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The Integrated Monitoring Area Lheebroekerzand - The Netherlands

Data of 1997-1998-1999

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Abstract

The International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP-IM) is an extensive monitoring programme with a large number of chemical, physical and biological variables. In this report the results of the last three years of monitoring in the Lheebroekerzand, Drenthe, carried out in the framework of the United Nations Economic Commission for Europe (UN-ECE) are presented. With the data collected in the field and the measurements in the laboratoria, a database is build up containing environmental information in relation to possible effects of air pollution on ecosystems for Europe and Canada.
The objectives of this report are to collect and present the 1997, 1998 and 1999 monitoring data of the Netherlands, to inform participating organizations and volunteers and to close the period of monitoring by RIVM in the Lheebroekerzand.
In the period from 1997 to 1999, the biological part of the integrated monitoring programme consisted of a regular inventory of vegetation, birds, epiphytes, leafminers and butterflies in the monitoring area, as well as inventories of the aquatic macrofauna present in the moorland pool Kliplo and observations on the performance of pine trees. The chemical-physical part included meteorological variables like temperature, humidity, the amount of precipitation and irradiation, together with chemical analysis of organic and inorganic compounds in air, precipitation, leaves, needles, mosses, soil, soilwater, groundwater and pool water.
Comparing the data of chemical variables of different subprogrammes of 1997, 1998 and 1999 no clear trends can be recognized. However the monitored concentrations for SO_4S in air, throughfall, stemflow and lake water seem to diminish in time. For concentrations of NO_3N and NH_4N in air and lake water the same conclusion can be drawn. This decrease in concentration can not be confirmed in rainwater. Concerning biological variables (Inventory of birds, Inventory of plants, Hydrobiology of lakes, Forest damage, Trunk epiphytes, Leafminers and Butterflies) nothing can be said about possible trends so far. However, it seems that the number of individuals for birds, macrofauna, leafminers and butterflies is decreasing in time. More years of sampling and analysis are required to draw conclusions on the applicability of these data. A data-analysis of all available data of the Lheebroekerzand is carried out and will be published in a separate report.

Preface

Since 1989, The Netherlands gradually developed its monitoring site at Lheebroekerzand in the province of Drenthe. The Laboratory for Ecotoxicology (ECO) from the National Institute for Public Health and the Environment (RIVM) carried out the coordination of the monitoring activities and the collection of data. RIVM-ECO is the National Focal Point of the Netherlands for ICP-IM. Since 1993, fieldwork started according to the Manual for Integrated Monitoring Programme (Phase 1993-1996). Data of previous studies carried out in the Lheebroekerzand were collected and made available. For the subprogramme on lake water chemistry, the available data even dated back to 1924. Next to the subprogrammes described in the Manual, additional biological inventories were added to the national programme. The biological monitoring activities consisted of regular inventory of breeding birds (BB), epiphytes (EP), butterflies (BF), leafminers (LM) and vegetation (VG) in the monitoring area, as well as inventories of aquatic macrofauna in the moorland pool Kliplo (LB) and observations on the performance of pine trees (FD). The chemical-physical part included meteorological parameters like temperature, humidity, the amount of precipitation and irradiation (AM), together with chemical analyses of organic and inorganic compounds in air (AC), wet and dry deposition (DC, TF, SF), mosses (MC), leaves and needles (FC, LF), lake water (LC), soil, soilwater and groundwater (SC, SW, GW). Many national institutes, organizations and volunteers made it possible to carry out this ambitious monitoring programme.

Since the start of the monitoring programme in 1993, there has been pressure on continuity. Every year, the importance of integrated monitoring in the Netherlands had to be proven. Many internal RIVM-discussions and presentations have been conducted. In 1997, the Director Environmental Research of RIVM concluded that the project did not provide the information that was required for the national tasks of RIVM. Still the decision to stop the monitoring task was postponed to enable the identification of topics that may be of national interest. In June 1999 this was successful. Cooperation was found with several projects within RIVM and requests for data for the validation of modeling were regularly posed.
In view of budget restrictions for national environmental research, the Dutch Minister of the Environment decided in July 1999 to put an end to our contribution to the ICP on Integrated Monitoring. Therefore, our equipment was moved from the Lheebroekerzand in January 2000. Some internal RIVM funding has been put aside to ensure proper data handling and reporting for the 1999 monitoring results. In 2001 some time is allowed to be spend on the initiation of vegetation effects modeling as planned during the 1999 ICP-IM Task Force meeting. The seven years of continued struggle to put up an international monitoring network was about to pay off in the sense of smooth operation and worthwhile interpretation of results.
Finally we would like to gratefully acknowledge all the institutes, organizations, volunteers, National Focal Points of ICP-IM, the ICP-IM Programme Centre and all the other persons

who contributed to this project on the national as well as the international level. The nice national and international co-operation we had over the past years was greatly appreciated.

Monique Wolters	(Coordinator Field Procedures)
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Samenvatting

In dit rapport worden de resultaten van 1997, 1998 en 1999 gepresenteerd van het monitoringprogramma uitgevoerd in het Lheebroekerzand, Drenthe. Het programma werd uitgevoerd in het kader van de United Nations Economic Commission for Europe (UN-ECE) International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP-IM).
Het doel van dit rapport is om de gegevens van 1997 tot en met 1999 te verzamelen en te presenteren, de deelnemende organisaties en vrijwilligers te informeren over de stand van zaken en om de monitoringsperiode in het Lheebroekerzand onder coördinatie van het RIVM af te sluiten. Het merendeel van de gegevens is reeds toegevoegd aan de internationale database die zich bevindt in Helsinki, Finland. Het is zeker niet de bedoeling om in dit rapport dieper in te gaan op oorzaak en effecten.
In de periode van 1997 tot 1999 bestond het biologische gedeelte van het monitoringprogramma uit een regelmatige inventarisatie van de vegetatie, vogels, korstmossen, bladmineerders en vlinders evenals inventarisaties van de macrofauna aanwezig in het ven Kliplo en observaties aan naaldbomen ter bepaling van de vitaliteit. Het chemisch-fysische deel van het programma bestond uit meteorologische variabelen zoals temperatuur, luchtvochtigheid, hoeveelheid neerslag en instraling samen met chemische analyses van lucht, neerslag, bladeren, naalden, mossen, bodem, bodemwater, grondwater en venwater.

Conclusies betreffende de resultaten van het monitoringprogramma zijn:

1. Uit vergelijking van de resultaten van de concentraties van chemische variabelen in de verschillende monitoringsprogramma's in 1997, 1998 en 1999 blijkt o.a. dat de concentraties van SO_4S in lucht, doorval, stamafvoer en venwater afnemen in de tijd. Voor concentraties van NO_3N en NH_4N in lucht en venwater lijkt dit ook het geval. Deze afname van concentraties kan echter niet bevestigd worden met een gemeten afname van deze variabelen in bulk regenwater. Interpretatie van deze gegevens vereisen een langere periode van monitoring.
2. Betreffende de biologische variabelen (Inventarisatie van vogels, korstmossen, vegetatie, macrofauna, bladmineerders en vlinders) kan eveneens geen uitspraak gedaan worden over mogelijke veranderingen in de tijd. Wel lijkt het aantal individuen voor vogels, macrofauna, bladmineerders en vlinders af te nemen. Meerdere jaren van inventariseren zijn noodzakelijk om deze vermeende trends te kunnen bevestigen.

Voortgang en conclusies betreffende de Nederlandse bijdrage aan het UN-ECE-integrale monitoringprogramma zijn:

1. In verband met het doorvoeren van bezuinigingen op milieuonderzoek heeft de minister van Milieu besloten monitoring in het Lheebroekerzand stop te zetten. In Januari 2000 zijn alle meetopstellingen in het Lheebroekerzand verwijderd. Wel is RIVM-ECO door de Minister verzocht om deel te blijven nemen aan de ICP-IM-werkgroep. Het 'National Focal Point' in Nederland wordt opgeheven en er zullen geen monitoringsgegevens meer aan de internationale database geleverd worden. Uitvoeren van onderzoek met ICP-IM

data zonder zelf een deelnemer te zijn van ICP-IM is in tegenspraak met de voorschriften van ICP-IM. Onderzoek met ICP-IM data mag alleen uitgevoerd worden door de deelnemende landen. Desondanks heeft de Task Force van ICP-IM toestemming gegeven voor voortzetting van het in 1998 gestarte vegetatieonderzoek om geïntegreerde effect-voorspellingsmodellen te gaan ontwikkelen op Europese schaal.
2. Ondanks de conclusie dat het voortbestaan van het Lheebroekerzand van belang is voor nationale en internationale netwerken (Mathijssen *et al.*, 1997) is de definitieve beslissing genomen om integrale monitoring op deze unieke locatie niet te continueren.

Belangrijke ontwikkelingen voor de voortgang van ICP-IM zijn:
1. De gereviseerde 'Manual for Integrated Monitoring' (1998) werd geaccepteerd tijdens de Task Force Meeting in Tallinn in April 1998. De subprogramma's zijn zoveel mogelijk afgestemd met vergelijkbare activiteiten van andere groepen onder de UN-ECE LRTAP Conventie. Bovendien zijn in de manual de relaties tussen de verschillende programma's geplaatst in een algemeen kader van oorzaak en effecten.
2. Deelname aan projecten en activiteiten van andere organisaties is gestimuleerd en heeft geresulteerd in samenwerkingsverbanden met o.a. IFEF, GTOS, ILTER and NoLIMITS.
3. Onderzoek met behulp van data uit de ICP-IM database wordt steeds meer uitgevoerd. Dit houdt in dat de database steeds waardevoller wordt naarmate hij omvangrijker wordt.

Helaas is dit het laatste rapport met monitoringsgevens afkomstig uit het Lheebroekerzand. Gezien de voortgang binnen het project en de internationale ontwikkelingen mag hier gesteld worden dat het aan te bevelen is een nieuw, vergelijkbaar monitoringprogramma te starten.

Summary

In this report the results of the monitoringprogramme of 1997, 1998 and 1999 in the Lheebroekerzand carried out in the framework of the United Nations Economic Commission for Europe (UN-ECE) International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP-IM) are presented.
The ICP-IM is an extensive monitoring programme with a large number of chemical, physical and biological variables. With the data collected a database is build up containing environmental information in relation to possible effects of air pollution on ecosystems for Europe and Canada.
The objectives of this report are to compile and present the 1997, 1998 and 1999 monitoring data of the Netherlands, to inform participating organizations and volunteers and to close the period of monitoring by RIVM in the Lheebroekerzand. It is explicitly not within the scope of this report to give a detailed analysis of causes and effects.
In the period from 1997 to 1999, the biological part of the integrated monitoring programme consisted of a regular inventory of vegetation, birds, epiphytes, leafminers and butterflies in the monitoring area, as well as inventories of the aquatic macrofauna present in the moorland pool Kliplo and observations on the performance of pine trees. The chemical-physical part included meteorological variables like temperature, humidity, the amount of precipitation and irradiation, together with chemical analysis of air, precipitation, leaves, needles, mosses, soil, soilwater, groundwater and pool water. The collected data on these variables can not yet be interpreted in detail until more elaborate time-series are available. Where possible, the series of data are compared with data of previous years.

Results and conclusions concerning the monitoring-programme are:

1. Comparing the data of chemical variables of different subprogrammes of 1997, 1998 and 1999 no clear trends can be recognized. However the monitored concentrations for SO_4S in air, throughfall, stemflow and lake water seem to diminish in time. For concentrations of NO_3N and NH_4N in air and lake water the same conclusion can be drawn. This decrease in concentration can not be confirmed in rainwater. A proper interpretation of data needs more years of monitoring data.
2. Concerning biological variables (Inventory of birds, Inventory of plants, Hydrobiology of lakes, Forest damage, Trunk epiphytes, Leafminers and Butterflies) nothing can be said about possible trends so far. However it seems that the number of individuals for birds, macrofauna, leafminers and butterflies is decreasing in time. More years of sampling and analysis are required to draw conclusions on the applicability of these data.

Concerning the participation of the Netherlands to ICP-IM, remarks to be made are:

1. The Minister of the Environment decided to stop the monitoring in January 2000 because of the austerity policy in studies on the environment. However, the Ministry of the Environment requests continued participation of RIVM/ECO in ICP-IM. This means that an appeal is made to use the know-how of ECO to participate in statistical and modeling studies with the international data. The National Focal Point of the Netherlands is

cancelled and no more monitoring data will be delivered to the international database. This is in direct conflict with the agreement that studies with ICP-IM data can only be carried out by members of ICP-IM. However the Task Force of ICP-IM gave permission to continue the study on modeling environmental vegetation effects on a European scale.
2. In spite of the conclusion that the existence of the monitoring site the Lheebroekerzand in the Netherlands is important for national and international parties and for policy aspects (Mathijssen *et al*., 1997), the definite decision is made to stop monitoring in this unique location.

Important to report about the progress of ICP-IM is:
1. The revised Manual for Integrated Monitoring (1998) was accepted at the Task Force Meeting in Tallinn in April 1998. ICPIM has succeeded in harmonizing the monitoring programmes with comparable activities of the other programmes under the UNECE LRTAP Convention. Besides, the revised manual defines the different programme levels in a general framework of causes and effects.
2. Participation and cooperation of ICPIM in projects and activities of external organizations is stimulated and performed with organizations as IFEF, GTOS, ILTER and NoLIMITS.
3. The data of the international ICPIM database becomes more valuable, what can be illustrated with the many studies carried out with data from this database.

Unfortunately this is the last report to present the Lheebroekerzand monitoring data. In view of the progress of ICP-IM and the many requests for data it is recommended here to start a new, similar monitoring programme.

1. Introduction

In 1993 the monitoring area, located in the nature reserve park Dwingelderveld in Drenthe (see Figure 1), became part of the international network of integrated monitoring sites of the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects (ICP-IM).

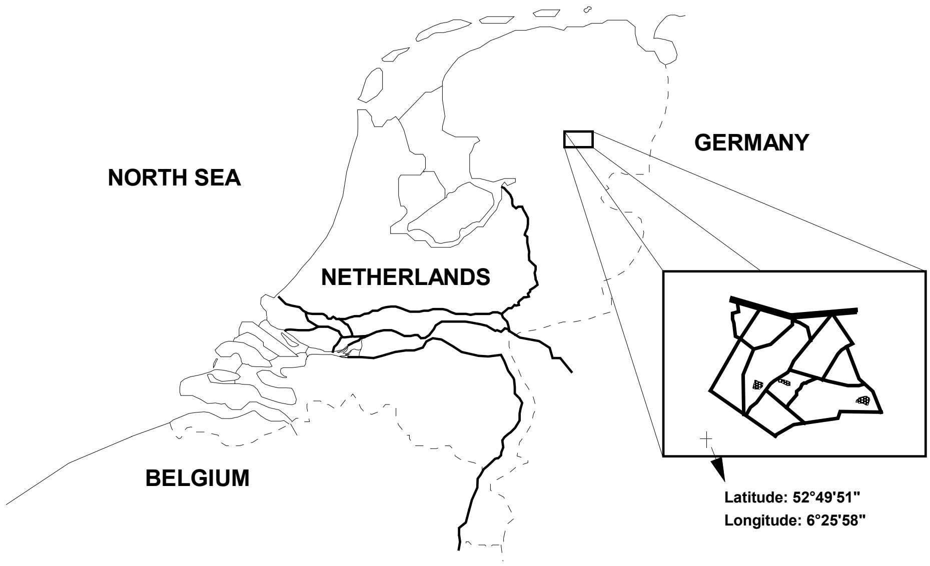

Figure 1: Location of the Lheebroekerzand in The Netherlands.

This monitoring network started with 36 stations in the Pilot Programme (1989-1991) and comprises at the moment 70 stations grossly distributed over Europe and Canada. The programme combines the collection of chemical, physical and biological data over time in different ecosystem compartments simultaneously at the same location (UN/ECE, 1993). The Dutch programme was set up according to the Manual for Integrated Monitoring, Programme Phase 1993-1996 (UN/ECE, 1993). The monitoring-activities prescribed in this manual were not fully implemented. Although the continuation of the monitoring has already been discussed before (Mathijssen *et al.,* 1997), a decision was made to continue the running programmes at a minimum level. No new programmes should start until a final decision on a possible continuation of the monitoring for a longer period would be taken. Alas, in January 2000 the monitoring in the Lheebroekerzand was not continued.

This report is the sixth in a series to present the data of the monitoring area the Lheebroekerzand in the Netherlands and will also be the last report. Monitoring data of previous years are reported (Mathijssen *et al*. 1995a, 1995b, 1996 and 1998). For more background information on the ICP-IM project and the participation of the Netherlands, the RIVM report *Development of the Integrated Monitoring Area - The Netherlands* (Mathijssen-Spiekman *et al.*, 1994) can be used as a reference.

Besides the data of 1997-1999, this report will show the state of affairs of the international monitoring activities carried out under auspices of the United Nations Economic Commission for Europe (UN/ECE). It is explicitly not within the scope of this report to give a detailed analysis of causes and effects. Therefore a study will be carried out with the use of historical data gathered in the Lheebroekerzand and its surroundings. The objectives of this report are to compile the monitoring data of 1997, 1998 and 1999, to inform participating organizations and volunteers and to close the period of monitoring by RIVM in the Lheebroekerzand.

2. Progress of the International Cooperative Programme on Integrated Monitoring on Air Pollution Effects (ICP-IM)

2.1 Introduction

Studies of air pollutants acting on particular receptors have often shown that an integrated approach is needed to fully understand the mechanisms of damage and the resulting effects. The ICP on Integrated Monitoring was established in 1992 (after the Pilot Programme 1989-1991) and is part of the Effects Monitoring Strategy under the UN/ECE Long-Range Transboundary Air Pollution Convention. The main aim of ICP-IM is to provide a framework to observe and understand the complex changes occurring in the external environment. Since it became evident that the internationally adopted emission reduction protocols are likely to lead to a situation where the critical pollutant loads on a continental scale are locally exceeded, it is becoming more and more important to be able to indicate the ecological impact of critical loadexceeding. This can be accomplished by putting more emphasis on studying biological effects in combination with local chemical exposure levels. Therefore, the monitoring and prediction of complex ecosystem effects on undisturbed reference areas require a continuous effort to improve the collection and assessment of data on the local and the international scale.
Besides the monitoring to provide an explanation of the changes in the ecosystem, ICP-IM has the objective to develop and validate models for the simulation of ecosystem responses and use them to estimate responses to actual or predicted changes in pollution stress and in concert with survey data to make regional assessments.

The programme is executed under the leadership of Sweden, and the ICP-IM Programme Centre in Helsinki, Finland, is entrusted with collecting, storing, processing and analyzing data from countries taking part in the programme. The history and the objectives of the programme as well as the organizational aspects are described in the first report concerning this monitoringproject (Mathijssen-Spiekman *et al.,* 1994).

2.2 Network of monitoring sites

In 1999, 22 countries carried out the integrated monitoring programme with 70 sites. Most of these are European countries. Of the North American countries only Canada is still taking part in the programme. The integrated monitoring network covers the following 22 countries: Austria, Belarus, Canada, Czech Republic, Denmark, Estonia, Finland, Germany, Iceland, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Russian Federation, Spain, Sweden, Switzerland, United Kingdom. These countries have either on-going data submission from at least one monitoring site or the data submission is just starting. Switzerland will carry out the IM programme on a lower level and a new decision on the extent of IM activities will be made in 2002. In the database in Helsinki, data are also

available of Hungary and Ukraine, but the monitoring activities in Hungary have been suspended and Ukraine has been unable to submit data the last few years.
In Table 1 an overview is given of the data from the participating countries reported to the ICP-IM Programme Centre.

The ICP-IM Manual detailing the protocols for monitoring each of the necessary physical, chemical and biological parameters was agreed upon in 1993 for the programme phase 1993-1996. In 1996 a start is made to set up a new manual with an intensive input of all countries. This manual more clearly illustrates the objectives of ICP-IM. The requirements of the monitoring activities are much more rationalized than in the previous manual, and the minimum requirements are more clearly specified to reduce the occurrence of non-overlapping cause and effects data. The new manual was accepted at the IM Task Force Meeting in Tallinn, April 20-22, 1998. The subprogrammes have as far as possible been harmonized with comparable activities of the other programmes under the UN ECE LRTAP Convention (mainly ICP Forests, ICP Waters and EMEP). The manual also contains the first versions of a new (optional) subprogramme 'Toxicity Assessment' (TA), as well as an overview on the monitoring of persistent organic pollutants (POPs) and heavy metals. The manual defines the different programme levels in a general framework of causes and effects (UN/ECE, 1998).

2.3 Studies carried out with data of the IM database

The amount of data in the IM database in Helsinki is valuable to carry out many different kind of studies. Recent assessment studies with ICP-IM data, which are reported in the 9th Annual Report 2000, are:

- *Input-output and proton budgets.*
  Ion mass budgets have proven to be useful for evaluating the importance of various biogeochemical processes that regulate the buffering properties in ecosystems. Long-term monitoring of mass balances and ion ratios in catchment/plots can also serve as an early warning system to identify the ecological effects of different anthropogenically-derived pollutants, and to verify the effects of emission reductions.
  The first results of input-output and proton budget calculations were presented in the 4th Annual Synoptic Report (1995) and the updated results regarding the effects of N deposition were presented in Forsius *et al*. (1996). Data from selected ICP-IM sites were also included in an European study for evaluating soil organic horizon C:N ratio as an indicator of nitrate leaching (Dise *et al*., 1998). The results regarding the calculation of fluxes and trends of S and N compounds are also presented in the Acid Rain Conference in December 2000.
  The budget calculations showed that there was a large difference between the sites regarding the relative importance of the various processes involved in the transfer of acidity. These differences reflected both the gradients in deposition inputs and the difference in site characteristics. The proton budget calculations showed a clear

Table 1: Internationally reported data held presently in the ICP-IM database (Annual Report 2001)

AREA	SUBPROGRAMME																					
	AM	**AC**	**DC**	**MC**	**TF**	**SF**	**SC**	**SW**	**GW**	**RW**	**LC**	**FC**	**LF**	**RB**	**LB**	**FD**	**VG**	**EP**	**AL**	**MB**	**BB**	**BV**
AT01	95-98	95-98	97		97						-						93,99	93,98				
BY02	89-99	89-99	89-99				95-98			95-99												
CA01	88-96		88-96						88-96	88-96												
CH01	88-97	88-97	88-97		91-97				90-96	88-97	-	89			-	95-97						
CZ01	89-98	89-98	89-98	89	89-98					89-98	-				-							
DE01	90-99	90-99	90-99	90	90-99	90-99	90	90-99	88-99	90-99	-	90-99	90-98		-	90-99	90-95	92-95		94-99	91-96	90,95
DK01			92-99		92		86	92-99		-	-			-	-							
DK02			97							97	-				-							
DK03			94-99		94-99		95	94-99		-	-			-	-		95					
EE01	95-99	94-99	94-99	94	94-99	94-99	94	94-99	95-96	-	-	94-99	94-99	-	-	94-95	94,97	94-96		94-99		94
EE02	94-99	98-99	94-99	94-97	94-99	94-99	94-95	95-99	95-99	94-99	96	94-99	94-99			96-99	96	94-95	94-99	96-99		
ES01			92-93		92-93		92	92-93		91-93	-				-							
FI01	88-99	94-99	88-99	88-96	89-99	89-99	88-89	89-99		88-99	87-99	88-97	90-97		90-93	88-91	88-98	88-97		90	87-89	87
FI03	88-99	93-99	88-99	89-96	89-99	89-99	88	89-99		88-99	87-99	88-97	90-97		90	88-91	90-98	90-97		90-91	87-89	
FI04	88-99	89-99	88-99	89-96	89-99	89-97	89	89-96		88-99	86-99	89-97	90-97			89-91	89-98	89-98		90-91	87-89	
FI05	88-99		88-99	91,96	89-97	89-97	88	89-96		89-99	87-99	88-97	90-97			88-91	89-98	89-97		90-91	88-89	
GB01	88-99	91-99	88-99				90		90-91	88-99	-				-							
GB02	88-99	91-99	88-99		88-91	88-91		90-91		88-99	-				-							
IE01			91-98		91-98	92-97		91-98				91-96	91-98									
IS01			97-99						98-99	97-99												96
IT02	77-99	93	93-99		93-99	93-99	93-95	93-99		-	-	93-95		-	-	92-99		92				
IT03	92-97	93-97	92-97		94-97	94-97	93,95	95-97		-	-	93,97	94	-	-	93-97	95	92				
IT04	92-97	93-97	92-97		94-97	94-97	93,95	95-97		-	-	93,95	94	-	-	93-97		92				
IT05	97	97	97		97	97	95			-	-	97		-	-	97						
IT06		97	97		97	97	95			-	-	97		-	-	97						
IT07	97	97	97		97	97	95			-	-	97		-	-	97						
IT08		97	97		97	97	95			97	-	97		-	-	97						
IT09	97	97	97		97	97	95			97	-	97		-	-	97						
IT10	97		97		97		95			-	-	97		-	-	97						
IT11		97	97		97		95			-	-	97		-	-	97						
IT12	97	97	97		97	97	95			-	-	97		-	-	97						
IT13	97	97					95			-	-	97		-	-	97						
LT01	93-99	93-99	93-99	93	93-98		93	94-99	93-99	93-99							93-99		93-98			93
LT02	93-98	93-99	93-98	93	94-98		93	94-99	93-99	93-99	-			93-98	-		93-99	93-99	93-98			93
LT03	95-98	95-99	95-99		95-98		94	95-99	95-99	95-99				95-98			94-99	94-99	94-98			94

AREA	SUBPROGRAMME																					
	AM	AC	DC	MC	TF	SF	SC	SW	GW	RW	LC	FC	LF	RB	LB	FD	VG	EP	AL	MB	BB	BV
LV01	93-99	93-99	93-99	94,98	94-99	94-99	94-99	94-99	94-99	93-99	-	94-99	94-99	95-98	-	94-99	94-98	94-98		96-98		
LV02	93-99	94-99	93-99	94,98	94-99	94-99	94,99	94-99	94-99	93-99	93-98	94-99	94-99	95-98	95-98	94-99	94,97	94-98		96-98		
NL01	61-99	86-99	61-99	93-99	93-99	93-99	93,97	97	80-99	-	80-99	93-99	93-98	-	92-99	84-99		99			90-98	
NO01	87-99	87-99	87-99	92	89-99		86	89-99	87-88	87-99	-	86			-	91-99	86	86				
NO02	87-91	87-99	87-99	88	89-99		89	89-99		87-99	-	89			-	92-99	89					
PL01	88-96	88-96	88-96	88-90	93-96		88	93-96		88-96	88-95	88-90										
PT01	88-99	89-99	94-99							90-99	90-99											
RU03	89-94	89-98	89-98																			
RU04	89-94	89-98	89-98	90										93-99		93-99	93	93		94-96		
RU12	93-94	93-98	93-94																			
RU14	94	94-98	94-98																			
RU15	90-98	90	90-97	94	90-98	90-96	90		90-98	90-98	-			93	-		91	94				
RU16				89-90			89	89	89						93-99	93-96	91-94	89-94	93	94-95		91
RU18			92-97	92	92-97	92-97	93	94-97	95-97	92	92-94	92				93	94	93		93		
SE04	87-97	88-99	87-99	95	87-96		95	87-88	79-96	87-96	-	99			-	97-99	95,98	96	92-98	95-99		
SE14	96-99	96-99	96-99	95	96-99			95-99	96-99	96-99	-	99	95,99		-	97-99	82-99	97	97-99	95-99		
SE15	97-99	96-99	96-99		96-99		97	95-99	97-99	96-99	-	97,99	95,99		-	98-99	96-99	98	97-99	95-99		
SE16	99	99	99		99					99		99					99					

- = not possible to carry out

relationship between the net acidifying effect of nitrogen processes and the amount of N deposition. As soon the deposition becomes greater, the importance of N processes increases as net sources of acidity. A critical deposition threshold of about 8-10 kg N/ha/a, indicated by several previous assessments, was confirmed by the input-output calculations with the ICP-IM data. The output flux of nitrogen was strongly correlated with key ecosystem variables like N deposition, N concentration in organic matter and current year needles, and N flux in litterfall. Soil organic horizon C:N ratio seems to give a reasonable estimate of the annual export flux of N for European forested sites receiving throughfall deposition of N up to about 30 kg N/ha/a. Such statistical relationships from intensively studied sites could be efficiently used in conjugation with regional monitoring data (e.g. ICP Forests and ICP Waters data) in order to link process levels data with regional-scale questions.
The reduction in deposition of S and N compounds at the ICP-IM sites, caused by the 'Protocol to Abate Acidification, Eutrophication and ground-level Ozone' of the CLRTAP , was estimated for the year 2010. Implementation of the protocol will further decrease the deposition of S and N at the ICP-IM sites in western and northwestern parts of Europe, but the decrease in eastern parts will be smaller.
Modeling of soil water fluxes at ICP-IM sites using the WATBAL model (Starr, 1999) has recently started. The inflow-fluxes are measured by the subprogrammes Precipitation-, Throughfall- and Stemflow-chemistry. On a catchment scale the outflow fluxes is measured by Runoff water chemistry. However measurement of the outflow flux at the plot scale, percolating soil water, is much more difficult. In this study data of ICP-IM sites is used for validating the model. The conclusion is that WATBAL provides a means of calculating the water balance components for a soil and at a suitable time interval (monthly). Most importantly, WATBAL can provide an estimate of the monthly soil water flux, a flux vital for making mass balances but which is difficult to measure. The results will enable a more detailed assessment of plot-scale results, as well as calculations of detailed ecosystem budgets and trends of different chemical compounds.

- *Trend analysis of bulk and throughfall deposition and runoff water chemistry.*
  The first results from a trend analysis of monthly ICP-IM data on bulk and throughfall deposition as well as runoff water chemistry were presented by Vuorenmaa (1997). ICP-IM data on water chemistry have also been used for a trend analysis carried out by the ICP Waters and presented in the 9-years report of that programme (Lükewille *et al*., 1997).
  New calculations on the trends of N and S compounds, base cations and hydrogen ions have been made for ICP-IM sites with available data across Europe. The site-specific trends were calculated for deposition and runoff water fluxes using monthly data and non-parametric methods.
  Statistically significant downward trends of SO_4 and H^+ deposition were observed at the majority of the ICP-IM sites. Decreasing NH_4 trends were more common than those of NO_3. Sites with higher N deposition and lower C/N-ratios clearly showed higher N output fluxes, and the results were consistent with previous observations from European forested ecosystems. Decreasing SO_4, NO_3, base cation and H^+ trends in output fluxes were observed at several sites in the Nordic countries. The results partly confirm the effective

implementation of emission reduction policy in Europe. However, clear responses were not observed at all sites, showing that recovery at many sensitive sites can be slow and that the response at individual sites may vary greatly.

- *Assessment of biological data using multivariate gradient analysis.*
  The effect of pollutant deposition on natural vegetation, including both trees and understorey vegetation, is one of the central concerns in the impact assessment and prediction. The first assessment of vegetation monitoring data at ICP-IM sites with regards to N and S deposition was carried out by Liu (1996). Vegetation monitoring was found useful in reflecting the effects of atmospheric deposition and soil water chemistry, especially regarding sulphur and nitrogen. The results suggested that plants respond to N deposition more directly than to S deposition with respect to vegetation indices.
  De Zwart (1998) carried out an exploratory multivariate statistical gradient analysis of possible causes underlying the aspect of forest damage at ICP-IM sites. These results suggested that coniferous defoliation, discolouration and lifespan of needles in the diverse phenomena of forest damage are for respectively 18%, 42% and 55% explained by the combined action of ozone and acidifying sulphur and nitrogen compounds in air.
  From the present and previous ordination exercises (De Zwart, 1997) it was concluded that the applied statistical techniques are capable of revealing underlying structure and possible cause-effect relationships in complex ecological data, provided that analyzed gradients have an adequate range to be interpolated. Since the data obtained was unexpectedly poor in span of environmental gradients, the results of the presented statistical ordination only indicated correlative cause-effect relationships with a limited validity. The poor span of gradients could be attributed to the relative scarcity of biological effect data and the occurrence of missing observations both in chemical and biological data sets. It was concluded, that the power of the vegetation monitoring in impact assessment would increase considerably with improvements in the ICP-IM data reporting and inclusion of additional sites.
  A scientific strategy to carry out further data assessment of cause-effect relationships for biological data, particularly vegetation, has been developed within the ICP-IM. This work is lead by the National Focal Point of the Netherlands.

