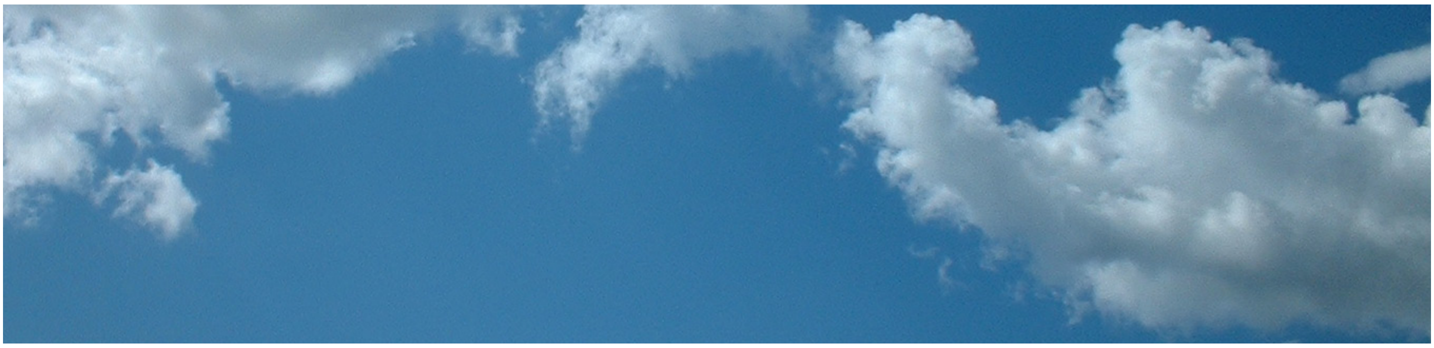
Annual Report and Accounts

2011



NILU's Research

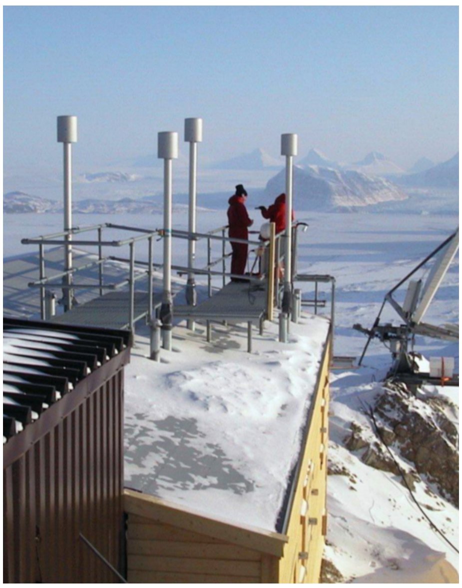
Through its research NILU increases the understanding of processes and effects of climate change, of the composition of the atmosphere, of air quality and of hazardous substances.

Based on its research, NILU markets integrated services and products within the analytical, monitoring and consulting sectors. NILU is concerned with increasing public awareness about climate change and environmental pollution.

NILU's 197 researchers, technicians and other experts are primarily commissioned by the Research Council of Norway and by Norwegian and international industry and government agencies. The institute takes an active part in the EU's research programs.

NILU holds a strong position both on the national and international level within its core fields. NILU's laboratories are among the most advanced in Europe. Also, the institute's observatories in the Arctic, in Antarctica and in Norway provide important information on global changes of the atmosphere and on long range transport of environmental pollutants.

NILU's Zeppelin Observatory at Svalbard.



NILU's topics

- Atmospheric composition GHG and climate-forcing agents
- Ozone-layer depletion and UV radiation
- Long-range transport of air pollution
- Urban and industrial pollution
- Aerosol and particulate matter
- Chemicals and their environmental effects
- Health-effect studies
- Ecology and economics

Annual Report 2011

The nature and location of the operation

The Norwegian Institute for Air Research (NILU) carries out research within the following main areas; air quality, climate, pollutants, and ecological economy. NILU also has a key role within monitoring and development of environmental technology, being engaged in considerable activity relating to monitoring of climate drivers both nationally and internationally. The institute is an environmental advisor to Norwegian and international authorities, and attaches great importance to publishing research in internationally renowned journals. We are also committed to informing about research in society at large.

NILU's activities are operated from its own business building at Kjeller in Skedsmo municipality. The institute also has a regional office in Tromsø, offices at CIENS, Oslo, and a branch in the United Arab Emirate, Abu Dhabi.

National earnings constituted 66 % and international earnings 34 % of revenue in 2011. The basic grant from the Norway's Research Council represents around 12 % of the institute's trade, of which around 22 % was earmarked strategic institute programs (SIS). NILU receives economic support from the Ministry of the Environment (MD) to perform national tasks as an advisory research institute to the government. NILU is certified according to ISO 9001, the quality standard, ISO 14001, the environmental standard, and is accredited under ISO 17025 to perform measurements of pollution, meteorological parameters and advanced chemical analyses.

Key tasks in 2011

Research linked to climate-related issues of concern is central to NILU. Next to carbon dioxide, methane is the prime contributor to man-made global warming. This gas has both man-made and natural emission sources. Measurements made by NILU at the Zeppelin observatory at Ny-Ålesund have identified a constant increase in methane concentrations over the last five years. This coincides with methane increases measured at other stations in the Arctic, as well as global measurements. Isotope measurements of methane at Zeppelin, conducted in cooperation with Royal Holloway, University of London, show that emissions from arctic wetlands in Russia are a substantial source.

The results of NILU's ozone monitoring over many years show that depletion of the ozone layer in the stratosphere above Norway has declined and appears to be coming to a stop. At the same time, and in spite of this positive development, this winter record-low seasonal values of ozone in the stratosphere were measured. The causes of the record-low ozone values this winter are unclear. Scientists have for a number of years been pointing to a connection between ozone depletion in the spring and climatic change, as ozone depletion increases with lower temperatures. An increase in greenhouse gas concentrations results in elevated temperatures at the earth surface. However, as the outgoing radiation is reduced, the stratosphere will get colder and this may increase the depletion of the ozone layer. While cold winters in the arctic stratosphere were rare in the past, this now appears to be occurring more frequently, and winters are becoming increasingly colder. There is a complex link between climatic change and ozone which is not fully understood.

In 2011 NILU participated in a large geosciences evaluation conducted by an international expert committee commissioned by the Research Council. NILU's research group on atmospheric transport achieved the highest score. The committee considers the quality of Norwegian geosciences research in general to be good, and refers to a survey made by Thompson Reuters, in which Norway is ranked on top relative to the number of quotes in scientific publications. Among the evaluated research institutes NILU clearly stands out as one of the best research communities.

The Norwegian government's white paper on the northern areas underlines the importance of investing in research in these areas. NILU is committed to performing research in the north, and is planning an expansion of its activities here. The work relating to its flagship 'Miljøgifter og klimaendringer' (Pollutants and climatic changes), one of five flagships in the FRAM center, is important to NILU. We have also seen a breakthrough in pollutant related research, an effort which has led to the EU's scientific committee deciding to examine the use of parabenes in cosmetics.
NILU has also seen a breakthrough in the use of advanced models to trace sources and transport of pollutants. Another important result of our strategic modeling

program is the modeling study, which shows that emissions of radioactive material from Fukushima, Japan, started earlier, were of longer duration, and larger than previously assumed. These results have attracted considerable attentions, in particular in Asia.

The inferior quality of air in a number of Norwegian cities and towns is a persistent problem during the winter season. NILU has a key role in monitoring and providing accessible information relating to these challenges. It is important to combine the need for reducing levels of local air pollution with identifying effective measures in order to cut greenhouse gas emissions. Environmental certification of all cars and setting limits on use are essential measures on which NILU has provided advice.

A major part of NILU's activities are based on measurements and monitoring of the composition of the atmosphere. In 2011 we initiated preparations to move the Troll observatory to Trollhaugen just above the research station. There is an increasing activity on Troll and a re-location is indispensable in order to avoid pollution impact. Pollution levels in the Antarctic are very low, and local impacts must therefore be avoided in order to secure the valuable data series.

NILU prioritizes innovation, both through its subsidiary company NILU Innovation (NI), and by establishing its own branch dedicated to developing good ideas. NILU has a number of good innovations under development, and several of the companies under the NI umbrella show an interesting and positive development. A good example from one of our innovation companies; Nicarnica Aviation AS has test flown its ash detection camera on Sicily in the presence of a large press corps. CNN, BBC, Reuters, National Geographic and other international media were present and were able to report that Nicarnica Aviation will be supplying cameras to the British airline company easyJet, which is planning to equip 20 new Airbus A320 aircraft with ash detection cameras.

NILU plays a key role in a number of European initiatives relating to air pollution, participating amongst others in the thematic centre for air quality and measures against climatic change (ETC-ACM) under the EEA. NILU has since 1979 acted as secretariat and coordinator for "The EMEP Chemical Coordinating Centre" (EMEP-CCC). The main task is to coordinate the EMEP's measurement program, providing recommendation on the use of methods, quality assurance and training, in addition to data validation, reporting and acting as data host.

NILU has through many years had great success with its EU projects. In 2011 NILU was engaged in 37 active EU projects, of which 7 were launched in 2011. These projects are related to our core areas; atmospheric processes, climatic and environmental impacts, nano safety and earth observations.

Norway's EEA membership fees are in part earmarked for environmental research in which NILU takes an active part. In 2011 NILU participated in 10 projects under this program.

Continued operations

The assumptions of continued operations are present, and the accounts for 2011 are based on these assumptions.

The board of directors believes that the annual report and accounts provide a true picture of the company's assets and debt, financial position and result.

The prospects for continued operations are considered as satisfactory with basis in a significant order reserve at year's end, in addition to the direct economic support provided by the Basic grant, as well as reasonable expectations for winning new contracts in 2012.

Equal opportunities

NILU aims at a balanced composition of staff and the board of directors in terms of gender. The institute's guidelines, wage system etc. are gender neutral. Of the 197 employees 83 are women and 114 men; and 76 persons have a foreign background representing 28 nations. Management consists of 7 women and 8 men. The board of directors consists of 2 women and 5 men.

Working environment

The institute has procedures in place for HSE work, and audits of the system have been conducted in line with "Forskrift om internkontroll – helse, miljø og sikkerhet" (Regulation relating to internal control – health, environment and safety). NILU is an IA company.

No work accidents entailing absence were reported in 2011.

Total sickness absence rate in 2011 was 4.0 %. Absence is equally divided between short-term and long- term sickness absence.

Exterior environment

The operation does not pollute the exterior environment to any great extent. NILU has established strict rules for waste control. Source segregation for ordinary waste is being practiced, and all hazardous waste is delivered to approved disposal facilities.

Allocation of profit

Profit for the year at NOK 4 010 917 is allocated to other equity.

Kjeller, 16 April 2012

The Board of Directors of the Norwegian Institute for Air Research

Suzanne Lacasse
Chairman of the Board

Erik Solhjell
Deputy Chairman

Hans Aasen
Board member

Peringe Grennfeldt
Board member

Kim Holmén
Board member

Christina Guerreiro
Board member

Thor Ofstad
Board member

Kari Nygaard
General Manager

Income Statement

	Note	2011	2010
OPERATING REVENUE			
Project revenue	1	169 790 857	165 104 130
Basic grant	2	22 765 000	20 741 000
Other operating revenue		350 393	681 356
Operating revenue		**192 906 250**	**186 526 486**
OPERATING EXPENSES			
Wages and social expenses	3	-125 672 421	-120 127 642
Direct project expenses	1	-26 766 770	-29 068 379
Changes relating to ongoing projects	9	-1 230 520	902 804
Depreciation	4	-8 034 333	-7 093 443
Rent, lighting, heating etc.		-6 766 430	-7 552 821
Consumables, operation and maintenance		-14 881 024	-14 388 763
Other purchasing, sales and administration costs		-7 052 899	-5 924 859
Operating expenses		**-190 404 397**	**-183 253 104**
OPERATING PROFIT		**2 501 853**	**3 273 382**
FINANCIAL ITEMS			
Result on investments in subsidiary company	6	788 574	-330 870
Income from interest		716 520	374 342
Foreign exchange profit		2 161 223	1 633 187
Interest expenses	5	-457 094	-431 329
Foreign exchange losses		-1 662 580	-1 882 218
Net result financial items		**1 546 643**	**-636 888**
PROFIT BEFORE TAX	**4 048 496**	**2 636 494**	
Tax	7	-37 579	-1 803 311
PROFIT FOR THE YEAR		**4 010 917**	**833 183**
ALLOCATION OF PROFIT FOR THE YEAR			
Allocated to other equity	11	4 010 917	833 183

Balance sheet

ASSETS	Note	31.12.2011	31.12.2010
Fixed assets			
Intangible assets:			
Patents	4	420 405	0
Deferred tax		42 560 565	42 598 144
Total intangible assets		**42 560 565**	**42 598 144**
Tangible fixed assets:			
Business building, Kjeller	4	20 628 170	20 628 170
Construction facility	4	5 000 758	2 495 435
Birkenes observatory	4	2 360 706	2 754 420
Instruments	4	14 622 774	9 793 804
ICT equipment, software etc.	4	1 397 497	1 735 518
Furniture and fixtures	4	1 017 370	987 537
Vehicles	4	56 140	16 418
Total tangible fixed assets		**45 083 415**	**38 411 303**
Financial fixed assets:			
Net pension funds	12	0	1 428 452
Investments in subisidary	6	2 522 934	1 734 360
Loan to subsidiary	8	1 820 000	3 520 000
Inevstments in CIENS building, Oslo	6	5 175 409	5 158 909
Investments in shares	6	1 651 890	1 652 996
Deposits/various interests		75 450	93 844
Total financial fixed assets		11 245 683	**13 588 561**
Total fixed assets		**99 310 068**	**94 598 008**
Current assets			
Ongoing projects	9	14 981 325	16 211 845
Accounts receivable		15 637 939	16 939 311
Receivables from subsidiaries		4 887 468	552 102
Other short-term receivables		3 571 399	4 126 347
Bank deposits and cash	10	42 216 992	40 267 022
Total current assets		**81 295 123**	**78 096 627**
TOTAL ASSETS		**180 605 190**	**172 694 634**
EQUITY AND LIABILITIES			
Equity:			
Contributed capital		10 000 000	10 000 000
Retained earnings:			
Other equity	11	99 776 489	98 542 534
Total equity		109 776 489	108 542 534
Liabilities			
Long-term liabilities			
Provision for liabilities:			
Pension commitments	12	2 040 403	0
Other long-term liabilities:			
Dept to credit institutions	13	10 987 500	8 972 500
Total long-term liabilities		**13 027 903**	**8 972 500**
Current liabilities			
Accoutns payable		7 734 279	9 232 386
Advance payments		27 371 927	26 846 913
Payable taxes	7	0	0
Public dues		11 071 071	9 534 378
Incurred holiday pay/wages		10 967 245	9 465 826
Other current liabilities		656 276	100 097
Total current liabilities		**57 800 798**	**55 179 600**
Total liabilities		**70 828 701**	**64 152 100**
TOTAL EQUITY AND LIABILITIES		**180 605 190**	**172 694 634**

Cash Flow Analysis

		2011	2010
CASH FLOW FROM OPERATIONAL ACTIVITES			
Profit before taxes		4 048 496	2 636 494
Paid taxes		0	3 524
Ordinary depreciation		8 034 333	7 093 443
Subsidiary company result		-788 574	330 870
Changes in ongoing projects		1 230 520	-902 804
Changes in accounts receivable		1 301 372	-4 106 770
Changes in subsidiary company receivable		-4 335 366	171 167
Changes in accounts payable		-1 498 107	1 183 408
Changes in advance payments in projects		525 014	8 207 275
Changes in pension commitments		691 893	574 853
Changes in other accruals		4 149 240	3 736 338
Net cash flow from operational activities	**A**	**13 358 821**	**18 927 798**
CASH FLOW FROM INVESTMENTS ACTIVITIES			
Payments relating to investments in CIENS building, Blindern		0	514 412
Payments relating to patent rights		-420 405	0
Payments relating to fixes assets investments		-14 706 445	-9 091 487
Net cash flow from investments activities	**B**	**-15 126 850**	**-8 577 075**
CASH FLOW FROM FINANCING ACTIVITIES			
Increased debt		2 500 000	0
Repayment of long-term liabilities		-485 000	-485 000
Payments made by subsidiary		1 700 000	
Increase in loan to subsidiary company		0	-200 000
Increase in deposits/various interests		3 000	-3 000
Net cash flow from financing activities	**C**	**3 718 000**	**-688 000**
Net change to cash and bank deposits throughout the year	**A+B+C**	1 949 971	9 662 723
Cash and bank deposits 01.01		40 267 022	30 604 299
Cash and bank deposits 31.12		**42 216 992**	**40 267 022**

Notes

Consolidated accounts do not need to be completed due to the small size and activity of the subsidiary NILU Innovation AS. The parent company's portfolio of shares is assessed with basis in the equity method.

