decennierna

Figure 31: Emissions and effluents of cadmium in Sweden 1930-2030



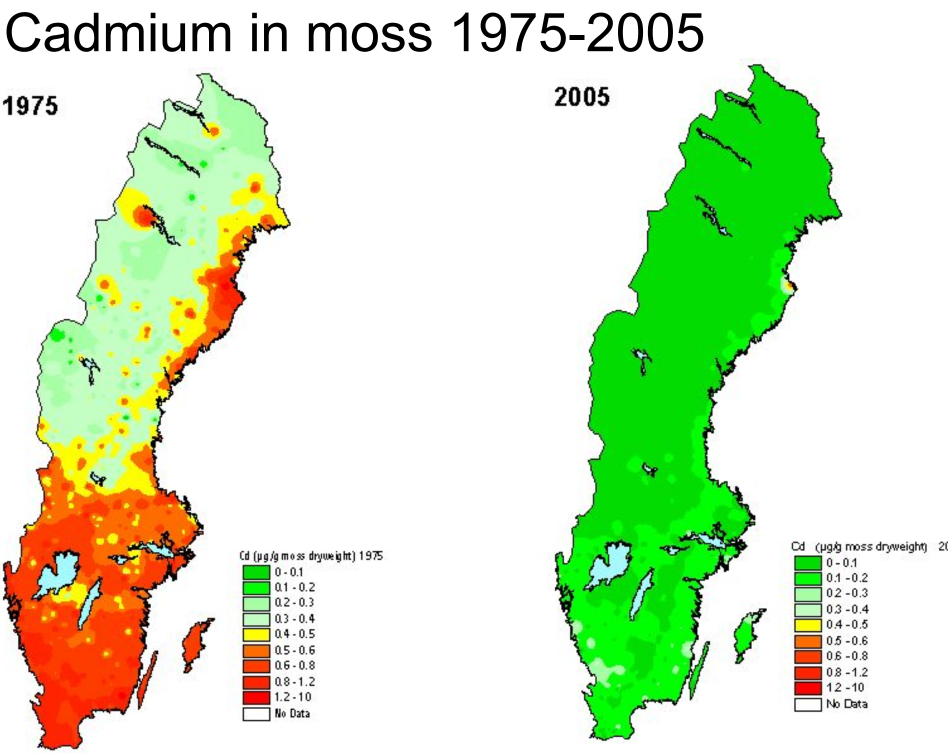
Sources: Richard Almgren (2012), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor: 1930-1965 Anderberg, 1989; Egen beräkning av diffus spridning enligt antal fordon från nivån 2005; 1970-1975 Naturvårdsverket, 1987 (Monitor); Anderberg,1989; Egen beräkning av diffus spridning enligt antal fordon från nivån 2005; 1980-2005 CLRTAP, 2009, 2012; Naturvårdsverket, 1993 (4234); Anderberg, 1989; Egen beräkning av diffus spridning enligt antal fordon från nivån 2005; SMED7/04; KUR; SCB, 2002; 2010-2030 Bedömning baserad på att metallutsläpp förväntas vara utfasade inom de närmaste decennierna

Figure 32: Emissions and effluents of chromium in Sweden 1930-2030



Source: IVL Svenska Miljöinstitutet

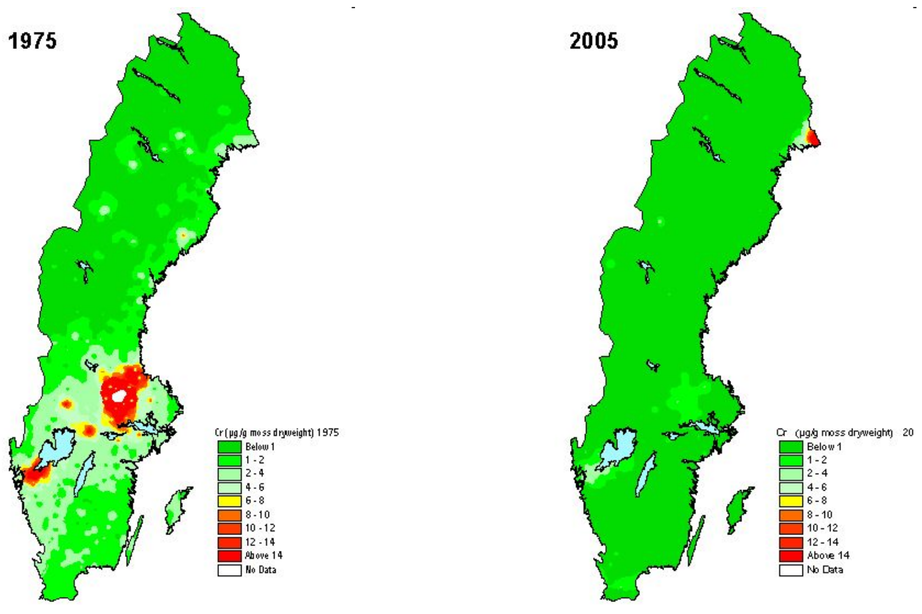
Figure 33: Concentrations of lead in moss in Sweden 1975-2005