- *Dynamic modeling and assessment of the effects of different emission/deposition scenarios.*
  In a policy-oriented framework, dynamic models are needed to explore the temporal aspect of ecosystem protection and recovery. The critical load concept, used for defining the environmental protection levels, does not reveal the time scales of recovery. Dynamic models have been developed and used for the emission/deposition scenario assessment at selected ICP-IM sites. (e.g. Forsius *et al*., 1997, 1998a, 1998b; Posch *et al*., 1997). These models are flexible and can be adjusted for the assessment of alternative scenarios of policy importance.
  These modeling studies have shown that both the amount and the time of implementation of emission reductions determine the recovery of soil and water quality of the ecosystems. According to the models, the timing of emission reductions determines the state of recovery over a short time scale (up to 30 years). The quicker the target level of reductions is achieved, the more rapidly the surface water and soil status recover. For the long-term

response (> 30 years), the magnitude of emission reductions is more important than the timing of the reduction. The model simulations also indicate that N emission controls are very important to enable the maximum recovery in response to S emission reductions. Increased nitrogen leaching has the potential to not only offset the recovery predicted in response to S emission reductions but further to promote substantial deterioration in pH status of freshwaters and other N pollution problems in some areas of Europe.
At the 17th session of the UN/ECE Executive Body in December 1999 the importance of the monitoring and dynamic modeling of recovery was underlined. The important results of the ICPs and the Task Force on Health in implementing the Convention were also noted. This underlines the need to continue with the dynamic modeling work within ICP-IM.

- *Assessment of concentrations, pools and fluxes of heavy metals.*
  A scientific strategy to carry out further data assessment on stores and fluxes of heavy metals has been developed within ICP-IM. This work is lead by the National Focal Point of Sweden and started in 1999 (Bringmark, 1998, 1999, 2000).

2.4 Task Force Meeting 1997, 1998, 1999

2.4.1 Task Force Meeting 1997, Dwingeloo, the Netherlands

The fifth meeting of the Task Force of ICP-IM was held from 23 to 26 March 1997 in Dwingeloo in the Netherlands. The meeting was attended by 38 experts from the following countries: Austria, Belarus, Canada, Czech Republic, Denmark, Estonia, Finland, Germany, Hungary, Latvia, Lithuania, the Netherlands, Norway, Poland, Russian Federation, Spain, Sweden, Switzerland and United Kingdom. The Vice-Chairman of the Working Group on Effects and a representative of the secretariat of the United Nations Economic Commission for Europe (ECE) were present. The International Cooperative Programmes on Forests and Surface Waters were also represented, as well as the Task Force on Mapping (TFM) and the Coordination Center for Effects (CCE).

Prof. Ir. N.D. van Egmond, RIVM Director of the Environment, and Prof. Dr. H.E. Eijsackers, Head of the RIVM Laboratory for Ecotoxicology noted the important role of the UN Economic Commission for Europe (ECE) and, in particular, the effect-oriented activities executed under the Convention. Mrs Dr. E. de Hullu, State Forestry Service The Netherlands, provided information on recent national efforts to protect forest ecosystems.
On the agenda for the meeting were the following issues: Preparation of the updated manual, Draft Annual Report 1997, Cooperation with other ICPs and the future work programme.
For updating the manual two working groups were established to update the relevant subprogrammes. During the meeting the draft-version of the manual was discussed in small groups. The TF requested the existing expert-groups to incorporate the agreed changes, amendments and additions. An editorial group was asked to finalize the draft manual for acceptation by the TF in 1998.
The draft of the sixth Annual Report 1997 and a draft contribution of ICP-IM to the Joint Report of the ICPs (UN-ECE, 1997) and the Mapping Programme were accepted.
The Task Force strongly recommended to the Working Group on Effects to consider all possible ways and means for promoting even closer cooperation and harmonization between

ICPs and in particular within the ongoing effect-oriented activities on the national level, in order to ensure most effective use of the limited resources.For the work-programme of ICP-IM for 1998 was noted that:

- Programme activities should be focused on the priority needs of the Executive Body, in particular those related to the preparation of future protocols.
- More data will be needed concerning environmental effects of heavy metals, persistent organic pollutants, volatile organic compounds and ozone.
- Continuing integration of effect-oriented activities would require further strengthening of cooperation with ICPs Forests and Waters, but also with the Task Force on Mapping and with EMEP.
- Effective continuing activities of the NFPs are indispensable for further implementation of the Programme; their activities should be adequately supported on both the national and international level.
- Successful implementation of the programme depends on a sufficient quantity of quality controlled data in the IM database.

2.4.2 Task Force Meeting 1998, Tallinn, Estonia

The sixth meeting of the Task Force of ICP-IM was held from 20 to 22 April 1998 in Tallinn in Estonia. The meeting was attended by 39 experts from the following countries: Austria, Czech Republic, Denmark, Estonia, Finland, Germany, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Russian Federation, Sweden, Switzerland and United Kingdom. Also represented were the Chairman of the Working Group on Effects, a representative of the secretariat of the United Nations Economic Commission for Europe (ECE), ICPs on Forests and Surface Waters. The participants were welcomed by Mr. O. Tammemäe, Director of the Nature Protection Department of the Estonian Ministry of the Environment. On the agenda were the revision of the manual, cooperation with other programmes and organizations, reports to the Working Group on Effects, Workplan for 1998/1999 and the independent external review of the ICPs.

The Annual Report (1998) and the Joint Report were presented. Concerning the Workplan for 1998/1999 the Task Force agreed that, in addition to further work on acidification and nitrogen parameters and related trend analyses, and on the application of dynamic modeling, future programme priorities should also cover:

- Studies in bioindication and heavy metals fluxes
- Intercomparison/intercalibration exercises
- Risk assessment
- Studies on the regional significance of site-specific dynamic models
- Integrated analyses of selected problems for longer time periods
- Closer cooperation with other ICPs as well as participation in projects outside the Convention.

The chairman informed the Task Force about the independent external review of all programmes participating in the effect-oriented activities. An external reviewer will document the scope and depth of ICP-IM activities, the quality of the results and their relevance to and importance for the Convention.

2.4.3 Task Force Meeting 1999, Wallingford, United Kingdom

This seventh meeting of the Programme Task Force was held from 20 to 21 April 1999 in Wallingford in the United Kingdom. The meeting was attended by 30 experts from the following countries: Austria, Belarus, Czech Republic, Denmark, Estonia, Finland, Germany, Latvia, Lithuania, the Netherlands, Norway, Russian Federation, Sweden and United Kingdom. Also represented were the Chairman of the Working Group on Effects, a representative of the secretariat of the United Nations Economic Commission for Europe (ECE) and representatives of ICP on Crops and ICP on SurfaceWaters.

The meeting started with reviewing the recent activities and results of the programme and their contributions to other bodies under the Convention, in particular to the Working Group on Effects and to the Executive Body. The Working Group on Effects did complete the revised manual. Cooperation with ICP on Waters has resulted in organizing the Workshop on biological monitoring and cooperation with organizations outside the Convention has been carried out (e.g. IFEF, GTOS, and NoLIMITS). The ICP-IM database has been improved and updated in October 1998.

The results of the external review of all the ICPs were discussed in the Working Group on Effects in February 1999. The main general conclusions drawn from the review are:

- the interests of the Executive Body are being well served by the effect-oriented activities of the Working group on Effects;
- the scientific quality is generally good;
- the results are rarely presented in a form that is easily understood by policy makers, media or the public.

Particularly the results of ICP-IM were well received in the review. The efforts to assemble a central database, harmonization of methods and the inter-site data comparisons were mentioned favorably. Only the need to write readable summaries in all reports in order to improve their usefulness to non-scientists was advised.

For future priorities for ICP-IM can be referred to the programme priorities of 1998.

2.5 Participation of the Netherlands in ICP-IM

Monitoring in the Lheebroekerzand has been carried out at a minimum level. Data has been delivered to Helsinki and has been imported in the ICP-IM database.

During the revision of the manual the Netherlands played an important role to stimulate the monitoring of biological parameters and put the whole monitoring programme in a general framework of causes and effects.

The Netherlands has been carried out the study: *Multivariate gradient analysis applied to relate chemical and biological observations* in 1997 and is coordinating the study: *IM data used for modeling environmental vegetation effects on a European scale* started in 1998 and continuing in 2000.

3. Monitoring Programme

3.1. Monitoring Programme according to the ICP-IM manual

In 1997, 1998 and 1999 the subprogrammes are carried out according the Manual for Integrated Monitoring (Programme Phase 1993-1996). The choice is made to run all the obligatory monitoring programmes for intensively monitored sites, if possible. However, since 1997 the continuation by RIVM has been discussed, the decision was made to continue the running programmes at a minimum level and no new programmes would start until was decided to stop or to continue the monitoring for a longer period (Mathijssen-Spiekman *et al*., 1997).

Table 2: Monitoring subprogrammes and availability of data

Compulsory subprogrammes	**Data NL01**
Inventory of birds (BB)	1928-1998
Inventory of plants (BV)	1988-1999
Climate (AM)	1961-1999
Air chemistry (AC)	1984-1999
Precipitation chemistry (DC)	1982-1999
Metal chemistry in Mosses (MC)	1993-1999
Throughfall and Stemflow chemistry (TF, SF)	1982-1999
Soil chemistry (SC)	1993-1997
Soil water chemistry (SW)	1997
Groundwater chemistry (GW)	1980-1999
Runoff water chemistry (RW)	-[1)]
Lake water chemistry (LC)	1924-1999
Foliage and litterfall chemistry (FC, LF)	1993-1999
Hydrobiology of streams (RB)	-[1)]
Hydrobiology of lakes (LB)	1992-1999
Forest damage (FD)	1984-1999
Vegetation (VG)	1988-1999
Trunk epiphytes (EP)	1951-1999
Aerial green algae (AL)	-[2)]
Microbial decomposition (MB)	-[2)]

1) Not possible in Lheebroekerzand
2) Possible, but not started in view of discussion of continuation of the monitoring

In Table 2 an overview is presented of the obligatory monitoring activities executed at the monitoring area Lheebroekerzand (NL01). The first year indicates the year in which the subprogramme started or since when data are available. Data of studies carried out in years before 1993 are not all collected according to the requirements described in the manual.
A description of the methods of the different monitoring studies is indicated in the following subchapters. Refer to the Figures 1 and 2 for an indication of the location of the involved stations.

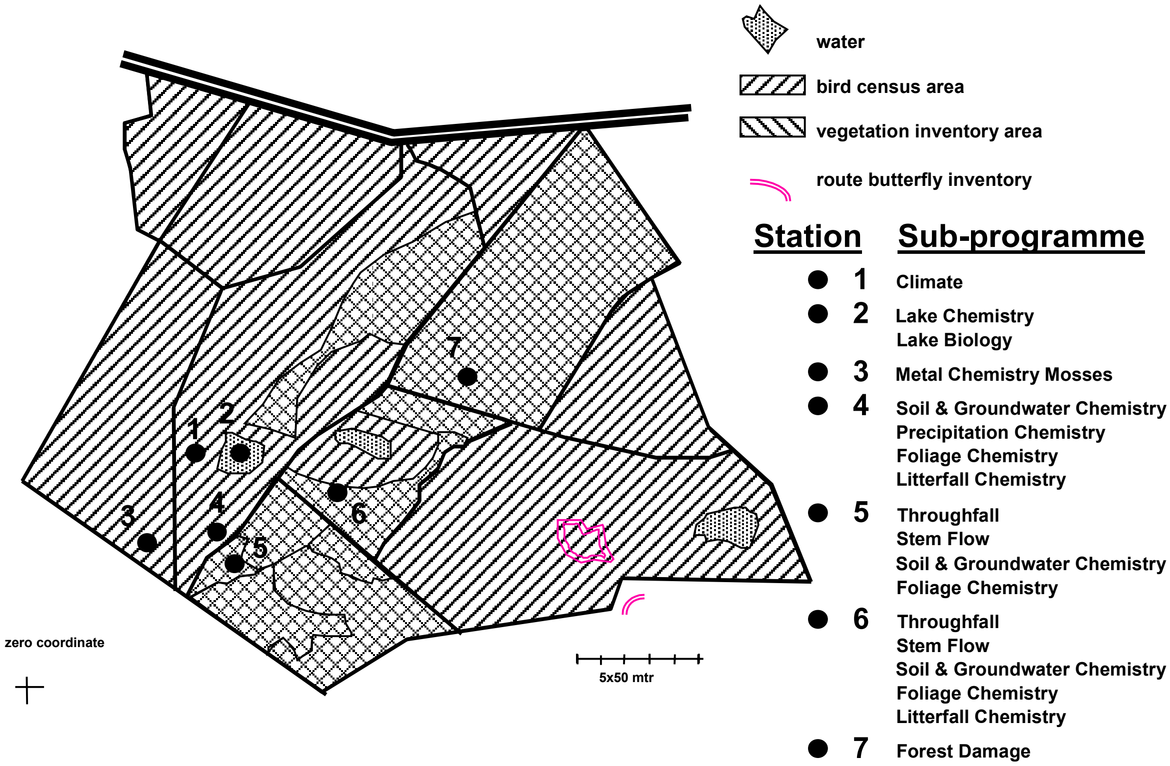

Figure 2: Base map Lheebroekerzand with station and activity indication.

3.1.1 Inventory of birds (BB)

The Dutch Cooperative Organizations on Bird Research (SOVON) carried out the breeding bird monitoring programme in 1997 and 1998. In 1999 the countings were not carried out. During the breeding season, in April, May and June, 6 visits in the field have to be made to count the number of pairs of breeding bird species according to the method described by Van Dijk (1993). The observations are done by P. Kerssies (SBB) in the entire Dutch monitoring area of 95 ha. No changes were made with regard to the previous years of bird monitoring in the Lheebroekerzand.

3.1.2 Inventory of plants (BV)

ALTERRA made an inventarisation of the plants in the area in1999. In 55 plots (10m x 10m) in the vegetation inventory area (Figure 2) all observed mosses, herbs, plants and shrubs smaller than 0.5 m were recorded with their coverage. The coverage is estimated according to the scale of Doing Kraft (Broekmeyer *et al.,* 1991) in Table 3.

Table 3: Scale of Doing Kraft.

Code	Coverage in %
R	< 5
P	< 5
A	< 5
M	< 5
1	5-15
2	15-25
3	25-35
4	35-45
5	45-55
6	55-65
7	65-75
8	75-85
9	85-95
10	95-100

A description of the detailed method is given by Broekmeyer *et al. (*1991).

3.1.3 Climate (AM)

The RIVM Laboratory for Ecotoxicology (ECO) carried out meteorological measurements. The meteostation of ECO is situated at station number 1 in the monitoring area (Figure 2) and measures air temperature at 1.50 m height, soil temperature just below the surface and at a depth of 20 cm, relative air humidity, irradiation (solari-meter) and UV-B-radiation at 1.50 m height. Every minute the variables are measured. Mean values are registered once an hour.
A description of the meteostation is provided in Standard Operating Procedure (SOP) no. ECO/271.

3.1.4 Air chemistry (AC)

The RIVM Laboratory of Air Research (LLO) carried out air chemistry measurements in the framework of the Dutch National Air Quality Monitoring Network. The measurements are continuous and include gaseous compounds: sulfur dioxide, ozone and nitrogen dioxide, and particulate compounds: ammonium, nitrate and sulfate. These data are collected from a station in Witteveen, approximately 15 km from Lheebroekerzand. The air samples are taken at a height of 3.5 meters. No changes were made with regard to the previous years of monitoring the Lheebroekerzand.

3.1.5 Precipitation chemistry (DC)

In the monitoring area at station 4 (Figure 2), the RIVM-ECO collects bulk deposition samples every week. They are collected by five funnels placed approximately 1.5 m above ground level to prevent direct soil contamination. Each funnel has a collecting surface area of 380.13 cm^2. Collectors are equipped with a guard ring to avoid bird droppings. Sampling bottles (polyethylene, 5 liters) are shielded from sunlight to prevent algal growth. To recognize influences during transport and cleaning procedure of the bottles analyses are carried out in two control-bottles filled with aquadest. These bottles follow the whole procedure of the sampling bottles in the laboratory, the field and the transport. The method of collection and transport of the samples is described in SOP no. ECO/234. The collected rainwater of the five sampling bottles is mixed and treated to be one sample. The mixture is vacuum filtered over a 0.45 µm pore size cellulose acetate filter prior to analysis. The Laboratory of Inorganic Chemistry (RIVM-LAC) measures the precipitation volume, pH and conductivity and determines concentrations in the mixture of sodium, potassium, calcium, magnesium, cadmium, copper, lead, zinc, nickel, arsenic, chromium, aluminium, chloride, ammonium, nitrate, phosphate and sulfate. The analytical methods have been standardised according to the internal procedures of LAC. Describing SOPs are available upon request.

3.1.6 Metal chemistry of mosses (MC)

RIVM-ECO carried out the sampling of the mosses. In June 1997, May 1998 and 1999, five samples are taken of *Pleurozium schreberi* according the method described in SOP no. ECO/317. The samples are collected at station number 3 in Figure 2. Each sample consists of about 2 litres of moss material collected in plastic bags. All the dead material and attached litter was removed from the samples. The samples are stored frozen at a temperature of - 20 ºC until further treatment. RIVM-LAC carried out the following analyses: total sulphate, total phosphate, aluminium, arsenic, barium, calcium, cadmium, cobalt, chromium, copper, iron, potassium, magnesium, manganese, sodium, nickel, lead, antimony, silicon, strontium, titanium, vanadium and zinc. The analytical methods have been standardised according to the internal procedures of LAC. Describing SOPs are available upon request.

3.1.7 Throughfall and stemflow (TF,SF)

In the monitoring area at station 5 and 6 (Figure 2) samples were collected every week by RIVM-ECO. The method of collection and transport of the samples is described in SOP no. ECO/234.

Throughfall precipitation is collected by the same type of funnel as used for bulk-deposition. Five collectors are placed under oak trees (*Quercus robur,* station 5 Figure 2) and five under pine trees (*Pinus sylvestris,* station 6 Figure 2).

The same trees are used to collect stemflow precipitation. Stemflow collectors of the spiral type are attached to four of the oak trees and five of the pines. Sampling bottles of 5 litres are installed at the base of the trunk digged in the ground to avoid large differences in temperature. The method used for attaching the spiral to the tree is not satisfying. Due to leakage, part of the stemflow is not collected. A better method is not known.

The collected rainwater of the sampling bottles is mixed and treated to be one sample. The mixture is vacuum filtered over a 0.45 µm pore size cellulose acetate filter prior to analysis. RIVM-LAC is analysing the mixtures for pH, specific conductivity, sodium, potassium, calcium, magnesium, cadmium, copper, lead, zinc, nickel, arsenic, chromium, aluminium, chloride, ammonium, nitrate, phosphate and sulphate. The analytical methods have been standardised according to the internal procedures of LAC. Describing SOPs are available upon request.

3.1.8 Soil chemistry (SC)

The sampling and measuring of the soil in the monitoring area is carried out by the RIVM Laboratory of Soil and Groundwater Research (LBG) in the framework of the project 'National Soil Quality Monitoring Network'. The sampling frequency is once every 7 years. This sampling is performed at the stations 4, 5 and 6 (Figure 2) and carried out in 1993.
The analysed variables are total organic carbon, pH (water and KCl extraction), cation exchange capacity, copper, lead, cadmium, zinc, chromium, iron, manganese and total phosphorous.
Besides the sampling of the 'National Soil Quality Monitoring Network' also samples are taken by ECO (Groot *et al*., 1998) at station 4 (Figure 2) in 1997. Between September and December 1997 30 l soil samples were collected from the top layer
(0-20 cm). The samples were transferred to the laboratory and stored in polyethylene containers at 5 °C for further handling and analysis. All roots present in the samples were removed in the laboratory and agglomerates were broken by hand or machine. Particles larger than 4 mm were removed by sieving, after which the remaining soil was homogenised. The soil material to be used for chemical analyses was air-dried, particles larger than 2 mm were removed by sieving. The samples were analysed by LAC only in 1997 (no samples have been taken in the latter two years). The measured values are pH($CaCl_2$), pH(H_2O), pH(KCl), total organic carbon, nitrogen total, arsenic, cadmium, chromium, copper, iron, nickel, lead and zinc. The analytical methods have been standardised according to the internal procedures of LAC. Describing SOPs are available upon request.

3.1.9 Soil water chemistry (SW)

In 1997 this program is carried out by RIVM-ECO (De Groot *et al.,* 1998). Pore water is collected from the same soil samples as used in the subprogram Soil chemistry. For pragmatic reasons, a somewhat modified procedure was applied for the collection of pore water, as compared to the procedure used by Janssen *et al*. (1996).
All roots present in the samples were removed and agglomerates were broken by hand or machine. Particles larger than 4 mm were removed by sieving, after which the remaining soil was homogenised. Two kg of soil sample was moistened with a 2 m*M* solution of $Ca(NO_3)_2$ to get a pH-value of 2. Subsequently the soils were stored for three weeks at 5 °C. After this equilibrium period, pore water was obtained by centrifugation of the soils at 7500 rpm (600g) at 5 °C. Centrifugation was continued until about 150 ml of pore water was collected. If insufficient quantities of pore water could be collected, another portion of two kg of soil was centrifuged. After centrifugation, the pore water collected was filtered over a 0.45 µm pore size filter, and the pH was measured (pH(H_2O)). The pore water collected was divided over two polyethylene bottles: one bottle of 30 ml of pore water was acidified with concentrated nitric acid to set the pH to 2, and used for metal analyses. The second bottle of 100 ml pore water was used for the determination of anions, pH and DOC.
The samples were analysed by LAC only in 1997 (no samples have been taken in the latter two years). for pH(H_2O), specific conductivity, dissolved organic carbon, aluminium, arsenic, calcium, cadmium, chloride, chromium, copper, iron, potassium, magnesium, manganese, nitrate, sodium, nickel, lead, phosphate, sulphate and zinc. The analytical methods have been standardised according to the internal procedures of LAC. Describing SOPs are available upon request. In 1998 and 1999 no samples were taken.

3.1.10 Groundwater chemistry (GW)

This programme is carried out by the RIVM-LBG in the framework of the project 'National Monitoring Network on Groundwater Quality' with a sampling frequency of once every 7 years. The groundwater samples are also taken at the stations 4, 5 and 6 (Figure 2). The sampling has been carried out in 1993. Measured variables are ammonium, arsenic, cadmium, calcium, chloride, chromium, copper, iron, lead, magnesium, manganese, nitrate, organic carbon, pH, phosphate, phosphorous total, potassium, sodium, water-level and zinc. Furthermore, groundwater samples are taken in Eemster, situated approximately 4 km from the monitoring site Lheebroekerzand. The groundwater-flow in the area is from the monitoring site to the direction of Eemster. The sampling is carried out every year in the framework of the project 'National Monitoring Network on Groundwater Quality' by LBG. The sampling methods are described in SOPs of LBG.
In 1997, 1998 and 1999 samples are taken through a sampling tube with filters at the depth of 11.05-13.05 m. In 1998 and 1999 supplementary samples are taken at the depth of 28.60-30.60 below ground level. The measured variables, carried out by LAC, are aluminium, arsenic, barium, calcium, cadmium, chloride, chromium, copper, iron, potassium, magnesium, manganese, ammonium, nitrate, sodium, nickel, phosphorous total, sulfate, strontium, zinc and pH. The analytical methods have been standardised according to the internal procedures of LAC. Describing SOPs are available upon request.

3.1.11 Lake water chemistry (LC)

The lake Kliplo is located at station number 2 (Figure 2) in the monitoring area. The monitoring of the lake Kliplo was carried out by RIVM-ECO. In 1997, 1998 and 1999 the samples are taken in February, May, August and November at a depth of 20 cm from the lake surface. Since August 1998 a different sampling-place was chosen because the previous sampling-place was impossible to reach with the necessary equipment. LAC is analysing the variables: waterlevel, color number (quantifying the amount of 'yellow substances' or humic compounds), temperature, pH, conductivity, oxygen content, sodium, potassium, calcium, magnesium, cadmium, copper, lead, zinc, nickel, arsenic, chromium, ammonium, nitrate, phosphate, sulphate, chloride, aluminium, alkalinity and silicon.
The sampling method is described in SOP no. ECO/312. The analytical methods have been standardised according to the internal procedures of LAC. Describing SOPs are available upon request.

3.1.12 Foliage and litterfall chemistry (FC, LF)

The collection of leaves and needles is carried out by RIVM-ECO and is described in SOP no. ECO/278. In 1997, 1998 and 1999 foliage samples are taken in September of 10 oak trees (*Quercus robur*) at the stations 5 and 6 (Figure 2), and in November of 10 pine trees (*Pinus sylvestris*) at the station number 4 (Figure 2). Approximately 100 leaves or needles were gathered at the wind and light exposed side of the trees and transported to the laboratory in plastic bags. In the laboratory the samples were kept under refrigeration (-20 °C) until analysis. In the autumn of 1997, 1998 and 1999 also litter is collected in specially designed litter containers. The litter sacs used have a depth of 0.5 m deep to prevent the litter from being blown out. Separate containers were placed under 5 oak and 5 pine trees at the stations 4 and 6 (Figure 2) from September until December. The analysis of leaves and needles is carried out by LAC. The measured variables in the leaves and needles are: oven-dry sample weight of 100 leaves or needles for foliage chemistry, litterfall weight of total amount, nitrogen total, sulphate total, total organic carbon, phosphorous total, aluminium, arsenic, barium, calcium, cadmium, cobalt, chromium, copper, iron, potassium, magnesium, manganese, sodium, nickel, lead, antimony, silicon, strontium, titanium, vanadium and zinc. The analytical methods have been standardised according to the internal procedures of LAC. Describing SOPs are available upon request.

3.1.13 Hydrobiology of lakes (LB)

ZUIVERINGSSCHAP DRENTHE started the monitoring programme of the macrofauna in the lake Kliplo in 1992 (station 2 in Figure 2). Kliplo is one of the lakes that is sampled in the framework of macrofauna monitoring in the province of Drenthe. Due to the uneven distribution of macrofauna species, the method of sampling can only generate semi-quantitative data. However, since the sampling method is standardised, the results are given in the number of organisms collected per species per year. This makes it possible to compare the results with data of previous years. From 1992 to 1998 samples are taken by G. Duursema in May and September at a depth of approximately 1 meter. In 1997 the sampling was carried out in October instead of September. Since 1999 the monitoring of the macrofauna is carried out by M. Fagel of the 'WATERSCHAP REEST EN WIEDEN'. In 1999 the monitoring was executed in May and September. In Mathijssen-Spiekman *et al.* (1994) a description of the used sampling and determination techniques is given.
The samples of the subprogramme lake water chemistry are used for analysing the chlorophyll content by the RIVM Laboratory of Water and Drinkingwater Research (LWD). In paper LWD WV011-003 a description of the used method is given. The samples are taken by ECO in February, May, August and November according to SOP no. ECO/312.

3.1.14 Forest damage (FD)

The monitoring variables required by the ICP-IM programme have been collected from two different sets of data, all compiled from the same 25 trees. Observations of the first set consist of yearly surveys done by P. Kerssies of the State Forestry Service (SBB). The height of the trees, the crown height and crown width is not measured by SBB. RIVM-ECO executed measurements on the height of the trees in 1997, 1998 and 1999 and since 1998 ECO started with the measuring of crown-height and crown-width.
In September 1997, P. Kerssies (SBB) was not able to do the measurements. Instead of SBB, ECO measured all the variables in 1997, with exception of the variable 'needle year'. ECO did not have the knowledge to observe this parameter properly. In 1998 and 1999 SBB did the measurements and observations as in previous years (1984-1996). The following variables have been measured: the diameter at breast height, tree class, crown condition (broken or dying), needle characteristics (coverage, year, discoloration and length), canopy cover, green needles and twigs on the ground and the presence of secondary shoots. In addition, the presence or

absence of removal damage, fungal damage, bark beetles or other insect infections, hanging twigs, sap/resin flow and dead bark is recorded.
In 1997, 1998 and 1999 ECO measured the tree height from the same 25 trees. Three different kinds of equipment are used to carry out these measurements. In principle the methods are similar.
In 1997 the height of the tree is measured as shown in Figure 3. Tree height is measured to the highest shoot in the center of the crown. The slope of measuring is
45 °. The height of the tree is the distance to the tree plus the eye-height from which is measured.

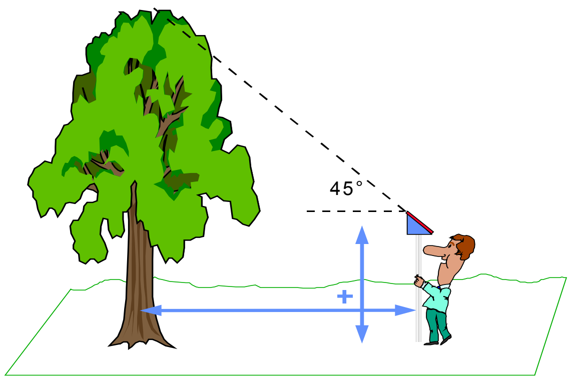

Figure 3: Method of measuring tree height in 1997

In 1998 the height of the tree and the crown-height is measured with a Blume Leiss which is shown in Figure 4. By pointing the equipment to the heighest shoot in the crown from a distance of 15 meter from the tree, the height of the tree was read directly from the equipment. By adding the eye-height of the observer the actual tree height is known.

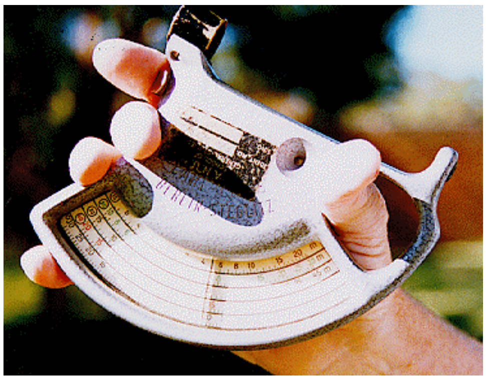

Figure 4: Method of measuring tree height in 1998 with a Blume Leiss

The equipment used in 1999 to measure the height of the tree and the crown-height is a Suunto optical height meter PM5/1520 (Figure 5).

Figure 5: Suunto optical height meter PM5/1520

From a distance of 15 meter from the tree, tree heights can be read straight off the instrument scale. The observer sights the top of the tree with both eyes open. The object sighted, the hairline and the scale will all be simultaneously visible in the instruments field of vision. The reading obtained from the 15 meter instruments scale is the height of the tree minus the eye level of the observer. By adding the eye-height of the observer the actual height of the tree is known.
In 1998 ECO started with the measuring of the crown-height and crown-width. Crown-height is defined as the average distance from the top of the crown to the lowest live branch, excluding epicormics. Crown-width is defined as the mean of two or more measurements of crown projection on the ground taken perpendicular to each other, excluding epicormic brancher.

3.1.15 Vegetation (VG)

For monitoring the vegetation of a plot, the vegetation should be separated into layers. In the Lheebroekerzand the vegetation is divided in two separate parts, namely monitoring on trees and monitoring of the understorey vegetation (smaller than
0.5 meter). Aside from the tree layer, the following vegetation layers were distinguished in the understorey: mosses, herbs, and shrubs. Vegetation monitoring is carried out by ALTERRA in 1999. In the vegetation inventory area of the Lheebroekerzand
(Figure 2) 55 plots of 10 x 10 meter were set out.
The tree measurement consists of observations of each individual living, fallen and dead tree including stumps. Observations as diameter at breast height, tree height, vitality and total damage are carried out on trees with a diameter of more than 5 cm.
For the understorey vegetation the coverage according the scale of Doing Kraft is recorded and the total coverage per layer per species is calculated.
A description of the detailed method is given by Broekmeyer *et al*. (1991).

3.1.16 Trunk epiphytes (EP)

In September 1999 a study is carried out on the epiphytic lichens growing on oak and pine trees by RIVM-ECO in co-operation with C.M. van Herk from LICHENOLOGISCH ONDERZOEKBUREAU NEDERLAND (LON). Sixteen trees of *Pinus sylvestris* and sixteen trees of *Quercus robur* are investigated in the Lheebroekerzand area.
The cover of each lichen species is measured according the line method (method A), described in the Manual for Integrated Monitoring (Programme Phase 1993-1996).

Lichens are recorded along a measuring tape fastened around the trunk of the investigated trees at the height of about 120 cm above the soil surface. The beginning and end of each thallus crossing the upper edge of the tape when watched horizontally is measured. The total length (in mm) of each separate species along the tape is calculated. The vitality of each species is estimated at all sampled trees according to a five point scale. In Table 4 the vitality classes for epiphytic lichens described in the Manual are specified in percentages by ECO.