Accounts receivable and other receivables are booked at nominal value after deduction of provision for potential losses. Provisions for bad debts are made with basis in an individual assessment of each outstanding claim. Additionally, an unspecified provision of accounts receivable is made to cover assumed losses. The general provision for bad debts is 0.4 MNOK compared to 3.5 MNOK in 2010, since an old claim has been written off in its entirety.

NOTE 1 PROJECT REVENUE

As in previous years, management projects have been eliminated from the "Operating revenue" item, in order to arrive at real trade. For 2011 the management projects constituted 6.9 MNOK and for 2010 15.0 MNOK. A corresponding amount has been eliminated from the "Direct project costs" item.

NOTE 2 BASIC GRANT

	2011	2010	2009	2008	2007
Basic grant	17 644 000	15 556 000	14 741000	10 543 000	9 690 000
Institute programs	5 121000	5 185 000	3 850 000	4 797 000	4 997 000
Total	**22 765 000**	**20 741000**	**18 591000**	**15 340 000**	**14 687 000**

NOTE 3 EMPLOYEES, REMUNERATION ETC.

	2011	2010
Wages	100 238 291	93 330 564
Employers contribution	14 041 919	13 200 239
Norwegian Public Service Pension Fund (SPK)	8 886 846	10 521005
Other personnel costs	2 505 365	3 075 834
Total wages and social costs	**125 672 421**	**120127 642**

	2011
General Manager received a total remuneration of:	1 054 087
Total remuneration paid to board of directors:	299 000
Number of man-years:	185
Auditor's fee only relates to audits (incl avd. Abu Dhabi branch):	143 004

NOTE 4 FIXED TANGIBLE ASSETS

	Acquistion cost 01.01.2011	Additions during the year	Disposals during the year	Acquistion cost 31.12.2011	Accumulated depreciation 01.01.2011	Ordinary depreciation for the year	Reversal on disposal	Accumulated depreciation 31.12.2011	Book value 31.12.2011
Business building, Kjeller	76 796 987	0	0	76 796 987	56 168 817	0	0	56 168 817	20 628 170
Construction facility	3 455 535	3 167 640	0	6 623 175	960 100	662 318	0	1 622 418	5 000 757
Birkenes observatory	3 937 137	0	0	3 937 137	1182 717	393 714	0	1 576 431	2 360 706
Instruments	83 214 420	10 637 717	-47 970	93 804 167	73 420 616	5 808 748	-47 970	79 181 394	14 622 773
ICT equipment	17 143 633	592 492	0	17 736 125	15 922 665	764 826	0	16 687 491	1048 634
Software	828 437	0	0	828 437	313 887	165 687	0	479 574	348 863
Furniture and fixtures	6 471962	233 742	0	6 705 704	5 484 424	203 909	0	5 688 333	1017 371
Vehicles in UAE	63 163	74 853	0	138 016	46 745	35131	0	81876	56140
Total	**191 911 274**	**14 706 444**	**-47 970**	**206 569 748**	**153 499 971**	**8 034 333**	**-47 970**	**161 486 334**	**45 083 414**

As of 01.01.09 the value of the business building at Kjeller is not being depreciated, since the market value is far higher than book value. Construction facilities and other buildings are depreciated annually and linearly by 10 %, instruments by 20 %, ICT equipment by 25 %, software by 20 %, furniture and fixtures by 12.5 % and cars by 25 %.

In 2011 investments of NOK 420 405 were made in patent rights, which will be charged against income over a 5-year period starting in 2012.

NOTE 5 INTEREST COSTS

Interest costs mainly relate to mortgage loan.

NOTE 6 SHARES

NILU Innovation AS is wholly owned by NILU with a share capital of NOK 750 000l. NILU Innovation AS equity was as of 31.12.2011 NOK 2 522 933, compared to NOK 1 734 360 as of 31.12.2010. The annual result of NOK 788 573 was entered as income in the parent company.
As of 31.12.2011 NILU holds shares in the following companies:

	Share capital	Number of shares owned	Nominal value of share	Entered
Campus Kjeller AS	8 830 399	32 856	100	1 585 990
Miljøalliansen AS	150 000	30	1000	30 000
Various small stockholdings				35 900
Total				**1 651 890**

Through CIENS Eiendom KS NILU has invested a 6.5% ownership interest in the CIENS building at Blindern. In 2008 the investment was written down by 1.5 MNOK to assumed market value.

NOTE 7 TAXES

Since its foundation NILU has not been regarded as liable to pay taxes. Taxation authorities have in recent years started to tax research companies, and have decided that NILU will be liable to pay taxes. In 2007 NILU was told to submit a tax return for 2006, and has since then submitted a tax return.

Basis of taxes for the year is:	
Profit before tax	4 048 496
SkatteFUNN (tax incentive) for 2011 entered as income	-374 654
Loss in subsidiary ucompany allocated to net income	-788 574
Non-deductible costs	99 029
Change in temporary differences of tangible fixed assets	-7 323 900
Pension commitment changes	691893
Reduced depreciation on ongoing projects	-1 887 361
Reduced provision for bad debts	-3 000 000
Tax-related loss in Ciens Eiendom KS	-73 123
Tax basis for the year s= loss carried forward	**-8 608 194**
Assessed loss carried forward from previous years	-25 826 025
Assessed loss for 2011	-8 608 194
Accumulated, assessed loss carried forward	**-34 434 219**
Tax for the year consist of:	
Changes in deferred tax advantage	37 579
Taxes for the year	**37 579**

Deferred tax for the year appears as follows:

	01.01.2011	31.12.2011	Endring
Tangible fixed assets	117 591 695	110 267 795	7 323 900
Pension commitments	-1 428 452	2 040 403	-3 468 855
Project reserves	5 246 961	3 359 600	1 887 361
Accounts receivable	3 400 000	400 000	3 000 000
Ciens Eiendom KS	1 500 000	1 500 000	0
Loss carried forward	25 826 025	34 434 219	-8 608 194
Basis of deferred tax	152 136 229	152 002 017	134 212
Deferred tax = 28 %	**42 598 144**	**42 560 565**	**37 579**

NOTES 8 LOAN TO SUBSIDIARY COMPANY

The parent company has given NILU Innovation AS a loan in connection with acquisition of shares and operation, booked at NOK 3 520 000 as of 01.01.11. NOK 1 700 000 of the loan was repaid in 2011.

NOTE 9 ONGOING PROJECTS

The value of ongoing projects consists of project work carried out which had not been invoiced at year's end. Each project is assessed as concerns the risk of costs overrun, and a write-down as required has been made. In addition to that, a general write-down has been made as in previous years.

	2011	**2010**
Billable value verdi	18 340 925	21 458 806
General depreciation	-3 359 600	-5 246 961
Total ongoing projects	**14 981 325**	**16 211 845**
General depreciation i %	18 %	25 %

NOTE 10 NON DISTRIBUTABLE RESERVES

NOK 4 487 204 of bank deposits are restricted funds.

NOTE 11 OTHER EQUITY

	2011	2010
Other equity as of 01.01.	98 542 534	48 184 397
Deferred tax 01.01.	0	44 750 237
Principal changes in pension funds	-2 776 962	4 774 717
Profit of the year	4 010 917	833 183
Other equity as of 31.12.	**99 776 489**	**98 542 534**

NOTE 12 PENSION COMMITMENT

The company's pension commitment is covered by the Norwegian Public Service Pension Fund (SPK), where all employees in Norway are members. Local employees in NILU's branch in Abu Dhabi have a local agreement where a combined final benefit/pension benefit is allocated, which is payable at termination of the contract of employment.

	31.12.2011	31.12.2009
Pension commitments	-248 494 716	-181 958 451
Pension funds	164 070 576	153 425 677
Estimated changes not allocated to net income	84 337 489	31 223 085
Insured pension commitments in Norway	**-86 651**	**2 690 311**
Allocated pension commitments in Abu Dhabi	-1 953 752	-1 261 859
Net pension funds recognozed in the balance sheet	**-2 040 403**	**1 428 452**

In connection with introduction of the current accounting act, the company has calculated its net pension commitment with basis in the new Norwegian accounting standard. The actuary estimate was carried out by the Norwegian Public Service Pension Fund and is based on an anticipated return of 5.5 %, a 3.9% discount interest, a 4.5 % annual wage growth, and an annual G-regulation of 3.5 %.

A change in parameters made by SPK has entailed a change in principles at NOK 2 776 962, which has been entered against other equity, cf. note 11.

NOTE 13 ASSETS PLEDGED AS SECURITY – PAYMENT OF LOAN

Of company debt NOK 10 987 500 is pledged with security in the business building at Kjeller, which as of 31.12.2011 had a book value of NOK 20 628 170. An old loan is at NOK 8 487 500 as of 31.12.11, and is being repaid through half-annual installments until 30.06.2030.

The company raised a new loan of NOK 2 500 000. The loan is being repaid through half-annual installments until 30.11.2016.

Independent Auditor's Report

Report on the Financial Statements

I have audited the accompanying financial statements of the foundation Norwegian Institute for Air Research, showing a profit of NOK 4.01.917,-. The financial statements comprise the balance sheet as at December 31, 2011, and the income statement and the cash statement for the year then ended, and a summary of significant accounting policies and other explanatory information.

The Board of Directors and the Managing Director's Responsibility for the Financial Statement

The Board of Directors and the Managing Director are responsible for the preparation and fair presentation of these financial statements in accordance with the Norwegian Accounting Act and accounting standards and practices generally accepted in Norway, and for such internal control as the Board of Directors and the Managing Director determine in necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

My responsibility is to express an opinion on these financial statements bases on my audit. I conducted my audit in accordance with laws, regulations, and auditing standards and practices generally accepted in Norway, including International Standards on Auditing. These Standards require that that I comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgment including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditors considers internal control relevant to the company's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the company's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by management, as well as evaluating the overall presentation of the financial statement.

I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my audit opinion.

Opinion

In my opinion the financial statements are prepared in accordance with the law and regulations and present fairly, in all material respects the financial position of Norwegian Institute for Air Research as at December 31, 2011, and its financial performance and its cash flows for the year then ended in accordance with the Norwegian Accounting Act and according standards and practices generally accepted in Norway.

Report on Other Legal and Regulatory Requirements

Opinion on the Board of Director's report

Based on my audit of the financial statements as described above, it is my opinion that the information presented in the Board of Directors report concerning the financial statements and the going concern assumption is consistent with the financial statements and complies with the law and regulations.

Opinion on the Registration and Documentation

Bases on my audit of the financial statements as described above, and control procedures I have considered necessary in accordance with the International Standards on Assurance Engagements (ISAE) 3000 "Assurance Engagements Other than Audits or Reviews of Historical Financial Information", it is my opinion that the management has fulfilled its duty to produce a proper and clearly set out registration and documentation of the company's accounting information in accordance with the law and bookkeeping standards and practices generally accepted in Norway.

Opinion of Management

Bases on my audit of the financial statements as described above, and control procedures I have considered necessary in accordance with the International Standards on Assurance Engagements (ISAE) 3000,it is my opinion that the foundation is managed in accordance with the law, the foundation's purpose and its statues.

Oslo,16 April 2012

Helge Thorvik
State Authorised Public Accountant (Norway)

Note: Translation has been made for information purpose only

NILU – Norwegian Institute for Air Research
NILU Head Office at Kjeller
PO Box 100
NO-2027 Kjeller
Norway
Visit: Instituttveien 18, Kjeller
Telephone + 47 63 89 80 00
Telefax + 47 63 89 80 50
E-mail nilu@nilu.no
www.nilu.no

NILU in the Fram Centre – Tromsø
Hjalmar Johansens gate 14
NO-9296 Tromsø
Norway
Telephone + 47 77 75 03 75
Telefax + 47 77 75 03 76
E-mail nilu@nilu.no
www.nilu.no

NILU UAE
Zayed University Area - Street No. 10,
Postboks 34137
Abu Dhabi, UAE.
United Arab Emirates
Telephone 971-2-445 00 88
Telefax +971-2-445 00 83
E-mail nilu-uae@nilu.no
www.nilu.no

NILU Polska Sp. z o.o.
ul. Ceglana 4
40-514 Katowice
Poland
Telephone +48 32 257 08 58
Telefax +48 32 257 08 58
E-mail nilu@nilu.pl
www.nilu.pl

www.nilu.no

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NILU

HIGHLIGHTS FROM 2011

A toxic-free future - even for developing nations p 14

Tighter EU rules on parabens on the way p 16

Content

Editorial:
Anne Nyeggen, editor
Sonja Grossberndt, Ingunn Trones, Kari Marie Kvamsdal and Hildegunn Hammer, contributions and adaptations.
Design: www.melkeveien.no
Translation: Nancy Bazilchuk
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Front page: Main picture: Methane hydrates. Photo: Ian R. MacDonald, Florida State University. Small picture above: Norwegian Climate and Pollution Agency, KLIF.
Small picture below: ©Fotolia

Photo: Ingar Næss

Welcome to NILU's 2012 annual magazine, where we present highlights from our research and activities from 2011. Some of the articles have been published previously, and some are new. The year featured a wide variety of research: From the dramatic weeks after the Fukushima catastrophe to special attention from media and consumers – and the EU's scientific committee – on NILU's research on parabens in cosmetics. If you are interested in NILU's key numbers, you will find them at the end of the magazine, along with an overview of scientific publications. If you are interested in reading NILU's annual statement of accounts, you can find it at **www.nilu.no**. Happy reading!