Source: IVL Svenska Miljöinstitutet

Figure 34: Concentrations of cadmium in moss in Sweden 1975-2005

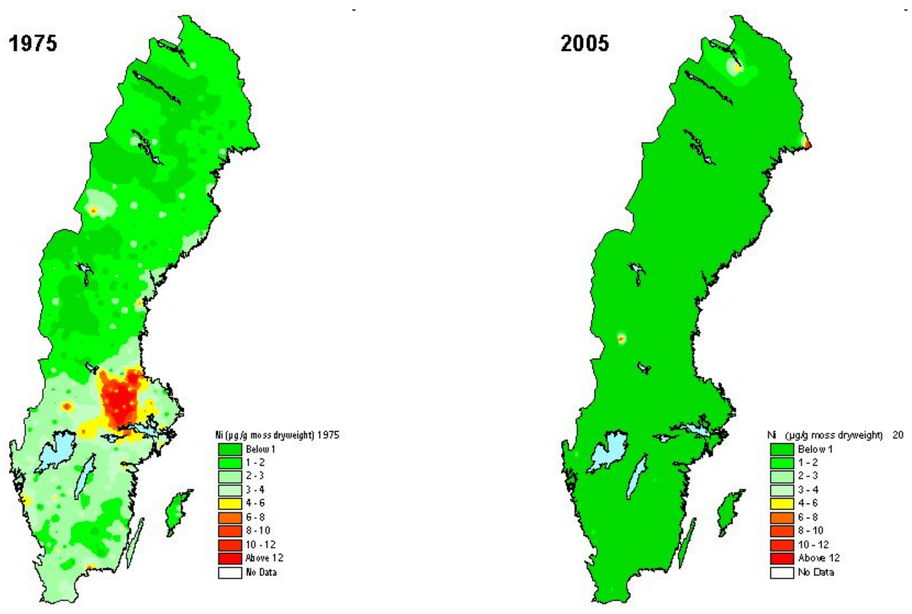
Chromium in moss 1975-2005



Source: IVL Svenska Miljöinstitutet

Figure 35: Concentrations of chromium in moss in Sweden 1975-2005

Nickel in moss 1975-2005



Source: IVL Svenska Miljöinstitutet

Figure 36: Concentrations of nickel in moss in Sweden 1975-2005

Concluding remarks

Initially we asked the question whether the environment is getting better or worse. As we have illustrated in this report the answer is yes, and no; better in some respects, worse in others. If we limit the question to how the environment has developed as a result of Swedish contributions, the answer is clear in all respects; it is getting better!

Remaining environmental aspects can mainly be linked to activities such as the use of energy and products, transport and agriculture (Table 1).

During the first period (1930-1970) defined in this report, Sweden's economical development (measured by GDP) was closely linked to the resulting environmental pressure (as measured by the Environmental Load Unit, ELU, under the EPS system). A clear break in this trend occurred from this point in time. Economical development has continued to improve. In contrast, the resulting environmental pressure from Swedish sources has reduced to about one-fifth of the values in 1970 (Figure 37).

If we expand the question to consider the impacts on the environment in Sweden, the answer is more complicated; the Swedish environment is largely influenced by events and activities in other countries. Pollution knows no borders and is transported over long distances by wind and sea currents.

To improve environmental policies the following three recommendations are put forward:

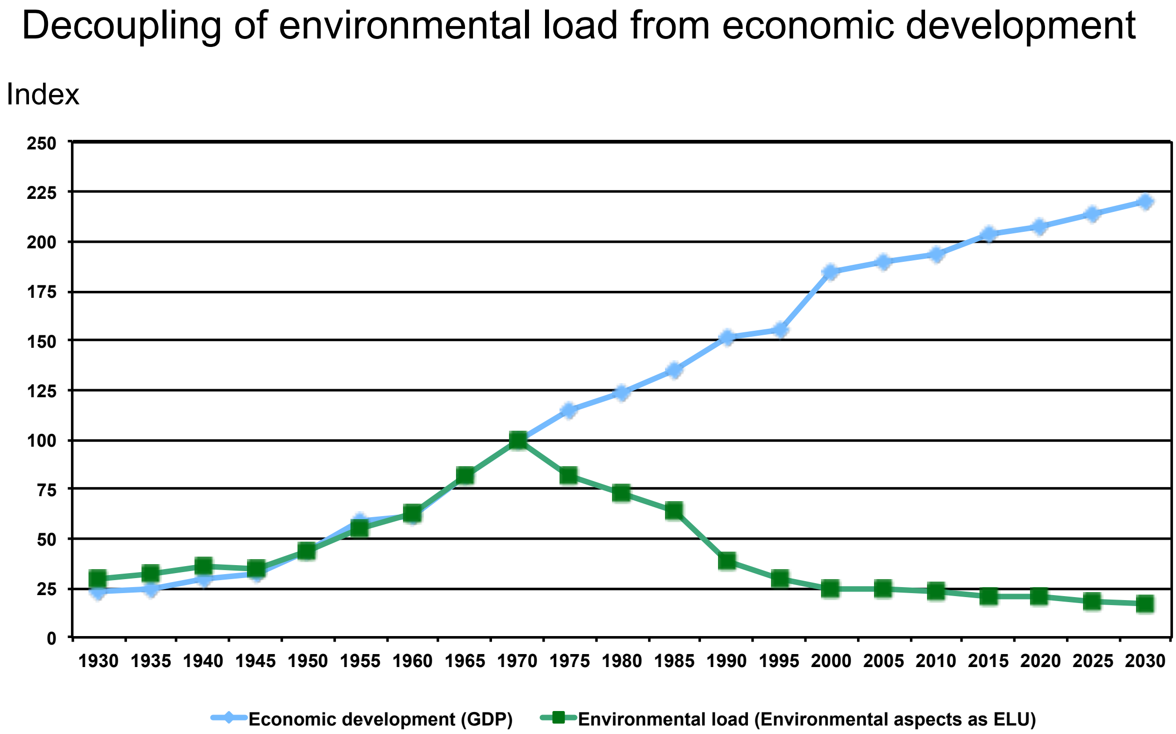
- Give priority to international cooperation
- Review the nature of Swedish policy instruments with regard to the new environmental agenda
- Facilitate the business community in taking care of its own environmental issues in a structured way, for example by supporting the voluntary implementation of environmental management systems in line with ISO 14001 or EMAS, standards which assist companies in prioritising actions