Table 4: Vitality classes lichens

Vitality class Manual ICPIM	Specification RIVM Mortality in %
1 normal	0
2 slight damage	0-10
3 distinct damage	10-50
4 severe damage	50-99
5 dead	99-100

In addition to the coverage measurements, a complete species list is made of all sampled trees. All lichen species present on the trunk and branches at a height of 50-200 cm above the soil surface are recorded. Trunk diameters of all sampled trees are noted.

3.2 Additional programme

According to the international manual the chemical variables are sufficiently represented in the Integrated Monitoring Programme (IMP). Biological variables however are still not being monitored at a larger scale. To discover possible biological indicators, the existing monitoring scheme could be enhanced with biological subprogrammes. In advance the Netherlands started additional biological monitoring programmes in the Lheebroekerzand.

3.2.1 Leafminers (LM)

In the Lheebroekerzand a study is started in 1993 for monitoring the abundance and species richness of Microlepidoptera leaf miners on birch and on oak by the RIVM Laboratory for Ecotoxicology (Mathijssen *et al.*, 1995[b]). In 1996 the program is extended with 5 beeches. The method is described by Ten Broeke *et al.* (1993). The recommended sampling period prescribed in the manual is between October 15th and November 1st. This sampling period is too late in the season because birch had already dropped its leaves in previous years. Therefore, starting in September, the trees were weekly observed on discoloration, fallen leaves, leafminers and fungal damage. These observations made it possible to choose the best period to collect the leaves. In 1997 for birch (5 trees, near station 7, Figure 2) and beeches (5 trees, near station 7, Figure 2) the leaves are collected on October 1st. Leaves of the oaks (10 trees, near station 5 and 6, Figure 2) are collected on October 26th. The samples consisted of 150 leaves each. 'INSECTEN ONDERZOEKBUREAU DONNER' carried out the examination of the leaves within a week after collection.

Ten Broeke *et al.* (1993) and Kuchlein (1993) provided the necessary identification keys. Unfortunately, in 1998 and in 1999 no samples are taken because of the RIVM-decision that monitoring in the Lheebroekerzand must be continued at a minimum level (Mathijssen *et al.*, 1997).

3.2.2 Butterflies (BF)

In 1990, the Butterfly Foundation started with a network of monitoring routes in the Netherlands. Many volunteers are co-operating in this national monitoring study, which will be continued for at least ten years.

In 1994, monitoring of butterflies started in the Lheebroekerzand. The Butterfly Foundation made a detailed description of the route as indicated in Figure 2. The route is 550 meters long and is divided in 11 sections of 50 meters each. The composition of the vegetation in each section is homogeneous. The method is described by Veling *et al.* (1991). With good weather conditions every week from April until September butterflies were determined and counted by P. Kleine and K. van Eerde.

4. Results and discussion

The individual data of the monitoring programmes are presented in Appendix I.
For several programmes there are no data of 1997, 1998 or 1999 available because the frequency of monitoring of these programmes is up to once every five, six or seven years. This concerns the programmes of *Inventory of plants (BV)*, *Soil chemistry (SC), Soil water chemistry (SW), Groundwater chemistry* (*GW*, Lheebroekerzand) and *Vegetation (VG)*. In previous yearly reports these data are presented (Mathijssen *et al*., 1995[a]), with exception of the data on the vegetation inventory.
The *Inventory of birds* is not carried out in 1999.

Preceeding the start of the ICP-IM monitoring programme in the Lheebroekerzand similar research is performed in the area. Available data of previous years is collected and treated in the same way as described in this report to try to get information over a longer period. A data-analyse of all available data of the Lheebroekerzand will be carried out in 2001 and published in a separate report.

4.1 Monitoring Results ICP-IM

4.1.1 Inventory of birds (BB)

Table 1.1 in Appendix I presents the number of breeding pairs in 1997 and 1998. In 1999 the monitoring is not carried out. P. Kerssies (who did the monitoring since 1987) was not able to continue his observations in 1999. No reliable substitution could be found to carry out the monitoring.
Since 1993 it seems that the total number of breeding pairs is decreasing (Figure 6).

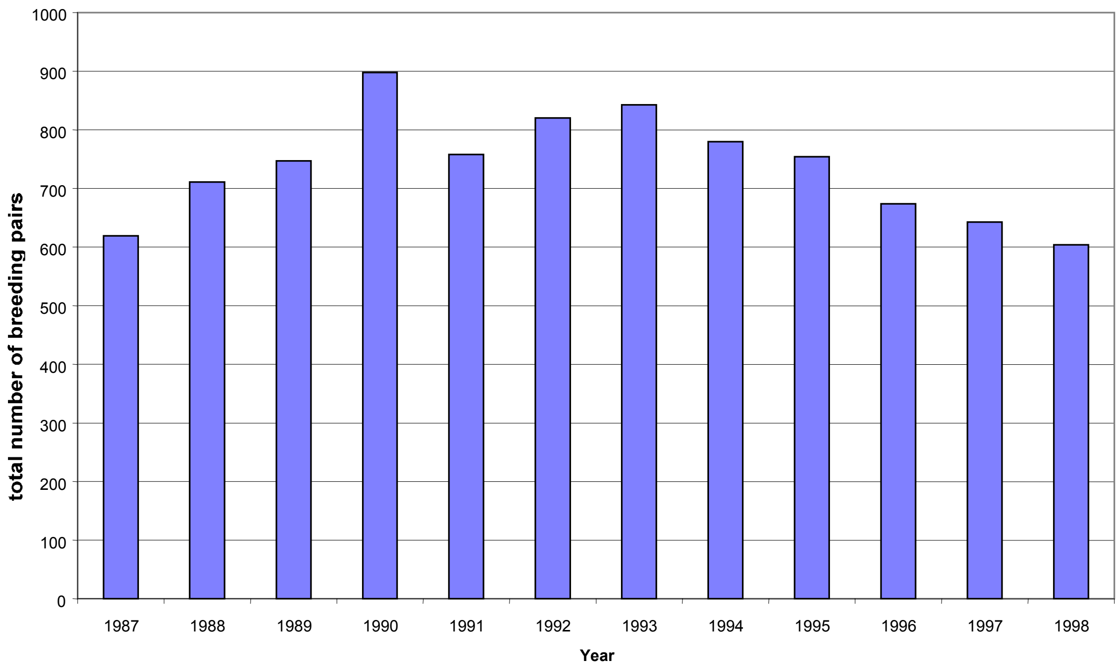

Figure 6: Total number of breeding pairs 1987-1998.

The number of 604 observed breeding pairs in 1998 is the lowest since 1987. The decreased number of breeding pairs in 1995 and 1996 could be explained by the extremely cold winter and the dry period from July to April 1996 (Van Dijk, 1997). An explanation for the lower levels in 1997 and 1998 can not be given here. In contrast to the total number of breeding pairs no clear influence is seen on the total number of species (Figure 7).

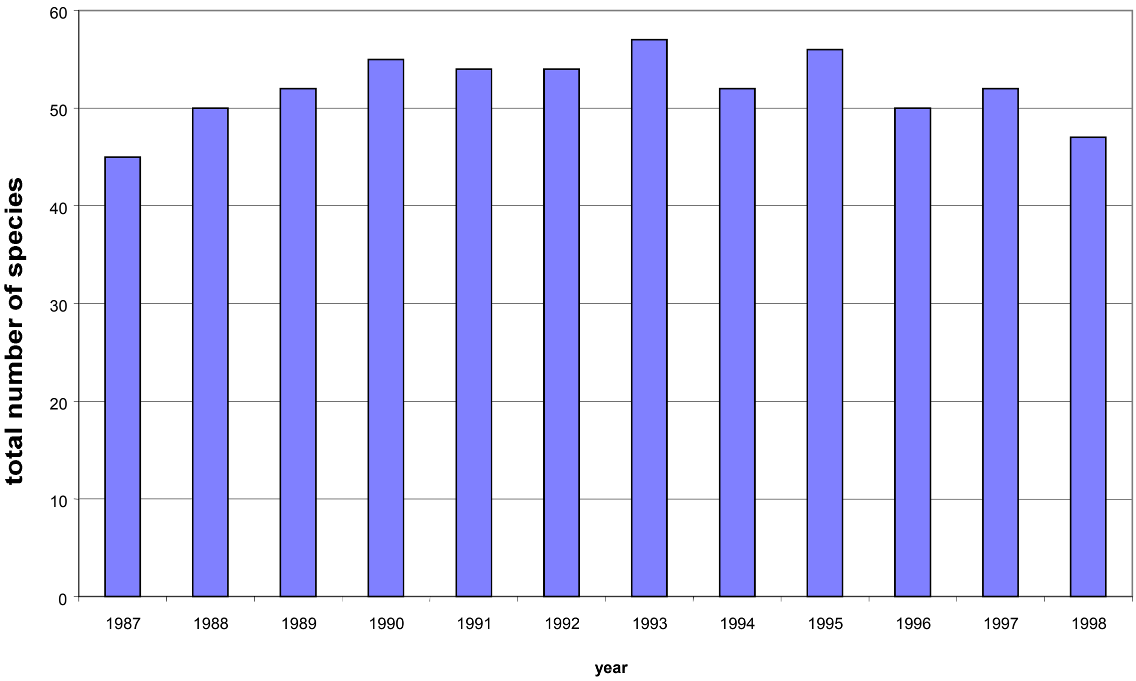

Figure 7: Total number of observed species 1987-1998.

After one or two years of absence, the long eared owl (*Asio otus*), the lesser spotted woodpecker (*Dendrocopus minor*), the ictarine warbler (*Hippolais icterina*), the tree sparrow (*Passer montanus*), the greenfinch (*Carduelis chloris*) and the crossbill *(Loxia curvirostra*) are again spotted in the area in 1997 or in 1998 (Table 1.1 in Appendix 1).

Species that did not return in 1997 and 1998 are for example the teal (*Anas crecca*), the goshawk (*Accipiter gentilis*), the pheasant (*Phazianus colchicus*), the coot (*Fulica atra*), the meadow pipit (*Anthus pratensis*), the wood warbler (*Phylloscopus sibilatrix*), the golden oriole (*Oriolus oriolus*) and the red bunting (*Embreza citrinella*) (Table 1.1 in Appendix 1).

The number of observed breeding pairs of the other species stayed approximately at the same level (Table 1.1 in Appendix 1).

4.1.2 Inventory of plants (BV)

Table 2.1 in Appendix I gives the number of plots per species per abundance class according to the scale of Doing Craft. In processing the results of the observations, the codes R, P, A and M of Doing Craft are replaced by 0, which represents an abundance of less than 5%. For each species, the sum of the abundance values in all the plots were the species occur (Table 2.1) is in most cases much lower than the total number of plots. In 55 plots 39 species are observed. *Deschampsia flexuosa*, *Hypnum jutlandicum*, *Pinus sylvestris* and *Quercus robur* are the most common species with an occurrence in respectively 53, 53, 51 and 48 plots. The most rare species are *Campylopus introflexus, Carex* sp*., Orchis* sp*., Polytrichum juniperinum* and *Sphagnum* sp*.,* all with only one record and an abundance of less than 5%.

4.1.3 Climate (AM)

Table 3.1 in Appendix I presents the meteorological data of the station in the area the Lheebroekerzand. The data are presented as monthly means. The data in Table 5 are presented as yearly averages. No standard deviations are given because the measured variables are related to the period of the year. The results show that there is no difference seen between these three years, although it seems that temperature is increasing the last two years.

Table 5: Yearly averages of the meteorologic variables.

Year	Temp. (ºC) air	Temp. (ºC) soil surface	Temp. (ºC) Soil 20 cm depth	Relative humidity (%)	Irradiation (W/m²)	UV-B (W/m²)
1997	8.6	8.6	7.3	78	113	5.6
1998	9.7	*	8.0	88	99	4.9
1999	9.7	9.4	7.9	85	97	*

* not available

4.1.4 Air chemistry (AC)

Table 4.1 in Appendix I presents the data on the measurements of the gaseous compounds SO_2, O_3, NO_2 and NH_3 and of the particulate associated NH_4, NO_3 and SO_4. The data are presented as monthly means. These results are not validated and not yet published by RIVM-LLO. It is possible that some data are rejected after all because of technical failure of the measuring equipment.
In Table 6 data are presented as yearly averages. No standard deviations are given because the measured variables are related to the period of the year.

Table 6: Yearly averages of the variables measured in air in µg/m³.

Year	SO_2S	O_3	NO_2N	NH_3N	NH_4N	NO_3N	SO_4S
1997	1.33	37	5.56	2.24	1.02	0.56	0.70
1998	0.88	37	4.83	2.10	0.92	0.54	0.60
1999	0.75	42	4.53	2.24	0.78	0.49	0.50

The results in Table 6 show that it seems that concentrations in air of SO_2S, NO_2N, NH_4N, NO_3N and SO_4S are decreasing in time. To draw a conclusion based on these data of three years is not possible. Data of concentrations in air of previous years is available.

4.1.5 Precipitation chemistry (DC)

Tables 5.1, 5.2 and 5.3 in Appendix I present the data of the measurements of the deposition in Lheebroekerzand. In the Appendix, the results are given as monthly weighed means for the analytes and monthly weighed sums for the amount of precipitation.
Yearly averages are given in Table 7. No standard deviations are given because the measured variables might be related to the period of the year. During these three years no differences are seen in the chemical variables. The total precipitation of 1319 mm for 1998 shows that it was extremely wet that year.

Table 7: Yearly averages of some chemical variables in rainwater and the total amount of precipitation.

Year	Total precipi-tation mm	pH unit	EC 25 °C mS/m	NH_4N mg/l	NO_3N mg/l	SO_4S mg/l
1997	758	5.46	3.09	1.34	0.69	1.03
1998	1319	5.10	2.84	0.96	0.56	0.84
1999	869	5.26	2.84	1.03	0.64	0.82

4.1.6 Metal chemistry of mosses (MC)

Table 6.1, 6.2 and 6.3 in Appendix I present the data of the concentration measurements of compounds in the moss *Pleurozium schreberi*. Contrary to the manual, where a sampling frequency of once in 5 years is recommended, sampling and analyses of mosses was done in the Lheebroekerzand every year, just to get trained in the way of sampling and the analyses. During these years, from 1993 to 1999, with exception of 1995 (no samples were taken), concentrations of the analytes in moss did show some variation. It seems that concentrations of metals like chromium, copper, iron, nickel, lead and zinc diminish in time and on the contrary concentrations of other measured variables, for example calcium, magnesium and sodium, increase in time.

4.1.7 Throughfall and stemflow (TF, SF)

The Tables 7.1 to 7.12 in Appendix I present the data of the measurements of respectively throughfall of *Pinus sylvestris* and *Quercus robur* and stemflow of *Pinus sylvestris* and *Quercus robur*. Data are given as monthly weighed means for the analytes and monthly sums for the amount of precipitation.

To get an impression of the differences in years and in types of rainfall water yearly averages of some variables are given in Table 8 to 11. No standard deviations are given because the measured variables might be related to the period of the year.

Table 8: Yearly averages of some chemical variables in throughfall samples of Pinus sylvestris and the total amount of collected throughfall.

Year	Total precipi-tation mm	pH unit	EC 25 °C mS/m	NH_4N mg/l	NO_3N mg/l	SO_4S mg/l
1997	587	5.59	9.16	4.37	1.60	3.31
1998	1035	5.16	6.92	2.38	1.11	2.06
1999	660	5.25	7.18	3.01	1.39	1.94

Table 9: Yearly averages of some chemical variables in throughfall samples of Quercus robur and the total amount of collected throughfall.

Year	Total precipi-tation mm	pH unit	EC 25 °C mS/m	NH_4N mg/l	NO_3N mg/l	SO_4S mg/l
1997	553	5.78	11.56	3.18	1.30	4.51
1998	993	5.42	8.41	1.48	0.74	2.45
1999	631	5.72	7.86	1.89	0.99	2.20

Table 10: Yearly averages of some chemical variables in stemflow samples of Pinus sylvestris and the total amount of collected stemflow.

Year	Total precipi-tation mm	pH unit	EC 25 °C mS/m	NH_4N mg/l	NO_3N mg/l	SO_4S mg/l
1997	236	5.18	21.00	11.28	2.85	6.98
1998	522	4.94	16.23	8.97	2.14	5.14
1999	716	5.26	15.87	7.58	2.42	3.93

Table 11: Yearly averages of some chemical variables in stemflow samples of Quercus robur and the total amount of collected stemflow.

Year	Total precipi-tation mm	pH unit	EC 25 °C mS/m	NH_4N mg/l	NO_3N mg/l	SO_4S mg/l
1997	413	5.52	26.88	6.78	2.17	9.39
1998	641	5.10	20.07	3.37	0.83	5.18
1999	1346	5.50	19.40	3.81	1.09	4.40

All measured concentrations in throughfall and stemflow samples are higher than in bulk samples (Table 7). It seems that the concentrations of SO4S in throughfall and stemflow samples are decreasing in time.

4.1.8 Soil chemistry (SC)

Table 8.1 in Appendix I presents the data of the analyses in soil-samples taken in 1997 by RIVM-ECO. In Table 12 the data of 1993 and 1997 are compared. It seems that the concentrations of the metals are increased with exception of Cr and Fe. To draw conclusions based upon data for only two years is not possible.

Table 12: Concentrations in soil - samples taken in 1993 and 1997

Year	pH Unit	COR mg/kg	Cd mg/kg	Cu mg/kg	Cr mg/kg	Fe mg/kg	Pb mg/kg	Zn mg/kg
1993	4.21	38250	0.10	1.43	7.85	1848	11.8	6.83
1997	4.05	54555	0.24	2.15	6.19	1659	23.48	10.43

4.1.9 Soilwater chemistry (SW)

Table 9.1 in Appendix I presents the results of the analyses in soilwater. Soilwater analyses are not carried out in previous years. As expected the concentrations of all measured variables in soilwater are higher than the concentrations in rainwater (Table 5.1, Appendix I)

4.1.10 Groundwater chemistry (GW)

Table 10.1 in Appendix I presents the data of the measurements carried out in the groundwater in Eemster. The table shows that during these years no differences are measured with exception of the increasing of the concentration of aluminium in 1999. The cause of this increase is unknown and can not be retraced in an increase of aluminium in rainwater analyses.

4.1.11 Lake water chemistry (LC)

Tables 11.1, 11.2 and 11.3 in Appendix I present the data of the concentration measurements of compounds in the water of the lake Kliplo in 1997, 1998 and 1999. In August 1998 a new location for sampling was chosen. At two locations independent samples were taken.

Concentrations of the variables in both collected samples are compared. No differences in concentrations have been measured (Appendix I, Table11.2).

In Figure 8, 9 and 10 measurements during these three years are shown.

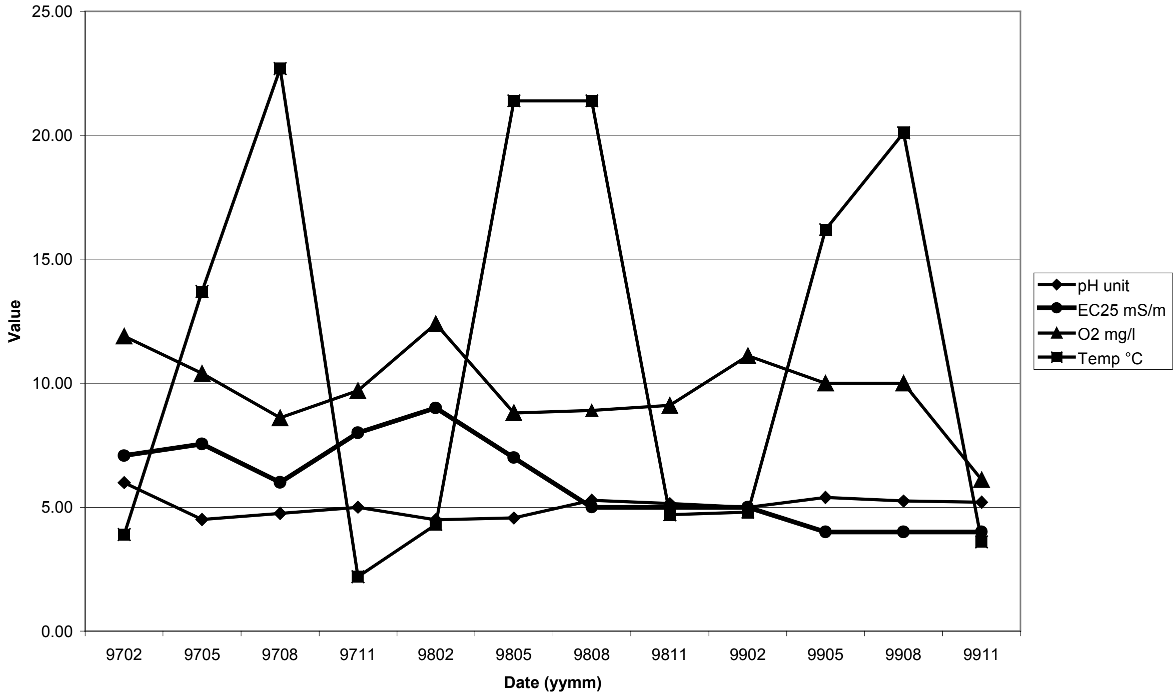

Figure 8: Measurements of acidity, conductivity, oxygen and temperature in the lake water of Kliplo.

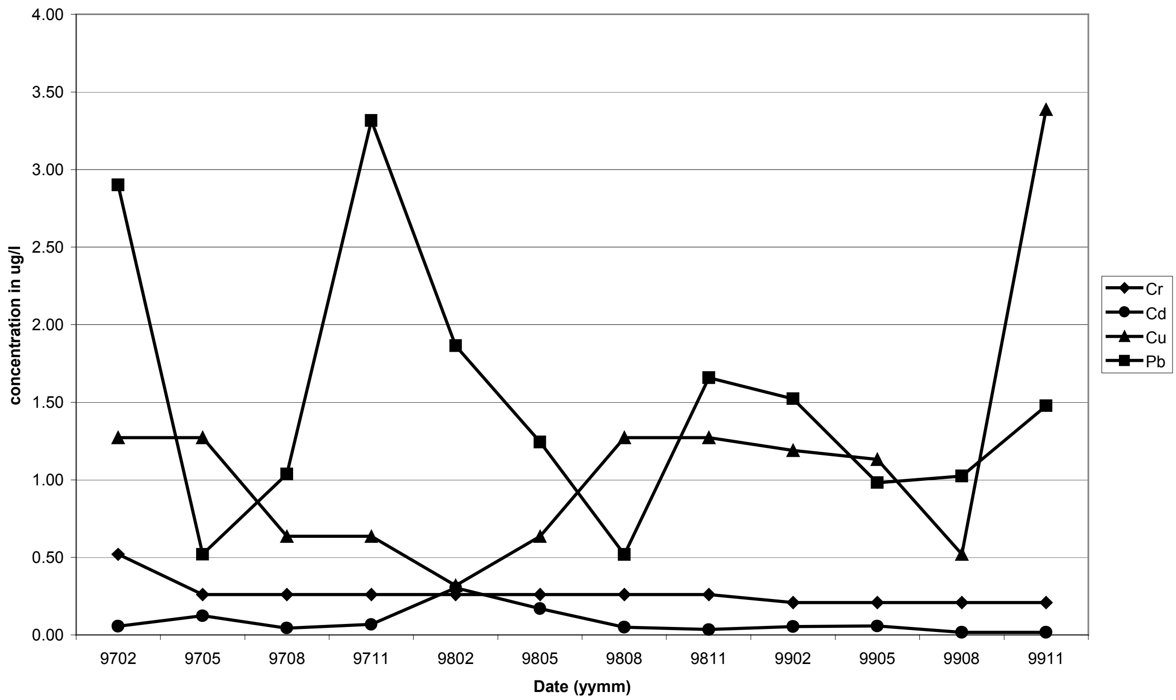

Figure 9: Concentrations of metals in the lake water of Kliplo.

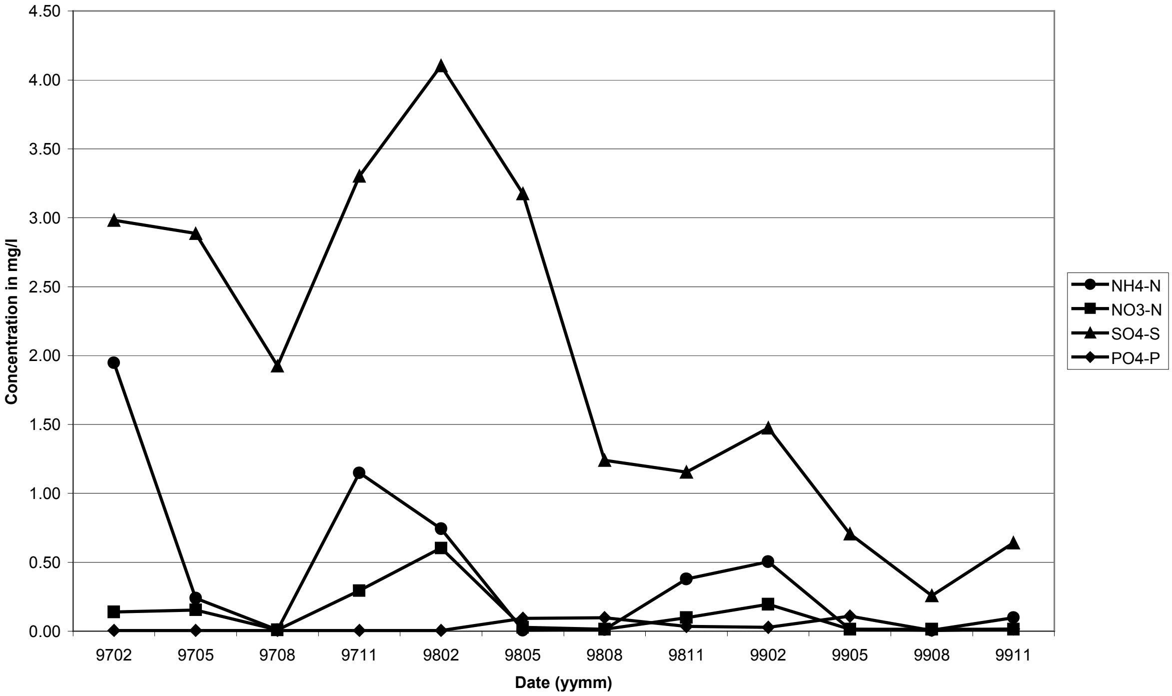

Figure 10: Concentrations of ammonium, nitrate, sulphate and phosphate in the lake water of Kliplo.

Figure 8 shows the seasonal periodicity in the measurements for temperature and in concentrations of oxygen. The conductivity and the pH are not related to the season. During these three years of measurements no differences in results are seen.
In Figure 9 no increasing or decreasing of the concentration of the variables is seen. The variation in the concentrations of copper and lead can not be explained.
In Figure 10 it seems that the concentrations of ammonium, nitrate and sulphate are decreasing in time, but the period shown here is too short to make that conclusion. Seasonal periodicity is seen for ammonium, nitrate and sulphate.

4.1.12 Foliage and litterfall chemistry (FC, LF)

Tables 12.1 to 12.12 in Appendix I present the data of the measurements of respectively foliage chemistry of *Pinus sylvestris* and *Quercus robur* and litterfall chemistry of both trees. To compare the data the averages are summarized in table 13.
Comparing concentrations in litterfall samples with concentrations in foliage samples do not give differences of more than a factor 2, with exception of phosphorous total and potassium.

Table 13: Analytical data of foliage and litterfall (averages ± sd in mg/kg) for Quercus robur and Pinus sylvestris.

Parameter	Year	Foliage chemistry *Q. robur*	Litterfall chemistry *Q. robur*	Foliage chemistry *P. sylvestris*	Litterfall chemistry *P. sylvestris*
nitrogen total	1997	34000 ± 10499	26200 ± 1789	26100 ± 2183	16400 ± 2078
	1998	30000 ± 3000	21400 ± 5550	21600 ± 1578	7000 ± 1871
	1999	30100 ± 4408	17800 ± 2775	19400 ± 2066	10500 ± 707
sulfate total	1997	1534 ±169	1238 ± 88	929 ± 79	737 ± 203
	1998	1574 ± 150	1347 ± 68	921 ± 99	786 ± 78
	1999	1528 ± 160	1233 ± 150	971 ± 79	780 ± 41
total organic carbon	1997	499200 ± 8509	511600 ± 5683	508000 ± 10435	532800 ± 3194
	1998	492000 ± 4000	506400 ± 8620	499800 ± 6088	521400 ± 9397
	1999	503400 ± 7501	506800 ± 5541	510600 ± 7260	524000 ± 2828
phosphorous total	1997	1324 ± 372	479 ± 67	1377 ± 251	392 ± 213
	1998	1101 ± 215	415 ± 38	1215 ± 186	310 ± 63
	1999	1053 ± 236	368 ± 99	1222 ± 182	324 ± 99
Calcium	1997	5188 ± 2097	4700 ± 1194	1461 ± 533	2794 ± 702
	1998	4221 ± 1263	5160 ± 1301	1486 ± 574	3446 ± 1022
	1999	4184 ± 1151	4668 ± 977	1474 ± 513	3575 ± 658
Cadmium	1997	0.75 ± 0	0.75 ± 0	0.75 ± 0	0.75 ± 0
	1998	0.75 ± 0	0.75 ± 0	0.75 ± 0	0.75 ± 0
	1999	0.75 ± 0	0.75 ± 0	0.75 ± 0	0.75 ± 0
Copper	1997	5.8 ± 2.5	5.0 ± 1.7	2.0 ± 0	2.0 ± 0
	1998	6.9 ± 1.2	7.2 ± 1.1	3.4 ± 1.3	2.0 ± 0
	1999	6.2 ± 0.7	4.5 ± 1.4	2.0 ± 1.0	2.0 ± 0
Potassium	1997	7953 ± 2069	2732 ± 451	6639 ± 886	1141 ± 556
	1998	7232 ± 2053	1610 ± 374	6978 ± 1616	660 ± 141
	1999	7957 ± 1673	1833 ± 356	6614 ± 933	760 ± 14
Magnesium	1997	2024 ± 419	1946 ± 296	620 ± 137	554 ± 170
	1998	1829 ± 366	2060 ± 365	730 ± 168	694 ± 132
	1999	1997 ± 336	1828 ± 136	770 ± 140	790 ± 184
Manganese	1997	306 ±119	319 ± 65	164 ± 49	267 ± 79
	1998	333 ± 158	377 ± 92	137 ± 38	244 ± 39
	1999	292 ± 104	326 ± 68	155 ± 45	262 ± 56
Sodium	1997	236 ±136	296 ± 50	214 ± 205	539 ± 157
	1998	230 ± 125	260 ± 55	260 ± 84	340 ± 114
	1999	110 ± 52	224 ± 36	270 ± 256	355 ± 106
Lead	1997	4.4 ± 2.8	3.5 ± 0	3.5 ± 0	3.5 ± 0
	1998	9.0 ± 0	9.0 ± 0	9 ± 0	9.0 ± 0
	1999	9.0 ± 0	9.0 ± 0	9 ± 0	9.0 ± 0
Zinc	1997	20.0 ± 4.0	30.0 ± 5.0	38.0 ± 8.0	38.0 ± 6.0
	1998	26.0 ± 5.0	37.0 ± 4.0	42.0 ± 7.0	46.0 ± 15.0
	1999	26.7 ± 4.6	25.8 ± 1.7	40.0 ± 11.0	58.0 ± 10.0

4.1.13 Hydrobiology of lakes (LB)

Table 13.1 and 13.2 (Appendix I) present the species and their numbers as identified in the samples of the lake Kliplo, respectively the chlorophyll concentrations in the samples taken for the subprogramme Lake water chemistry (LC).
The Figures 11, 12 and 13 show the variation in number of organisms, number of species and in concentration of chlorophyll since 1992.