Anne Nyeggen
Editor

Climate research is still important – so is monitoring

The Norwegian Government's 2012 white paper on climate change states that research on the effects of global warming and measures to address the problem will continue to be a high priority, along with research on the climate system itself. Research is also an important priority in the Government's High North strategy. But is the same effort being made in environmental monitoring, the cornerstone of climate research?

Budgets for monitoring remain unchanged

The fact is that whereas the white paper signals that investment in research is good, budgets for monitoring remain unchanged. Environmental monitoring form the foundation for climate and environmental research, and the need for basic monitoring data relevant to the North is on the increase. Even with a little growth over the past five years, the total monitoring budget for the Norwegian Climate and Pollution Agency, KLIF, is lower today than it was twenty years ago. When the numbers are adjusted according to the consumer price index, KLIF received in excess of NOK 90 million for monitoring in 1990, compared to just under NOK 77 million in 2011.

The tight budget means that KLIF must make difficult choices, and under this assessment, the loser is monitoring that does not have as much relevance for immediate management efforts, but has great value to Norway's longer-term national knowledge needs and research. To fund new priorities, the Agency now proposes to reduce the monitoring of acidifying substances. As an institution, NILU is very concerned that an almost 40-year-old and very valuable monitoring series may now be lost. The result will be a monitoring programme that does not meet international requirements for atmospheric monitoring.

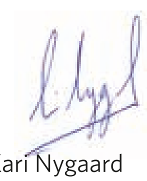
Part of this programme was originally established to monitor acid rain, but the use for the data is far broader than that. The data provide basic information about the composition of the Earth's atmospheric, along with details of the climate system and the effects of climate change. This includes information on aerosols, which represent a major uncertainty in our understanding of the impact of different atmospheric components on the climate. This is actually quite common for many atmospheric monitoring programmes, where the results are often socially beneficial in ways that were not anticipated when the monitoring was originally set up.

Marginal costs

Monitoring has marginal costs when seen in relation to potential consequences for the environment and human health. Any measures we take to avoid or reduce negative environmental effects will involve costs at a completely different and higher level. It is therefore essential to see monitoring, research and environmental measures in a larger social context, to assess the true value of long time series measurements.

In light of all of this, it should be quite clear that monitoring budgets must be increased. Furthermore, long-term monitoring programmes should not be expected to compete every year for funding from the same budgets that fund more acute monitoring needs. Basic environmental monitoring should be protected and should have a long-term approach that is both responsible to the needs of the government to understand how the climate and our environment are changing over time, and to ensure that this information contributes to long-term capacity building. In this way, monitoring will be useful to both society at large and government administrators.

This annual magazine presents NILU's research highlights from 2011. Virtually all the projects described rely on monitoring data in some way. They illustrate in just a small way the substantial environmental significance of environmental monitoring.



Kari Nygaard
Director

Photo: Ingar Næss

No methane emissions from thawing permafrost – yet

Senior scientist Cathrine Lund Myhre is reassuring: "For the time being there is no sign of any methane release from thawing permafrost." Photo: Ingar Næss

By Anne Nyeggen

Using isotopic analyses of methane, a research team has been investigating the reasons behind the increase in atmospheric methane concentrations that have been measured at the Zeppelin Atmospheric Monitoring Station at Ny-Ålesund in Svalbard. The results from 2008 and 2009 show that there were particularly large methane emissions from wetlands and gas leaks from Russian gas fields during these years. There is no evidence that methane emissions from hydrates on the ocean floor are reaching the atmosphere.

"For the time being, we also don't see any clear indication of increased methane emissions from thawing permafrost," says NILU senior scientist Cathrine Lund Myhre.

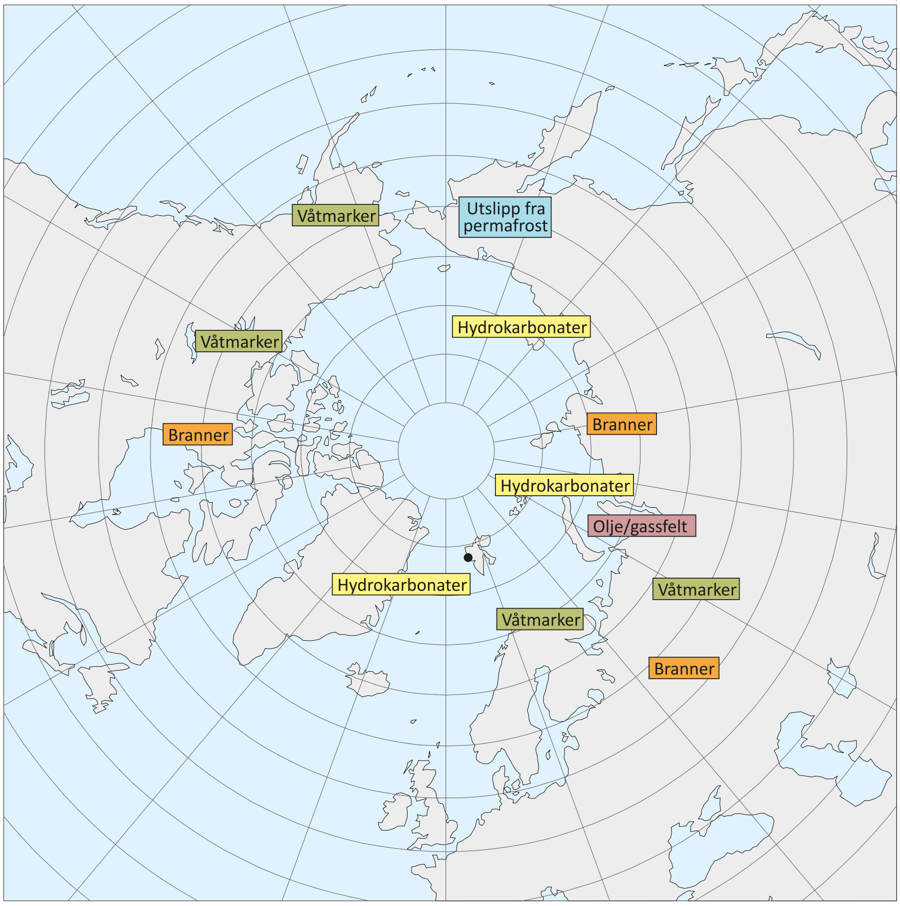
Disturbing methane increases

Next to CO_2, methane is the most important contributor to man-made global warming, and comes from both man-made and natural sources.

Measurements that NILU has conducted at its monitoring station on Zeppelin Mountain at Ny-Ålesund in Svalbard have shown a steady rise in methane concentrations over the past five years. These results have been concurrent with methane increases measured at other stations in the Arctic, as well as globally.

But researchers are particularly worried about the great potential sources of methane in the Arctic. Huge amounts of carbon are stored in permafrost, both on land and on the ocean floor. These sources may emit large amounts of methane if the permafrost thaws.

"In that case, we will get what is



▲ **Illustration showing the location of different methane sources.**

◀ **Arctic wetlands in Russia proved to be an important source of methane emissions that were measured at Zeppelin in 2007 and 2008.**
Photo: Michael Trepel

called positive feedback, or a feedback mechanism," explains Lund Myhre. "When the permafrost thaws, large amounts of methane are released. This contributes to even more warming and increased thawing of the permafrost, which in turn contributes to even more increases in methane emissions."

Why is methane on the increase?

Over the past few years, research on methane has been intensified, because scientists want to understand the changes that affect the levels of the gas in the atmosphere:

"There was a particularly large increase in methane in 2007 and 2008. Isotope measurements of methane at Zeppelin that we have conducted in cooperation with Royal Holloway, University of London, show that a particularly large proportion of the methane came from arctic wetlands in northern Russia. This may be due to the summer of 2007 having been unusually warm in the Arctic. On the whole, wetlands are an important source of methane emissions during the summer," explains Lund Myhre. Scientists have found that the increase recorded during the spring of 2009 may be partly explained by gas pipeline leakage. "It's remarkable that gas pipelines can leak so much that they cause increases in regional methane concentrations. This is something people should be interested in reducing, because these leaks are also not profitable from a financial viewpoint," says Lund Myhre.

The scientists were particularly interested in seeing whether there was any indication that methane was being emitted from methane hydrates. Great quantities of the ice-like substance can be found on the ocean floor near Zeppelin Mountain and west of Spitsbergen. Research cruises to study the phenomenon were organized and coordinated with measurements at Zeppelin. "So far, we cannot see any indication that the methane increase is coming from this source. But this may change, particularly in shallow ocean areas, if the temperature in the Arctic continues to rise," says Lund Myhre.

Methane hydrates are crystals formed of methane bound to water. Methane leaks from these hydrates, but for the time being, the methane does not reach the sea surface and escape into the atmosphere to any significant extent. However, this is dependent on the temperature: at higher ocean temperatures, » methane hydrates dissolve more easily in seawater. This is one of the scientists' concerns.

Tropical wetlands and fires

An increase in methane concentrations has also been measured in the southern hemisphere. It is presumed that this is due to greater emissions from tropical wetlands in the Amazon and Indonesia as a consequence of changed and increased precipitation, and from tropical fires during the autumn of 2006.

Complicated measuring method

The research team has been using what are called isotope measurements to figure out the source of the methane. Different methane sources have different proportions of carbon isotopes. This fact is used in combination with modelling of air transport to Zeppelin in order to identify sources and source areas. This method is particularly challenging in the Arctic, because the sources have weak isotopic signals. "This demands a high level of precision from both the measuring devices and the measuring methodology," says Lund Myhre. The work on isotopes and the analyses are being headed by and carried out at Royal Holloway, University of London.

The study is an international cooperative research effort with NILU and the University of Tromsø in Norway, the universities of London, Southampton and Oxford in England, and the Royal Netherlands Institute for Sea Research. The project leaders are R.E. Fisher and E. Nisbet from Royal Holloway, University of London.

The project has been supported by the UK's Natural Environment Research Council, as part of their contribution to the International Polar Year, and by Royal Holloway. The EU has also contributed with funds from the GEOMON Programme, among others.

Cathrine Lund Myhre is now coordinating a research project under the direction of the Research Council of Norway called "Causes and effects of Global and Arctic changes in the Methane budget" (GAME), in which isotope measurements will be further developed. One goal is to collect continuous isotope measurements at Zeppelin.

Methane hydrates are composed of methane in ice crystals that are found under the seabed. Methane is currently leaking from the hydrates, and the warmer the water, the more the methane leaks out. For the moment, the monitoring station at Svalbard has not detected any leakage of methane hydrates to the atmosphere. Photo: Ian R. MacDonald

Reference: Fisher et al.: Arctic methane sources: Isotopic evidence for atmospheric inputs, Geophysical Research Letters, Vol. 38, 2011, L21803, 6 pp doi:10.1029/2011GL049319.

More about methane

Whereas NILU's measurements of methane from 1998 to 2005 have shown relatively stable concentrations, there have been annual increases from 2006 to 2009. The increases were particularly dramatic during autumn 2007 and late autumn 2009. Scientists measured a level of 1975 ppb (parts per billion) on 26 December 2009. This is the highest methane level ever measured at the Zeppelin station. There have been other episodes with very high values since then as well. The global level also reached a new record in 2009 at 1803 ppb, an increase of 5 ppb since 2008.

Around 60 per cent of the methane in the atmosphere at present comes from man-made sources. The most important of these sources are farming (ruminants), rice paddies, rubbish dumps, coal, oil, gas and fires. The most important natural sources are wetlands, termites, geological sources, oceans, wild animals and fires.

There are also vast natural reservoirs of methane stored in the permafrost, both on land and under the ocean. An increase of methane in the atmosphere may be due to either an increase in emissions from one or more sources, or to a change in methane decomposition.

Atmospheric methane mainly breaks down through chemical reactions and is eliminated on a timescale of about 10 years. It is expected that many of the natural methane sources will be impacted by climate change, such as changes in temperature, particularly in the Arctic, and changes in precipitation.

Climate policies especially affect POP emissions from industry, transport and the waste sector, explains Jozef Pacyna, NILU department director. Photo: Marek Zaborowski, Bellona Polska.

Climate change and POPs: The right measures can reduce both

Emissions of both CO_2 and POPs can be reduced using the same mitigation efforts, NILU scientists report in a recent UN publication.

By Sonja Grossberndt

Greenhouse gas (GHGs) emissions can increase the toxic effects of persistent organic pollutants (POPs) on humans and the environment. But mitigation measures to reduce GHG emissions can also simultaneously reduce unintentional emissions of POPs and other contaminants of concern – in a synergistic effect called a co-benefit.

NILU scientists Jozef Pacyna, Kyrre Sundseth and Elisabeth Pacyna have contributed to the UN report 'Climate Change and POPs Inter-Linkages' with a chapter on the co-benefits of mitigation efforts to reduce emissions of both CO_2 and POPs.

Qualitative assessment

"Climate policies on unintentionally produced POPs mainly affect three sectors: industry, transport and housing," explains Pacyna, a senior scientist at NILU. "We carried out a qualitative assessment of the co-benefits of reducing CO_2 emissions from different emission sources."

The researchers found that structural changes, such as improving the energy efficiency of power stations or replacing fossil fuels with renewable energy, can provide greater co-benefits in the reduction of both CO_2 and unintentional POPs emissions than using traditional 'end-of-pipe' technologies such as catalysers or filters to remove pollutants from the environment after they have already been released. Banning the open burning of waste will also result in the co-benefit of reducing GHGs and unintentionally produced POPs.

Next steps

"Better communication and collaboration between key policymakers within climate change and air pollution will be absolutely crucial for reducing the risks to humans and the environment," Pacyna says. "Developing co-benefit strategies at the regional, national and international levels will be the main task of all stakeholders involved, including scientists, policymakers and industrial leaders."

A systematic review

For the first time, leading experts from 12 countries have conducted a systematic and authoritative review of the impacts of climate change on the release, transport and exposure of GHGs and POPs. The report was commissioned by the United Nations Environmental Programme (UNEP) and the Arctic Mapping and Assessment Programme (AMAP), and provides a comprehensive overview of the complex inter-linkages between climate and POPs. The results have been prepared to support informed decision-making.

THE STOCKHOLM CONVENTION

The Stockholm Convention on Persistent Organic Pollutants is an international environmental treaty that aims at eliminating or restricting the production and use of these chemicals. This United Nations treaty was signed in 2001 in Stockholm and entered into force in 2004. In 2011, 173 parties committed to take measures to eliminate or reduce the release of POPs into the environment. The Convention is administered by the United Nations Environment Programme based in Geneva, Switzerland.

POPs

Persistent Organic Pollutants (POPs) are organic chemical substances with specific properties that make them resistant to environmental degradation. Due to their long persistence in the environment, they are widely distributed in soil, water and air, and bioaccumulate in humans and animals. They are found at higher concentrations at higher levels of the food chain and are toxic to humans and the environment. These industrial chemicals are used in the production of solvents, polyvinyl chloride and pharmaceuticals. In the past they have been used in pesticides, but this use was banned by the Stockholm Convention. Nevertheless, some older pesticide stocks still in use contain POPs.

Reactivating POPs

The good news: most levels of persistent organic pollutants, or POPs, have shown decreasing trends in the Arctic since the 1990s. The bad news: the effects of climate change can reverse this development.