Figure 13: Decoupling of environmental aspects from economic development

Table 1: Reductions of pollutants in Sweden 1970-2010

Environmental impact **Indicator**	**Reduction of environmental aspect (%)** **More than 20%**	 **More than 50%**	 **More than 80%**	 **More than 95%**	 **More than 99%**	**Swedish influence on environmental impact in Sweden (percent)**
Climate change						
GHGs excl methane och nitrous oxides	Yes	Yes	No	No	No	0,15
Depletion of the ozone layer						
Ozone affecting substances	Yes	Yes	Yes	Yes	Yes	0,5
Acidification						
Acid gases (SOx)	Yes	Yes	Yes	Yes	No	8
Acid gases (NOx)	Yes	Yes	No	No	No	10 (ox), 27(red)
Human toxicity						
Particles (TSP)	Yes	Yes	Yes	No	No	10
Toxic substances (nmVOC)	Yes	Yes	No	No	No	..
Toxic substances (CO)	Yes	Yes	Yes	No	No	..
Toxic substances (PAH)	Yes	Yes	Yes	No	No	42[1]
Eutrophication						
Organic substances (TOC)	Yes	Yes	Yes	No	No	..
Suspended solids (susp)	Yes	Yes	Yes	No	No	..
Nutrients (P)	Yes	Yes	Yes	No	No	10[2]
Nutrients (N)	Yes	No	No	No	No	12[2]
Eco-toxicity						
POPs						
Chlororganic substances (AOX)	Yes	Yes	Yes	Yes	No	..
Pesticides (Active substance in agriculture)	Yes	Yes	No	No	No	..
DDT	Yes	Yes	Yes	Yes	Yes	..
PCB	Yes	Yes	Yes	Yes	Yes	..
Dioxines	Yes	Yes	Yes	No	No	13
Metals						
Mercury (Hg)	Yes	Yes	Yes	Yes	Yes	..
Lead (Pb)	Yes	Yes	Yes	Yes	Yes	10
Cadmium (Cd)	Yes	Yes	Yes	Yes	Yes	..
Chromium (Cr)	Yes	Yes	Yes	Yes	Yes	..
Copper (Cu)	Yes	Yes	Yes	Yes	No	..
Arsenic (As)	Yes	Yes	Yes	Yes	Yes	..
Zinc (Zn)	Yes	Yes	Yes	Yes	No	..
Nickel (Ni)	Yes	Yes	Yes	Yes	No	..

[1]Refers to Bens(a)pyrén
[2]Refers to the Baltic Sea



Sources: Richard Almgren (2012), Vår miljö 1930-2030, Svenskt Näringsliv, med bearbetning av följande källor:
BNP 1930-1950: Lund University Macroeconomic and Demografic Database; 1955-2005: SCB; 2005-2030: LU08
Miljöbelastning: EPS 2000, Steen, 1999 (Miljöaspekter enligt Kyoto-protokollet, Montreal-protokollet och IPPC-direktivet)
NOTE: Index 100 has been fixed for 1970 considering the uncertain data for the years 1930-1970

Figure 37: Decoupling of environmental load from economic development

References

This is a shortened version of a more complete report available at the following web-site: www.svensktnaringsliv.se or www.swedishenterprise.se

The original report includes a full list of references.

Back-side of the cover:

Is the environment getting better or worse? It is certainly an urgent question we ask ourselves after all the conflicting reports in recent years. The complete answer will not be delivered in this report. However, the reader will get a brief overview of six key environmental areas. The answer is highly complex, because the Swedish environment is heavily influenced by activities in other countries. The focus of this report is on the extent to which Sweden pollutes the environment. The purpose of this report is to provide perspective on major environmental issues. The report can also be seen as a contribution to the larger discussion on finding the necessary international solutions.