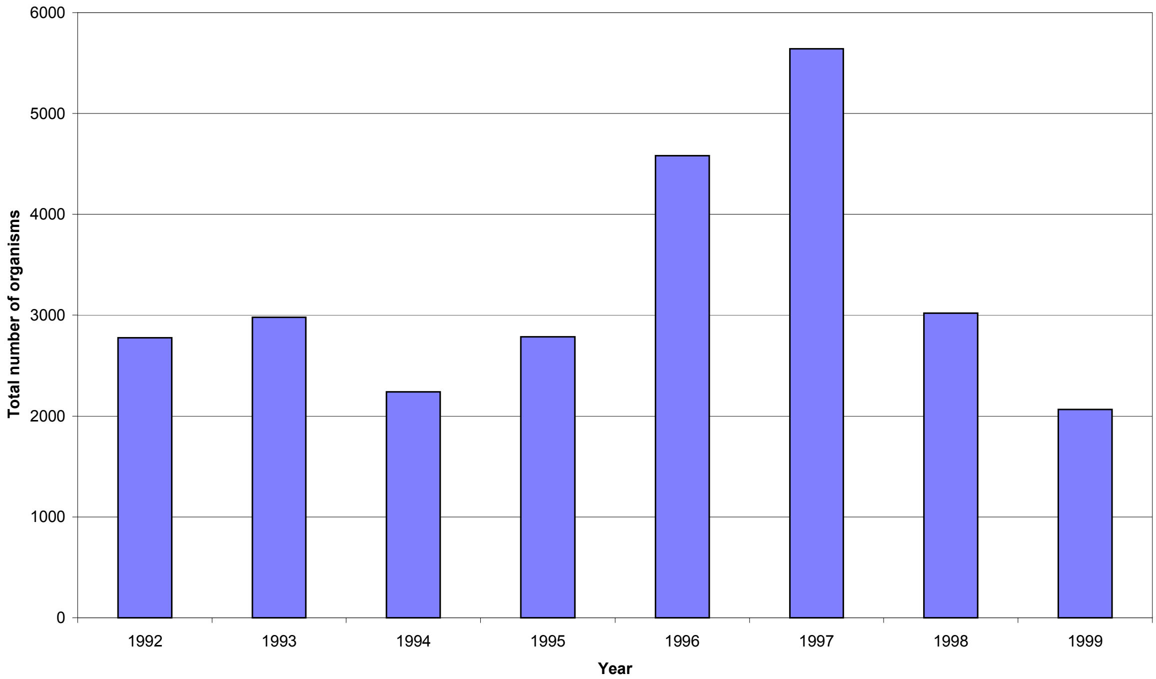

Figure 11: Total number of organisms 1992-1999, Kliplo.

A reliable explanation for the increase in the abundance of most organisms in 1996 and 1997 (Figure 11) can not be given.

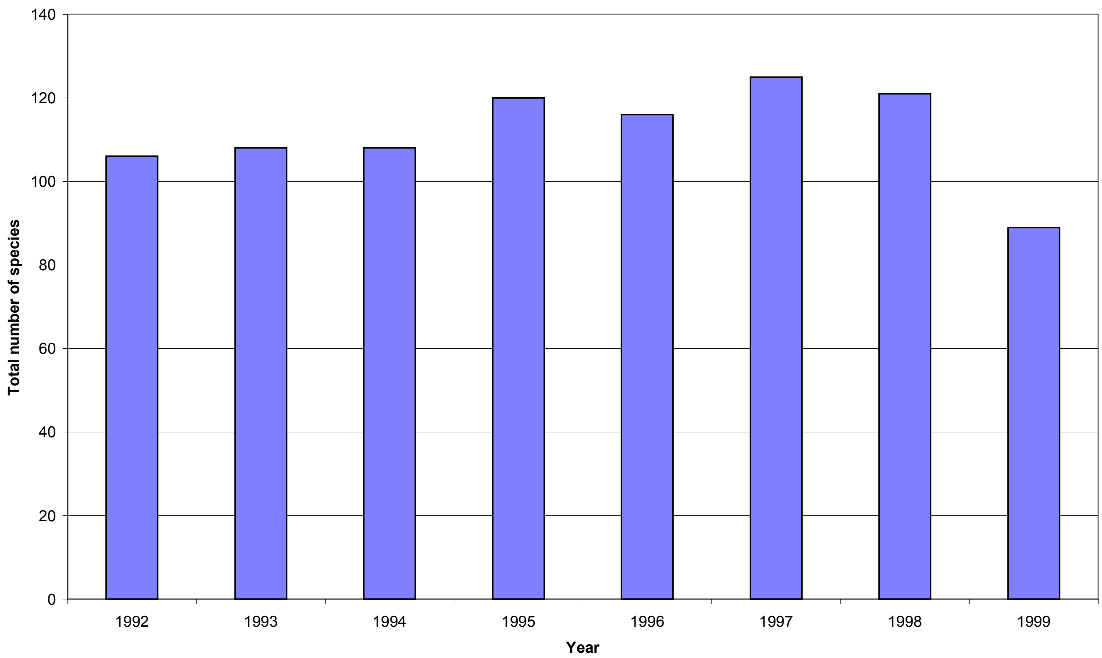

Figure 12: Total number of species 1992-1999, Kliplo.

However, although the amount of the species shows less variation (Figure 12), the species number in 1999 (89 species) seems to point out an alarming perturbation within the investigated ecosystem in the period of monitoring. Since the impact slightly different sampling periods and/or identification methodologies during the field survey can not be evaluated at this stage, a long-term monitoring appears necessary to allow a future assessment of the actual resilience of Lheebroekerzand.

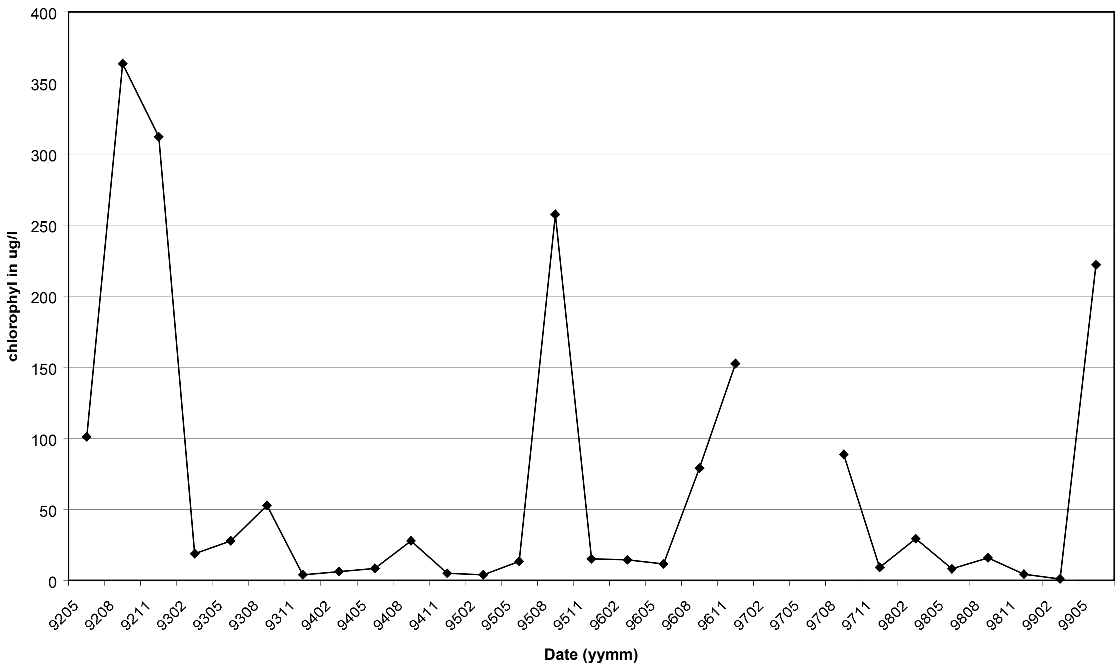

Figure 13: Chlorophyll-concentrations 1992-1999, Kliplo. (February and May 1997: no data available)

In Figure 13 seasonal periodicity is clearly shown. In summer the amount of chlorophyll is increased in all years of monitoring.

4.1.14 Forest damage (FD)

In Tables 14.1, 14.2 and 14.3 in Appendix I the tree class, diameter, height of the trees, crown height and crown width are shown. The observation of tree class is not different from past years of monitoring. The mean diameter of the stem at breast height is 30.4 ± 4.8 cm in 1997 against 30.6 ± 4.9 cm in 1998 and 30.6 ± 4.8 cm in 1999. The average height of the trees did also not increase: in 1997 the height was 17.5 ± 1.9 m, in 1998 17.3 ± 2.3 m and in 1999 17.5 ± 2.3 m. Tables 14.4, 14.5 and 14.6 (Appendix I) give information about the canopy cover and the needle characteristics of the same 25 trees. The observations of crown condition, needle characteristics, canopy cover, green needles and twigs on the ground and the presence of secondary shoots are not different from past years of monitoring. No removal damage, fungal damage, bark beetles or other insect infections, hanging twigs, sap/resin flow and dead bark is detected.

4.1.15 Vegetation (VG)

The results concerning the monitoring of the trees are presented in Table 15.1 in Appendix I. Dead trees and stumps are not recorded or not observed. In the 55 plots *Pinus sylvestris*, *Quercus robur* and *Betula pendula* are the most common trees observed with respectively 1670.9, 307.3 and 238.2 trees per hectare. The vitality of the community is mostly considered as normal. To estimate the vitality of the trees, defoliation, discoloration and damage were observed. Figure 14 gives an impression of the vitality of the trees.

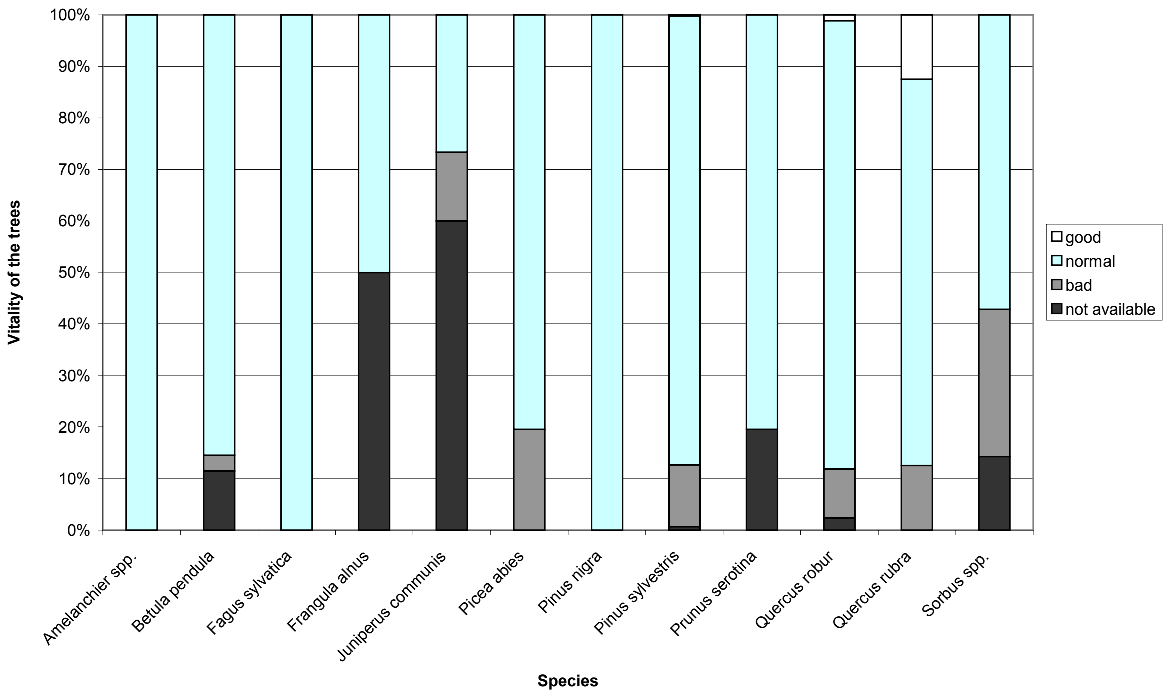

Figure 14: Vitality of trees, Lheebroekerzand, 1999.

The vitality of species of *Sorbus with 29%* is considered as bad, for *Picea abies* this is 20% and for *Pinus sylvestris* 12%. For *Juniperus communis* and *Frangula alnus* many specimens are not scored on vitality.

The results concerning the monitoring on the understorey vegetation is presented in Table 15.2 in Appendix I. The abundance of the different species per layer in the 55 plots is recorded according the scale of Doing Kraft. Transforming the data to the unit of coverage of species per layer, as mentioned in the ICPIM manual, the abundance according Doing Kraft is translated to percentages coverage per species per layer.
A coverage with more than 10% was observed for *Pleurozium schreberi* in the moss layer, *Empetrum nigrum, Deschampsia flexuosa* and *Molinia caerulea* in the herb layer and *Picea abies, Pinus sylvestris Quercus rubra, Quercus robur* and *Prunus serotina* in the tree layer.

4.1.16 Trunk epiphytes (EP)

Tables 16.1 and 16.2 in Appendix I present the data of the coverage of epiphytic lichens on individual pine, respectively oak trees. Vitality classes of the monitored epiphytes on the individual trees are presented in Table16.3 and 16.4 in Appendix I.
In some cases it was not possible to realize a tape at the height of 120 cm around the tree due to existing low branches. In that cases the tape was fixed at the closest height that was possible. The exact heights are given in Table 16.1 and 16.2.

The mean cover of epiphytic lichen species and vitality on trunks at a height of 1.20 m is shown in Table 14.

Table 14: Mean cover (%) and mean vitality class (mode) of epiphytic lichen species on trunks on a line of about 1.20 m height.

Species	*Pinus sylvestris*		*Quercus robur*	
	Coverage	Vitality*	Coverage	Vitality*
Chaenotheca ferruginea	0.41	1		
Cladonia macilenta	0.10	1		
Cladonia merochlorophaea	0.27	1		
Dimerella pineti			7.62	1
Hypogymnia physodes	1.27	3	0.96	4
Hypocenomyce scalaris	0.17	1		
Lecanora aitema	0.02	4		
Lecanora conizaeoides	1.45	1		
Lecanora expallens			1.32	1
Lepraria incana	17.57	1	27.03	1
Micarea denigrata	0.04	2		
Micarea prasina			0.94	1
Parmelia subaurifera			0.01	1
Trapeliopsis granulosa	0.29	1		

** 1 = normal, 2 = slight damage, 3 = distinct damage, 4 = severe damage, 5 = dead*

With the line method fourteen species are observed in the monitoring area. Ten species were detected on pine trees and six species on oak trees. *Lepraria incana* was the most common species with a healthy condition. No mortality or damaged organisms were seen. *Hypogymnia physodes* was found in a bad condition both on pine and on oak trees.

All sixteen pine and oak trees were searched for the occurrence of lichens. In Table 16.5 and 16.6 in appendix I species determined on trunks between 50 and 200 cm above the soil surface are presented; species determined on branches on the sampled trees not higher than 200 cm are presented in Tables 16.7 and 16.8.
On the trunk of *Pinus sylvestris* fourteen species were detected and fifteen on the branches. These fifteen species were detected on only four trees because the other trees did not have branches beneath 2 m. *Cladonia chlorophaea, Xanthoria polycarpa* (both on 1 tree) and *Placynthiella icmalea* (on 2 trees) were seen on the branches but not on the trunk of *Pinus sylvestris*. Species only detected on the trunk were *Micarea denigrata* (on 3 trees) and *Trapeliopsis flexuosa* (on 1 tree).
On trunks of *Quercus robur* thirteen species were detected and much more on branches namely 41 different species. Nevertheless two species present on the trunk were absent on branches (*Chaenotheca ferruginea, Lecanora conizaeoides*).

4.2 Additional programme

4.2.1 Leafminers (LM)

Species that are identified on birch, beech and oak are given in Table 17.1, 17.2 and 17.3 in Appendix I.
In Figure 15 the percentage of infected leaves for birch, oak and from 1996 also for beech, for the period 1993-1997 is shown.

During the period of monitoring differences are seen between the trees. Every year birch has less infected leaves than oak. In 1997 the number of infected leaves was less than in other years for the three different kind of trees.

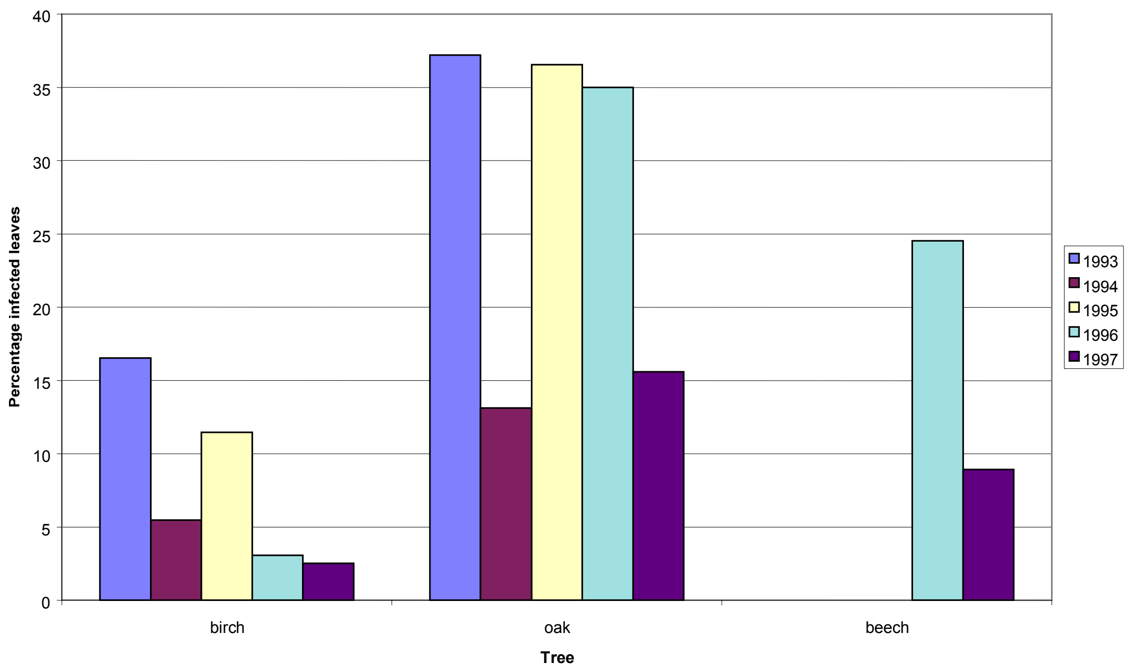

Figure 15: Percentage of infected leaves for birch, oak and beech, 1993-1997.

Similar to 1996 the most common species on birch and beech were *Stigmella* sp., followed by *Phyllonorycter maestingella* only recorded on beech. The most prevalent species on oak was, as in 1996, *Ectoedemia albifasciella*.
From these five years of monitoring no conclusions can be made regarding the difference in frequency, species diversity and the eventual relation between the appearance of leafminers and the condition of the trees.

4.2.2 Monitoring of butterflies (BF).

The results of the counting of butterflies are given in Table 18.1, 18.2 and 18.3 in Appendix I. Weather conditions during the observations are presented in Table 18.4 in Appendix I. Unlike other years monitoring in 1997 started in June because no volunteer was available for performing the countings. In 1998 and 1999 the countings started as usual in April.

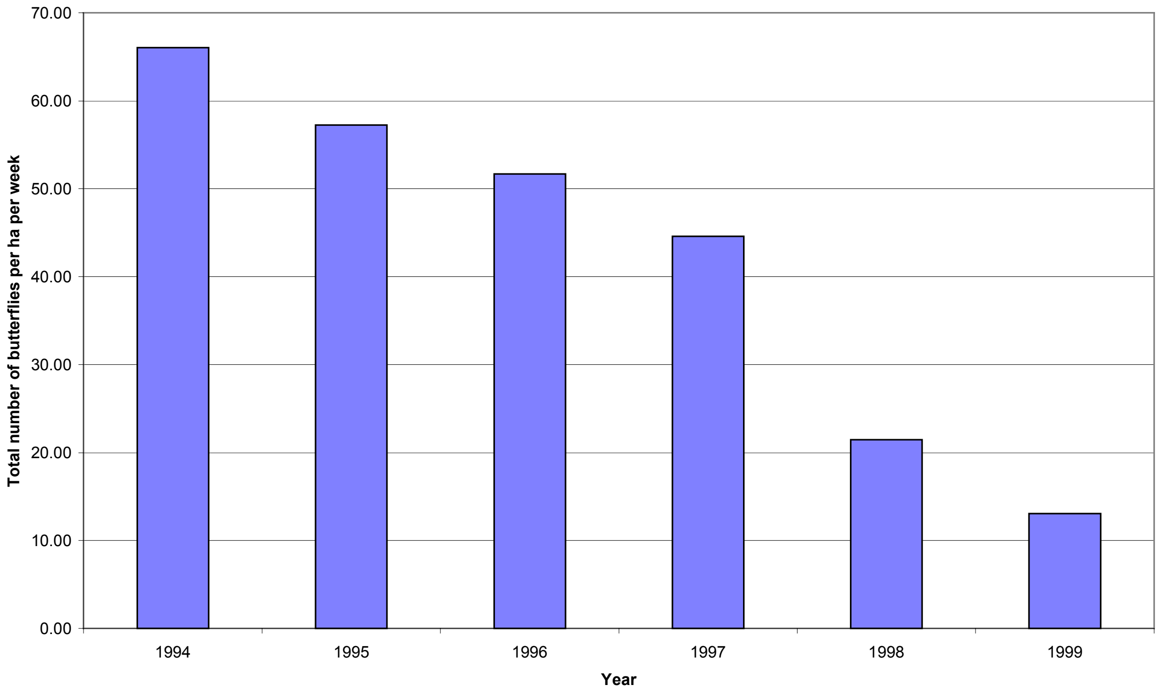

Figure 16: Total number of butterflies per hectare per flying week, Lheebroekerzand, 1994 - 1999.

Figure 16 shows that the total number of observed butterflies is decreasing since 1994, the start of the monitoring. It seems an alarming trend in the Lheebroekerzand. This trend is not seen in the counts made by the Dutch Butterfly Conservation (van Swaay *et al.*, 2000). According van Swaay and colleagues the number of butterflies counted in the Netherlands in 1999 was higher than in 1998. This is an effect of the very high numbers of a few common species like *Maniola jurtina*. On the contrary an increase of the number of *Maniola jurtina* in the Lheebroekerzand is not seen (see Figure 17).

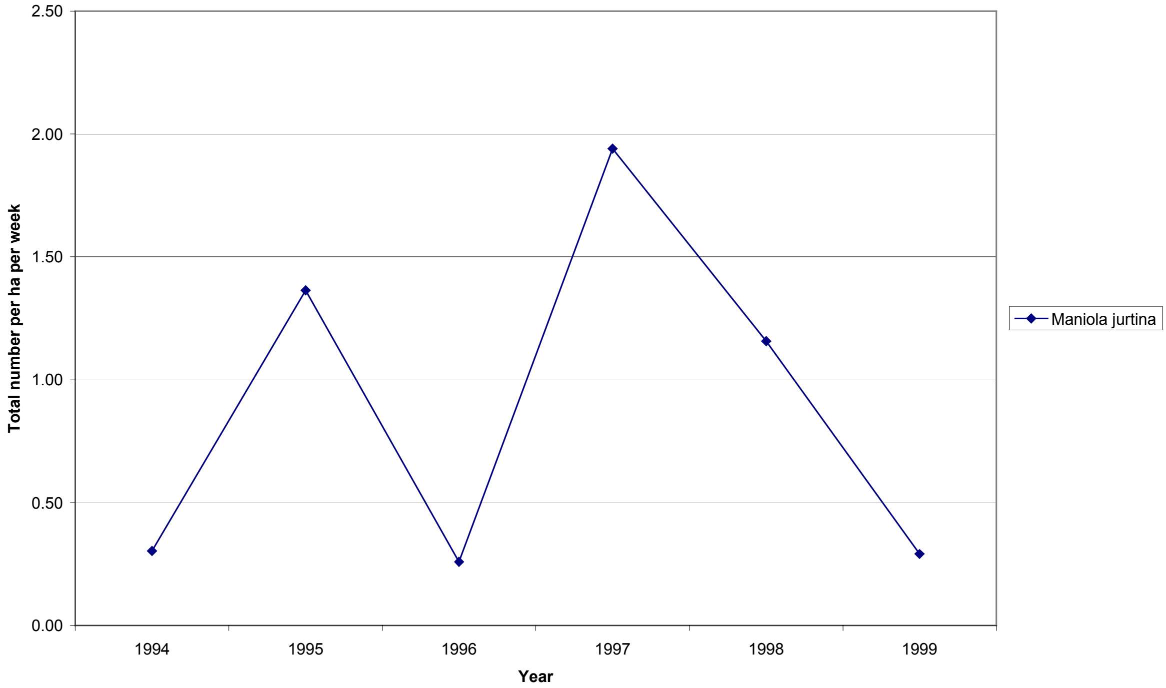

Figure 17: Total number of Maniola jurtina, Lheebroekerzand, 1994-1999.

Many of the threatened butterflies in the Netherlands show a further decline in 1999. In Figure 18 the decreasing trend of two threatened butterflies in the Lheebroekerzand is shown.

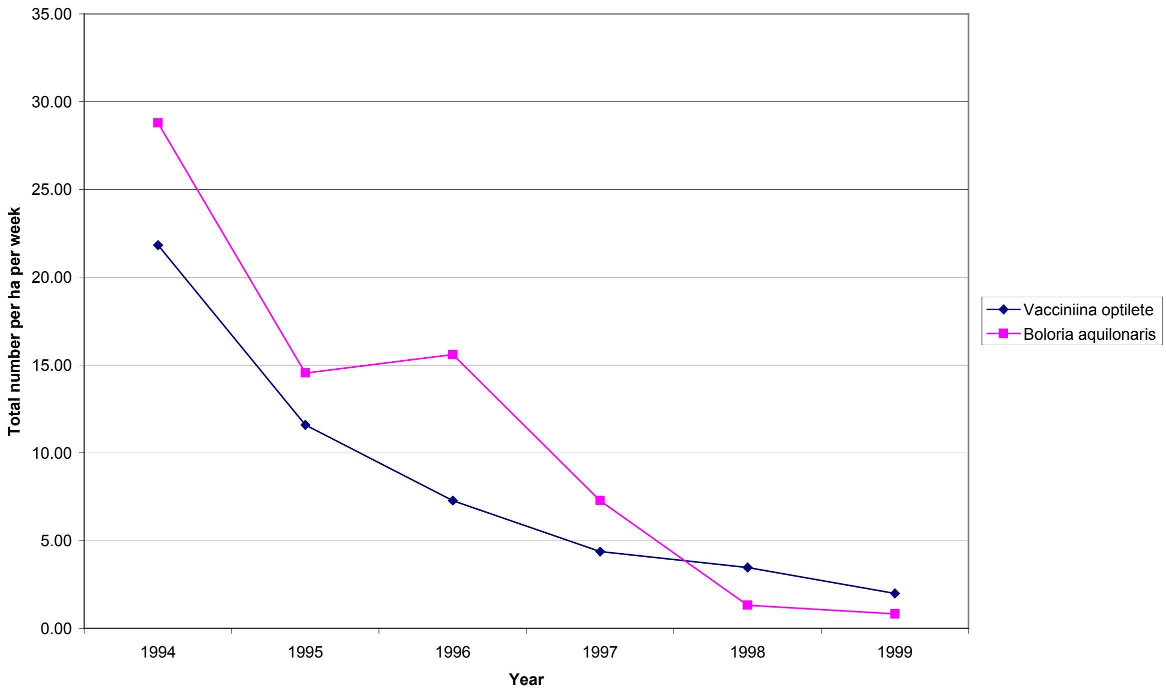

Figure 18: Total number of Vacciniina optilete and Boloria aquilonaris, Lheebroekerzand, 1994-1999.

To compare the data over the mentioned period, an index is given per species. The index is the total number of butterflies as the percentage of the total number in the first year of their appearance. In Table 15 the indices of the species in the Lheebroekerzand are shown. The table illustrates that there are 11 species that show a decreasing trend against 3 with an increasing trend. The increasing species (*Inachis io, Lycaena phlaeas and Thymelicus sylvestris)* are common species.

Table 15: Indices of the observed species in the Lheebroekerzand.

	Index					
	1994	**1995**	**1996**	**1997**	**1998**	**1999**
Species that show an increasing trend						
Lycaena phlaeas	100	225	343	1360	818	192
Inachis io	100	113	129	760	136	168
Thymelicus sylvestris					100	264
Species that show a decreasing trend						
Ochlodes venata	100	100	61	30	29	16
Aphantopus hyperantus				100	0	0
Boloria aquilonaris	100	51	54	25	5	3
Cynthia cardui	100	0	171	0	0	0
Vacciniina optilete	100	53	33	20	16	8
Hespera comma					100	0
Hipparchia semele		100	114	0	0	0
Pieris napi	100	75	21	47	32	8
Plebejus argus		100	0	0	0	0
Quercusia quercus		100	57	0	0	0
Thymelicus lineola			100	93	0	56
Species that are fluctuating						
Gonepteryx rhamni			100	187	191	93
Aglais urticae	100	1125	171	1840	55	0
Callophrys rubi	100	750	1929	80	464	120
Celastrina argiolus		100	57	107	182	64
Maniola jurtina	100	450	86	640	382	96
Heodes tityrus	100	2100	1371	160	164	0
Pieris brassicae	100	0	0	400	55	144
Pieris rapae	100	300	0	800	545	288
Pyronia tithonus	100	75	171	240	91	48
Vanessa atalanta	100	75	43	440	82	216

From the 10 species that vary in number, 8 species are less observed in 1999 comparing to 1998. The other two species (*Pieris brassicae* and *Vanessa atalanta)* are common species. This means that not only the total number of observed butterflies in the Lheebroekerzand is decreasing but also the number of species is decreasing. Based on this observations it is to be expected that both the total number and the number of species of butterflies will diminish the coming years. Figure 19 shows the decreasing in species from 1996.

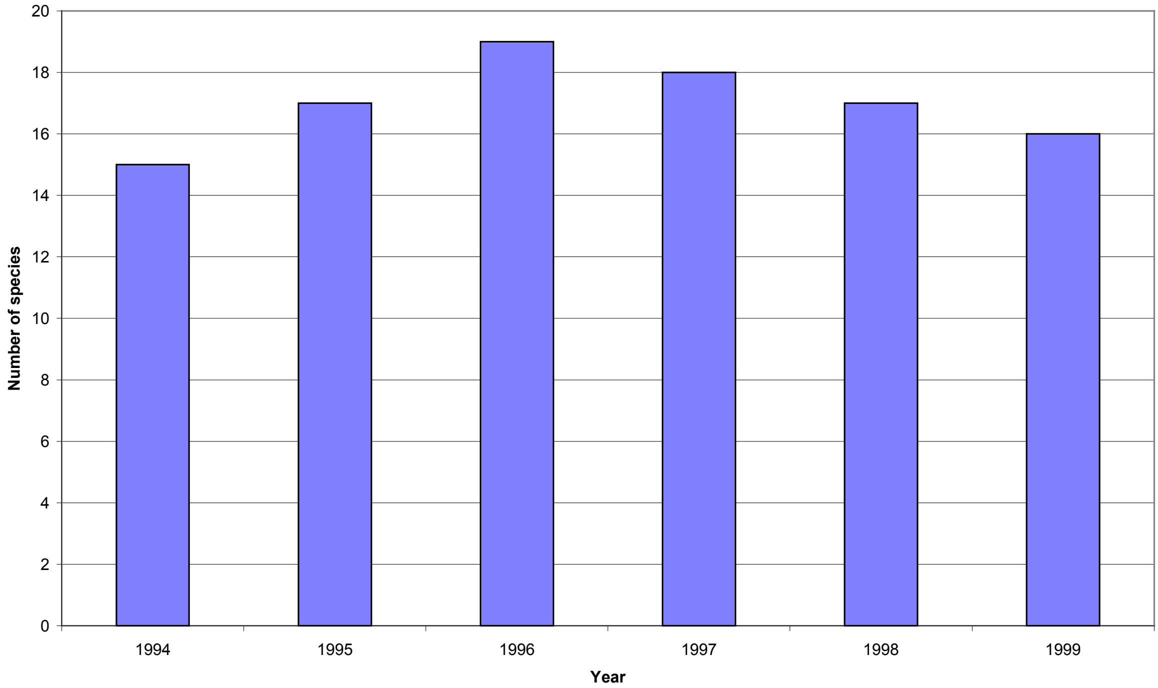

Figure 19: The number of species of butterflies, Lheebroekerzand, 1994-1999.

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Appendix I Data of the monitoring programme

1 Inventory of birds

Table 1.1 Inventory of birds, 1987-1998, Lheebroekerzand. Total number of breeding pairs.

2 Inventory of plants

Table 2.1: Inventory of plants, 1999, Lheebroekerzand, data Alterra.
Number of plots per species for each abundance class according to the scale of Doing Kraft.
Number of monitored plots is 55

3 Climate

Table 3.1 Climate, 1997, 1998 and 1999, Lheebroekerzand. Values are given as monthly means.