By Sonja Grossberndt

For many years, persistent organic pollutants (POPs) have been widely used in industrial processes in many countries around the globe. A shift towards more environmentally friendly processes resulted in a decrease in POP emissions in the 1990s. This development has been supported by the Stockholm Convention, in which 173 countries (2011) committed themselves to take measures to eliminate or reduce the release of POPs into the environment. The convention entered into force in 2004.

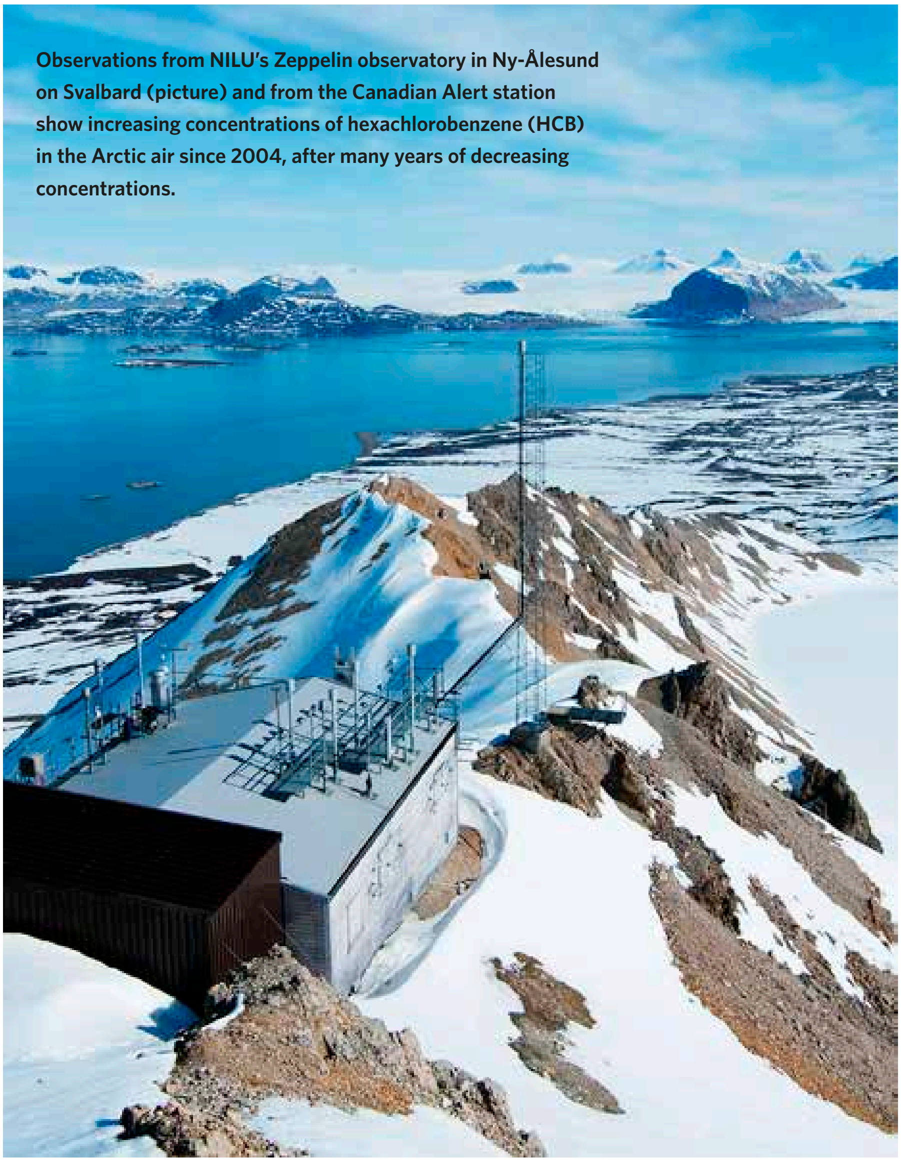
However, there is evidence that concentrations of POPs in the air will increase in the near future, according to research results from NILU.

"POPs are extremely persistent. Once they are released to the atmosphere, they can accumulate in the environment and cause damage to the flora, fauna and humans due to their toxic properties," says NILU scientist Roland Kallenborn (now at the Norwegian University of Life Sciences in Ås). "They also travel long distances in the air, reaching remote places like the Arctic, where they accumulate in the environment."

However, measurements show that a large percentage of these pollutants do not remain locked up in the snow, ice and permafrost .

"We were able to demonstrate that global warming from climate change affects the fate of POPs in the Arctic environment," explains Kallenborn. The results were published in *Nature Climate Change* in July 2011. Observations at NILU's Zeppelin Mountain Air Monitoring Station at Svalbard and at the Canadian Alert station showed increasing levels of hexachlorobenzene (HCBs) and PCBs in Arctic air in the early- to mid-2000s after many years of decrease. Arctic warming and ice retreat will release the POPs that have been trapped in the snow and ice to the atmosphere, making them available once more to circulate through the environment. As a result, exposure pathways and health impacts might be changed.

The results of this long-term measurement campaign highlight the importance of improved understanding and awareness of the effects of climate change, especially on environmental pollutants such as POPs and their mobility. This knowledge can contribute to global endeavours to develop adaptation and mitigation strategies to reduce our exposure to environmental pollutants that are released by climate change.



Observations from NILU's Zeppelin observatory in Ny-Ålesund on Svalbard (picture) and from the Canadian Alert station show increasing concentrations of hexachlorobenzene (HCB) in the Arctic air since 2004, after many years of decreasing concentrations.

Bad air quality in Norwegian cities - but solutions are possible

Air quality in several major Norwegian cities is now so bad that it causes significant health problems, and if worst comes to worst, air quality may even be poorer in the coming years. "The good news is that there are measures that can improve air quality," says NILU's Leonor Tarrasón.

By Bjarne Røsjø

Everyone was talking about diesel cars and air quality in Norway's major cities in 2011, especially after NILU scientist Dag Tønnesen presented a calculation showing that the road toll for diesel cars in Oslo would have to be increased by several hundred kroner if it was going to have any effect on air quality. "That event was a signal that it is necessary to take drastic action if we want to do something about pollution problems on the worst days in our major cities. But the most important thing Dag said was that it is entirely possible – and high time – to introduce systems that require those who pollute more to pay more than those who don't pollute so much" says Tarrason, who is director of NILU's Urban Environment and Industry division.

Nitrogen oxides cause health problems

Nitrogen oxides (NO_X) is the collective term for nitrogen monoxide (NO) and nitrogen dioxide (NO_2) gases, both formed during combustion in automobile engines, among other sources. NO_2 in particular constitutes a health risk, because this pollutant results in increased morbidity and mortality from cardiovascular and lung diseases. Currently, Norwegian authorities allow much higher NO_X emissions from diesel vehicles than from petrol vehicles, but beginning in 2014 there will be much stricter NO_X requirements throughout the entire EEA.

The Norwegian Pollution Control regulations were tightened in 2010, including a provision that limited the annual average for airborne NO_2 in inhabited areas to be below 40 micrograms per cubic meter (mg/m^3). The regulation also set an hourly maximum for NO_2 of 200 mg/m^3 not to be exceeded more than 18 times over the course of a year (the 18-hour limit). NILU published figures in 2011 that showed that Oslo, Bergen, Trondheim and Stavanger all had annual mean values above 40 mg/m^3 in 2010, and that both Oslo and Bergen had more than 150 individual episodes with exceedances of the 18-hour limit.

Could be worse

Calculations performed by NILU for the Norwegian Asthma and Allergy Association (NAAF) in 2011 showed that air quality in Oslo in 2025 could be even worse if the trend in passenger car sales continues as it is today. "We have concluded that it is a safe choice for both the climate and local air pollution to enhance tax policies and local initiatives that favour the use of smaller gasoline vehicles, hybrid and electric cars. In addition, it is obviously important to increase the focus on public transport, and to develop more effective systems for professional transport and light duty vehicles. In Oslo, the small diesel vans and trucks that are used for transportation of goods are actually a bigger problem for public health than the heavy duty vehicles travelling across the major roads" says Tarrasón.

Dialogue with relevant authorities

In 2007 Norwegian tax laws were changed to make diesel cars more attractive, because they have lower emissions of the greenhouse gas CO_2 than petrol or gasoline driven cars. In 2011, the Norwegian government presented a new proposal for changes in fuel taxes. This time, the proposal was presented after a process including a major meeting of relevant experts, involving NILU, the Norwegian Health Directorate, the Norwegian Climate and Pollution Agency, the Institute of Transport Economics, NAAF and local government representatives, who discussed these issues with the state secretaries of the ministries concerned. "It is very positive that scientific and technical experts and research groups were able to join in the discussion and provide quantified information, so that policy decisions could be based on best available knowledge" Tarrasón said.

"It is fully possible to implement systems that enable those who pollute more to pay more than those who pollute less", says Leonor Tarrasón, director of NILU's Urban Environment and Industry Department. Photo: Ingar Næss

Actual emissions are much higher by tests for approval

Calculations made by the Institute of Transport Economics (TØI) and NILU show that particulate emissions from vehicles have decreased, while emissions of harmful nitrogen dioxide (NO_2) in Norwegian cities have increased.

By Anne Nyeggen and Sonja Grossberndt

These findings can be explained by two trends. "Diesel engines have become much more efficient than in the past, and this has reduced CO_2 emissions. In addition, the pollution control systems in modern diesel engines reduce particulate emissions, but unfortunately not NO_2 emissions. In fact, NO_2 emissions (a component of NO_x) from new diesel cars have increased considerably since 2000," says Karl Idar Gjerstad, a NILU researcher. The reason for this is twofold, he says: more efficient engines operate at higher combustion temperatures, which in turn results in higher emissions of NO_x, while at the same time a significant proportion of this NO_x reacts with oxygen in the particulate filter and forms NO_2.

This development has occurred at the same time that Norway reduced taxes on diesel vehicles, which led to a significant increase in the proportion of diesel cars on the road. In 2010, approximately 75% of all new passenger cars sold in Norway were diesel.

"Many will remember the winter of 2010/2011, when air pollution in Bergen and Oslo exceeded NO_2 limits many times," Gjerstad said. "The combination of an increased proportion of diesel cars, traffic congestion, a cold climate and temperature inversions led to this situation, which is likely to occur more frequently if the percentage of diesel-powered vehicles continues to increase."

One diesel bus versus 300 gasoline-powered cars

This trend with diesel vehicles will also cause problems for pollution control measures for days when pollutions levels are high, such as banning car use on a day-to-day basis based on the vehicle registration date.

"If date-controlled driving bans are put into effect, it is important to ensure that the buses that are used to replace the cars do not pollute more than the cars that the buses are meant to replace. A diesel bus emits as much NO_2 as four diesel cars, or the same as 300 gasoline-powered vehicles," explains Gjerstad. "It would be much more effective to ban diesel cars on heavily polluted days than to use date-controlled driving bans for all personal automobiles.

Actual emissions much higher than shown by tests

All cars must pass inspection before they can be driven in traffic. To pass inspection, drivers must be able to document that their vehicles' NO_x emissions are lower than the permissible limit in accordance with applicable requirements. Cars are generally tested using an approved kind of assessment. The question is whether this test actually reflects reality when it comes to Norwegian conditions.

In a study performed by TØI and NILU, it turned out that diesel cars actually emit much more NO_x under real driving conditions, in urban situations and in traffic jams in cold winter conditions, than they do during an approved emissions test.

The report presented calculations showing how emissions from road traffic in the greater Oslo area can be expected to develop until 2025. NILU made the calculations based on updated emission factors from TØI. These factors took into account actual measurements of emissions from different vehicle classes.

Under real conditions, a diesel vehicle releases 6-8 times more NO_x than it is approved to release. The same type of discrepancy is not found in gasoline-powered cars. Thus, a diesel car emits

Karl Idar Gjerstad, an NILU scientist, has worked with TØI to calculate actual emissions from diesel vehicles. Photo: Ingar Næss

than shown

as much NO_x as the equivalent of 20-40 gasoline-powered cars, and as much NO_2 as the equivalent of 50-80 gasoline-powered cars.

– Under real conditions, a diesel vehicle releases 6-8 times more NO_x than it is approved to release.

The way forward

There are many different measures that can be considered to bring NO_2 limits into compliance. Stricter emission standards for vehicles will come into effect in 2014, but no one knows what the vehicles that meet these new requirements will emit under real traffic conditions. The technology for reducing and removing NO_x exists, but it is difficult to predict its effectiveness. Driving bans on days when pollution levels are high or a one-time fee for cars with high NO_x emissions are two approaches for tackling the NO_2 problem in Norway's big cities. However, reducing emissions of NO_x, NO_2 and other emissions that are harmful to human health and the environment will require comprehensive expertise in developing technologies, measuring and monitoring emissions, and understanding the dispersion of automobile exhaust.

Link to report:
http://www.vegvesen.no/Om+Statens+vegvesen/Media/Siste+nyheter/Vis?key=287228

Better air quality in Europe, but still far from targets

Air quality in Europe has shown a slight improvement over the past twenty years, but some pollution concentrations continue to pose a threat to human health, according to a new report on Europe's air quality, which was released by the European Parliament in November 2011.

By Sonja Grossberndt

"Air pollution levels in Europe have decreased, but are still a risk to human health'", says Cristina Guereiro, an NILU scientist.
Photo: Ingar Næss

The report shows that air quality on the continent has improved over the past 10 years. The improvements are mainly due to reduction in emissions of sulphur and lead.

"Europe's air quality has generally improved, but the concentration of some pollutants is still a danger to human health," says Cristina Guerreiro from NILU. "There are several air quality objectives that have not yet been reached. In particular, concentrations of ozone and particulate matter have remained stable in recent years, despite efforts to reduce emissions and improve air quality. Exceedances of limits for NO_2 - nitrogen dioxide - are also common in European cities, including Oslo and Bergen."

Guerreiro and Steinar Larssen from NILU, along with researchers from the Dutch National Institute for Public Health and the Environment - RIVM - prepared the report on behalf of the EEA.

"Air quality in Europe - 2011 report" provides updated data on Europe's air quality over the past twenty years. It also provides an overview of policies and measures that can improve air quality at European level. The report was released at the European Parliament in November 2011 and is the first of a new annual series of EEA reports on the status and development of air quality in Europe.

The report is part of the work of the European Topic Center for Air Quality and Climate Mitigation (ETC/ACM).

The report can be downloaded here: http://www.eea.europa.eu/publications/air-quality-in-europe-2011.

Foto: © Morten Almeland/Fotolia

NILUs applied research activities in world's most polluted cities – Dhaka

Dhaka, Bangladesh, is one of the most polluted cities in the world. NILU is half way through a three year institutional building project funded by NORAD for training the authorities in Bangladesh.