4 Air chemistry

Table 4.1 Air chemistry, 1997, 1998 and 1999, Witteveen. Values are given as monthly means.

5 Precipitation chemistry

Table 5.1 Precipitation chemistry, 1997, Lheebroekerzand.
Results are monthly weighed means.

Table 5.2 Precipitation chemistry, 1998, Lheebroekerzand.
Results are monthly weighed means.

Table 5.3 Precipitation chemistry, 1999, Lheebroekerzand.
Results are monthly weighed means.

6 Chemistry of Mosses

Table 6.1 Chemistry of mosses, 1997, Lheebroekerzand.

Table 6.2 Chemistry of mosses, 1998, Lheebroekerzand.

Table 6.3 Chemistry of mosses, 1999, Lheebroekerzand.

7 Throughfall and Stemflow

Table 7.1 Throughfall *Quercus robur*, 1997, Lheebroekerzand.
Results are monthly weighed means.

Table 7.2 Throughfall *Quercus robur*, 1998, Lheebroekerzand.
Results are monthly weighed means.

Table 7.3 Throughfall *Quercus robur*, 1999, Lheebroekerzand.
Results are monthly weighed means.

Table 7.4 Throughfall *Pinus sylvestris*, 1997, Lheebroekerzand.
Results are monthly weighed means.

Table 7.5 Throughfall *Pinus sylvestris*, 1998, Lheebroekerzand.
Results are monthly weighed means.

8 Soil chemistry

9 Soil water chemistry

10 Groundwater chemistry

11 Lake water chemistry

12 Foliage en Litterfall Chemistry

13 Hydrobiology of lakes

14 Forest Damage

15 Vegetation

16 Trunk epiphytes

17 Leafminers

18 Butterflies

Table 1.1: Inventory of birds, 1987-1998, Lheebroekerzand.
Total number of breeding-pairs.

Name	Scientific name	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
little grebe	*Tachybaptus ruficollis*	-	1	-	-	-	1	-	-	1	-	-	1
grey heron	*Ardea cinerea*	5	7	15	27	25	19	18	20	23	10	14	11
Teal	*Anas crecca*	-	-	2	2	3	3	2	2	1	-	-	-
Mallard	*Anas platyrhynchos*	-	1	4	6	4	2	2	6	3	3	2	1
Goshawk	*Accipiter gentilis*	-	1	1	2	1	1	1	1	1	-	-	-
Sparrowhawk	*Accipiter nisus*	-	1	-	-	-	-	1	-	-	-	-	-
Buzzard	*Buteo buteo*	1	1	-	2	2	2	2	1	3	1	1	1
Kestrel	*Falco tinnunculus*	-	-	-	1	-	-	-	-	-	-	-	-
Hobby	*Falco subbuteo*	-	-	-	-	-	1	-	-	-	-	-	-
Pheasant	*Phazianus colchicus*	-	-	1	2	3	-	-	2	-	-	-	-
Coot	*Fulica atra*	-	-	-	-	1	-	-	2	1	-	-	-
Moorhen	*Gallinula chloropus*	-	-	-	-	-	-	1	-	-	-	-	-
stock dove	*Columba oenas*	-	1	2	-	2	4	4	1	4	4	3	3
Woodpigeon	*Columba palumbus*	13	11	11	19	12	17	15	22	21	25	15	14
Woodcock	*Scolopax rusticola*	-	-	-	-	-	-	-	-	-	-	1	-
turtle dove	*Streptopelia turtur*	1	5	5	3	9	2	8	6	3	3	13	4
Cuckoo	*Cuculus canorus*	4	3	3	4	3	2	2	2	2	2	2	2
long-eared owl	*Asio otus*	1	-	3	1	-	1	2	-	-	2	-	1
green woodpecker	*Picus viridis*	-	-	1	1	1	1	-	1	1	1	1	1
black woodpecker	*Dryocopus martius*	3	2	2	3	3	2	1	2	2	2	2	1
great spotted woodpecker	*Dendrocopus major*	8	15	20	20	27	13	15	13	13	15	14	13
lesser spotted woodpecker	*Dendrocopus minor*	-	-	-	2	1	1	-	-	1	-	2	3
Woodlark	*Lullula arborea*	-	1	1	1	2	3	2	3	2	3	4	3
tree pipit	*Anthus trivialis*	30	35	26	36	41	39	38	38	26	26	25	28
meadow pipit	*Anthus pratensis*	-	-	-	1	1	1	1	-	-	-	-	-
white wagtail	*Motacilla alba*	1		1	2	1	1	2	1	2	2	4	2
Wren	*Troglodytes troglodytes*	19	42	45	52	32	37	38	32	39	11	9	17
Dunnock	*Prunella modularis*	4	5	11	11	7	10	11	7	11	4	5	5
Robin	*Erithacus rubecula*	44	72	72	83	59	82	104	87	81	77	64	68
Redstart	*Phoenicurus phoenicurus*	19	21	18	25	15	14	16	15	18	16	15	9
Stonechat	*Saxicola torquata*	-	-	-	-	1	-	1	-	1	1	1	1
Blackbird	*Turdus merula*	25	29	46	55	43	59	42	45	52	51	44	52
song trush	*Turdus philomelos*	8	10	12	16	10	16	8	8	15	11	12	12
mistle trush	*Turdus viscivorus*	4	3	3	7	6	4	5	6	5	3	1	1
icterine warbler	*Hippolais icterina*	-	-	-	1	-	-	-	-	-	-	-	1
lesser whitethroat	*Sylvia curruca*	2	2	1	1	-	-	1	2	3	4	1	-
Whitethroat	*Sylvia communis*	-	1	2	1	-	1	2	1	2	2	1	-
garden warbler	*Sylvia borin*	13	14	6	4	6	5	7	4	4	6	2	3
Blackcap	*Sylvia atricapilla*	14	18	19	23	15	23	21	21	19	16	20	17
wood warbler	*Phylloscopus sibilatrix*	1	2	3	4	5	1	11	2	1	1	-	-
Chiffchaff	*Phylloscopus collybita*	13	28	21	37	20	27	25	21	21	16	21	24
willow warbler	*Phylloscopus trochilus*	110	102	98	108	94	124	147	110	113	87	90	99

Name	Scientific name	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Goldcrest	*Regulus regulus*	10	21	35	36	10	14	12	17	10	8	10	16
Firecrest	*Regulus ignicapillus*	-	1	1	2	-	-	-	-	-	-	-	-
spotted flycatcher	*Muscicapa striata*	2	-	3	1	-	2	1	3	4	2	1	-
pied flycatcher	*Ficedula hypoleuca*	13	2	3	2	7	6	4	3	4	1	1	3
long-tailed tit	*Aegithalos caudatus*	18	13	17	24	20	19	9	13	8	7	6	4
marsh tit	*Parus palustris*	-	1	-	2	3	3	2	1	1	3	2	-
willow tit	*Parus montanus*	1	5	4	8	7	2	6	4	6	4	5	3
crested tit	*Parus cristatus*	6	8	9	13	9	6	6	8	7	5	3	-
coal tit	*Parus ater*	16	12	17	15	21	21	20	23	17	13	20	16
bleu tit	*Parus caeruleus*	9	13	11	11	13	16	10	11	12	18	13	12
graet tit	*Parus major*	27	18	20	25	31	39	38	30	17	36	25	21
short toed treecreeper	*Certhia brachydactyla*	11	13	13	15	18	14	17	16	15	14	11	8
golden oriole	*Oriolus oriolus*	1	1	1	-	-	1	1	-	1	1	-	-
Jay	*Garrulus glandarius*	8	7	10	9	13	11	13	10	11	9	11	6
Jackdaw	*Corvus monedula*	1	2	6	5	2	1	2	2	1	-	1	-
carrion crow	*Corvus corone*	4	4	7	12	11	11	12	10	10	10	12	9
Starling	*Sturnus vulgaris*	5	13	18	22	14	13	10	7	7	6	7	2
tree sparrow	*Passer montanus*	-	-	-	-	1	1	1	-	-	-	1	1
Chaffinch	*Fringella coelebs*	115	119	93	109	89	107	107	116	107	117	106	94
Greenfinch	*Carduelis chloris*	2	-	1	1	-	-	1	-	1	-	3	-
Linnet	*Carduelis cannabina*	19	11	12	6	9	6	4	5	4	3	7	3
Crossbill	*Loxia curvirostra*	2	5	-	-	8	-	-	3	-	-	2	1
Bullfinch	*Pyrrhula pyrrhula*	2	3	7	16	11	6	5	10	10	6	5	4
Hawfinch	*Coccothraustes coccothraustes*	1	1	2	-	3	-	2	1	1	2	1	1
Yellowhammer	*Embreza citrinella*	3	4	2	1	2	2	3	3	3	3	1	2
Redbunting	*Embreza schoeniclus*	-	-	-	-	1	-	1	-	-	1	-	-
Siskin	*Carduelis spinus*	-	-	-	-	-	-	-	-	2	-	-	-
Total number of species		**45**	**50**	**52**	**55**	**54**	**54**	**57**	**52**	**56**	**50**	**52**	**47**
Total number of breeding pairs		**619**	**711**	**747**	**898**	**758**	**820**	**843**	**780**	**754**	**674**	**643**	**604**

Table 2.1: *Inventory of plants, 1999, Lheebroekerzand, data Alterra.*
Number of plots per species for each abundance class according to the scale of Doing Kraft.
Number of monitored plots is 55

Species	**Abundance class**											
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Agrostis capillaris	2											2
Amelanchier lamarckii	11	10	3				1					25
Betula pendula	5	12	7	1	1			1				27
Brachythecium rutabulum	17											17
Calluna vulgaris	20	1										21
Campylopus introflexus	1											1
Carex	1											1
Ceratocapnos claviculata	19	1	1									21
Deschampsia flexuosa	12	8	6	10	7	6	4					53
Dicranella heteromalla	13											13
Dicranum scoparium	36	7	2			1						46
Dryopteris dilatata	35		2	1								38
Empetrum nigrum	8	5	4		1	3	1	1	6	2		31
Erica tetralix	6	1		1								8
Eurhynchium praelongum	7											7
Fagus sylvatica	2											2
Galium saxatile	6		1									7
Hypnum jutlandicum	18	10	11	8	5		1					53
Ilex aquifolium	3											3
Juniperus communis	4	3			1							8
Lonicera periclymenum	2	1										3
Molinia caerulea	15	3	1	5		1	1		3			29
Orchis	1											1
Picea abies	2	1			2	1		1				7
Pinus sylvestris	1	2	9	11	13	7	7	1				51
Plagiothecium undulatum	4											4
Pleurozium schreberi	12	12	2	4	5	5	3	1				44
Polytrichum formosum	24	1			1							26
Polytrichum juniperinum	1											1
Prunus serotina	4	4	1	1	2	1						13
Pseudoscleropodium purum	2											2
Quercus robur	16	6	11	1	7	4	1			2		48
Quercus rubra	5		1	1		1						8
Rhamnus frangula	15	22	5	1	1							44
Rubus fruticosus	15											15
Rumex acetosella	3											3
Salix		1										1
Sorbus aucuparia	20	9	2									31
Sphagnum	1											1

Table 3.1: Climate, 1997, 1998 and 1999, Lheebroekerzand.
Values are given as monthly means.

Date yymm	Temp air °C 1.50 m height	Temp soil °C Surface	Temp soil °C 20 cm depth	Relative humidity % 1.50 m height	Irradiation[1)] W/m^2 1.50 m height	UV-B W/m^2 1.50 m height
9701	-2.6	-1.5	0.0	82	28.4	2.5
9702	4.7	3.6	2.6	81	46.5	3.2
9703	5.9	5.3	4.5	78	86.3	4.9
9704	6.1	6.1	4.9	68	152.0	6.3
9705	11.2	10.7	8.2	76	185.2	10.2
9706	14.6	13.5	10.7	75	212.8	9.0
9707	16.7	15.4	12.5	79	202.6	7.7
9708	19.4	17.3	14.0	75	194.0	6.9
9709	12.4	12.2	11.7	79	132.6	5.5
9710	7.5	8.2	8.9	82	70.4	3.5
9711	4.5	4.3	5.5	85	28.3	3.2
9712	3.0	*	4.2	77	16.3	3.7
9801	4.4[1)]	*	4.1	88[1)]	25.3	4.0
9802	6.0[1)]	*	3.5	86[1)]	47.1	4.6
9803	6.9[1)]	*	4.6	84[1)]	81.8	4.9
9804	9.0[1)]	*	6.3	87[1)]	114.6	2.4
9805	14.2[1)]	13.1	9.5	78[1)]	201.3	4.1
9806	15.5[1)]	15.6	11.7	86[1)]	174.4	3.9
9807	15.5[1)]	15.5	12.7	86[1)]	169.3	4.2
9808	15.7[1)]	15.4	12.8	85[1)]	176.1	5.4
9809	14.1[1)]	13.8	11.8	93[1)]	95.5	7.9
9810	9.0[1)]	8.9	9.1	92[1)]	45.9	7.7
9811	3.1[1)]	5.4	6.6	94[1)]	37.7	7.7
9812	3.2[1)]	2.6	3.1	93[1)]	19.6	1.9
9901	3.8	3.8	3.8	88.9	26.0	4.2
9902	1.7	1.7	2.4	89.7	52.7	5.9
9903	6.2	5.9	4.1	84.1	84.8	7.3
9904	8.9	8.9	6.4	80.7	163.2	*
9905	13.1	13.1	9.6	72.2	209.8	*
9906	14.0	14.4	11.3	78.5	220.1	*
9907	18.0	17.8	13.9	78.4	225.0	*
9908	16.3	15.9	13.4	81.6	163.0	*
9909	16.6	15.6	13.1	86.8	130.9	*
9910	9.5	8.5	8.9	90.3	73.3	*
9911	5.3	4.5	5.2	93.9	35.3	*
9912	3.6	3.2	3.4	95.3	20.2	*

* not available; 1) measured in Hoogeveen

Table 4.1: Air chemistry, 1997, 1998 and 1999, Witteveen.
Values are given as monthly means.

Date yymm	**SO_2S** µg/m³	**O_3** µg/m³	**NO_2N** µg/m³	**NH_4N** µg/m³	**NO_3N** µg/m³	**SO_4S** µg/m³	**NH_3N** µg/m³
9701	5.22	15	10.52	1.73	0.88	1.09	0.34
9702	0.75[1)]	42	6.00	*	*	*	1.39
9703	0.75[1)]	41	5.33	1.63	0.98	0.96	5.03
9704	0.75[1)]	59	3.87	0.48	0.32	0.27	2.82
9705	0.75[1)]	*	*	1.19	0.67	0.78	3.30
9706	0.75[1)]	57	3.52	0.51	0.28	0.46	*
9707	0.75[1)]	43	3.18	0.91	0.45	0.72	2.89
9708	0.75[1)]	54	5.11	1.41	0.61	1.12	2.65
9709	0.75[1)]	33	4.43	0.72	0.51	0.53	2.11
9710	0.75[1)]	25	5.31	0.67	0.40	0.37	1.62
9711	2.30	15	7.34	0.97	0.54	0.67	1.68
9712	1.74	22	6.59	*	*	*	0.82
9801	0.75[1)]	33	5.71	0.66	0.43	0.47	1.17
9802	2.15	28	8.68	1.66	1.08	0.77	4.12
9803	0.75[1)]	46	4.61	0.77	0.51	0.43	2.54
9804	0.75[1)]	50	3.67	0.84	0.53	0.44	2.39
9805	0.75[1)]	60	3.75	1.19	0.58	0.85	3.26
9806	0.75[1)]	43	3.26	0.94	0.49	0.77	1.42
9807	0.75[1)]	39	2.59	0.75	0.36	0.57	1.50
9808	0.75[1)]	41	2.98	0.69	0.44	0.53	2.25
9809	0.75[1)]	29	3.78	1.03	0.57	0.63	1.83
9810	*	35	3.67	0.31	0.19	0.34	1.35
9811	0.75[1)]	18	7.56	0.97	0.52	0.60	1.97
9812	0.75[1)]	24	7.68	1.27	0.78	0.79	1.45
9901	0.85	32	5.74	0.45	0.46	0.37	1.17
9902	0.93	43	5.30	0.86	0.61	0.38	1.28
9903	1.09	41	5.21	1.14	0.85	0.57	3.04
9904	1.06	58	3.56	0.95	0.57	0.59	2.99
9905	1.03	61	3.51	0.74	0.45	0.49	3.03
9906	0.87	52	2.95	0.33	0.18	0.27	2.05
9907	0.81	53	2.88	0.64	0.26	0.44	2.41
9908	1.03	43	3.88	1.10	0.64	0.80	2.50
9909	0.87	42	4.61	1.12	0.63	0.84	3.53
9910	0.95	25	4.84	0.77	0.44	0.43	1.98
9911	0.99	21	6.44	0.69	0.44	0.48	1.81
9912	0.81	34	5.45	0.52	0.33	0.32	1.07

* not available; 1) less than detection limit; value is half of the detection limit

Table 5.1: Precipitation chemistry, 1997, Lheebroekerzand. Results are monthly weighed means.

Date yymm	Total precipitation mm	pH unit	EC 25°C mS/m	Na mg/l	K mg/l	Ca mg/l	Mg mg/l
9701	10.0	4.94	5.26	2.04	0.24	0.53	0.23
9702	86.8	5.83	2.36	1.45	0.06	0.17	0.19
9703	33.6	5.57	4.51	1.78	0.17	0.55	0.25
9704	49.3	6.18	4.12	3.29	0.19	0.53	0.41
9705	76.6	5.03	2.08	0.36	0.16	0.16	0.07
9706	113.1	6.06	1.66	0.40	0.07	0.19	0.07
9707	58.7	5.38	2.29	0.47	0.10	0.36	0.10
9708	55.5	5.10	2.03	0.46	0.06	0.21	0.07
9709	44.1	5.79	2.90	2.13	0.12	0.34	0.28
9710	118.0	5.65	3.54	3.65	0.20	0.25	0.44
9711	23.0	4.92	3.42	0.90	0.66	0.29	0.11
9712	89.6	5.00	2.91	1.85	0.24	0.19	0.23

Date yymm	Cd µg/l	Cu µg/l	Pb[1)] µg/l	Zn µg/l	Ni µg/l	As[1)] µg/l	Cr[1)] µg/l
9701	0.17	2.41	0.52	26.63	1.03	0.56	0.26
9702	0.04	0.32[1)]	0.52	3.27[1)]	0.44[1)]	0.56	0.26
9703	0.05	0.32[1)]	0.52	15.62	0.44[1)]	0.56	0.26
9704	0.01[1)]	0.32[1)]	0.52	3.27[1)]	0.44[1)]	0.56	0.26
9705	0.05	0.32[1)]	0.52	8.80	0.44[1)]	0.56	0.26
9706	0.04	2.46	0.52	3.27[1)]	0.44[1)]	0.56	0.26
9707	0.07	4.67	0.52	8.18	0.96	0.56	0.26
9708	0.02	0.86	0.52	3.27[1)]	0.44[1)]	0.56	0.26
9709	0.03	1.94	0.52	3.27[1)]	0.44[1)]	0.56	0.26
9710	0.05	0.32[1)]	0.53	3.27[1)]	0.44[1)]	0.56	0.26
9711	0.08	4.89	0.52	15.09	0.44[1)]	0.56	0.26
9712	0.05	0.81	0.52	3.27[1)]	0.44[1)]	0.56	0.26

Date yymm	Al µg/l	Cl mg/l	NH_4N mg/l	NO_3N mg/l	PO_4P µg/l	SO_4S mg/l
9701	23.39	3.48	2.85	1.29	29.20	2.16
9702	6.75[1)]	2.49	1.02	0.44	6.20[1)]	0.78
9703	6.75[1)]	3.20	2.65	1.14	6.20[1)]	1.77
9704	6.75[1)]	5.72	1.43	0.70	6.20[1)]	1.26
9705	6.75[1)]	0.70	1.07	0.69	6.20[1)]	0.77
9706	6.75[1)]	0.61	0.88	0.50	6.20[1)]	0.63
9707	6.75[1)]	0.81	1.20	0.72	15.06	0.89
9708	6.75[1)]	0.74	1.04	0.54	18.35	0.68
9709	6.75[1)]	3.80	0.90	0.50	17.10	0.77
9710	6.75[1)]	6.42	0.59	0.30	6.20[1)]	0.78
9711	6.75[1)]	1.52	1.63	0.90	25.18	1.15
9712	6.75[1)]	3.10	0.77	0.51	16.28	0.74

1) less than detection limit; value is half of the detection limit

Table 5.2: *Precipitation chemistry, 1998, Lheebroekerzand. Results are monthly weighed means.*

Date yymm	Total precipitation mm	pH unit	EC 25°C mS/m	Na mg/l	K mg/l	Ca mg/l	Mg mg/l
9801	90.1	5.23	3.46	3.18	0.18	0.20	0.37
9802	31.5	5.44	4.23	2.49	0.19	0.49	0.30
9803	109.2	5.42	2.22	1.27	0.05	0.27	0.14
9804	169.0	5.13	2.21	0.24	0.09	0.16	0.02[1)]
9805	38.4	5.16	2.92	0.64	0.22	0.23	0.09
9806	133.9	4.95	2.34	0.47	0.08	0.42	0.07
9807	74.2	4.74	3.41	1.08	0.10	0.28	0.15
9808	87.5	5.48	1.83	0.18	0.05	0.12	0.14
9809	121.8	5.18	2.08	0.54	0.05	0.16	0.17
9810	264.7	4.87	2.72	0.64	0.06	0.15	0.24
9811	77.5	4.73	3.85	2.50	0.14	0.18	0.35
9812	122.0	4.92	2.86	1.77	0.05	0.10	0.19

Date yymm	Cd µg/l	Cu µg/l	Pb µg/l	Zn µg/l	Ni[1)] µg/l	As[1)] µg/l	Cr[1)] µg/l
9801	0.04	0.76	0.52[1)]	6.58	0.44	0.56	0.26
9802	0.15	3.00	1.67	27.19	0.44	0.56	0.26
9803	0.03	2.08	0.52[1)]	9.94	0.44	0.56	0.26
9804	0.03	0.32[1)]	0.52[1)]	8.40	0.44	0.56	0.26
9805	0.08	0.32[1)]	0.52[1)]	3.27[1)]	0.44	0.56	0.26
9806	0.05	0.32[1)]	0.52[1)]	8.34	0.44	0.56	0.26
9807	0.04	3.27	0.52[1)]	8.14	0.44	0.56	0.26
9808	0.01[1)]	0.89	0.52[1)]	3.27[1)]	0.44	0.56	0.26
9809	0.01[1)]	1.50	0.52[1)]	3.27[1)]	0.44	0.56	0.26
9810	0.04	0.32[1)]	0.52[1)]	3.27[1)]	0.44	0.56	0.26
9811	0.02	0.32[1)]	0.52[1)]	3.27[1)]	0.44	0.56	0.26
9812	0.03	0.32[1)]	0.52[1)]	3.27[1)]	0.44	0.56	0.26

Date yymm	Al[1)] µg/l	Cl mg/l	NH_4N mg/l	NO_3N mg/l	PO_4P µg/l	SO_4S mg/l
9801	6.75	5.59	0.64	0.38	6.20[1)]	0.78
9802	6.75	4.20	1.87	0.84	6.20[1)]	1.44
9803	6.75	2.05	0.80	0.49	6.20[1)]	0.70
9804	6.75	0.25	1.30	0.77	6.20[1)]	0.75
9805	6.75	0.88	1.78	0.81	20.13	1.24
9806	6.75	0.67	1.00	0.70	6.20[1)]	0.86
9807	6.75	1.76	1.28	0.84	6.20[1)]	1.24
9808	6.75	0.61	0.59	0.31	6.20[1)]	0.52
9809	6.75	1.38	0.50	0.37	6.20[1)]	0.50
9810	6.75	2.20	0.38	0.30	6.20[1)]	0.58
9811	6.75	4.82	0.60	0.51	6.20[1)]	0.75
9812	6.75	3.16	0.76	0.45	6.20[1)]	0.72

1) less than detection limit; value is half of the detection limit

Table 5.3: Precipitation chemistry, 1999, Lheebroekerzand. Results are monthly weighed means.

Date	Total precipitation	pH	EC 25°C	Na	K	Ca	Mg
yymm	mm	unit	mS/m	mg/l	mg/l	mg/l	mg/l
9901	83.8	4.41	3.89	1.33	0.08	0.13	0.16
9902	95.7	5.39	4.37	4.20	0.15	0.20	0.50
9903	53.5	5.32	2.84	1.06	0.07	0.21	0.15
9904	57.6	5.52	2.10	0.86	0.08	0.21	0.11
9905	23.4	4.90	3.88	0.69	0.31	0.81	0.18
9906	74.5	5.56	1.97	0.46	0.10	0.22	0.07
9907	91.9	5.91	1.60	0.40	0.05	0.19	0.05
9908	80.7	5.70	2.15	0.91	0.12	0.18	0.11
9909	56.3	5.38	2.06	0.63	0.07	0.23	0.09
9910	52.9	5.05	3.36	2.57	0.14	0.22	0.32
9911	66.4	4.88	3.07	2.19	0.11	0.15	0.27
9912	132.3	5.05	2.85	2.29	0.12	0.18	0.28
Date	**Cd**	**Cu**	**Pb**	**Zn**	**Ni**	**As[1)]**	**Cr[1)]**
yymm	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**
9901	0.07	1.00	0.97	7.39	0.21[1)]	0.22	0.21
9902	0.02[1)]	0.52	0.62	1.64[1)]	0.21[1)]	0.22	0.21
9903	0.04	0.70	0.60	5.96	0.21[1)]	0.22	0.21
9904	0.02[1)]	0.41	0.38	8.12	0.21[1)]	0.22	0.21
9905	0.10	1.14	0.67	20.00	0.53	0.22	0.21
9906	0.04	0.64	0.25	9.13	0.21[1)]	0.22	0.21
9907	0.02[1)]	0.19[1)]	0.10[1)]	6.78	0.21[1)]	0.22	0.21
9908	0.02[1)]	0.41	0.10[1)]	5.61	0.21[1)]	0.22	0.21
9909	0.04	0.45	0.31	8.00	0.21[1)]	0.22	0.21
9910	0.02[1)]	0.53	0.40	5.82	0.21[1)]	0.22	0.21
9911	0.02[1)]	0.40	0.38	5.45	0.21[1)]	0.22	0.21
9912	0.02[1)]	0.19[1)]	0.35	4.81	0.21[1)]	0.22	0.21
Date	**Al**	**Cl**	**NH_4N**	**NO_3N**	**PO_4P**	**SO_4S**	
yymm	**µg/l**	**mg/l**	**mg/l**	**mg/l**	**µg/l**	**mg/l**	
9901	4.05[1)]	2.34	0.85	0.61	55.90	0.75	
9902	4.05[1)]	7.35	0.70	0.45	14.95	0.88	
9903	4.05[1)]	1.81	1.32	0.75	47.42	0.97	
9904	4.05[1)]	1.28	1.11	0.65	55.36	0.65	
9905	19.91	1.00	1.95	1.46	52.77	1.51	
9906	4.05[1)]	0.65	1.22	0.64	32.65	0.78	
9907	4.05[1)]	0.63	1.00	0.49	26.23	0.67	
9908	4.05[1)]	1.37	1.19	0.62	39.93	0.70	
9909	4.05[1)]	1.02	1.05	0.64	27.21	0.74	
9910	4.05[1)]	4.37	0.80	0.48	40.53	0.88	
9911	4.05[1)]	3.72	0.67	0.47	32.14	0.70	
9912	4.05[1)]	4.02	0.48	0.40	6.20[1)]	0.61	

1) less than detection limit; value is half of the detection limit

Table 6.1: Chemistry of mosses, 1997, Lheebroekerzand.

Date yymm	number	S-TOT mg/kg	P-TOT mg/kg	Al mg/kg	As[1)] mg/kg	Ba mg/kg	Ca mg/kg	Cd[1)] mg/kg	Co[1)] mg/kg
9706	1	902	687	385	3.5	9.8	1617	0.75	0.4
9706	2	1462	1299	485	3.5	11.7	1595	0.75	0.4
9706	3	959	994	284	3.5	9.2	1841	0.75	0.4
9706	4	1206	1025	480	3.5	16.2	2390	0.75	0.4
9706	5	848	1055	279	3.5	9.8	2180	0.75	0.4
	mean	**1075**	**1012**	**382**	**3.5**	**11.3**	**1925**	**0.75**	**0.4**
	sd	**256**	**218**	**101**	**-**	**2.9**	**351**	**-**	**-**
	max	**1462**	**1299**	**485**	**3.5**	**16.2**	**2390**	**0.75**	**0.4**
	min	**848**	**687**	**279**	**3.5**	**9.2**	**1595**	**0.75**	**0.4**

Date yymm	number	Cr[1)] mg/kg	Cu mg/kg	Fe mg/kg	K mg/kg	Mg mg/kg	Mn mg/kg	Na mg/kg	Ni mg/kg
9706	1	1.0	4.2	405	2687	852	166	52[1)]	0.85[1)]
9706	2	1.0	6.8	506	1791	764	214	52[1)]	1.97
9706	3	1.0	4.2	297	4087	984	216	121	0.85[1)]
9706	4	1.0	6.2	503	3123	886	293	185	1.88
9706	5	1.0	2.0[1)]	296	3479	927	226	111	0.85[1)]
	mean	**1.0**	**4.7**	**401**	**3033**	**883**	**223**	**104**	**1.28**
	sd	**-**	**1.9**	**104**	**863**	**82**	**45**	**55**	**0.59**
	max	**1.0**	**6.8**	**506**	**4087**	**984**	**293**	**185**	**1.97**
	min	**1.0**	**2.0**	**296**	**1791**	**764**	**166**	**52**	**0.85**

Date yymm	number	Pb mg/kg	Sb[1)] mg/kg	Si mg/kg	Sr mg/kg	Ti mg/kg	V[1)] mg/kg	Zn mg/kg
9706	1	17.1	11.5	1116	7.2	15.0	2.5	52
9706	2	16.5	11.5	1080	7.5	19.0	2.5	54
9706	3	12.0	11.5	644	6.5	11.4	2.5	73
9706	4	11.0	11.5	1181	10.1	16.2	2.5	65
9706	5	3.5[1)]	11.5	886	5.9	7.9	2.5	52
	mean	**12.0**	**11.5**	**982**	**7.4**	**13.9**	**2.5**	**59**
	sd	**5.5**	**-**	**218**	**1.6**	**4.3**	**-**	**9**
	max	**17.1**	**11.5**	**1181**	**10.1**	**19.0**	**2.5**	**73**
	min	**3.5**	**11.5**	**644**	**5.9**	**7.9**	**2.5**	**52**

1) less than detection limit; value is half of the detection limit

Table 6.2: Chemistry of mosses, 1998, Lheebroekerzand.

Date yymm	number	S-TOT mg/kg	P-TOT mg/kg	Al mg/kg	As[1)] mg/kg	Ba mg/kg	Ca mg/kg	Cd[1)] mg/kg	Co[1)] mg/kg
9805	1	1389	1413	357	3.5	18	2880	0.8	0.4
9805	2	917	783	272	3.5	14	2070	0.8	0.4
9805	3	1058	925	261	3.5	20	2450	0.8	0.4
9805	4	1231	1332	278	3.5	28	2640	0.8	0.4
9805	5	937	722	315	3.5	9	1310	0.8	0.4
	mean	**1106**	**1035**	**297**	**3.5**	**18**	**2270**	**0.8**	**0.4**
	sd	**201**	**318**	**39**	**-**	**7**	**613**	**-**	**-**
	max	**1389**	**1413**	**357**	**3.5**	**28**	**2880**	**0.8**	**0.4**
	min	**917**	**722**	**261**	**3.5**	**9**	**1310**	**0.8**	**0.4**

Date yymm	number	Cr[1)] mg/kg	Cu mg/kg	Fe mg/kg	K mg/kg	Mg mg/kg	Mn mg/kg	Na mg/kg	Ni[1)] mg/kg
9805	1	1.0	8.0	462	3950	900	226	200	0.9
9805	2	1.0	5.0	341	4020	960	212	200	0.9
9805	3	1.0	5.0	277	3270	860	174	300	0.9
9805	4	1.0	6.0	281	5970	1600	608	200	0.9
9805	5	1.0	5.0	381	3310	960	149	100	0.9
	mean	**1.0**	**5.8**	**348**	**4104**	**1056**	**274**	**200**	**0.9**
	sd	**-**	**1.3**	**77**	**1100**	**307**	**189**	**71**	**-**
	max	**1.0**	**8.0**	**462**	**5970**	**1600**	**608**	**300**	**0.9**
	min	**1.0**	**5.0**	**277**	**3270**	**860**	**149**	**100**	**0.9**

Date yymm	number	Pb mg/kg	Sb[1)] mg/kg	Si mg/kg	Sr mg/kg	Ti mg/kg	V[1)] mg/kg	Zn mg/kg
9805	1	9[1)]	18	1540	10	12	2.5	51
9805	2	21	18	870	10	7	2.5	61
9805	3	9[1)]	18	890	9	6	2.5	53
9805	4	9[1)]	18	810	11	8	2.5	98
9805	5	9[1)]	18	1090	6	10	2.5	42
	mean	**11**	**18**	**1040**	**9**	**9**	**2.5**	**61**
	sd	**5**	**-**	**299**	**2**	**2**	**-**	**22**
	max	**21**	**18**	**1540**	**11**	**12**	**2.5**	**98**
	min	**9**	**18**	**810**	**6**	**6**	**2.5**	**42**

1) less than detection limit; value is half of the detection limit

Table 6.3: Chemistry of mosses, 1999, Lheebroekerzand.