By Scott Randall and Bjarne Sivertsen

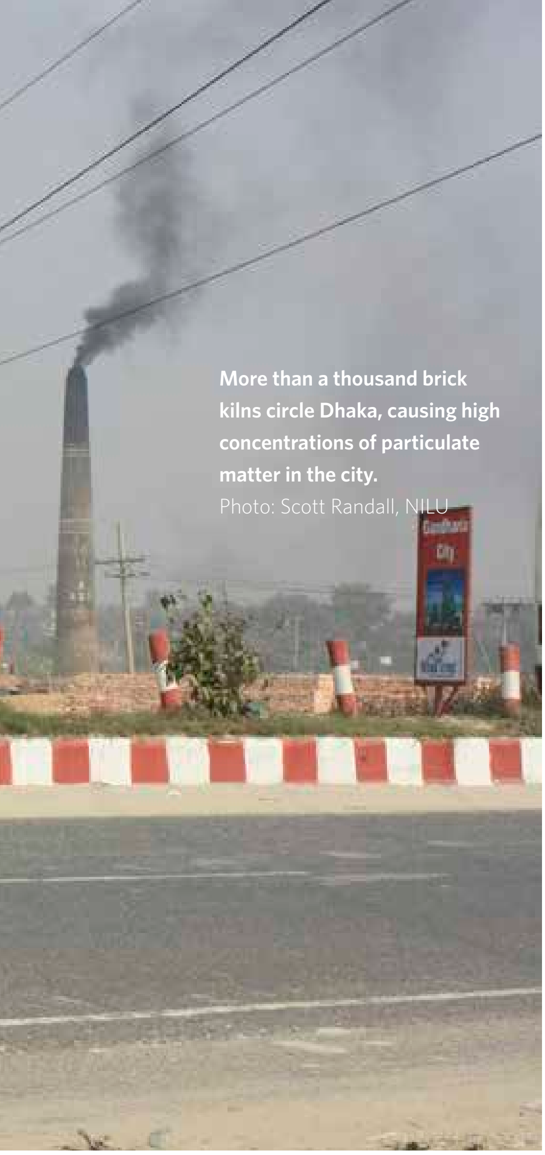
The main objectives are to provide knowledge and tools for air quality management and future sustainability at the Department of Environment in Bangladesh.

Through the institutional building project *Bangladesh Air Pollution Management (BAPMAN)* a team of NILU experts have locally been undertaking screening studies, established air management planning tools and prepared emission inventory data collection.

The project performed field studies in February in Dhaka sample NO_2, SO_2, ground level ozone and particulate matter (PM). It can be presumed from the sampling results that national and international standards are regularly exceeding during the dry season. Local sources for the high PM concentrations found include about 1100 brick kilns circling the city, as well as traffic and regional and remote sources of various kinds. A regional cloud of haze may thus be contributing to a large amount of the fine PM concentrations over Bangladesh during peak events. These regional haze clouds can clearly be seen from satellite observations.

Air pollution emission inventories are important elements of the air quality management systems. The BAPMAN project has therefore aimed at training local authorities on the procedures for completing a comprehensive emission inventory for Dhaka. To collect adequate information from industrial and other sources in the Dhaka air shed has been a challenge. NILU will therefore apply top-down approaches in combination with bottom-up data collection in order to produce estimates of present and future emissions of air pollutants.

A second project, financed by the World Bank, has been initiated during 2011 and started in 2012. This *Bangla-*



More than a thousand brick kilns circle Dhaka, causing high concentrations of particulate matter in the city.
Photo: Scott Randall, NILU

one of the , Bangladesh

desh Air Pollution Studies (BAPS) will include compiling an emissions inventory for Dhaka and Chittagong. The BAPS project will also perform dispersion modeling, source apportionment assessments, industrial emissions estimates, and road dust mitigation assessments.

Contact: Project Manager for BAPMAN and BAPS projects, Scott Randall (Research Scientist)

FACTS

Field studies performed in Dhaka in February 2011 were based on passive sampling of NO_2, SO_2, and ground level ozone. Particulate matter (PM) concentrations were collected through grab sampling during the dry season (winter). Average concentrations for PM during the sampling period ranged from approximately 150 µg/m³ up to 500 µg/m³.

NILU monitors air quality in Abu Dhabi

Since 2008, NILU has been a strategic partner for the environmental authorities in Abu Dhabi (Environment Agency – Abu Dhabi, EAD) for all air pollution and greenhouse gas related issues. NILU is responsible for managing and implementing air quality measurements on behalf of the EAD, and reports on environmental conditions in the emirate. Particulate matter is one of the main problems in the region, with dust storms occasionally leading to very high levels of dust in the air.

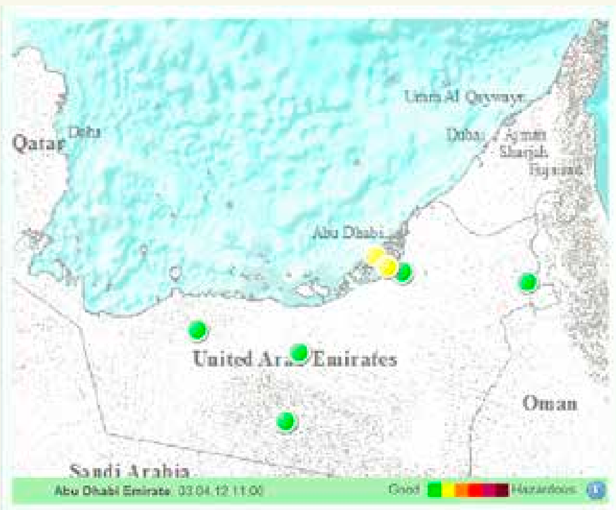
By Trond Bøhler

NILU operates 10 automatic monitoring stations across Abu Dhabi. Air pollution in Abu Dhabi is dominated by dust from desert areas and from sandstorms. These "natural" sources tend to result in the highest concentrations of particulate matter.

The average daily concentrations of PM_{10} frequently exceed national and international air quality standards. PM_{10} limits were exceeded on average about 30% of the time, with the highest exceedances occurring about 50% of the time. This situation has not changed significantly since NILU started taking measurements in 2008. During sandstorms, the maximum hourly concentration for PM_{10} can often exceed 1000 mg/m³.

Other air pollutants, such as carbon monoxide (CO), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2), were not observed to exceed acceptable air quality limits, while ozone concentrations were above the limit for less than 1% of the year.

All measurements are transmitted every hour to EAD's air quality Internet portal, which is operated by NILU. In addition to general information on air pollution, the site provides an hourly air quality index (AQU-Air Quality Index) that is available to the public (www.adairquality.ae).



NILU is operating EAD's air quality portal that shows the Air Quality Index for the United Arab Emirates

A toxic free future – even for developing nations

The toxic burden from banned industrial organic pollutants has generally declined in rich industrialized countries such as Norway, but remains surprisingly high in parts of Africa and Asia. How much of the emission reductions in rich countries are better explained by the dumping of toxic waste in poorer countries?

By Knut Breivik

The Norwegian government has previously stated that its priority environmental issues are environmental contaminants, the loss of biological diversity and climate change. POPs (persistent organic pollutants) are chemical substances that pose a serious threat to the environment and human health, both now and to future generations. Some of these pollutants are industrial chemicals, the most dangerous of which are now regulated by international agreements. Among the worst are PCBs, which can cause cancer, weaken the immune system, damage the nervous system and harm foetal development. The global production of PCBs has decreased dramatically since 1970 and was halted in 1993. In Norway, the new use of PCBs has been prohibited since 1980, but the substance is still in circulation in the form of older electrical equipment and building materials. Public agencies and other players are thus still working on management of PCBs remaining in stock.

Norway has been a driving force to reduce the production, use and release of some of the most hazardous substances through international agreements, such as the Stockholm Convention. An important goal has been to support international measures to protect people and the environment in northern areas which aims to limit the long-range transport of pollutants via air and ocean currents. As a result of national and international regulations, levels of many POPs have generally decreased in the Nordic region. In Sweden, the levels of brominated flame retardants - PBDEs and PCBs – have declined in human breast milk since 1990 and the 1970s, respectively.

In spite of this, the levels of both substances have significantly increased in breast milk in women from Ghana over a five-year period up to 2009. The levels of PCBs in breast milk in Ghana are now at levels that pose a possible health risk for children who are breastfed. How is this possible more than 40 years after the world became aware of the problem? Have well-off nations been more concerned with protecting people and the environment here in the north, rather than in poor countries in the south?

Are we sure that our hazardous waste is ending up where it is supposed to be?
Photo: Mampato, Wikimedia Commons

Rich industrialized countries are the only nations that have gained a significant advantage from the production and use of these hazardous substances in different products in the past. For that reason, emissions in industrialized countries have previously been high in these areas. While particularly high levels of PCBs were once found in the major cities of the industrialized world, the picture now seems to have changed. There has long been a considerable amount of dumping of discarded electrical and electronic equipment (commonly called WEEE, an acronym for waste electrical and electronic equipment) and other toxic wastes containing PCBs and PBDEs in the poorer parts of the world. This export has been on going, often disguised as reuse through the donation of obsolete equipment to developing countries. Another reason why this partially illegal market has developed is that the costs associated with recycling and disposal are higher — and are subject to more stringent regulations — in industrialized countries.

The export of toxic waste has thus been a cheap solution to a difficult problem. Only recently, however, have scientists begun to thoroughly investigate the impact of toxic waste on the areas where

Not much protection equipment where PCs are being dismantled. From a landfill in Ghana. Photo: Klima- og forurensningsdirektoratet

it is exported. Emissions of industrial pollutants are now significant in parts of Africa and Asia. Levels of PCBs in the air ~400 km off the west coast of Africa have recently been measured and found to be similar to levels within cities such as London and Chicago.

Despite a very modest consumption of PCBs in southern Asia compared with Europe and North America, the toxic burden of these contaminants in large cities that receive waste in India and China is now higher than in London and Chicago. At a Chinese site where relevant wastes are burned, levels of PCBs are a thousand times higher than London and Chicago. Much of this waste originates from Europe and America, while recipient countries are often in southern Asia and Africa. The methods used to recycle WEEE in these regions are often very primitive, with minimal measures to protect people and the environment. WEEE is often burned or smelted to recover valuable metals, but which also releases contaminants and causes significant toxic emissions. A warmer climate, combined with primitive recycling procedures, combine to deliver much higher emissions than what might have been anticipated if industrial countries had taken care of the waste.

A better knowledge about the major sources of toxic industrial organic contaminants in regions implicated as recipients of toxic wastes is not only vital to understand regional fate of these chemicals. It is also essential for supporting the development of rational control strategies to help get rid of these toxic chemicals to protect environmental and human health, both in e.g. West Africa and, possibly, even on a global scale. Many of these countries do not have the resources to undertake these investigations themselves. Rich countries, which have benefited from the extensive use of industrial chemicals for various applications and consumer goods for decades, may carry a particular responsibility to identify the major sources and source regions to reduce future exposure.

The potential for detrimental effects on environmental and human health due to long range transport by air, water, wastes or by any other means should therefore be of equal concern when managing and regulating POP-like chemicals. A better integration of life-cycle approaches / considerations in industrial organic contaminant management and regulation is therefore needed to protect environmental and human health from industrial POPs on a truly global scale. The goal of a toxic free future at home should not be achieved at the expense of people and the environment elsewhere.

Funded by the Norwegian Research Council (NFR), Knut Breivik has become leader of the project "Long-range transport of POPs with wastes" with the objective to study the regional and global scale implications of emissions associated with trans-boundary export of toxic wastes from rich countries to developing regions. The project has been funded by the Norwegian Research Council (NFR) and will last from 01.01.2012 over a period of three years.

Knut Breivik, an NILU senior scientist, wants to find out why the PCB levels far beyond the African west coast are as high as in large cities such as Chicago or London.

NILU research contributes to tighter EU rules on parabens

The EU is about to introduce a ban on the use of parabens in skin care products for children younger than six months. Part of the research that formed the foundation for the new ban came from NILU Senior Researcher Torkjel M. Sandanger, who has found high levels of parabens in the blood of heavy users of cosmetic products.

By Bjarne Røsjø

Torkjel M. Sandanger and a group of NILU scientists at the Fram Centre in Tromsø analysed 350 blood samples from Norwegian women, and found a very clear link between the women's self-reported use of cosmetic products and the level of parabens in their blood. Among the highest cosmetics users, blood levels of parabens were found to be higher than the levels of all other potential contaminants that the researchers were investigating.

"This is cause for concern, because parabens are chemicals that can disrupt the body's hormonal balance. Studies show that these kinds of endocrine disrupters can affect the reproductive capacity of both women and men, in addition to causing certain types of cancer from long-term use. There is great need for more studies on the effects of these substances on the population," Sandanger says.

"We know little about the combined effects of all the substances that surround us", says Torkjel M. Sandanger, an NILU senior scientist at the Fram Centre in Tromsø and at the University of Tromsø. Photo: Helge Markusson, Framsenteret

Prohibited in Denmark

Parabens are a type of preservative used in a wide range of cosmetic products and have been viewed with increasing scepticism in recent years. Many cosmetics also contain other chemical substances with partially unknown or adverse effects. In Denmark, concern about these substances led the government to introduce a ban on 15 March 2011 on the use of propyl- and butylparabens in cosmetic products intended for children three years old and younger.

The EU's Scientific Committee on Consumer Safety (SCCS) had previously thought that parabens were not a health risk, but the Danish decision triggered a reassessment in November 2011 that led the SCCS to recommend a ban on parabens in products aimed at children younger than six months. The Scientific Committee quoted Sandanger's research as an important foundation for the new assessment, along with a handful of other publications on the same subject.

The European Commission, the executive body of the European Union, has since followed up on the scientific recommendation and is in the process of implementing the ban for the entire EU. The Commission will also reduce the maximum permissible content of propyl-and butylparabens in all types of cosmetics.

Parabens in the news

NILU's research on parabens received a great deal of attention in 2011. In March, Sandanger's research was on the Norwegian Broadcasting Corporation's (NRK) science show, "Schrödinger's Cat", during which it was shown that the programme's director, Hanne Kari Fossum, had twice as much parabens in her blood as Norway's then-Minister of the Environment and International Development, Erik Solheim. The television show "FBI – Consumer Inspectors," on NRK's Channel 1, broadcast a major programme segment in September about the parabens debate with NILU as one of the main sources.

– Today, researchers must prove that a substance is likely to be dangerous before the authorities can ban the substance.

During the broadcast, Sandanger explained that propylparaben is chemically very similar to oestradiol, which is one of the most common female sex hormones. At the same time, the Norwegian Consumer Council launched an "app" that can be downloaded to smart phones to check the contents of cosmetics. The app "Hormone Checks" then alerts consumers when cosmetics contain potential endocrine disrupting chemicals. The Cosmetic Suppliers Association (KLF) quickly criticized the app, but the little computer program quickly climbed to the top of the list of most downloaded free apps.

It has been difficult in the past to investigate whether parabens can cause cancer or hormonal disorders in humans, but researchers at NILU took a big step forward when they analysed blood samples from the Norwegian

There are particularly good reasons for children to avoid using products containing parabens.
Photo: © Joanna Zielinska/Fotolia

"Women and Cancer" study. The study, led by Professor Eiliv Lund at the University of Tromsø, has collected data and questionnaires from more than 70 000 Norwegian women. NILU analysed blood samples from 350 of these women and compared them to their own reports on the use of skin creams and other skin-care products. NILU's research showed that parabens could be detected in blood samples from randomly selected women.