Date yymm	number	S-TOT mg/kg	P-TOT mg/kg	Al mg/kg	As[1)] mg/kg	Ba mg/kg	Ca mg/kg	Cd[1)] mg/kg	Co[1)] mg/kg
9905	1	1196	564	623	3.5	12	1686	0.8	0.4
9905	2	1017	681	396	3.5	20	2881	0.8	0.4
9905	3	842	798	260	3.5	9	1871	0.8	0.4
9905	4	907	559	336	3.5	9	1664	0.8	0.4
9905	5	1002	857	256	3.5	10	1755	0.8	0.4
	mean	**993**	**692**	**374**	**3.5**	**12**	**1971**	**0.8**	**0.4**
	sd	**134**	**135**	**151**	**-**	**5**	**515**	**-**	**-**
	max	**1196**	**857**	**623**	**3.5**	**20**	**2881**	**0.8**	**0.4**
	min	**842**	**559**	**256**	**3.5**	**9**	**1664**	**0.8**	**0.4**

Date yymm	number	Cr mg/kg	Cu mg/kg	Fe mg/kg	K mg/kg	Mg mg/kg	Mn mg/kg	Na mg/kg	Ni mg/kg
9905	1	3.2	6.8	737	2181	819	92	135	2.3
9905	2	1.0[1)]	6.3	465	2823	868	210	253	0.9[1)]
9905	3	1.0[1)]	4.4	275	4611	1043	347	181	0.9[1)]
9905	4	1.0[1)]	5.1	385	2741	1020	231	127	0.9[1)]
9905	5	1.0[1)]	4.7	290	3454	1197	288	273	0.9[1)]
	mean	**1.4**	**5.4**	**430**	**3162**	**989**	**234**	**194**	**1.1**
	sd	**1.0**	**1.0**	**188**	**927**	**151**	**95**	**67**	**0.7**
	max	**3.2**	**6.8**	**737**	**4611**	**1197**	**347**	**273**	**2.3**
	min	**1.0**	**4.4**	**275**	**2181**	**819**	**92**	**127**	**0.9**

Date yymm	number	Pb mg/kg	Sb[1)] mg/kg	Si mg/kg	Sr mg/kg	Ti mg/kg	V[1)] mg/kg	Zn mg/kg
9905	1	20	18	1407	9.1	25	2.5	57
9905	2	9[1)]	18	1076	9.5	12	2.5	64
9905	3	9[1)]	18	695	5.3	8	2.5	42
9905	4	9[1)]	18	957	7.1	9	2.5	53
9905	5	9[1)]	18	792	8.0	7	2.5	61
	mean	**11**	**18**	**985**	**7.8**	**12**	**2.5**	**55**
	sd	**5**	**-**	**278**	**1.7**	**7**	**-**	**8**
	max	**20**	**18**	**1407**	**9.5**	**25**	**2.5**	**64**
	min	**9**	**18**	**695**	**5.3**	**7**	**2.5**	**42**

1) less than detection limit; value is half of the detection limit

Table 7.1: Throughfall Quercus robur, 1997, Lheebroekerzand. Results are monthly weighed means.

Date	Total precipitation	PH	EC 25°C	Na	K	Ca	Mg
yymm	mm	unit	mS/m	mg/l	mg/l	mg/l	mg/l
9701	9.9	4.86	25.98	9.05	10.24	6.41	5.57
9702	95.8	5.08	7.93	5.04	2.84	1.09	0.96
9703	27.5	3.96	15.56	5.66	2.65	1.30	0.89
9704	49.3	5.90	14.18	11.06	3.82	1.58	1.46
9705	55.5	6.34	5.62	3.48	4.38	0.57	0.48
9706	66.0	6.56	6.31	2.40	7.63	0.82	0.67
9707	29.6	6.53	6.68	2.21	6.36	1.32	0.69
9708	32.7	6.25	7.87	2.27	8.06	1.37	0.78
9709	24.7	6.19	9.75	5.17	7.56	1.30	1.09
9710	68.7	6.19	10.48	7.29	8.68	1.37	1.16
9711	11.9	5.89	20.30	9.52	20.38	3.65	3.26
9712	81.1	5.67	8.05	5.15	5.82	1.12	1.05

Date	Cd	Cu	Pb	Zn	Ni	As 1)	Cr 1)
yymm	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
9701	0.25	12.15	2.68	37.89	1.70	0.56	0.26
9702	0.05	1.63	1.01	3.27 1)	0.44 1)	0.56	0.26
9703	0.08	2.86	1.62	16.91	0.44 1)	0.56	0.26
9704	0.04	4.37	1.42	13.11	0.44 1)	0.56	0.26
9705	0.03	2.84	1.28	11.82	0.44 1)	0.56	0.26
9706	0.04	9.63	1.72	7.30	0.44 1)	0.56	0.26
9707	0.05	14.19	1.23	3.27 1)	0.44 1)	0.56	0.26
9708	0.03	5.04	1.43	8.04	1.02	0.56	0.26
9709	0.03	7.27	0.52 1)	6.69	1.04	0.56	0.26
9710	0.03	2.95	0.52 1)	3.27 1)	0.44 1)	0.56	0.26
9711	0.06	11.08	0.52 1)	25.27	1.93	0.56	0.26
9712	0.03	1.83	0.52 1)	3.27 1)	0.44 1)	0.56	0.26

Date	Al	Cl	NH_4N	NO_3N	PO_4P	SO_4S
yymm	µg/l	mg/l	mg/l	mg/l	µg/l	mg/l
9701	54.16	14.17	8.48	2.63	17.00	20.77
9702	6.75 1)	9.93	2.14	0.64	6.20 1)	3.03
9703	29.83	14.18	4.51	1.77	22.11	4.39
9704	28.76	23.77	4.35	1.36	6.20 1)	3.50
9705	26.88	3.67	1.92	0.94	34.78	1.40
9706	34.52	3.28	1.99	0.75	49.25	1.25
9707	22.10	3.76	2.45	1.30	52.31	1.78
9708	39.49	4.06	3.05	1.68	68.26	1.98
9709	24.07	11.68	2.69	1.08	68.13	2.31
9710	25.64	16.21	1.83	0.67	24.45	2.53
9711	36.25	25.72	3.18	1.98	47.45	7.76
9712	6.75 1)	9.16	1.57	0.75	20.01	3.46

1) less than detection limit; value is half of the detection limit

Table 7.2: Throughfall Quercus robur, 1998, Lheebroekerzand.
Results are monthly weighed means

Date	Total precipitation	pH	EC 25°C	Na	K	Ca	Mg
yymm	mm	unit	mS/m	mg/l	mg/l	mg/l	mg/l
9801	73.2	5.53	10.72	10.37	4.08	1.54	1.63
9802	27.5	5.69	12.69	8.37	4.16	1.58	1.38
9803	109.3	5.86	4.75	3.55	2.02	0.54	0.45
9804	146.0	5.42	3.52	1.79	1.77	0.51	0.36
9805	21.2	5.05	15.07	4.61	24.02	1.95	1.94
9806	66.8	5.56	6.63	2.41	8.49	1.18	0.75
9807	34.5	4.74	9.78	4.84	8.62	1.80	1.21
9808	56.2	5.03	6.70	1.69	6.86	1.19	0.67
9809	85.8	5.81	6.51	2.12	6.78	0.95	0.64
9810	219.6	5.79	6.12	2.77	5.26	0.89	0.77
9811	48.9	5.30	11.76	10.28	5.93	2.05	2.15
9812	103.4	5.23	6.64	5.23	3.89	1.02	0.97

Date	Cd	Cu	Pb	Zn	Ni	As 1)	Cr 1)
yymm	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
9801	0.08	2.18	0.52 1)	6.96	0.44 1)	0.56	0.26
9802	0.25	6.36	5.66	33.79	0.96	0.56	0.26
9803	0.05	2.34	2.37	3.27 1)	0.44 1)	0.56	0.26
9804	0.01 1)	1.30	1.11	6.75	0.44 1)	0.56	0.26
9805	0.05	8.90	5.06	18.18	1.93	0.56	0.26
9806	0.05	3.32	3.95	9.81	0.44 1)	0.56	0.26
9807	0.05	14.19	1.74	3.27 1)	0.44 1)	0.56	0.26
9808	0.01 1)	3.51	1.35	3.27 1)	0.44 1)	0.56	0.26
9809	0.04	2.90	1.42	6.77	0.44 1)	0.56	0.26
9810	0.03	2.53	0.52 1)	3.27 1)	0.44 1)	0.56	0.26
9811	0.03	1.83	0.52 1)	3.27 1)	0.44 1)	0.56	0.26
9812	0.03	1.20	0.52 1)	3.27 1)	0.44 1)	0.56	0.26

Date	Al	Cl	NH_4N	NO_3N	PO_4P	SO_4S
yymm	µg/l	mg/l	mg/l	mg/l	µg/l	mg/l
9801	6.75 1)	20.33	1.06	0.51	6.20 1)	2.84
9802	18.78	14.18	4.54	1.55	22.63	5.67
9803	6.75 1)	5.20	1.36	0.62	15.54	1.66
9804	6.75 1)	1.75	1.13	0.84	25.41	1.25
9805	55.19	7.76	2.56	0.60	71.68	3.60
9806	33.16	3.11	1.56	0.99	55.97	1.90
9807	19.29	9.65	1.32	1.20	25.75	3.16
9808	18.57	5.18	1.07	0.79	43.18	1.52
9809	22.98	6.04	1.30	0.49	61.94	1.47
9810	6.75 1)	7.59	0.64	0.37	33.11	1.52
9811	16.36	22.50	0.48	0.48	26.44	2.49
9812	6.75 1)	9.21	0.68	0.42	6.20 1)	2.28

1) less than detection limit; value is half of the detection limit

Table 7.3: Throughfall Quercus robur, 1999, Lheebroekerzand. Results are monthly weighed means

Date yymm	Total precipitation mm	pH unit	EC 25°C mS/m	Na mg/l	K mg/l	Ca mg/l	Mg mg/l
9901	71.4	4.42	7.54	4.48	2.98	0.93	0.87
9902	89.8	5.16	10.36	10.44	2.77	1.34	1.66
9903	44.3	5.28	6.22	4.61	2.08	0.83	0.75
9904	48.0	5.42	5.00	3.51	2.15	0.63	0.52
9905	7.7	6.55	12.55	4.65	11.39	1.84	1.36
9906	33.2	6.25	9.06	3.71	10.46	1.49	1.15
9907	67.1	6.01	4.26	1.65	4.56	0.74	0.45
9908	43.5	6.10	6.40	2.84	5.88	1.06	0.71
9909	28.0	6.37	7.53	2.62	7.22	1.33	0.74
9910	20.5	6.09	9.74	5.36	8.41	1.57	1.30
9911	56.3	5.59	8.51	5.17	8.61	1.27	1.20
9912	120.7	5.45	7.17	6.54	3.55	0.93	1.00

Date yymm	Cd µg/l	Cu µg/l	Pb µg/l	Zn µg/l	Ni µg/l	As µg/l	Cr µg/l
9901	0.06	2.58	1.77	7.62	0.21 1)	0.22 1)	0.22 1)
9902	0.06	1.40	1.16	5.87	0.21 1)	0.22 1)	0.22 1)
9903	0.05	1.57	1.33	6.80	0.21 1)	0.22 1)	0.22 1)
9904	0.02 1)	2.26	1.25	8.49	0.21 1)	0.22 1)	0.22 1)
9905	0.06	9.90	2.59	20.93	2.12	0.46	0.53
9906	0.04	6.05	2.04	15.58	1.40	0.30	0.43
9907	0.02 1)	2.43	1.34	8.45	0.57	0.22 1)	0.22 1)
9908	0.02 1)	2.92	1.32	9.27	0.54	0.22 1)	0.22 1)
9909	0.02 1)	3.84	1.00	11.23	0.96	0.22 1)	0.47
9910	0.02 1)	3.13	0.82	11.97	0.80	0.22 1)	0.22 1)
9911	0.02 1)	2.41	1.11	9.08	0.74	0.22 1)	0.22 1)
9912	0.04	0.98	0.86	6.13	0.21 1)	0.22 1)	0.22 1)

Date yymm	Al µg/l	Cl mg/l	NH_4N mg/l	NO_3N mg/l	PO_4P µg/l	SO_4S mg/l
9901	4.05 1)	7.02	1.01	0.69	62.03	2.56
9902	4.05 1)	19.69	0.97	0.54	12.48	2.37
9903	8.36	6.99	1.57	0.80	29.79	2.31
9904	13.78	4.82	1.57	0.83	77.93	1.48
9905	101.21	5.12	5.01	1.77	85.57	3.34
9906	71.34	5.30	2.45	1.70	121.31	2.33
9907	22.44	2.10	1.30	0.82	70.99	1.18
9908	26.09	5.22	2.00	1.14	96.02	1.56
9909	38.00	3.88	2.80	1.60	97.09	2.14
9910	25.81	11.48	2.14	0.93	79.82	3.08
9911	19.67	12.15	1.09	0.60	38.72	2.29
9912	4.05 1)	12.82	0.71	0.48	12.45	1.73

1) less than detection limit; value is half of the detection limit

Table 7.4: Throughfall Pinus sylvestris, 1997, Lheebroekerzand. Results are monthly weighed means.

Date yymm	Total precipitation mm	pH unit	EC 25°C mS/m	Na mg/l	K mg/l	Ca mg/l	Mg mg/l
9701	9.1	5.16	18.86	5.99	3.97	1.37	1.09
9702	68.9	5.86	8.69	5.11	1.71	0.41	0.42
9703	23.7	5.82	9.85	4.50	2.00	0.54	0.39
9704	41.4	5.96	13.09	10.12	2.18	1.10	1.17
9705	62.3	6.02	4.64	1.83	2.24	0.37	0.31
9706	92.4	6.12	4.08	1.42	2.91	0.44	0.29
9707	44.0	5.37	5.32	1.57	2.75	0.91	0.40
9708	47.3	4.95	6.00	1.87	2.69	0.66	0.34
9709	37.0	5.41	8.34	6.17	2.53	0.87	0.72
9710	81.0	5.71	9.66	8.41	3.82	0.95	0.84
9711	12.7	5.26	13.47	7.35	5.17	1.10	0.86
9712	67.1	5.42	7.95	5.06	2.25	0.52	0.53

Date yymm	Cd µg/l	Cu µg/l	Pb µg/l	Zn µg/l	Ni µg/l	As[1)] µg/l	Cr[1)] µg/l
9701	0.13	6.71	1.76	25.94	0.44[1)]	0.56	0.26
9702	0.05	1.32	0.52[1)]	3.27[1)]	0.97	0.56	0.26
9703	0.04	1.96	1.10	16.58	0.44[1)]	0.56	0.26
9704	0.06	2.90	1.60	10.49	0.44[1)]	0.56	0.26
9705	0.03	1.53	0.52[1)]	12.77	0.91	0.56	0.26
9706	0.04	8.70	0.52[1)]	8.87	0.44[1)]	0.56	0.26
9707	0.07	11.41	0.52[1)]	13.22	0.44[1)]	0.56	0.26
9708	0.05	3.47	1.24	9.57	1.38	0.56	0.26
9709	0.07	6.16	0.52[1)]	7.14	0.44[1)]	0.56	0.26
9710	0.05	2.45	0.52[1)]	9.78	1.18	0.56	0.26
9711	0.07	9.84	1.11	20.81	1.25	0.56	0.26
9712	0.05	1.58	0.52[1)]	10.41	0.44[1)]	0.56	0.26

Date yymm	Al µg/l	Cl mg/l	NH_4N mg/l	NO_3N mg/l	PO_4P µg/l	SO_4S mg/l
9701	41.39	9.73	12.02	3.23	12.81	11.70
9702	6.75[1)]	9.95	4.28	1.04	6.20[1)]	3.32
9703	30.78	7.67	6.17	1.96	14.78	4.21
9704	34.44	20.17	4.93	1.59	6.20[1)]	3.61
9705	27.75	2.77	2.41	1.35	6.20[1)]	1.35
9706	31.65	2.26	1.74	1.12	6.20[1)]	0.96
9707	25.11	2.47	2.63	1.61	6.20[1)]	1.29
9708	63.22	2.99	3.34	1.95	6.20[1)]	1.20
9709	50.21	11.85	2.99	1.17	6.20[1)]	1.51
9710	36.77	15.46	2.54	0.72	6.20[1)]	1.57
9711	31.06	11.74	6.04	2.36	6.20[1)]	5.76
9712	6.75[1)]	8.82	3.37	1.06	6.20[1)]	3.30

1) less than detection limit; value is half of the detection limit

Table 7.5: Throughfall Pinus sylvestris, 1998, Lheebroekerzand. Results are monthly weighed means.

Date yymm	Total precipitation mm	pH unit	EC 25°C mS/m	Na mg/l	K mg/l	Ca mg/l	Mg mg/l
9801	59.5	5.46	9.60	8.84	1.80	0.72	0.93
9802	22.0	5.61	13.34	8.95	2.07	0.97	0.96
9803	84.0	5.91	5.44	3.72	1.08	0.37	0.33
9804	141.6	5.36	3.80	1.23	0.90	0.29	0.17
9805	30.9	5.08	8.98	3.17	7.58	1.06	0.66
9806	107.0	4.85	4.42	1.29	2.74	0.82	0.35
9807	51.4	4.72	7.28	3.41	2.45	1.21	0.69
9808	69.3	4.88	5.86	1.48	1.90	0.79	0.43
9809	101.1	4.91	5.12	1.95	2.13	0.73	0.41
9810	221.4	5.08	4.92	2.39	1.67	0.60	0.46
9811	57.4	4.87	7.51	6.30	1.18	0.72	0.85
9812	89.3	5.18	6.73	4.87	1.07	0.52	0.55

Date Yymm	Cd µg/l	Cu µg/l	Pb µg/l	Zn µg/l	Ni µg/l	As[1)] µg/l	Cr[1)] µg/l
9801	0.06	1.36	0.52[1)]	3.27[1)]	0.44[1)]	0.56	0.26
9802	0.13	3.36	2.84	24.15	1.11	0.56	0.26
9803	0.04	0.75	0.52[1)]	3.27[1)]	0.44[1)]	0.56	0.26
9804	0.03	0.81	0.52[1)]	3.27[1)]	0.44[1)]	0.56	0.26
9805	0.07	5.03	1.57	15.05	3.74	0.56	0.26
9806	0.06	1.95	0.52[1)]	12.08	0.44[1)]	0.56	0.26
9807	0.09	4.40	0.52[1)]	12.68	0.44[1)]	0.56	0.26
9808	0.04	5.40	0.52[1)]	8.84	0.44[1)]	0.56	0.26
9809	0.04	2.43	0.52[1)]	3.27[1)]	0.44[1)]	0.56	0.26
9810	0.05	1.89	0.52[1)]	3.27[1)]	0.44[1)]	0.56	0.26
9811	0.06	0.90	0.52[1)]	7.56	0.44[1)]	0.56	0.26
9812	0.03	0.48	0.52[1)]	3.27[1)]	0.44[1)]	0.56	0.26

Date Yymm	Al µg/l	Cl mg/l	NH_4N mg/l	NO_3N mg/l	PO_4P µg/l	SO_4S mg/l
9801	6.75[1)]	16.76	2.62	0.84	6.20[1)]	2.67
9802	19.28	15.42	6.20	1.98	23.75	5.23
9803	6.75[1)]	6.11	2.44	0.85	6.20[1)]	1.84
9804	6.75[1)]	1.41	2.21	1.20	13.03	1.36
9805	97.76	5.62	3.31	1.80	26.02	2.48
9806	17.56	1.80	1.43	1.17	32.82	1.30
9807	6.75[1)]	6.30	2.16	1.44	44.17	2.31
9808	17.00	3.98	2.15	1.30	44.31	1.20
9809	14.40	4.81	1.22	0.62	32.14	0.94
9810	17.81	6.00	0.91	0.45	6.20[1)]	1.04
9811	6.75[1)]	11.48	1.44	0.77	6.20[1)]	1.92
9812	6.75[1)]	8.49	2.39	0.85	6.20[1)]	2.45

1) less than detection limit; value is half of the detection limit

Table 7.6: Throughfall Pinus sylvestris, 1999, Lheebroekerzand. Results are monthly weighed means.

Date	Total precipitation	pH	EC 25°C	Na	K	Ca	Mg
yymm	**mm**	**unit**	**mS/m**	**mg/l**	**mg/l**	**Mg/l**	**mg/l**
9901	59.2	4.98	6.56	4.03	1.08	0.47	0.49
9902	69.7	5.16	9.51	9.24	1.02	0.61	1.01
9903	38.2	5.34	6.60	3.85	0.92	0.43	0.44
9904	45.5	5.45	5.71	3.01	1.23	0.38	0.30
9905	12.5	5.49	10.65	3.55	5.34	1.33	0.63
9906	58.9	5.27	7.30	2.48	5.64	0.73	0.49
9907	79.1	5.09	3.68	1.20	1.35	0.40	0.20
9908	63.6	5.13	5.60	2.75	1.98	0.58	0.37
9909	42.8	5.03	7.20	2.82	3.31	0.76	0.42
9910	36.3	5.26	8.31	5.69	3.83	0.90	0.73
9912	97.7	5.42	7.39	6.57	1.58	0.51	0.65
Date	**Cd**	**Cu**	**Pb**	**Zn**	**Ni**	**As**	**Cr**
yymm	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**
9901	0.09	2.11	1.12	9.43	0.21 1)	0.22 1)	0.21 1)
9902	0.07	1.02	0.84	6.84	0.21 1)	0.22 1)	0.21 1)
9903	0.05	1.39	0.98	7.14	0.21 1)	0.22 1)	0.21 1)
9904	0.04	1.99	0.90	9.06	0.49	0.22 1)	0.21 1)
9905	0.06	4.58	1.57	15.90	1.73	0.47	0.62
9906	0.05	3.37	1.74	13.04	2.22	0.22 1)	0.21 1)
9907	0.02 1)	1.36	1.16	7.67	0.61	0.22 1)	0.21 1)
9908	0.02 1)	1.75	1.04	9.42	0.59	0.22 1)	0.21 1)
9909	0.06	2.39	1.83	13.64	1.02	0.22 1)	0.46
9910	0.04	1.61	0.67	13.81	0.81	0.22 1)	0.21 1)
9911	0.05	1.42	0.84	8.46	0.21 1)	0.22 1)	0.21 1)
9912	0.05	0.75	0.54	7.09	0.21 1)	0.22 1)	0.21 1)
Date	**Al**	**Cl**	**NH_4N**	**NO_3N**	**PO_4P**	**SO_4S**	
yymm	**µg/l**	**mg/l**	**mg/l**	**mg/l**	**µg/l**	**mg/l**	
9901	10.10	6.84	2.65	1.20	33.14	2.46	
9902	4.05 1)	16.93	2.41	0.81	16.54	2.29	
9903	9.98	6.48	2.93	1.28	28.52	2.44	
9904	18.85	4.64	3.22	1.40	37.26	1.78	
9905	98.91	4.75	6.12	2.68	89.19	3.37	
9906	65.77	4.46	3.06	2.08	39.59	1.73	
9907	18.93	1.60	1.91	1.02	27.46	0.97	
9908	24.85	4.68	2.67	1.50	36.48	1.17	
9909	39.08	4.89	3.65	1.93	45.59	1.47	
9910	30.14	11.31	2.47	1.02	39.11	1.93	
9911	20.52	10.55	3.04	0.99	16.65	1.96	
9912	4.05 1)	12.43	1.96	0.77	19.00	1.73	

1) less than detection limit; value is half of the detection limit

Table 7.7: Stemflow Quercus robur, 1997, Lheebroekerzand. Results are monthly weighed means.

Date yymm	Total precipitation mm	pH unit	EC 25°C mS/m	Na mg/l	K mg/l	Ca mg/l	Mg mg/l
9701	1.5	4.94	33.33	19.99	23.26	6.90	4.36
9702	93.3	4.86	20.39	12.85	16.00	3.40	2.23
9703	7.0	5.02	30.49	19.20	21.49	5.80	3.64
9704	80.5	4.78	34.78	21.48	20.44	6.03	4.11
9705	27.4	5.48	18.32	13.21	13.25	3.49	1.54
9706	29.1	5.92	16.05	11.25	14.08	2.89	1.34
9707	8.6	6.92	13.24	9.41	12.22	2.94	1.20
9708	4.7	6.07	26.46	13.87	21.46	5.53	2.13
9709	4.9	6.16	28.68	17.09	25.72	7.83	2.90
9710	41.9	5.00	23.98	14.78	22.59	4.51	2.39
9711	1.9	6.07	57.90	34.25	49.52	5.34	7.81
9712	112.5	5.04	18.95	12.37	17.96	3.82	2.06

Date yymm	Cd µg/l	Cu µg/l	Pb µg/l	Zn µg/l	Ni µg/l	As µg/l	Cr µg/l
9701	0.17	4.90	2.91	20.49	1.03	0.56 1)	0.26 1)
9702	0.12	3.43	2.20	3.27 1)	1.10	0.56 1)	0.26 1)
9703	0.17	6.04	2.69	18.40	1.37	0.56 1)	0.93
9704	0.21	5.11	3.00	13.11	1.68	0.56 1)	0.76
9705	0.12	8.02	15.86	16.53	1.48	0.56 1)	0.86
9706	0.11	21.87	4.07	17.86	1.49	0.56 1)	0.93
9707	0.10	25.53	2.88	15.22	1.28	0.56 1)	0.64
9708	0.20	19.81	4.37	34.99	2.91	1.44	1.38
9709	0.21	22.98	4.70	28.61	2.87	0.56 1)	1.43
9710	0.18	9.25	5.84	3.27 1)	2.84	0.56 1)	1.01
9711	0.31	10.82	6.47	20.75	1.74	1.14	1.44
9712	0.11	4.94	3.61	10.11	1.32	0.56 1)	0.26 1)

Date yymm	Al µg/l	Cl mg/l	NH_4N Mg/l	NO_3N mg/l	PO_4P µg/l	SO_4S mg/l
9701	50.86	21.36	7.77	2.83	23.78	24.17
9702	42.36	22.47	3.33	1.65	6.20 1)	9.88
9703	85.37	36.66	6.43	3.36	6.20 1)	12.51
9704	95.56	55.22	8.58	3.38	6.20 1)	9.62
9705	98.27	19.15	4.53	2.54	55.94	3.98
9706	108.43	14.21	4.73	1.61	65.96	2.41
9707	72.47	10.21	3.83	0.97	69.32	2.42
9708	186.48	18.96	11.91	1.68	56.47	4.25
9709	189.73	31.35	8.62	1.45	56.47	4.78
9710	112.08	30.89	5.08	1.68	6.20 1)	4.45
9711	148.55	76.85	13.79	3.36	45.30	25.92
9712	57.08	18.43	2.75	1.55	6.20 1)	8.26

1) less than detection limit; value is half of the detection limit

Table 7.8: Stemflow Quercus robur, 1998, Lheebroekerzand. Results are monthly weighed means.

Date	Total precipitation	pH	EC 25°C	Na	K	Ca	Mg
yymm	mm	unit	mS/m	mg/l	mg/l	mg/l	mg/l
9801	95.1	4.81	24.10	17.27	19.45	4.51	2.98
9802	16.3	4.70	32.99	22.08	23.37	5.87	4.09
9803	62.5	4.94	14.17	9.77	11.15	2.06	1.29
9804	73.8	4.84	9.84	7.69	9.08	1.71	0.80
9805	5.9	4.79	16.73	12.38	15.81	3.29	1.74
9806	29.2	5.02	12.91	10.30	15.33	3.09	1.20
9807	4.0	6.49	43.63	26.76	31.33	15.89	4.23
9808	22.7	4.99	19.58	12.30	19.56	4.67	1.89
9809	63.2	5.27	14.72	9.06	15.68	2.98	1.09
9810	108.4	5.21	15.27	9.07	16.30	3.02	1.32
9811	46.2	5.26	23.92	17.67	22.26	4.63	2.63
9812	114.1	4.95	13.02	9.98	12.65	2.90	1.47

Date	Cd	Cu	Pb	Zn	Ni	As[1)]	Cr
yymm	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
9801	0.14	2.54	1.30	3.27[1)]	0.44[1)]	0.56	0.26[1)]
9802	0.17	2.33	2.55	10.82	0.44[1)]	0.56	0.26[1)]
9803	0.09	2.41	2.11	3.27[1)]	0.44[1)]	0.56	0.26[1)]
9804	0.05	3.67	1.85	3.27[1)]	0.44[1)]	0.56	0.26[1)]
9805	0.07	5.02	1.25	12.17	0.44[1)]	0.56	0.26[1)]
9806	0.13	9.19	5.23	10.41	1.49	0.56	0.77
9807	0.26	28.00	4.93	48.67	2.33	0.56	1.18
9808	0.13	10.52	6.62	12.83	1.70	0.56	0.76
9809	0.11	7.71	4.91	9.92	1.05	0.56	0.26[1)]
9810	0.09	5.08	2.49	7.07	0.95	0.56	0.26[1)]
9811	0.11	3.58	1.11	3.27[1)]	0.44[1)]	0.56	0.26[1)]
9812	0.02	2.41	1.40	3.27[1)]	0.44[1)]	0.56	0.26[1)]

Date	Al	Cl	NH_4N	NO_3N	PO_4P	SO_4S
yymm	µg/l	mg/l	Mg/l	mg/l	µg/l	mg/l
9801	29.01	43.82	2.35	0.99	6.20[1)]	6.70
9802	50.69	42.72	5.94	2.96	6.20[1)]	14.06
9803	16.94	16.33	2.60	1.26	6.20[1)]	5.46
9804	38.71	8.21	1.09	1.14	28.49	3.00
9805	50.36	15.23	2.29	0.83	47.33	4.69
9806	97.60	9.03	1.68	0.09	78.93	1.83
9807	124.70	48.47	14.84	0.05	75.13	7.32
9808	84.73	20.87	3.02	0.94	89.08	3.41
9809	54.13	16.54	2.47	0.34	57.11	1.83
9810	47.77	18.52	2.24	0.55	40.21	3.46
9811	31.15	46.21	1.52	0.34	16.88	4.75
9812	21.03	14.26	0.37	0.42	33.17	5.69

1) less than detection limit; value is half of the detection limit

Table 7.9: Stemflow Quercus robur, 1999, Lheebroekerzand. Results are monthly weighed means.