"If these substances are in your blood, they are also in your liver and everywhere else in the body," says Sandanger.

Pregnant women should be better protected

"It is encouraging that both Denmark and the EU have tightened rules on the use of parabens, but research suggests that we should also consider a ban that includes pregnant women. This is a complicated issue, but it has been shown that exposing a foetus to these chemicals may have greater consequences than exposure after birth. The EU scientific committee nevertheless believes that there is no reason to impose such a ban before there is more documentation on the effects," says Sandanger.

"We humans are exposed to thousands of chemicals every day, and the basic idea should be that we do not need to have even more chemicals in our bodies. Today, researchers must prove that a substance is likely to be dangerous before the authorities can ban the substance, but it would be better to use the precautionary principle. We know little about how each drug affects the body and the environment, but we know even less about the so-called cocktail effect of several drugs at once," warns Sandanger.

"However, people can also make their own decisions without waiting for a stricter law. The Norwegian Consumer Council's app and other tools, such as the website of the environmental organization Green Day, have made it quite easy for most of us to avoid products that contain parabens," says Sandanger.

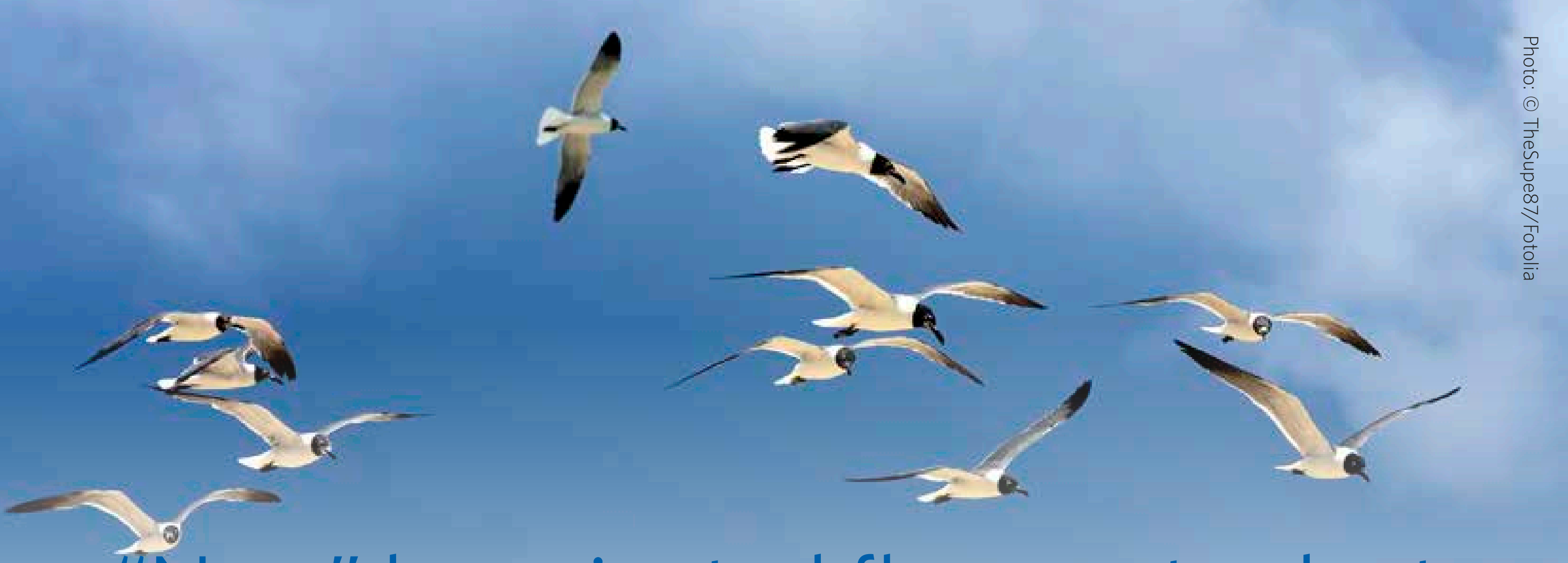


Photo: © TheSupe87/Fotolia

"New" brominated flame retardants in all Nordic countries

A screening study has found 'new' brominated flame retardants in samples from across the entire Nordic region.

By Sonja Grossberndt

Brominated flame retardants (BFRs) are organic substances that are used to reduce the flammability of furniture and electronic components, among many other products. BFRs are suspected of having negative effects on both the environment and human health. Due to their long persistence in the environment, some BFRs have accumulated in the Nordic countries, especially in the long and lipid-rich marine food chain. The highest accumulation levels are found at the top of the food chain. This is the main route by which flame retardants and other hazardous chemicals enter the human body – when people eat fish and other contaminated seafood that come from the top of the marine food chain.

"The existence of flame retardants in the air shows that they are being transported over long distances", says senior scientist Martin Schlabach.

Polybrominated diphenyl ethers (PBDEs) are one group of BFRs that were finally banned in 2008. After the phase out of PBDEs, a range of alternative – 'new' – flame retardants was introduced to the market. These new chemicals are also believed to have harmful effects on the environment and human health.

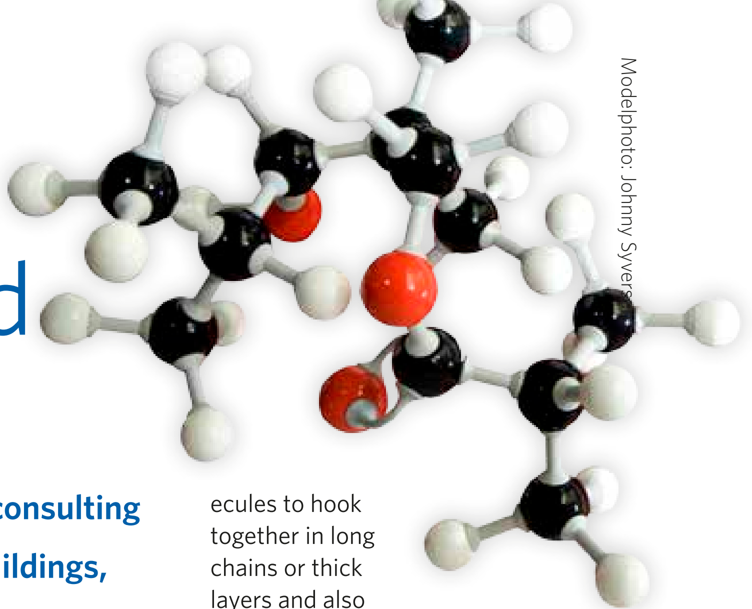
To determine the extent and geographic spread of these 'new' BFRs in the Nordic countries, the Nordic Council of Ministers initiated a screening project, run by a project group with representatives from universities, governmental bodies and research institutions from throughout the Nordic region. NILU and IVL Svenska Miljøinstitutet were responsible for conducting the chemical analyses.

Samples from the air, different biota, sediment, sludge and moss were collected in Denmark, the Faroe Islands, Finland, Iceland, Norway and Sweden. The samples have been processed and analysed for a number of different PBDEs and related substances.

All samples contained 'new' BFRs, which proves that they are widely distributed in the Nordic environment. However, there were differences in the geographic extent and occurrence among the substances:

"The samples represent different so-called source characteristics. This means that several of the chemicals we examined have been found both in animal species and air samples from background areas," explains Martin Schlabach, the project's coordinator at NILU. "The presence of flame retardants in background air samples indicates that these substances have been transported a long distance in the atmosphere. This means that they can cause harm not only in their areas of origin, but also far away in other ecosystems that previously had not been exposed to them."

Although the screening study contained a broad collection of samples, the fact that only a few samples were taken from several sites means that the scientists only have a 'snapshot' of the situation in the Nordic region. Additionally, there is only very limited data on the ecotoxicological effects of the substances in question, so there is not enough evidence to satisfactorily assess the ecotoxicological risks they might pose. As a next step, the participating scientists suggest that follow-up studies be conducted to identify emission sources and important pathways of the 'new' BFRs, with additional studies that would provide more information about the toxic effects of these chemicals on the environment and human health.



Modelphoto: Johnny Syvers

The culprit behind black dust?

Working in cooperation with NILU, Mycoteam, a consulting company that works with biological damage to buildings, has discovered a plausible explanation for why the walls and objects in some homes may be suddenly coated with a thin veneer of black soot. The culprit appears to be a substance found in most paints.

By Anne Nyeggen

These findings were met with a great deal of interest in the construction industry and ended up as the second most read article in the online construction magazine bygg.no in 2011.

Recently renovated homes with poor ventilation are at risk

"Black dust", or chemical blackening, occurs most often in new or renovated homes. Homes with poor ventilation are particularly at risk. Black dust only occurs during the winter months of December to February. In experiments in closed research chambers, Mycoteam and NILU demonstrated that under special conditions soot particles (from the use of candles or wood burning) can aggregate to bigger particles of which black dust is mainly composed.

"When what we call semi-volatile compounds (semi-VOCs) are also present, these soot particles can grow in size. But the conditions must also be very dry, with a relative humidity below 15%," says Norbert Schmidbauer, a senior researcher at NILU.

"In chamber experiments conducted by Mycoteam we found that the substance 2,2,4-trimethyl-1, 3-pentanediol monoisobutyrate, abbreviated TMPD-MIB, plays an important role in the process leading to black dust," Schmidbauer says. "This substance is ingredient in all water-based paints. It works to help the paint form a film – in other words, it knits the latex particles together to form a surface that is flexible, reasonably hard and waterproof. The substance, which is a main ingredient in paint (between 3 and 8%), is not very water soluble (less than 0.1% on a weight basis) but will condensate on the surface of soot particles as long as there are dry conditions", Schmidbauer explains.

The individual molecules of TMPD-MIB do not react chemically with each other or the soot particles, but they have the potential to make intramolecular hydrogen bonds. This causes the molecules to hook together in long chains or thick layers and also to hook together particles covered with TMPD-MIB. The presence of water/moisture can disturb this growth. That means that the phenomenon only occurs under very dry conditions.

Black dust, also known internationally as "Black Magic Dust" or "Schwarze Wohnungen" has been studied in large international research projects, but no one has come up with a good explanation for the phenomenon. It has also been difficult to perform experiments which could explain extraordinary particle-growth in closed research chambers. However, all the experiments performed for these studies were conducted with standardized relative humidity of either 25 or 50% - but never under very dry conditions.

«Important research work»

The Norwegian Homebuilders Association has received many complaints from homeowners who have been affected by black dust, and therefore initiated the effort to commission Norwegian researchers to look at why more and more houses were suddenly plagued by black walls indoors.

"This is very important research, even by international standards," says Per Jaeger, chief executive officer of the Homebuilders Association.

Black dust can be a vexing sight on newly painted surfaces.
Photo: Mycoteam.

New technology reveals unknown

Senior scientist Armin Wisthaler and NILU's new mass spectrometer can detect volatile contaminants at unprecedented speed including species that have never been detected before. It is now also possible to analyse for example organic pollutants in the atmosphere from an airplane at full speed, to study unknown chemical reactions in indoor air and to investigate a series of other dependencies of importance for environment and human health.

By Bjarne Røsjø

A traditional method for measuring air pollutants is to direct air through a filter or cartridge for several minutes or even hours and to later analyse in the laboratory what kind of compounds have been captured. But pollutants can vary on very short timescales (seconds) and traditional methods only give a single snap-shot from an extended period of time. Armin Wisthaler is one of Europe's most experienced experts in using a new instrument called PTR-TOF-MS (Proton-Transfer-Reaction Time-of-Flight Mass Spectrometer), that is eliminating many of the old technologies' weaknesses.

"The instrument can detect volatile organic compounds (VOC), both in indoor and outdoor air," explains Armin Wisthaler. "In the past samples have been analysed offline in the laboratory, but this instrument analyses the air quality immediately. By this we can for example place the instrument on board of an airplane, analysing the air continuously from its start until landing, from ground level up to flight altitude," explains Wisthaler.

Analysis as fast as lightning

In brief, the new instrument consists of a small reactor with negative pressure, which is continuously flushed with air to be analysed. In the reactor water vapour molecules that carry an extra proton (H_3O^+) react as fast as lightning with organic compounds. The organic compounds obtain a positive electric charge and can be analysed in a high resolution mass spectrometer, which gives immediate information about the atomic composition of the molecule.

"One of the advantages about this technology is that the analysis goes very fast while we are doing our field work. Another advantage is that we do not any longer need to treat the air samples before analysis. The new spectrometer has already detected many molecules that are usually so reactive that they are lost on filters or cartridges or during the traditional laboratory analysis. I believe that these compounds are very important, because due to their reactivity they may also cause a biologic response in humans, for example in the respiratory tract or the eyes. There is a theory that these compounds contribute to the increasing incidence of irritation symptoms, asthma and allergies in many parts of the world," explains Wisthaler.

Required big environment

The PTR technology has been developed for air sampling at the University of Innsbruck in the 1990s where Wisthaler and a small group of physicists have been working for many years to further develop this technology so that it can also be used for atmospheric research. In November 2011 he came to NILU to fully exploit the potential of this technology in a big center for air research with colleagues that can stimulate each other and develop new ideas. "In Innsbruck we were a small and exotic group of scientists at an institute that was actually working with other things," explains Wisthaler.

Indoor air environment is more important than you think

Armin Wisthaler is full of ideas of how the PTR-technology can be used for practical surveillance of the environment and for new research projects. "We can for example examine if there are any unknown compounds in the exhaust of busses driven by bioethanol. We can also analyse the air that you breathe in and out to find out what kind of organic molecules have been taken up from your body. I am in deed very much interested in looking closer at indoor air pollution, which is probably more important than many might think. We spend most of our time indoors and many common building materials release chemical compounds that we know only little about. In addition, many of these compounds undergo pollutants

Armin Wisthaler (right) and Tomas Nikovini measure the exhaust from an ethanol bus using the PTR instrument. Photo: Lone Lohne, Aftenposten

chemical transformations in the indoor environment - forming highly reactive species which we have overlooked in the past. If I turn on the instrument inside my office or at the lab, I can see immediately that the air contains at least 100 different substances we know nothing about. I believe it is very important to develop more knowledge about indoor air pollution," declares Armin Wisthaler.

FLEXPART: a model with important applications

Observations are essential to all areas of earth and environmental sciences. Senior researcher Rona L. Thompson collects atmospheric data from global observation networks, and especially from the Arctic and Southeast Asia, and uses these with models for monitoring emissions of greenhouse gases - an important task in understanding global climate change.

By Bjarne Røsjø

Rona Thompson is one of NILU's newcomers in 2011. Among her skills is the ability to determine if countries are correctly reporting the amounts of their greenhouse gas emissions. Photo: Ingar Næss

Rona Thompson came to NILU's Department of Atmospheric and Climate Research in October 2011, after a period as a postdoctoral fellow at the Laboratoire de Sciences du Climat et de l'Environment (LSCE), part of the French Centre National de Recherche, in the Paris region. At NILU, she soon became involved in two important projects that both make use of the FLEXPART computer model, developed by NILU scientist Andreas Stohl and his colleagues in the late 1990s.

FLEXPART was originally designed to monitor and calculate the dispersion of pollution from point sources but the model has since been further developed and is now used by several research groups in many countries to estimate how difference substances disperse in the atmosphere; including greenhouse gases, radio-nuclides (from e.g. nuclear fall-out), industrial pollution, and ash clouds from volcanic eruptions.

FLEXPART can also be used to help determine the amount and locations where atmospheric pollutants and greenhouse gases are emitted. Thompson explains that to do this "FLEXPART is run using meteorological data to calculate how gases or pollutants disperse with e.g. wind speed and direction. We then compare our FLEXPART calculations with observations of these gases from aircraft, land-based stations and satellites measurements. The comparison between the model (FLEXPART) and the observations helps to determine how much gas or pollutant was emitted and where it was emitted".

Monitoring greenhouse gases

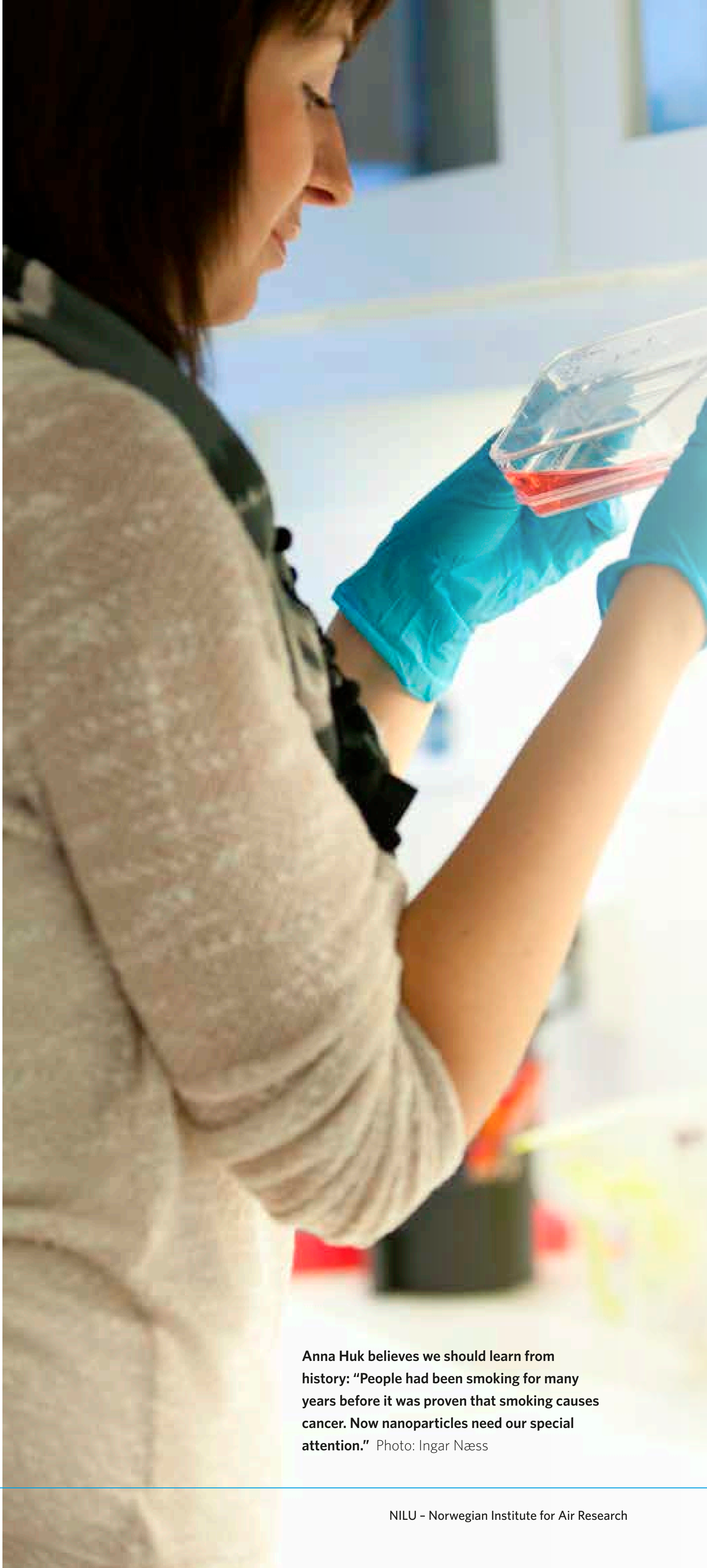
While at LSCE in France, Thompson worked to estimate the sources of the greenhouse gases, methane and nitrous oxide. She is now continuing in this » line of research at NILU, where she is currently involved in two projects, one of which is to identify and estimate the sources of methane in the Arctic. Thompson uses methane measurements from the Zeppelin Observatory on Svalbard, among other research stations in the Northern Hemisphere.

"The greenhouse effect is likely to cause more rapid warming in the Arctic than in many other places on the planet and this can lead to increased emissions of methane from melting permafrost as well as from large marsh and peat lands in the high northern latitudes. We also see that large amounts of methane are being released by offshore operations in the North Sea," Thompson says.

Growing economies - and emissions

Thompson is also following the emissions of greenhouse gases from China and other countries in Southeast Asia, which are undergoing rapid economic development: "This leads to an overall increase in the emission of the important greenhouse gases, CO_2, CH4 and N2O. In addition, emissions of other greenhouse gases such as the HFCs (hydrofluorocarbons) are increasing in Asia as well as globally. This is because HFCs are being used to replace CFCs (chlorofluorocarbons), which destroy the ozone layer and have therefore been phased out by the Montreal Protocol put into effect 1989. So while concentrations of CFCs are going down, concentrations of HFCs are going up. HFC gases have the advantage that they do not destroy the ozone layer but they also have the disadvantage that they are strong greenhouse gases," says Thompson.

The FLEXPART model has previously been used to verify the emissions of HFCs (and the similar group of species, the HCFCs) reported by different countries to e.g. the United Nations Framework Convention on Climate Change. "Large discrepancies in emissions reporting were found, which were not necessarily deliberate but rather because there are many sources of these gases of which no one has a full overview and that is exactly why atmospheric measurements are so important; because the atmosphere does not hide anything," Thompson explains.



Anna Huk believes we should learn from history: "People had been smoking for many years before it was proven that smoking causes cancer. Now nanoparticles need our special attention." Photo: Ingar Næss

Nanosafety

The increasing use of nanoparticles in industrial processes and consumer products raises questions about their safety for consumers. PhD candidate Anna Huk explains how NILU's Health Effect Group is developing methods to find out more about the toxic effects of nanoparticles to make our world a bit safer.

Anna Huk, holder of a Marie Curie Action scholarship in nanosafety. Photo: Ingar Næss

By Sonja Grossberndt

"Nanoparticles and particularly engineered nanomaterials are a hot topic," says Anna Huk, a PhD candidate at NILU. "They are now used in many industrial processes and consumer products – but there is still no consensus among scientists regarding their toxic potential. The EU has stricter laws on the use of nanoparticles than the USA, for example, but a large number of cosmetic and food products are still being produced with nanoparticles. Their advantageous properties, such as their antibiotic characteristics, make them very attractive."

Comprehensive training

Huk has recently started her PhD education with a Marie Curie Action stipend as a part of a scientific education programme under NanoTOES, an EU FP7 project. The project includes 11 PhD candidates and two postdocs who are participating in a comprehensive training programme to turn them into nanosafety experts.

It is important to have experts who can carry out an extensive risk assessment of nanoparticles, including their production and use, but also their fate in the environment and their potential effects on human health. And this is where Anna Huk comes into play.

Comprehensive research

At NILU's Health Effect Laboratories, Anna Huk found comprehensive equipment for her research: she is investigating the damage nanoparticles can cause to human DNA by using what is called a comet assay. This method helps her to detect damage in DNA by visualization.

"After extracting the DNA from the cell nucleus, electrophoresis will 'pull' the damaged DNA away from the ravel of undamaged strands. Under the microscope you can see a comet with a tail, the comet being the whole DNA strands, and the tail the damaged ones. With the help of a Laser Scanning Microscope, we can also investigate if different nanoparticles can cross the cell membrane, enter the cell nucleus and damage DNA," explains Huk. Her research also includes the study of changes in the character of nanoparticles after their uptake into the body. Do human proteins change the shape, size or surface of nanoparticles? And what effects do these modifications have on human cells? *In vitro* studies with human kidney cells should help answer these questions.

Comprehensive communication

Anna Huk is very pleased with her work. New equipment will help her to modify old methods that have been used for the analysis of traditional chemical substances so she can apply them to analysis of nanoparticles. "I am mainly focused on nanosilver, a substance that is used in many cosmetics and other consumer products, such as electrical equipment or clothes," she says. A lot of work lies ahead of her. Additional training in the context of the Marie Curie Action programme will help her to develop skills she needs to learn more about assessing the risks posed by nanoparticles. This also includes some communication training.

"It is so important to communicate the risks and benefits of nanoparticles in a balanced way. People are often afraid of the new technologies and know very little about nanosafety. This is where my future field of work lies," says Huk. "But there are still many uncertainties and unknown factors that require further research."

"The situation today is comparable to the use of nicotine in the past – people had been smoking for many decades before it was proven that smoking causes cancer. The same applies to the use of pesticides, such as DDT. And now nanoparticles need our special attention," she says. "With extensive and comprehensive research we might be able to analyse the toxicity of nanoparticles early enough before they can cause major damage to the environment and human health."

Fukushima – biggest nuclear accident since Chernobyl

The major accident at the Fukushima power plant did not only affect Japan, but became a global threat due to the release of massive amounts of radioactivity.

By Anne Nyeggen and Sonja Grossberndt

Tragic moments

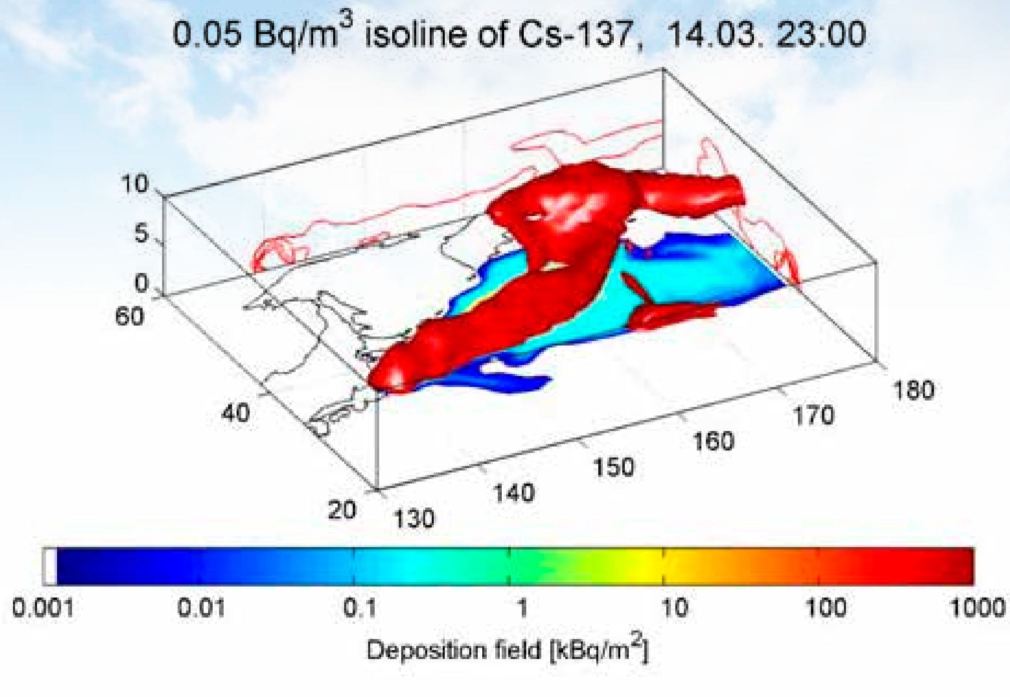
We all remember the tragic moments on 11 March 2011, when an earthquake with measure 9.0 on the Richter scale caused a large tsunami to hit the East coast of Japan's main island Honshu. The loss of electric power at the Fukushima Dai-ichi nuclear power plant (FD-NPP) caused a disaster by releasing a massive amount of radioactivity into the atmosphere. In addition to the damages by the tsunami, the Japanese population now had to face radioactive contamination.

Spreading danger

In order to find out more about the distribution of the released radioactivity, NILU scientist Andreas Stohl began working on calculations of the time-varying radionuclide emissions, using the atmospheric transport model FLEXPART, meteorological data and radionuclide data from the CTBTO data base (see fact frame). Andreas Stohl and his team began calculating to what extent radioactivity had been released from FD-NPP into the atmosphere and carried to different places in the world. He focused on xenon-133 (^{133}Xe) and caesium-137 (^{137}Cs). While the noble gas ^{133}Xe 'only' takes 5.25 days to decrease by half and is of relatively small concern for human health, ^{137}Cs has a half-life of 31 years and can cause damage to the environment, agriculture, stock farming, and human health. Andreas Stohl came to the following reconstruction of the events:

A guard in full protective equipment at the gates of the Dai-ichi nuclear power plant.
Photo: Voice of America, S. Herman

- After the radioactive cloud had been released on March 11, it was carried away by the wind over the Pacific. However, four days later a cyclone caused the radioactive cloud to return to the Japanese mainland. According to the measurements, this was the period with highest ^{137}Cs emissions. On March 20 the cloud reached the capital Tokyo with its 35 million popula-



The FLEXPART model shows the distribution and transport of radioactive emissions from the nuclear reactor.

tion. Fortunately it did not rain these days, so the radioactivity was not deposited onto the mega city, but stayed in the higher layers of the atmosphere. However, it rained for three days over other areas of the Japanese island Honshu.

Of the total amount of ^{137}Cs released, 80 % have been deposited into the Pacific Ocean, 18 % onto the Japanese mainland and only 2 % onto other continents. Due to strong dilution of the emissions, no consequences for the environment or human health can be expected in land areas outside Japan.

Alarming numbers

Stohl calculated that in total 36.6 PBq of ^{137}Cs and 15.3 EBq of ^{133}Xe have been released, which for the ^{133}Xe is more than twice as much as the ^{133}Xe release from Chernobyl 26 years ago. The soils around Fukushima were heavily contaminated with the deposition of ^{137}Cs of more than 100,000 MBq per km^2, decreasing to 10,000 MBq per km^2 in the neighbouring prefectures

Could have ended much worse

- The catastrophe in Fukushima was the biggest nuclear incident after the nuclear accident in the Chernobyl Nuclear Power Plant, 26 years ago, states Andreas Stohl. Unlike in Japan, the radioactive cloud from Chernobyl was carried over the whole European continent, the worst hit regions being Belarus, Ukraine and Russia. In Fukushima, the accident released less than half of the amount of ^{137}Cs from Chernobyl. In the end it wasn't as bad is it could have become, concludes Stohl.

Andreas Stohl, an NILU senior scientist, believes that it could have been much worse for Japan and other countries if the wind direction had been different after the catastrophe at the nuclear power plant in Fukushima.

BECQUEREL:

Becquerel is the unit of radioactivity. One Bq is defined as the activity of a quantity of radioactive material in which one nucleus decays per second.