Date **yymm**	**Total precipitation** **mm**	**pH** **unit**	**EC 25°C** **mS/m**	**Na** **mg/l**	**K** **mg/l**	**Ca** **mg/l**	**Mg** **mg/l**
9901	147.7	4.75	16.46	13.52	16.07	2.73	1.46
9902	171.6	4.68	21.97	17.97	15.80	4.38	3.05
9903	56.0	4.86	12.16	10.16	8.83	2.36	1.49
9904	25.5	4.80	15.44	14.70	11.76	2.98	1.72
9905	1.7	6.61	35.08	21.23	32.36	15.47	4.14
9906	8.3	6.69	26.42	13.02	21.16	5.90	2.97
9907	152.8	5.68	12.63	9.29	11.74	3.30	1.28
9908	91.2	6.01	19.55	13.47	16.81	5.22	2.11
9909	26.0	5.87	22.85	10.95	17.56	4.94	1.98
9910	47.6	5.45	17.92	12.42	15.84	4.19	2.09
9911	219.9	5.33	17.68	12.28	15.88	3.68	2.22
9912	398.1	5.30	14.68	11.13	12.74	2.81	1.95
Date **yymm**	**Cd** **µg/l**	**Cu** **µg/l**	**Pb** **µg/l**	**Zn** **µg/l**	**Ni** **µg/l**	**As** **µg/l**	**Cr** **µg/l**
9901	0.08	3.48	1.87	6.60	0.65	0.22 1)	0.21 1)
9902	0.12	2.59	1.51	8.66	0.67	0.22 1)	0.21 1)
9903	0.06	2.41	1.45	5.77	0.53	0.22 1)	0.21 1)
9904	0.08	5.06	2.17	10.92	1.01	0.22 1)	0.21 1)
9905	0.29	44.41	4.26	67.16	4.85	0.75	1.18
9906	0.07	16.05	3.34	30.60	2.76	0.64	0.94
9907	0.09	7.22	3.24	13.40	1.33	0.22 1)	0.58
9908	0.16	11.61	4.29	20.87	2.33	0.58	1.24
9909	0.13	12.29	3.21	22.59	2.25	0.62	1.05
9910	0.13	9.01	4.80	18.09	2.30	0.57	0.79
9911	0.11	6.01	3.06	13.07	1.48	0.22 1)	0.21 1)
9912	0.09	3.10	1.90	8.23	0.67	0.22 1)	0.21 1)
Date **yymm**	**Al** **µg/l**	**Cl** **mg/l**	**NH_4N** **mg/l**	**NO_3N** **mg/l**	**PO_4P** **µg/l**	**SO_4S** **mg/l**	
9901	25.77	18.71	0.47	1.14	46.74	6.90	
9902	21.11	37.93	0.51	1.01	38.04	5.72	
9903	18.34	17.01	0.27	0.53	61.75	3.87	
9904	46.38	20.30	0.99	0.96	23.36	4.12	
9905	133.96	25.89	9.94	1.39	77.87	6.82	
9906	136.92	20.09	10.61	2.07	77.87	4.56	
9907	69.88	9.89	2.50	1.08	36.84	2.70	
9908	100.99	18.22	4.67	0.72	57.10	2.98	
9909	85.16	13.30	8.27	1.28	59.97	4.11	
9910	97.57	17.19	3.67	1.32	28.94	2.87	
9911	61.30	24.49	2.80	0.93	57.73	4.03	
9912	27.81	23.00	1.07	0.68	21.09	4.09	

1) less than detection limit; value is half of the detection limit

Table 7.10: Stemflow Pinus sylvestris, 1997, Lheebroekerzand
Results are monthly weighed means.

Date	Total precipitation	PH	EC 25°C	Na	K	Ca	Mg
yymm	mm	unit	mS/m	mg/l	mg/l	mg/l	mg/l
9701	0.6	5.71	24.13	9.47	4.69	2.55	0.92
9702	77.5	4.49	21.39	9.85	3.88	0.99	0.56
9703	1.4	3.88	15.93	6.66	3.22	1.53	0.55
9704	33.3	4.47	39.74	18.70	6.80	2.77	1.48
9705	7.6	5.75	19.04	8.58	4.97	2.66	0.70
9706	18.5	6.74	13.87	6.14	3.86	1.30	0.41
9707	7.1	5.21	13.82	5.80	3.72	1.68	0.46
9708	5.4	4.34	12.52	4.30	3.49	1.97	0.47
9709	6.4	4.96	19.62	10.94	4.27	2.43	1.03
9710	36.8	4.65	29.65	14.23	6.22	2.80	0.97
9711	2.1	7.12	16.98	10.01	5.61	3.70	1.43
9712	39.6	4.84	25.36	11.59	4.93	2.67	0.75

Date	Cd	Cu	Pb	Zn	Ni	As 1)	Cr
yymm	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
9701	0.12	7.51	1.98	24.75	1.22	0.56	0.54
9702	0.12	2.25	2.46	3.27 1)	0.44 1)	0.56	0.26 1)
9703	0.10	5.46	1.63	32.13	0.44 1)	0.56	0.26 1)
9704	0.23	5.82	4.82	23.87	1.88	0.56	1.03
9705	0.15	5.77	2.69	26.12	1.61	0.56	0.58
9706	0.11	27.62	2.93	13.35	0.93	0.56	0.55
9707	0.09	31.98	2.23	12.03	0.44 1)	0.56	0.26 1)
9708	0.11	7.69	1.18	15.89	1.45	0.56	0.26 1)
9709	0.17	10.10	2.58	19.07	1.15	0.56	0.79
9710	0.22	5.72	3.83	20.26	1.88	0.56	1.00
9711	0.07	9.80	1.13	29.25	1.09	0.56	0.26 1)
9712	0.15	4.29	2.87	11.14	0.93	0.56	0.70

Date	Al	Cl	NH_4N	NO_3N	PO_4P	SO_4S
yymm	µg/l	mg/l	mg/l	mg/l	µg/l	mg/l
9701	117.84	13.63	14.44	2.92	33.02	11.65
9702	103.98	18.61	12.64	2.18	6.20 1)	10.28
9703	84.83	14.82	4.92	1.62	25.17	4.00
9704	359.28	50.40	24.03	4.70	6.20 1)	13.34
9705	190.58	14.39	10.79	3.79	16.26	6.17
9706	195.57	9.41	8.62	2.43	18.57	3.43
9707	138.87	9.01	8.28	2.21	18.06	3.26
9708	91.53	6.45	6.13	2.58	28.16	2.08
9709	159.20	24.08	10.39	3.13	6.20 1)	4.03
9710	296.90	37.87	17.70	3.53	6.20 1)	6.30
9711	59.82	11.83	5.17	2.03	42.10	7.42
9712	164.06	21.21	12.20	3.06	6.20 1)	11.84

1) less than detection limit; value is half of the detection limit

Table 7.11: Stemflow Pinus sylvestris, 1998, Lheebroekerzand
Results are monthly weighed means.

Date	Total precipitation	PH	EC 25°C	Na	K	Ca	Mg
yymm	mm	unit	mS/m	mg/l	mg/l	mg/l	mg/l
9801	43.8	4.81	21.10	11.03	3.91	1.58	0.62
9802	6.5	4.87	30.22	14.57	5.12	2.45	1.12
9803	69.7	4.73	22.65	10.64	4.05	1.20	0.49
9804	70.9	4.89	12.17	5.62	2.41	0.86	0.19
9805	4.9	5.27	13.07	5.77	6.05	2.03	0.66
9806	25.2	4.97	13.50	6.21	3.91	1.57	0.37
9807	5.0	5.45	11.04	5.57	3.99	3.00	0.71
9808	17.9	4.76	18.03	7.66	4.41	2.31	0.68
9809	48.2	4.91	14.24	6.21	3.54	1.82	0.35
9810	116.8	4.81	11.69	4.72	2.76	1.31	0.27
9811	32.3	4.90	15.45	9.13	3.62	1.72	0.49
9812	80.3	4.88	11.58	6.80	2.59	1.04	0.23
Date	**Cd**	**Cu**	**Pb**	**Zn**	**Ni**	**As[1)]**	**Cr**
yymm	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**
9801	0.09	2.41	1.08	3.27[1)]	0.44[1)]	0.56	0.26[1)]
9802	0.13	1.85	1.44	10.05	0.44[1)]	0.56	0.26[1)]
9803	0.10	3.51	1.72	3.27[1)]	0.44[1)]	0.56	0.26[1)]
9804	0.06	2.62	1.55	6.85	0.44[1)]	0.56	0.26[1)]
9805	0.05	7.65	0.52[1)]	11.94	1.81	0.56	0.26[1)]
9806	0.11	5.22	3.12	14.41	0.44[1)]	0.56	0.69
9807	0.07	7.46	0.52[1)]	12.15	0.44[1)]	0.56	0.26[1)]
9808	0.14	6.49	2.47	14.39	0.44[1)]	0.56	0.67
9809	0.09	4.88	2.27	8.17	0.44[1)]	0.56	0.53
9810	0.06	2.38	0.52[1)]	3.27[1)]	0.44[1)]	0.56	0.26[1)]
9811	0.05	2.24	0.52[1)]	3.27[1)]	0.44[1)]	0.56	0.26[1)]
9812	0.02	1.55	0.52[1)]	3.27[1)]	0.44[1)]	0.56	0.26[1)]
Date	**Al**	**Cl**	**NH_4N**	**NO_3N**	**PO_4P**	**SO_4S**	
yymm	**µg/l**	**mg/l**	**mg/l**	**mg/l**	**µg/l**	**mg/l**	
9801	88.83	27.51	11.85	1.79	6.20[1)]	7.46	
9802	122.51	33.16	18.34	3.86	6.20[1)]	13.69	
9803	121.05	22.99	14.01	2.45	6.20[1)]	8.68	
9804	94.99	7.78	7.51	2.39	16.40	4.36	
9805	108.53	9.37	6.48	2.49	46.44	3.90	
9806	221.18	7.20	8.59	2.94	19.85	3.04	
9807	76.16	10.15	4.61	1.65	21.75	3.11	
9808	194.74	15.90	9.87	3.41	6.20[1)]	3.80	
9809	142.59	15.02	8.03	1.44	16.84	2.44	
9810	72.80	12.32	5.82	1.05	6.20[1)]	2.74	
9811	46.79	23.64	6.74	1.01	15.94	3.62	
9812	35.53	11.08	5.74	1.20	21.55	4.78	

1) less than detection limit; value is half of the detection limit

Table 7.12: Stemflow Pinus sylvestris, 1999, Lheebroekerzand
Results are monthly weighed means.

Date	Total precipitation	pH	EC 25°C	Na	K	Ca	Mg
yymm	mm	unit	mS/m	mg/l	mg/l	mg/l	mg/l
9901	25.2	5.01	14.15	8.19	3.29	1.54	0.41
9902	74.1	4.77	16.44	10.91	3.41	1.14	0.50
9903	31.7	4.74	11.83	7.48	2.68	0.75	0.23
9904	8.7	5.00	10.59	6.63	2.53	1.55	0.41
9905	1.3	5.66	18.99	7.82	7.30	9.14	1.07
9906	9.0	6.03	12.57	4.50	9.43	2.61	0.63
9907	109.3	4.99	12.53	6.75	3.62	1.33	0.27
9908	53.7	5.36	15.83	8.49	4.30	2.01	0.51
9909	26.7	6.08	15.39	6.96	4.88	2.22	0.49
9910	26.3	5.50	18.40	10.30	5.47	2.61	0.63
9911	94.6	5.00	23.95	14.13	5.85	2.51	0.79
9912	254.7	4.95	19.77	12.65	4.91	1.45	0.64
Date	**Cd**	**Cu**	**Pb**	**Zn**	**Ni**	**As**	**Cr**
yymm	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**
9901	0.09	2.91	0.96	9.65	0.48	0.22[1)]	0.21[1)]
9902	0.07	1.63	1.28	6.86	0.21[1)]	0.22[1)]	0.21[1)]
9903	0.05	1.71	1.38	5.17	0.21[1)]	0.22[1)]	0.21[1)]
9904	0.07	3.64	1.06	11.50	0.65	0.22[1)]	0.21[1)]
9905	0.19	10.89	1.32	38.24	3.28	0.64	1.83
9906	0.08	7.84	1.40	24.29	3.75	0.22[1)]	0.70
9907	0.08	3.32	2.73	11.18	0.95	0.22[1)]	0.64
9908	0.07	4.02	2.05	14.22	0.95	0.22[1)]	0.72
9909	0.07	3.93	1.61	16.69	1.23	0.22[1)]	0.63
9910	0.10	4.50	1.90	15.73	1.11	0.22[1)]	0.73
9911	0.14	4.10	2.50	19.94	0.94	0.22[1)]	0.60
9912	0.08	2.47	1.88	13.22	0.55	0.22[1)]	0.21[1)]
Date	**Al**	**Cl**	**NH_4N**	**NO_3N**	**PO_4P**	**SO_4S**	
yymm	**µg/l**	**mg/l**	**mg/l**	**mg/l**	**µg/l**	**mg/l**	
9901	39.79	13.73	6.64	2.05	37.33	6.00	
9902	47.35	23.92	6.79	1.31	27.61	4.66	
9903	46.64	13.55	4.76	1.10	41.53	3.84	
9904	63.44	9.96	4.76	1.98	31.48	3.52	
9905	135.91	11.06	9.19	3.39	60.50	4.06	
9906	150.35	7.63	5.74	2.80	87.40	2.46	
9907	182.07	8.22	6.93	2.73	28.43	3.18	
9908	149.76	13.94	8.26	2.96	42.41	2.93	
9909	112.86	10.03	7.22	3.22	46.98	2.52	
9910	137.72	18.98	7.66	2.48	33.62	2.89	
9911	176.08	31.19	12.85	2.97	6.2[1)]	5.82	
9912	107.12	28.76	10.16	2.06	11.79	5.30	

1) less than detection limit; value is half of the detection limit

Table 8.1: Soil chemistry, 1997, Lheebroekerzand.

Date yymmdd	$pH(CaCl_2)$ unit	$pH(H_2O)$ unit	pH(KCl) unit	TOC mg/kg	N-tot mg/kg	As mg/kg	Cd mg/kg
971103	3.59	4.05	3.06	54555	4643	1.58	0.24
Date yymmdd	**Cr mg/kg**	**Cu mg/kg**	**Fe mg/kg**	**Ni mg/kg**	**Pb mg/kg**	**Zn mg/kg**	
971103	6.19	2.15	1659	2.06	23.48	10.43	

Table 9.1: Soil water chemistry, 1997, Lheebroekerzand.

Date yymmdd	$pH(H_2O)$	EC mS/m	DOC µg/l	Al µg/l	As µg/l	Ca mg/l	Cd µg/l
971103	4.05	16.5	54234	6418	10.19	6.29	2.99
Date yymmdd	**Cl mg/l**	**Cr µg/l**	**Cu µg/l**	**Fe µg/l**	**K mg/l**	**Mg mg/l**	**Mn µg/l**
971103	13.72	15.65	83.25	7288	5.55	1.00	102.18
Date yymmdd	**NO_3N mg/l**	**Na mg/l**	**Ni µg/l**	**Pb µg/l**	**PO_4P µg/l**	**SO_4S mg/l**	**Zn µg/l**
971103	3.78	6.60	19.96	90.75	170.36	6.54	176.53

Table 10.1: Groundwater chemistry, 1997, 1998 and 1999, Eemster.

Date yymmdd	Al µg/l	As µg/l	Ba mg/l	Ca mg/l	Cd µg/l	Cl mg/l
110997	6.75[1)]	0.22	0.04	7.46	0.02[1)]	41.83
300798	6.75[1)]	0.30	0.04	7.63	0.11	41.02
230699	26.98	0.37	0.04	7.51	0.05[1)]	33.39
Date yymmdd	**Cr µg/l**	**Cu[1)] µg/l**	**Fe µg/l**	**K mg/l**	**Mg mg/l**	**Mn µg/l**
110997	0.37[1)]	0.35	25670	2.03	3.89	180
300798	0.73	0.35	27090	2.03	3.96	190
230699	0.35[1)]	0.35	27580	2.03	3.84	190
Date yymmdd	**NH_4N mg/l**	**NO_3N[1)] mg/l**	**Na mg/l**	**Ni µg/l**	**Ptot µg/l**	**SO_4S mg/l**
110997	0.17	0.015	29.29	8.51	100	17.60
300798	0.07	0.015	29.82	8.57	110	19.10
230699	0.07	0.04	29.82	7.82	120	11.20
Date yymmdd	**Sr mg/l**	**Zn µg/l**	**pH**	**waterlevel cm**		
110997	0.05	3.27[1)]	5.52	123		
300798	0.06	6.54	5.62	87		
230699	0.06	3.27[1)]	5.61	116		

1) less than detection limit; value is half of the detection limit

Table 11.1: Lake water chemistry, 1997, Lheebroekerzand (Kliplo).

Date yymmdd	Depth m NAP	Color mg Pt/l	Temp °C	pH lab	pH field	EC25-lab mS/m	EC25-field mS/m
970218	12.66	167	3.9	5.88	5.99	7.0	7.1
970528	12.64	90	13.7	4.71	4.50	7.1	7.6
970805	12.55	100	22.7	4.79	4.75	5.8	6.0
971119	12.52	188	2.2	5.22	5.00	7.7	8.0
Date yymmdd	**DO mg O_2/l**	**Na mg/l**	**K mg/l**	**Ca mg/l**	**Mg mg/l**	**Cd µg/l**	**Cu µg/l**
970218	11.9	5.45	1.60	0.96	0.85	0.06	1.27
970528	10.4	5.95	2.11	1.39	0.97	0.12	1.27
970805	8.6	6.07	1.25	1.18	0.85	0.04	0.64
971119	9.7	6.30	1.68	1.68	1.12	0.07	0.64
Date yymmdd	**Pb µg/l**	**Zn µg/l**	**Ni µg/l**	**As µg/l**	**Cr µg/l**	**NH_4N mg/l**	**NO_3N mg/l**
970218	2.90	19.61	0.44[1)]	1.20	0.52	1.95	0.14
970528	0.52[1)]	26.15	0.44[1)]	1.20	0.26[1)]	0.24	0.15
970805	1.04	13.08	0.44[1)]	0.56[1)]	0.26[1)]	0.01[1)]	0.01[1)]
971119	3.32	32.69	1.17	0.56[1)]	0.26[1)]	1.15	0.29
Date yymmdd	**PO_4P[1)] µg/l**	**SO_4S mg/l**	**Cl mg/l**	**Al mg/l**	**HCO_3 mg/l**	**Si mg/l**	
970218	6.19	2.98	9.25	0.21	6.71	0.67	
970528	6.19	2.89	10.18	0.26	3.66	0.34	
970805	6.19	1.92	10.35	0.13	3.66	0.11	
971119	6.19	3.30	11.10	0.23	3.66	0.20	

1) less than detection limit; value is half of the detection limit

Table 11.2: Lake water chemistry, 1998, Lheebroekerzand (Kliplo).

Date yymmdd	Depth m NAP	Color mg Pt/l	Temp °C	pH lab	pH field	EC25-lab mS/m	EC25-field mS/m
980210	12.66	68	4.3	4.55	4.49	9.0	9.0
980520	12.70	60	21.4	4.39	4.56	7.0	7.0
980818(a)	12.58	200	21.4	4.59	5.28	5.0	5.0
980818(b)	12.58	200	21.4	4.59	5.27	5.0	5.0
981117	12.86	190	4.7	4.78	5.14	5.0	5.0
Date yymmdd	**DO mg O_2/l**	**Na mg/l**	**K mg/l**	**Ca mg/l**	**Mg mg/l**	**Cd µg/l**	**Cu µg/l**
980210	12.4	6.09	1.60	2.14	1.29	0.30	0.32[1)]
980520	8.8	5.52	1.49	1.64	1.00	0.17	0.64
980818(a)	8.9	5.47	0.82	1.29	0.75	0.04	1.27
980818(b)	8.9	5.50	0.82	1.29	0.75	0.06	1.27
981117	9.1	4.46	1.09	0.77	0.66	0.03	1.27
Date yymmdd	**Pb µg/l**	**Zn µg/l**	**Ni µg/l**	**As µg/l**	**Cr[1)] µg/l**	**NH_4N mg/l**	**NO_3N mg/l**
980210	1.86	78.46	0.44[1)]	0.56[1)]	0.26	0.74	0.60
980520	1.24	45.77	1.17	1.80	0.26	0.01[1)]	0.03
980818(a)	0.52[1)]	13.08	0.44[1)]	1.57	0.26	0.01[1)]	0.01[1)]
980818(b)	0.52[1)]	13.08	0.44[1)]	2.02	0.26	0.01[1)]	0.01[1)]
981117	1.66	13.08	0.44[1)]	0.56[1)]	0.26	0.38	0.10
Date yymmdd	**PO_4P µg/l**	**SO_4S mg/l**	**Cl mg/l**	**Al mg/l**	**HCO_3 mg/l**	**Si mg/l**	
980210	6.19[1)]	4.10	10.21	0.22	1.53[1)]	0.20	
980520	92.92	3.17	9.08	0.19	1.53[1)]	0.03	
980818(a)	96.02	1.19	9.11	0.18	3.66	0.11	
980818(b)	102.21	1.28	9.04	0.15	3.66	0.11	
981117	34.07	1.15	7.55	0.16	3.66	0.20	

1) less than detection limit; value is half of the detection limit; (a) is old location, (b) is new location

Table 11.3: Lake water chemistry, 1999, Lheebroekerzand (Kliplo).

Date yymmdd	**Depth m NAP**	**Color mg Pt/l**	**Temp °C**	**pH lab**	**PH Field**	**EC25-lab mS/m**	**EC25-field mS/m**
990203	12.87	120	4.8	4.86	5.00	4.8	5.0
990511	12.75	100	16.2	4.61	5.40	4.4	4.0
990811	12.53	100	20.1	5.20	5.25	3.9	4.0
991116	12.56	120	3.6	5.12	5.20	4.3	4.0
Date yymmdd	**DO mg O_2/l**	**Na mg/l**	**K mg/l**	**Ca mg/l**	**Mg mg/l**	**Cd µg/l**	**Cu µg/l**
990203	11.1	3.96	1.01	0.61	0.62	0.05	1.19
990511	10.0	4.30	0.77	0.85	0.54	0.06	1.13
990811	10.0	4.95	0.36	0.40	0.65	0.02[1)]	0.52
991116	6.1	4.86	1.08	0.63	0.77	0.02[1)]	3.39
Date yymmdd	**Pb µg/l**	**Zn µg/l**	**Ni µg/l**	**As µg/l**	**Cr[1)] µg/l**	**NH_4N mg/l**	**NO_3N mg/l**
990203	1.52	14.84	0.55	0.64	0.21	0.50	0.20
990511	0.98	14.38	0.69	1.03	0.21	0.01	0.01[1)]
990811	1.02	6.86	0.21[1)]	1.03	0.21	0.01[1)]	0.01[1)]
991116	1.48	9.35	0.45	0.87	0.21	0.10	0.01[1)]
Date yymmdd	**PO_4P µg/l**	**SO_4S mg/l**	**Cl mg/l**	**Al mg/l**	**HCO_3 mg/l**	**Si mg/l**	
990203	27.88	1.47	6.77	0.13	3.66	0.10	
990511	108.41	0.71	7.27	0.13	1.53[1)]	0.03[1)]	
990811	6.19[1)]	0.26	8.08	0.11	3.66	0.06	
991116	15.49	0.64	8.26	0.15	3.66	0.12	

1) less than detection limit; value is half of the detection limit

Table 12.1: Foliage chemistry Quercus robur, 1997, Lheebroekerzand.

Date yymm	Code tree	Weight 100 leaves gram	N-tot mg/kg	S-tot mg/kg	TOC mg/kg	P-tot mg/kg	Al mg/kg	As[1)] mg/kg	Ba mg/kg	Ca mg/kg
9709	Qr01	32.0	43000	1757	503000	1506	62	3.5	14.2	5300
	Qr02	24.5	35000	1119	498000	705	51	3.5	18.0	5210
	Qr03	17.3	34000	1494	515000	1002	47	3.5	6.8	4920
	Qr04	23.0	35000	1494	492000	2102	48	3.5	44.7	10840
	Qr05	19.8	36000	1630	503000	1499	89	3.5	4.0	3410
	Qr06	18.5	6000	1579	503000	1238	98	3.5	10.2	4800
	Qr07	21.2	41000	1609	503000	1086	75	3.5	4.5	3830
	Qr08	22.9	36000	1518	494000	1308	39	3.5	10.3	5020
	Qr09	20.6	32000	1492	483000	1484	36	3.5	4.6	4870
	Qr10	21.1	42000	1650	498000	1306	45	3.5	4.5	3680
	mean	**22.1**	**34000**	**1534**	**499200**	**1324**	**59**	**3.5**	**12.2**	**5188**
	sd	**4.1**	**10499**	**169**	**8509**	**372**	**22**	**-**	**12.3**	**2097**
	max	**32.0**	**43000**	**1757**	**515000**	**2102**	**98**	**3.5**	**44.7**	**10840**
	min	**17.3**	**6000**	**1119**	**483000**	**705**	**36**	**3.5**	**4.0**	**3410**
Date yymm	**Code tree**	**Cd[1)] mg/kg**	**Co[1)] mg/kg**	**Cr[1)] mg/kg**	**Cu mg/kg**	**Fe mg/kg**	**K mg/kg**	**Mg mg/kg**	**Mn mg/kg**	**Na mg/kg**
9709	Qr01	0.75	0.40	1.0	9.6	189	10690	1300	522	260
	Qr02	0.75	0.40	1.0	2.0[1)]	65	4470	1420	182	170
	Qr03	0.75	0.40	1.0	2.0[1)]	102	5820	2080	372	480
	Qr04	0.75	0.40	1.0	4.4	66	11140	2050	343	430
	Qr05	0.75	0.40	1.0	6.8	79	7830	2210	97	340
	Qr06	0.75	0.40	1.0	4.1	139	6700	1930	335	150
	Qr07	0.75	0.40	1.0	6.9	94	7790	1880	217	120
	Qr08	0.75	0.40	1.0	7.7	79	9470	2600	295	100
	Qr09	0.75	0.40	1.0	7.3	63	8160	2510	385	140
	Qr10	0.75	0.40	1.0	7.3	113	7460	2260	311	170
	mean	**0.75**	**0.40**	**1.0**	**5.8**	**99**	**7953**	**2024**	**306**	**236**
	sd	**-**	**-**	**-**	**2.5**	**40**	**2069**	**419**	**119**	**136**
	max	**0.75**	**0.40**	**1.0**	**9.6**	**189**	**11140**	**2600**	**522**	**480**
	min	**0.75**	**0.40**	**1.0**	**2.0**	**63**	**4470**	**1300**	**97**	**100**
Date yymm	**Code tree**	**Ni mg/kg**	**Pb mg/kg**	**Sb[1)] mg/kg**	**Si mg/kg**	**Sr mg/kg**	**Ti[1)] mg/kg**	**V[1)] mg/kg**	**Zn mg/kg**	
9709	Qr01	3.6	3.5[1)]	11.5	1070	10.0	1.5	2.5	26	
	Qr02	1.9	3.5[1)]	11.5	960	18.9	1.5	2.5	11	
	Qr03	0.9[1)]	3.5[1)]	11.5	950	5.3	1.5	2.5	18	
	Qr04	0.9[1)]	3.5[1)]	11.5	1210	25.6	1.5	2.5	24	
	Qr05	2.1	3.5[1)]	11.5	990	4.1	1.5	2.5	20	
	Qr06	1.8	12.5	11.5	1010	11.4	1.5	2.5	19	
	Qr07	2.3	3.5[1)]	11.5	1070	4.7	1.5	2.5	22	
	Qr08	1.9	3.5[1)]	11.5	980	4.2	1.5	2.5	20	
	Qr09	0.9[1)]	3.5[1)]	11.5	1000	3.1	1.5	2.5	22	
	Qr10	0.9[1)]	3.5[1)]	11.5	960	3.2	1.5	2.5	23	
	mean	**1.7**	**4.4**	**11.5**	**1020**	**9.0**	**1.5**	**2.5**	**20**	
	sd	**0.9**	**2.8**	**-**	**79**	**7.7**	**-**	**-**	**4**	
	max	**3.6**	**12.5**	**11.5**	**1210**	**25.6**	**1.5**	**2.5**	**26**	
	min	**0.9**	**3.5**	**11.5**	**950**	**3.1**	**1.5**	**2.5**	**11**	

1) less than detection limit; value is half of the detection limit

Table 12.2: Foliage chemistry Quercus robur, 1998, Lheebroekerzand.

Date yymm	Code tree	Weight 100 leaves gram	N-tot mg/kg	S-tot mg/kg	TOC mg/kg	P-tot mg/kg	Al mg/kg	As[1)] mg/kg	Ba mg/kg	Ca mg/kg
9809	Qr01	24.2	32000	1715	489000	1276	46	3.5	15	6180
	Qr02	20.0	27000	1421	486000	1133	53	3.5	6	3480
	Qr03	17.2	25000	1287	498000	660	61	3.5	15	5290
	Qr04	19.2	30000	1586	494000	1057	37	3.5	6	4940
	Qr05	18.0	27000	1500	493000	1118	62	3.5	3	3500
	Qr06	21.7	35000	1795	494000	1058	100	3.5	10	5350
	Qr07	20.8	31000	1535	495000	865	54	3.5	3	2730
	Qr08	16.3	30000	1559	486000	1144	34	3.5	11	5010
	Qr09	14.4	33000	1691	496000	1293	49	3.5	2	2830
	Qr10	16.8	32000	1651	488000	1406	36	3.5	5	2900
	mean	**18.9**	**30000**	**1574**	**492000**	**1101**	**53**	**3.5**	**8**	**4221**
	sd	**2.9**	**3000**	**150**	**4000**	**215**	**19**	**-**	**5**	**1263**
	max	**24.2**	**35000**	**1795**	**498000**	**1406**	**100**	**3.5**	**15**	**6180**
	min	**14.4**	**25000**	**1287**	**486000**	**660**	**34**	**3.5**	**2**	**2730**

Date yymm	Code tree	Cd[1)] mg/kg	Co[1)] mg/kg	Cr[1)] mg/kg	Cu mg/kg	Fe mg/kg	K mg/kg	Mg mg/kg	Mn mg/kg	Na mg/kg
9809	Qr01	0.8	0.4	1.0	9.0	106	9160	1290	676	300
	Qr02	0.8	0.4	1.0	6.0	111	7230	1630	326	100
	Qr03	0.8	0.4	1.0	5.0	85	4520	1330	215	300
	Qr04	0.8	0.4	1.0	7.0	104	5160	2080	465	400
	Qr05	0.8	0.4	1.0	6.0	76	7780	1850	180	400
	Qr06	0.8	0.4	1.0	6.0	139	5330	2020	453	100
	Qr07	0.8	0.4	1.0	7.0	87	6480	1770	189	100
	Qr08	0.8	0.4	1.0	8.0	79	7710	2540	335	100
	Qr09	0.8	0.4	1.0	7.0	126	7500	1820	282	300
	Qr10	0.8	0.4	1.0	8.0	82	11450	1960	211	200
	mean	**0.8**	**0.4**	**1.0**	**6.9**	**100**	**7232**	**1829**	**333**	**230**
	sd	**-**	**-**	**-**	**1.2**	**21**	**2053**	**366**	**158**	**125**
	max	**0.8**	**0.4**	**1.0**	**9.0**	**139**	**11450**	**2540**	**676**	**400**
	min	**0.8**	**0.4**	**1.0**	**5.0**	**76**	**4520**	**1290**	**180**	**100**

Date yymm	Code tree	Ni mg/kg	Pb[1)] mg/kg	Sb[1)] mg/kg	Si mg/kg	Sr mg/kg	Ti[1)] mg/kg	V[1)] mg/kg	Zn mg/kg
9809	Qr01	2.1	9	18	1680	12.3	1.5	2.5	30
	Qr02	0.9[1)]	9	18	1330	4.5	1.5	2.5	34
	Qr03	1.8	9	18	1750	18.7	1.5	2.5	21
	Qr04	0.9[1)]	9	18	1440	5.1	1.5	2.5	24
	Qr05	2.0	9	18	1790	2.9	1.5	2.5	18
	Qr06	0.9[1)]	9	18	1190	12.6	1.5	2.5	27
	Qr07	0.9[1)]	9	18	1570	3.3	1.5	2.5	21
	Qr08	0.9[1)]	9	18	1620	4.5	1.5	2.5	31
	Qr09	0.9[1)]	9	18	1670	2.8	1.5	2.5	28
	Qr10	1.8	9	18	1460	3.2	1.5	2.5	28
	mean	**1.3**	**9**	**18**	**1550**	**7.0**	**1.5**	**2.5**	**26**
	sd	**0.6**	**-**	**-**	**192**	**5.5**	**-**	**-**	**5**
	max	**2.1**	**9**	**18**	**1790**	**18.7**	**1.5**	**2.5**	**34**
	min	**0.9**	**9**	**18**	**1190**	**2.8**	**1.5**	**2.5**	**18**

1) less than detection limit; value is half of the detection limit

Table 12.3: Foliage chemistry Quercus robur, 1999, Lheebroekerzand.