1 EBq (exabecquerel) = 1018 Bq

1 MBq (megabecquerel) = 106 Bq

1 PBq (petabecquerel) = 1015 Bq

THE COMPREHENSIVE NUCLEAR-TEST-BAN TREATY ORGANIZATION

(CTBTO) embraces a global network of 80 measuring stations that are continuously delivering data about the occurrence of radionuclides all around the world. These measuring stations have been originally established to deliver data on nuclear weapons tests, but the obtained data can also be used for scientific purposes.

Good volcanic ash data saves European air traffic

Three days after a volcanic eruption in Iceland in May 2011, the Met Office in London warned that volcanic ash in the skies over large parts of southern Norway could represent a danger to air traffic. But Norwegian experts had their own models and good satellite data and concluded that air traffic could resume as normal.

By Bjarne Røsjø

When Iceland's Eyjafjallajökull volcano erupted in April and May 2010, hurling vast quantities of ash into the atmosphere, both Norwegian and international aviation authorities were poorly prepared. It had been a long time since anything like this had happened in Europe, and the ash cloud from Eyjafjallajökull grounded more planes than any previous volcanic eruption. Millions of airline passengers remained "trapped by volcanic ash", and the airlines lost huge amounts of money.

"It was primarily observational data from satellites that enabled us to have good enough estimates of the ash concentrations from the eruption," says Kjetil Tørseth, director of the Department for Atmospheric and Climate Research at NILU. Photo: Ingar Næss

But when Iceland's Grimsvötn volcano in Iceland erupted a year later, on 21 May 2011, both the Norwegian and international aviation authorities were far better prepared. On Tuesday 24 May, the London Volcanic Ash Advisory Centre (VAAC), based at the UK Met Office, warned that the airspace above Haugesund, Stavanger and Kristiansand forecast high enough concentrations of ash so that it would be inadvisable to fly, and making it likely that thousands of passengers would be stranded starting at 14.00 that day.

An emergency meeting

In spite of these warnings, Norwegian air traffic was able to continue as normal because the country's aviation authorities had entered into a unique collaboration with a number of Norwegian research institutions. Experience from the Eyjafjallajökull eruption led the Civil Aviation Authority to established Agency Volcanic Ash Group (EVA), with representatives and experts from the Civil Aviation Authority, Avinor, the Norwegian Meteorological Institute and the Norwegian Institute for Air Research (NILU).

When the Grimsvötn volcano erupted, EVA members were called into an emergency meeting, where scientists were able to present reliable satellite data on the probability that the airspace over the southwestern part of Norway would not be subject to high concentrations of ash.

This was a historic decision: Norway was the first country in Europe that chose to rely on its national expertise instead of warnings from the VAAC, and the Civil Aviation Authority allowed air traffic to proceed normally in an area where the VAAC had warned that ash concentrations would be unacceptably high. This decision resulted in savings for airlines and prevented a great number of travellers from suffering the inconvenience of being unnecessarily grounded.

The Agency Group's decision was sent to the airlines just minutes before air traffic over large parts of southern Norway would have been paralyzed. The EVA subsequently had daily meetings until the volcano's eruptions calmed down, and it turned out that the Norwegian forecasts were accurate. Norwegian airlines thus avoided significant economic losses from rescheduling several hundred flights, while air traffic over Iceland, northern Sweden, Denmark, Germany and Scotland was hit hard.

Satellite data kept the air space open

"It was primarily observational data from satellites that enabled us to have good enough estimates of the ash concentrations from the eruption. EVA is a concrete example of how good working relationship between the research community and regulatory agencies can provide results that benefit society," says Kjetil Tørseth, director of NILU's Department of Atmospheric and Climate Research.

NILU has studied the spread and detection of volcanic ash clouds for a number of years, and has monitored the spread of ash clouds with the aid of satellite-borne instruments that were originally designed to detect radiation »

The ash cloud that ascended into the atmosphere right after the eruption of Grimsvötn in May 2011.
Photo: Wikimedia commons, Calistemon

NASA MODIS satellite image acquired at 05:15 UTC on May 22, 2011 shows the plume casting shadow to the west.
Photo: NASA/GSFC/Jeff Schmaltz/MODIS Land Rapid Response Team

and clouds. "Researchers at NILU have developed methods that make it possible to use data from these instruments to determine whether there is ash in the atmosphere. These algorithms proved their worth when the Grimsvötn volcano erupted in May 2011," Tørseth says.

The Eyjafjallajökull eruption in 2010 led to several changes in international aviation authority regulations. "When Eyjafjallajökull erupted, regulations were issued that prohibited commercial flights if there was any ash whatsoever in the air. But this was too restrictive, so threshold levels were established that would allow planes to fly in low levels of ash if certain procedures were followed. In May 2011, the VAAC in London forecasted that these threshold limits could be exceeded in southern Norway, while our satellite data showed lower ash concentrations than the limits," Tørseth said.

Although the Norwegian government chose to ignore the VAAC advice to close the air space, it does not mean that the watchdogs in London did a bad job. Providing forecasts of ash concentrations is actually a very difficult task.

"Bringing in national, in addition to international expertise, provided an improved basis for decision-making. In addition, this made it possible to take advantage of local knowledge and made for closer proximity to the important decisions that had to be taken," Tørseth said.

EVA thanked

"Norway stood out as a model for the rest of Europe. Both the airlines and the general public were saved from great financial losses, the travellers were spared cancellations and delays," Norway's Minister of Transport and Communications, Magnhild Meltveit Kleppe told the Norwegian aviation journal Avinorpuls.

The EVA was also thanked by SAS and Norwegian Air Shuttle for the assessments it made during the volcanic eruption. "Over the past year, we have gained great confidence in the assessments made by the Civil Aviation Authority, Avinor and the Norwegian meteorological community in these kinds of situations. Without these careful assessments, Norwegian society and the aviation industry would have been hit hard," Ole Christian Melhus, Deputy Director of Flight Operations at Norwegian Air Shuttle said to Avinorpuls. "We note that the EVA made significant contributions to avoiding the unnecessary closure of Norwegian airspace," commented Paul Hengebøl, head of external relations at SAS.

Norway's Minister of Transport, Magnhild Meltveit Kleppa, is grateful for the information she was given, which made it possible to keep the airspace over Norway open.
Photo: ©Stortingsarkivet

The ash camera is tested over Stromboli in Italy.

AVOID

NILU's Fred Prata has developed an "ash camera" that alerts airplane pilots to the presence of ash clouds, allowing the aircraft to avoid having to be grounded by volcanic eruptions. The camera is now being tested on EasyJet's aircraft.

By Anne Nyeggen

When Fred Prata came to NILU five years ago, he came with the idea for an "ash camera", an idea he had worked on for 17 years. In Norway, he found both an advanced research environment and funding for further development. After another five years of work, the camera has now been test-driven over the Etna and Stromboli volcanoes in Sicily, with good results.

AVOID detects ash from 100 kilometres away

AVOID, an infrared camera, can detect ash that is 100 kilometres away, even at night. This is possible through technology that makes particles in the ash cloud visible. The silicate particles in ash are very harmful to planes, because they can be sucked into the engine, where they can melt and clog the equipment. To avoid this kind of damage, it is important for pilots to know in advance whether or not the ash clouds from volcanic eruptions will cross their route.

"The pilot gets information about the composition of the particles in the air, and can evaluate whether it is possible to fly through the ash cloud, or whether the plane has to fly around the cloud," Prata says. "This gives the pilot 5-10 minutes if necessary to fly around the ash cloud, and can prevent potentially serious damage."

Interest in the market

John Ackerman, business director for Nicarnica, which is marketing the camera, says that he has had interest from several airlines. "Nicarnica have discussed the camera with Airbus and Boeing, as well as EasyJet, but we're now ready to finish up the test phase we are in so that we can perfect the technology," Ackerman says. "After this, the AVOID technology be available to all airlines."

A test flight with a large press turnout

After several weeks of flight-testing, the camera was presented to a planeload of journalists in Sicily in December 2011. CNN, BBC, Reuters, National Geographic and other international media were present and heard a proud Fred Prata say that Nicarnica will deliver the camera to the British airline EasyJet, which will equip 20 new Airbus A320 aircraft with the Norwegian technology in 2012. The UK, much like Norway, is affected by volcanic ash from Iceland, but EasyJet is confident that the camera will make it possible to still maintain its plane service if Katla were to erupt, for example.

After 22 years of work, NILU's senior scientist Fred Prata is very happy that his ash camera has finally become reality.

NILU – making a difference for the environment

NILU is an independent, nonprofit institution established in 1969. Through its research NILU increases the understanding of processes and effects of climate change, of the composition of the atmosphere, of air quality and of hazardous substances. Based on its research, NILU markets integrated services and products within the analytical, monitoring and consulting sectors. NILU is concerned with increasing public awareness about climate change and environmental pollution.

NILU topics

- Atmospheric composition
- GHG and climate-forcing agents
- Ozone-layer depletion and UV radiation
- Long-range transport of air pollution
- Urban and industrial pollution
- Aerosol and particulate matter
- Chemicals and their environmental effects
- Health-effect studies
- Ecology and economics

NILU holds a strong position within its core fields both on the national and international level.

Services

Air quality consulting services

NILU has 40 years of experience in handling air pollution issues. By combining highly qualified scientific researchers and in-house software developers, NILU has introduced a complete range of air quality consulting services to meet any requirement.

Chemical analysis

NILU's laboratories can perform advanced analysis on a broad range of organic and inorganic pollutants on all kinds of samples.

From Pole to Pole

NILU monitors climate change, global air quality and air pollution transport pathways through observatories in Norway (Birkenes and ALOMAR at Andøya), in the Arctic (Zeppelin at Svalbard) and in Antarctica (Troll). NILU's observatories supply researchers all over the world with important data on a wide spectrum of pollutants, climate gasses and climate forcing agents.

Laboratories

NILU's chemical laboratories are among the most advanced in Europe. The laboratories have a range of state-of-the art analytical equipment, including a series of high-resolution mass spectrometers to determine a broad range of organic and inorganic pollutants.

Health effect laboratory

The health effect laboratory investigates the direct health impact of pollution, climate change and new materials on humans and animals. The laboratory has developed amongst others methods for risk assessment of nanoparticles in industrial processes and consumer products.

International activities

NILU has a long experience in coordinating international research projects and is involved in a long range of international assignments. The institute is strategic partner for the environmental authorities in Abu Dhabi in the United Arab Emirates and has also an office in Poland. Furthermore NILU takes an active part in EU's framework programmes for research. It is also co-ordinating the Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (EMEP). Finally, NILU has a leading international role in collecting and storing measurement data from atmospheric research and monitoring programmes.

Major international NILU clients

- European Commission (EC)
- European Environmental Agency (EEA)
- United Nations Environment Programme (UNEP)
- United Nations Economic Commission for Europe (UNECE)
- Environment Agency Abu Dhabi (EAD)
- International Bank for Reconstruction and Development (IBRD)
- World Meteorological Organization (WMO)
- World Health Organization (WHO)

Innovation

NILU is marketing its innovations through NILU Innovation AS. The 100% owned subsidiary is also the holding company for various new establishments, such as Nicarnica AS, Nicarnica Aviation AS og Comet Bio Tech.

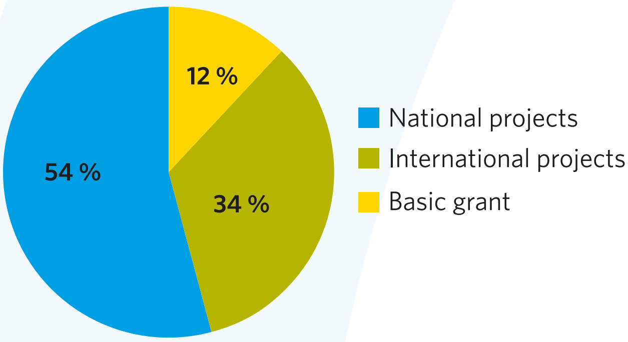
Key figures

Extract from the Annual accounts: All figures in MNOK

INCOME STATEMENT	2011	2010
Project revenue	169,8	165,1
Basic grant	22,8	20,7
Other operating income	0,4	0,7
Operating revenue	**193,0**	**186,5**
Personell expenses	-125,7	-120,1
Direct project expenses	-26,8	-29,1
Other expenses	-38,0	-34,0
Operating profit	**2,5**	**3,3**
Net financial items	1,5	-0,6
Tax	0	-1,8
Net operating profit	**4,0**	**0,9**

BALANCE	31.12.11	31.12.10
Total current assets	81,3	78,1
Total fixed assets	99,3	94,6
Total assets	**180,6**	**172,7**
Equity	109,8	108,5
Liabilities	70,8	64,2
Total equity and liabilities	**180,6**	**172,7**

PROJECT PORTFOLIO - PERCENTAGE 2011



NUMBER OF MAN-YEARS	2011	2010
Total	185	182
- whereof research man-years	98	97
- whereof man-years of other personnel	87	85
Turnover per research man-year	1 966	1 923

NUMBER OF EMPLOYEES		
Total	197	194
- whereof women	83	86
- whereof men	114	108
Number of employees holding a doctorate	58	55

INTERNATIONAL PROJECTS - NUMBERS		
EU-projects	30	34
Nordic Council of Ministers	6	4
United Nations	3	1
World Bank	2	2
Other projects	24	21
Total	**65**	**62**

PROJECT PORTFOLIO - NUMBERS		
0 - 100 000	106	108
101 000 - 500 000	119	134
501 000 - 2 000 000	54	68
2 001 000 and over	21	16
Total	**300**	**326**

NILU PUBLICATIONS		
Scientific Papers	116	109
Scientific Reports	73	92
Technical Reports	4	15
EMEP/CCC reports	7	4
Lectures	91	111
Posters	18	31

NILU scientists contributed to the publishing of:

External reports	16	21
Chapters/articles in books/reports	74	56

Scientific Papers

Ahlgren, H., Henjum, K., Ottersen, O.P., Runden-Pran, E. (2011) Validation of organotypical hippocampal slice cultures as an ex vivo model of brain ischemia: different roles of NMDA receptors in cell death signalling after exposure to NMDA or oxygen and glucose deprivation. *Cell Tissue Res., 345*, 329-341. doi:10.1007/s00441-011-1218-2.

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NILU – Norwegian Institute for Air Research
NILU main office
P.O. Box 100
NO-2027 Kjeller
Norway
Visiting address: Instituttveien 18, Kjeller
Telephone 63 89 80 00
Fax number 63 89 80 50
E-mail nilu@nilu.no
www.nilu.no

NILU in the Fram Centre
Hjalmar Johansens gate 14
NO-9296 Tromsø
Norway
Telephone 77 75 03 75
Fax number 77 75 03 76
E-mail nilu@nilu.no
www.nilu.no

NILU UAE
Villa No. 8, Street No. 10
Sector 16, Zone 1
Zayed University Area
P.O. Box 34137
Abu Dhabi
United Arab Emirates
Telephone +971 2 445 00 88
Fax number +971 2 445 00 83
E-mail uae@nilu.com
www.nilu.no

NILU Polska Sp. z o.o.
ul. Ceglana 4
40-514 Katowice
Poland
Telephone +48 32 257 08 58
Fax number +48 32 257 08 58
E-mail nilu@nilu.pl
www.nilu.pl

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