Date yymm	Code tree	Weight 100 leaves gram	N-tot mg/kg	S-tot mg/kg	TOC mg/kg	P-tot mg/kg	Al mg/kg	As[1)] mg/kg	Ba mg/kg	Ca mg/kg
9909	Qr01	27.7	25000	1411	501000	1088	80	3.5	12	5115
	Qr02	28.6	26000	1343	504000	975	63	3.5	4	3501
	Qr03	39.9	24000	1321	509000	646	64	3.5	18	5984
	Qr04	33.5	30000	1460	517000	903	55	3.5	5	4111
	Qr05	26.8	32000	1552	509000	1192	90	3.5	4	2961
	Qr06	22.6	39000	1856	501000	1190	134	3.5	9	5585
	Qr07	31.7	32000	1513	506000	747	79	3.5	1[1)]	2738
	Qr08	23.4	30000	1552	496000	1157	53	3.5	6	4930
	Qr09	19.5	33000	1594	501000	1207	75	3.5	1[1)]	3153
	Qr10	21.9	30000	1673	490000	1424	66	3.5	4	3756
	mean	**27.6**	**30100**	**1528**	**503400**	**1053**	**76**	**3.5**	**6**	**4184**
	sd	**6.2**	**4408**	**160**	**7501**	**236**	**23**	**-**	**5**	**1151**
	max	**39.9**	**39000**	**1856**	**517000**	**1424**	**134**	**3.5**	**18**	**5984**
	min	**19.5**	**24000**	**1321**	**490000**	**646**	**53**	**3.5**	**1**	**2738**

Date yymm	Code tree	Cd[1)] mg/kg	Co[1)] mg/kg	Cr[1)] mg/kg	Cu mg/kg	Fe mg/kg	K mg/kg	Mg mg/kg	Mn mg/kg	Na mg/kg
9909	Qr01	0.8	0.4	1.0	6.6	106	9623	1710	434	84
	Qr02	0.8	0.4	1.0	5.7	118	7984	1870	270	76
	Qr03	0.8	0.4	1.0	5.0	87	5397	1380	233	88
	Qr04	0.8	0.4	1.0	5.4	142	5886	1920	330	234
	Qr05	0.8	0.4	1.0	6.5	110	7383	2220	82	161
	Qr06	0.8	0.4	1.0	5.6	162	8272	2080	359	72
	Qr07	0.8	0.4	1.0	6.1	123	6609	1800	184	76
	Qr08	0.8	0.4	1.0	6.9	101	8217	2470	385	81
	Qr09	0.8	0.4	1.0	6.9	163	9860	2070	295	91
	Qr10	0.8	0.4	1.0	7.1	143	10334	2450	346	136
	mean	**0.8**	**0.4**	**1.0**	**6.2**	**125**	**7957**	**1997**	**292**	**110**
	sd	**-**	**-**	**-**	**0.7**	**26**	**1673**	**336**	**104**	**52**
	max	**0.8**	**0.4**	**1.0**	**7.1**	**163**	**10334**	**2470**	**434**	**234**
	min	**0.8**	**0.4**	**1.0**	**5.0**	**87**	**5397**	**1380**	**82**	**72**

Date yymm	Code tree	Ni mg/kg	Pb[1)] mg/kg	Sb[1)] mg/kg	Si mg/kg	Sr mg/kg	Ti[1)] mg/kg	V[1)] mg/kg	Zn mg/kg
9909	Qr01	2.5	9	18	1638	6.4	1.5	2.5	26.0
	Qr02	2.0	9	18	1425	3.5	1.5	2.5	29.4
	Qr03	1.8	9	18	1868	21.7	1.5	2.5	21.3
	Qr04	1.9	9	18	1447	4.4	1.5	2.5	21.1
	Qr05	2.5	9	18	1671	4.7	1.5	2.5	24.2
	Qr06	1.9	9	18	1747	9.6	1.5	2.5	34.7
	Qr07	0.9[1)]	9	18	1665	2.4	1.5	2.5	22.1
	Qr08	0.9[1)]	9	18	1660	3.3	1.5	2.5	30.1
	Qr09	0.9[1)]	9	18	1763	2.3	1.5	2.5	26.9
	Qr10	2.0	9	18	1585	3.1	1.5	2.5	31.4
	mean	**1.7**	**9**	**18**	**1647**	**6.1**	**1.5**	**2.5**	**26.7**
	sd	**0.6**	**-**	**-**	**136**	**5.9**	**-**	**-**	**4.6**
	max	**2.5**	**9**	**18**	**1868**	**21.7**	**1.5**	**2.5**	**34.7**
	min	**0.9**	**9**	**18**	**1425**	**2.3**	**1.5**	**2.5**	**21.1**

1) less than detection limit; value is half of the detection limit

Table 12.4: Foliage chemistry Pinus sylvestris, 1997, Lheebroekerzand.

Date yymm	Code Tree	Weight 100 needles gram	N-tot mg/kg	S-tot mg/kg	TOC mg/kg	P-tot mg/kg	Al mg/kg	As[1)] mg/kg	Ba mg/kg	Ca mg/kg
9711	Ps26	3.8	24000	989	488000	1600	178	3.5	1.0[1)]	759
	Ps27	3.3	25000	920	498000	1223	158	3.5	1.0[1)]	967
	Ps28	3.5	27000	930	519000	1600	284	3.5	1.0[1)]	1384
	Ps29	3.7	26000	956	524000	1139	108	3.5	1.0[1)]	1684
	Ps30	3.2	25000	946	510000	1428	298	3.5	2.6	1749
	Ps31	3.5	29000	989	516000	1698	214	3.5	2.5	2171
	Ps32	4.3	29000	835	508000	938	216	3.5	2.2	1165
	Ps33	3.3	27000	1045	505000	1579	201	3.5	1.0[1)]	1062
	Ps34	2.8	27000	908	509000	1406	224	3.5	2.1	2408
	Ps35	3.0	22000	771	503000	1160	168	3.5	1.0[1)]	1263
	mean	**3.4**	**26100**	**929**	**508000**	**1377**	**205**	**3.5**	**1.5**	**1461**
	sd	**0.4**	**2183**	**79**	**10435**	**251**	**57**	**-**	**0.7**	**533**
	max	**4.3**	**29000**	**1045**	**524000**	**1698**	**298**	**3.5**	**2.6**	**2408**
	min	**2.8**	**22000**	**771**	**488000**	**938**	**108**	**3.5**	**1.0**	**759**

Date yymm	Code tree	Cd[1)] mg/kg	Co[1)] mg/kg	Cr[1)] mg/kg	Cu[1)] mg/kg	Fe mg/kg	K mg/kg	Mg mg/kg	Mn mg/kg	Na mg/kg
9711	Ps26	0.75	0.40	1.0	2.0	36	7228	485	93	50[1)]
	Ps27	0.75	0.40	1.0	2.0	55	5520	618	156	224
	Ps28	0.75	0.40	1.0	2.0	44	6034	546	147	105
	Ps29	0.75	0.40	1.0	2.0	55	4943	509	158	191
	Ps30	0.75	0.40	1.0	2.0	61	6948	711	178	405
	Ps31	0.75	0.40	1.0	2.0	45	7588	810	200	142
	Ps32	0.75	0.40	1.0	2.0	65	7540	461	213	709
	Ps33	0.75	0.40	1.0	2.0	46	6804	699	156	50[1)]
	Ps34	0.75	0.40	1.0	2.0	40	6534	838	248	50[1)]
	Ps35	0.75	0.40	1.0	2.0	40	7254	524	90	217
	mean	**0.75**	**0.40**	**1.0**	**2.0**	**49**	**6639**	**620**	**164**	**214**
	sd	**-**	**-**	**-**	**-**	**10**	**886**	**137**	**49**	**205**
	max	**0.75**	**0.40**	**1.0**	**2.0**	**65**	**7588**	**838**	**248**	**709**
	min	**0.75**	**0.40**	**1.0**	**2.0**	**36**	**4943**	**461**	**90**	**50**

Date yymm	Code tree	Ni mg/kg	Pb[1)] mg/kg	Sb[1)] mg/kg	Si mg/kg	Sr mg/kg	Ti[1)] mg/kg	V[1)] mg/kg	Zn mg/kg
9711	Ps26	2.1	3.5	11.5	344	0.5[1)]	1.5	2.5	34
	Ps27	0.9[1)]	3.5	11.5	298	1.6	1.5	2.5	34
	Ps28	0.9[1)]	3.5	11.5	276	1.4	1.5	2.5	44
	Ps29	0.9[1)]	3.5	11.5	336	1.2	1.5	2.5	26
	Ps30	0.9[1)]	3.5	11.5	387	2.2	1.5	2.5	40
	Ps31	0.9[1)]	3.5	11.5	239	2.9	1.5	2.5	50
	Ps32	0.9[1)]	3.5	11.5	236	2.2	1.5	2.5	39
	Ps33	0.9[1)]	3.5	11.5	313	2.0	1.5	2.5	28
	Ps34	0.9[1)]	3.5	11.5	250	3.1	1.5	2.5	47
	Ps35	0.9[1)]	3.5	11.5	325	1.6	1.5	2.5	35
	mean	**1.0**	**3.5**	**11.5**	**300**	**1.9**	**1.5**	**2.5**	**38**
	sd	**0.4**	**-**	**-**	**50**	**0.8**	**-**	**-**	**8**
	max	**2.1**	**3.5**	**11.5**	**387**	**3.1**	**1.5**	**2.5**	**50**
	min	**0.9**	**3.5**	**11.5**	**236**	**0.5**	**1.5**	**2.5**	**26**

1) less than detection limit; value is half of the detection limit

Table 12.5: Foliage chemistry Pinus sylvestris, 1998, Lheebroekerzand.

Date yymm	Code tree	Weight 100 needles gram	N-tot mg/kg	S-tot mg/kg	TOC mg/kg	P-tot mg/kg	Al mg/kg	As[1)] mg/kg	Ba mg/kg	Ca mg/kg
9811	Ps26	2.7	23000	1045	489000	1495	173	3.5	1.0[1)]	710
	Ps27	4.6	23000	968	502000	1139	164	3.5	1.0[1)]	720
	Ps28	4.4	21000	927	506000	1287	251	3.5	1.0[1)]	1510
	Ps29	4.5	23000	798	499000	1079	119	3.5	1.0[1)]	1390
	Ps30	4.2	22000	867	491000	1376	244	3.5	2.0	1270
	Ps31	4.0	21000	1055	498000	1224	177	3.5	2.0	2610
	Ps32	4.1	23000	985	507000	1253	135	3.5	2.0	1940
	Ps33	3.5	22000	958	505000	1354	164	3.5	2.0	1490
	Ps34	2.8	19000	834	498000	1105	213	3.5	1.0[1)]	1280
	Ps35	3.5	19000	777	503000	836	135	3.5	1.0[1)]	1940
	mean	**3.8**	**21600**	**921**	**499800**	**1215**	**178**	**3.5**	**1.4**	**1486**
	sd	**0.7**	**1578**	**99**	**6088**	**186**	**45**	**-**	**0.5**	**574**
	max	**4.6**	**23000**	**1055**	**507000**	**1495**	**251**	**3.5**	**2.0**	**2610**
	min	**2.7**	**19000**	**777**	**489000**	**836**	**119**	**3.5**	**1.0**	**710**

Date yymm	Code tree	Cd[1)] mg/kg	Co[1)] mg/kg	Cr[1)] mg/kg	Cu mg/kg	Fe mg/kg	K mg/kg	Mg mg/kg	Mn mg/kg	Na mg/kg
9811	Ps26	0.8	0.4	1.0	6.0	40	10910	540	90	200
	Ps27	0.8	0.4	1.0	4.0	50	6850	570	105	300
	Ps28	0.8	0.4	1.0	4.0	45	6490	570	137	300
	Ps29	0.8	0.4	1.0	2.0[1)]	43	5830	630	118	200
	Ps30	0.8	0.4	1.0	4.0	43	8060	920	127	200
	Ps31	0.8	0.4	1.0	2.0[1)]	85	6950	730	219	400
	Ps32	0.8	0.4	1.0	2.0[1)]	49	5100	930	162	200
	Ps33	0.8	0.4	1.0	4.0	48	6740	930	168	200
	Ps34	0.8	0.4	1.0	4.0	33	7170	880	139	200
	Ps35	0.8	0.4	1.0	2.0[1)]	47	5680	600	103	400
	mean	**0.8**	**0.4**	**1.0**	**3.4**	**48**	**6978**	**730**	**137**	**260**
	sd	**-**	**-**	**-**	**1.3**	**14**	**1616**	**168**	**38**	**84**
	max	**0.8**	**0.4**	**1.0**	**6.0**	**85**	**10910**	**930**	**219**	**400**
	min	**0.8**	**0.4**	**1.0**	**2.0**	**33**	**5100**	**540**	**90**	**200**

Date yymm	Code tree	Ni mg/kg	Pb[1)] mg/kg	Sb[1)] mg/kg	Si mg/kg	Sr mg/kg	Ti[1)] mg/kg	V[1)] mg/kg	Zn mg/kg
9811	Ps26	1.9	9	18	260	0.7[1)]	1.5	2.5	39
	Ps27	0.9[1)]	9	18	220	0.7[1)]	1.5	2.5	37
	Ps28	0.9[1)]	9	18	70	1.9	1.5	2.5	44
	Ps29	0.9[1)]	9	18	270	0.7[1)]	1.5	2.5	38
	Ps30	0.9[1)]	9	18	320	1.5	1.5	2.5	42
	Ps31	0.9[1)]	9	18	160	2.5	1.5	2.5	48
	Ps32	0.9[1)]	9	18	50	3.9	1.5	2.5	51
	Ps33	0.9[1)]	9	18	120	3.0	1.5	2.5	28
	Ps34	0.9[1)]	9	18	80	2.0	1.5	2.5	50
	Ps35	0.9[1)]	9	18	370	2.0	1.5	2.5	39
	mean	**1.0**	**9**	**18**	**192**	**1.9**	**1.5**	**2.5**	**42**
	sd	**0.3**	**-**	**-**	**112**	**1.1**	**-**	**-**	**7**
	max	**1.9**	**9**	**18**	**370**	**3.9**	**1.5**	**2.5**	**51**
	min	**0.9**	**9**	**18**	**50**	**0.7**	**1.5**	**2.5**	**28**

1) less than detection limit; value is half of the detection limit

Table 12.6: Foliage chemistry Pinus sylvestris, 1999, Lheebroekerzand.

Date yymm	Code Tree	Weight 100 needles gram	N-tot mg/kg	S-tot mg/kg	TOC mg/kg	P-tot mg/kg	Al mg/kg	As[1)] mg/kg	Ba[1)] mg/kg	Ca mg/kg
9911	Ps26	3.1	22000	1071	508000	1594	144	3.5	1.0	833
	Ps27	3.6	18000	872	521000	1046	161	3.5	1.0	735
	Ps28	3.8	20000	947	500000	1373	218	3.5	1.0	1247
	Ps29	3.7	20000	933	522000	1012	117	3.5	1.0	1538
	Ps30	3.4	18000	904	507000	1232	220	3.5	1.0	2067
	Ps31	1.7	16000	1033	510000	1007	156	3.5	1.0	2233
	Ps32a	3.8	23000	1068	514000	1260	169	3.5	1.0	2007
	Ps33	3.2	19000	1038	508000	1315	170	3.5	1.0	1135
	Ps34a	4.4	20000	862	514000	1148	221	3.5	1.0	1598
	Ps35	3.9	18000	979	502000	1230	178	3.5	1.0	1350
	mean	**3.5**	**19400**	**971**	**510600**	**1222**	**175**	**3.5**	**1.0**	**1474**
	sd	**0.7**	**2066**	**79**	**7260**	**182**	**35**	**-**	**-**	**513**
	max	**4.4**	**23000**	**1071**	**522000**	**1594**	**221**	**3.5**	**1.0**	**2233**
	min	**1.7**	**16000**	**862**	**500000**	**1007**	**117**	**3.5**	**1.0**	**735**

Date yymm	Code Tree	Cd[1)] mg/kg	Co[1)] mg/kg	Cr[1)] mg/kg	Cu mg/kg	Fe mg/kg	K mg/kg	Mg mg/kg	Mn mg/kg	Na mg/kg
9911	Ps26	0.8	0.4	1.0	5.0	37	8050	631	104	136
	Ps27	0.8	0.4	1.0	2.0[1)]	42	6506	638	118	255
	Ps28	0.8	0.4	1.0	2.0[1)]	39	6209	580	129	152
	Ps29	0.8	0.4	1.0	2.0[1)]	38	5510	706	141	94
	Ps30	0.8	0.4	1.0	2.0[1)]	60	6236	892	202	398
	Ps31	0.8	0.4	1.0	2.0[1)]	80	7175	695	207	947
	Ps32a	0.8	0.4	1.0	2.0[1)]	46	5307	1021	218	96
	Ps33	0.8	0.4	1.0	2.0[1)]	55	6906	840	171	214
	Ps34a	0.8	0.4	1.0	2.0[1)]	36	6221	841	167	130
	Ps35	0.8	0.4	1.0	2.0[1)]	40	8018	854	89	275
	mean	**0.8**	**0.4**	**1.0**	**2.0**	**47**	**6614**	**770**	**155**	**270**
	sd	**-**	**-**	**-**	**1.0**	**14**	**933**	**140**	**45**	**256**
	max	**0.8**	**0.4**	**1.0**	**5.0**	**80**	**8050**	**1021**	**218**	**947**
	min	**0.8**	**0.4**	**1.0**	**2.0**	**36**	**5307**	**580**	**89**	**94**

Date yymm	Code Tree	Ni[1)] mg/kg	Pb[1)] mg/kg	Sb[1)] mg/kg	Si Mg/kg	Sr mg/kg	Ti[1)] mg/kg	V[1)] mg/kg	Zn mg/kg
9911	Ps26	0.9	9	18	261	0.4[1)]	1.0	2.5	41.5
	Ps27	0.9	9	18	283	0.8	1.0	2.5	32.0
	Ps28	0.9	9	18	199	1.2	1.0	2.5	39.2
	Ps29	0.9	9	18	402	0.9	1.0	2.5	33.4
	Ps30	0.9	9	18	255	2.6	1.0	2.5	46.2
	Ps31	0.9	9	18	251	2.1	1.0	2.5	37.3
	Ps32a	0.9	9	18	514	2.8	1.0	2.5	66.2
	Ps33	0.9	9	18	276	1.6	1.0	2.5	24.4
	Ps34a	0.9	9	18	189	4.0	1.0	2.5	39.5
	Ps35	0.9	9	18	367	1.4	1.0	2.5	40.8
	mean	**0.9**	**9**	**18**	**300**	**1.8**	**1.0**	**2.5**	**40.0**
	sd	**-**	**-**	**-**	**100**	**1.1**	**-**	**-**	**11.0**
	max	**0.9**	**9**	**18**	**514**	**4.0**	**1.0**	**2.5**	**66.2**
	min	**0.9**	**9**	**18**	**189**	**0.4**	**1.0**	**2.5**	**24.4**

1) less than detection limit; value is half of the detection limit

Table 12.7: Litterfall chemistry Quercus robur, 1997, Lheebroekerzand.

Date yy	**Code tree**	**Weight total leaves gram**	**N-tot mg/kg**	**S-tot mg/kg**	**TOC mg/kg**	**P-tot mg/kg**	**Al mg/kg**	**As[1)] mg/kg**	**Ba mg/kg**	**Ca mg/kg**
97	Qr06	33.4	24000	1198	504000	538	164	3.5	13.6	5531
	Qr07	32.5	26000	1249	512000	397	109	3.5	7.1	4581
	Qr08	71.7	25000	1128	508000	428	88	3.5	15.5	6214
	Qr09	23.9	28000	1246	517000	552	79	3.5	5.1	3925
	Qr10	52.2	28000	1370	517000	479	79	3.5	6.5	3250
	mean	**42.7**	**26200**	**1238**	**511600**	**479**	**104**	**3.5**	**9.6**	**4700**
	sd	**19.2**	**1789**	**88**	**5683**	**67**	**36**	**-**	**4.7**	**1194**
	max	**71.7**	**28000**	**1370**	**517000**	**552**	**164**	**3.5**	**15.5**	**6214**
	min	**23.9**	**24000**	**1128**	**504000**	**397**	**79**	**3.5**	**5.1**	**3250**

Date yy	**Code tree**	**Cd[1)] mg/kg**	**Co[1)] mg/kg**	**Cr[1)] mg/kg**	**Cu mg/kg**	**Fe mg/kg**	**K mg/kg**	**Mg Mg/kg**	**Mn mg/kg**	**Na mg/kg**
97	Qr06	0.75	0.40	1.0	2.0[1)]	223	2843	2026	385	288
	Qr07	0.75	0.40	1.0	6.4	137	2462	2394	269	250
	Qr08	0.75	0.40	1.0	5.7	142	2211	1693	393	263
	Qr09	0.75	0.40	1.0	5.3	155	3407	1664	292	379
	Qr10	0.75	0.40	1.0	5.6	153	2738	1954	258	299
	mean	**0.75**	**0.40**	**1.0**	**5.0**	**162**	**2732**	**1946**	**319**	**296**
	sd	**-**	**-**	**-**	**1.7**	**35**	**451**	**296**	**65**	**50**
	max	**0.75**	**0.40**	**1.0**	**6.4**	**223**	**3407**	**2394**	**393**	**379**
	min	**0.75**	**0.40**	**1.0**	**2.0**	**137**	**2211**	**1664**	**258**	**250**

Date yy	**Code Tree**	**Ni mg/kg**	**Pb[1)] mg/kg**	**Sb[1)] mg/kg**	**Si mg/kg**	**Sr mg/kg**	**Ti[1)] mg/kg**	**V[1)] mg/kg**	**Zn mg/kg**
97	Qr06	2.7	3.5	11.5	722	12.2	1.5	2.5	23
	Qr07	2.8	3.5	11.5	932	6.4	1.5	2.5	32
	Qr08	2.9	3.5	11.5	897	6.0	1.5	2.5	31
	Qr09	2.1	3.5	11.5	630	3.8	1.5	2.5	36
	Qr10	2.7	3.5	11.5	778	4.6	1.5	2.5	29
	mean	**2.6**	**3.5**	**11.5**	**791**	**6.6**	**1.5**	**2.5**	**30**
	sd	**0.3**	**-**	**-**	**124**	**3.3**	**-**	**-**	**5**
	max	**2.9**	**3.5**	**11.5**	**932**	**12.2**	**1.5**	**2.5**	**36**
	min	**2.1**	**3.5**	**11.5**	**630**	**3.8**	**1.5**	**2.5**	**23**

1) less than detection limit; value is half of the detection limit

Table 12.8: Litterfall chemistry Quercus robur, 1998, Lheebroekerzand.

Date yy	Code Tree	Weight total leaves gram	N-tot mg/kg	S-tot mg/kg	TOC mg/kg	P-tot mg/kg	Al mg/kg	As[1)] mg/kg	Ba mg/kg	Ca mg/kg
98	Qr06	36.5	16000	1263	502000	393	146	3.5	13.0	5900
	Qr07	40.2	16000	1324	498000	382	111	3.5	6.0	4200
	Qr08	52.4	21000	1320	501000	428	91	3.5	15.0	7010
	Qr09	27.1	28000	1439	518000	476	108	3.5	5.0	4870
	Qr10	42.5	26000	1390	513000	397	90	3.5	7.0	3820
	mean	**39.7**	**21400**	**1347**	**506400**	**415**	**109**	**4**	**9.2**	**5160**
	sd	**9.2**	**5550**	**68**	**8620**	**38**	**23**	**-**	**4.5**	**1301**
	max	**52**	**28000**	**1439**	**518000**	**476**	**146**	**4**	**15.0**	**7010**
	min	**27**	**16000**	**1263**	**498000**	**382**	**90**	**4**	**5.0**	**3820**

Date yy	Code Tree	Cd[1)] mg/kg	Co[1)] mg/kg	Cr[1)] mg/kg	Cu mg/kg	Fe mg/kg	K mg/kg	Mg mg/kg	Mn mg/kg	Na mg/kg
98	Qr06	0.8	0.4	1.0	6.0	223	1190	1970	464	200
	Qr07	0.8	0.4	1.0	7.0	179	1750	2120	274	300
	Qr08	0.8	0.4	1.0	9.0	165	1910	2630	470	200
	Qr09	0.8	0.4	1.0	7.0	196	1230	1950	384	300
	Qr10	0.8	0.4	1.0	7.0	172	1970	1630	294	300
	mean	**0.8**	**0.4**	**1.0**	**7.2**	**187**	**1610**	**2060**	**377**	**260**
	sd	**-**	**-**	**-**	**1.1**	**23**	**374**	**365**	**92**	**55**
	max	**0.8**	**0.4**	**1.0**	**9.0**	**223**	**1970**	**2630**	**470**	**300**
	min	**0.8**	**0.4**	**1.0**	**6.0**	**165**	**1190**	**1630**	**274**	**200**

Date yy	Code Tree	Ni mg/kg	Pb[1)] mg/kg	Sb[1)] mg/kg	Si mg/kg	Sr mg/kg	Ti[1)] mg/kg	V[1)] mg/kg	Zn mg/kg
98	Qr06	1.8	9	18	1830	13.9	1.5	2.5	39
	Qr07	2.0	9	18	1730	6.5	1.5	2.5	38
	Qr08	1.7	9	18	1820	7.6	1.5	2.5	36
	Qr09	0.9[1)]	9	18	1790	5.8	1.5	2.5	41
	Qr10	2.0	9	18	1770	5.3	1.5	2.5	31
	mean	**1.7**	**9**	**18**	**1788**	**7.8**	**1.5**	**2.5**	**37**
	sd	**0.5**	**-**	**-**	**40**	**3.5**	**-**	**-**	**4**
	max	**2.0**	**9**	**18**	**1830**	**13.9**	**1.5**	**2.5**	**41**
	min	**0.9**	**9**	**18**	**1730**	**5.3**	**1.5**	**2.5**	**31**

1) less than detection limit; value is half of the detection limit

Table 12.9: Litterfall chemistry Quercus robur, 1999, Lheebroekerzand.

Date yy	Code Tree	Weight Total leaves gram	N-tot mg/kg	S-tot mg/kg	TOC mg/kg	P-tot mg/kg	Al mg/kg	As mg/kg	Ba mg/kg	Ca mg/kg
99	Qr06	35.9	16000	1068	503000	316	169	3.5	11.2	6083
	Qr07	44.9	19000	1190	510000	259	111	3.5	3.9	3665
	Qr08	59.3	14000	1131	500000	319	114	3.5	10.1	5238
	Qr09	28.2	21000	1423	507000	486	133	3.5	4.8	4219
	Qr10	38.2	19000	1353	514000	461	128	3.5	5.6	4135
	mean	**41.3**	**17800**	**1233**	**506800**	**368**	**131**	**3.5**	**7.1**	**4668**
	sd	**11.7**	**2775**	**150**	**5541**	**99**	**23**	**-**	**3.3**	**977**
	max	**59.3**	**21000**	**1423**	**514000**	**486**	**169**	**3.5**	**11.2**	**6083**
	min	**28.2**	**14000**	**1068**	**500000**	**259**	**111**	**3.5**	**3.9**	**3665**
Date yy	**Code Tree**	**Cd[1)] mg/kg**	**Co[1)] mg/kg**	**Cr[1)] mg/kg**	**Cu mg/kg**	**Fe mg/kg**	**K mg/kg**	**Mg mg/kg**	**Mn mg/kg**	**Na mg/kg**
99	Qr06	0.8	0.4	1.0	2.0[1)]	219	1607	1792	354	200
	Qr07	0.8	0.4	1.0	5.0	146	2045	1723	206	270
	Qr08	0.8	0.4	1.0	4.9	185	2355	2038	340	220
	Qr09	0.8	0.4	1.0	5.1	222	1651	1707	357	250
	Qr10	0.8	0.4	1.0	5.4	221	1507	1879	375	180
	mean	**0.8**	**0.4**	**1.0**	**4.5**	**199**	**1833**	**1828**	**326**	**224**
	sd	**-**	**-**	**-**	**1.4**	**33**	**356**	**136**	**68**	**36**
	max	**0.8**	**0.4**	**1.0**	**5.4**	**222**	**2355**	**2038**	**375**	**270**
	min	**0.8**	**0.4**	**1.0**	**2.0**	**146**	**1507**	**1707**	**206**	**180**
Date yy	**Code Tree**	**Ni mg/kg**	**Pb mg/kg**	**Sb mg/kg**	**Si mg/kg**	**Sr mg/kg**	**Ti mg/kg**	**V mg/kg**	**Zn mg/kg**	
99	Qr06	1.8	9	18	1510	13.7	1.0[1)]	2.5	25.7	
	Qr07	0.9[1)]	9	18	1660	4.8	1.0[1)]	2.5	25.2	
	Qr08	2.0	9	18	1670	5.3	3.2	2.5	25.0	
	Qr09	0.9[1)]	9	18	1650	4.2	3.6	2.5	28.7	
	Qr10	2.2	9	18	1680	3.9	3.9	2.5	24.3	
	mean	**1.5**	**9**	**18**	**1634**	**6.4**	**2.5**	**2.5**	**25.8**	
	sd	**0.6**	**-**	**-**	**70**	**4.1**	**1.4**	**-**	**1.7**	
	max	**2.2**	**9**	**18**	**1680**	**13.7**	**3.9**	**2.5**	**28.7**	
	min	**0.9**	**9**	**18**	**1510**	**3.9**	**1.0**	**2.5**	**24.3**	

1) less than detection limit; value is half of the detection limit

Table 12.10 Litterfall chemistry Pinus sylvestris, 1997, Lheebroekerzand.

Date yy	Code Tree	Weight Total needles gram	N-tot mg/kg	S-tot mg/kg	TOC mg/kg	P-tot mg/kg	Al mg/kg	As[1)] mg/kg	Ba mg/kg	Ca mg/kg
97	Ps26a	38.5	16000	695	529000	402	218	3.5	3.7	3078
	Ps27a	49.5	16000	634	537000	281	140	3.5	2.9	1657
	Ps28a	24	15000	623	535000	213	185	3.5	4.9	3188
	Ps32a	48.6	15000	636	531000	313	183	3.5	3.8	2616
	Ps33a	17.6	20000	1096	532000	754	246	3.5	6.0	3433
	mean	**35.6**	**16400**	**737**	**532800**	**392**	**194**	**3.5**	**4.3**	**2794**
	sd	**14.4**	**2074**	**203**	**3194**	**213**	**40**	**-**	**1.2**	**702**
	max	**49.5**	**20000**	**1096**	**537000**	**754**	**246**	**3.5**	**6.0**	**3433**
	min	**17.6**	**15000**	**623**	**529000**	**213**	**140**	**3.5**	**2.9**	**1657**
Date yy	**Code tree**	**Cd[1)] mg/kg**	**Co[1)] mg/kg**	**Cr[1)] mg/kg**	**Cu[1)] mg/kg**	**Fe mg/kg**	**K mg/kg**	**Mg mg/kg**	**Mn mg/kg**	**Na mg/kg**
97	Ps26a	0.75	0.40	1.0	2.0	131	808	533	207	385
	Ps27a	0.75	0.40	1.0	2.0	118	939	442	189	546
	Ps28a	0.75	0.40	1.0	2.0	114	686	460	236	394
	Ps32a	0.75	0.40	1.0	2.0	136	1194	483	362	759
	Ps33a	0.75	0.40	1.0	2.0	193	2076	852	339	613
	mean	**0.75**	**0.40**	**1.0**	**2.0**	**139**	**1141**	**554**	**267**	**539**
	sd	**-**	**-**	**-**	**-**	**32**	**556**	**170**	**79**	**157**
	max	**0.75**	**0.40**	**1.0**	**2.0**	**193**	**2076**	**852**	**362**	**759**
	min	**0.75**	**0.40**	**1.0**	**2.0**	**114**	**686**	**442**	**189**	**385**
Date yy	**Code tree**	**Ni[1)] mg/kg**	**Pb[1)] mg/kg**	**Sb[1)] mg/kg**	**Si mg/kg**	**Sr mg/kg**	**Ti mg/kg**	**V[1)] mg/kg**	**Zn mg/kg**	
97	Ps26a	0.9	3.5	11.5	540	6.2	1.5[1)]	2.5	43	
	Ps27a	0.9	3.5	11.5	366	3.3	1.5[1)]	2.5	29	
	Ps28a	0.9	3.5	11.5	381	6.5	1.5[1)]	2.5	45	
	Ps32a	0.9	3.5	11.5	393	5.3	1.5[1)]	2.5	37	
	Ps33a	0.9	3.5	11.5	480	9.4	3.6	2.5	39	
	mean	**0.9**	**3.5**	**11.5**	**432**	**6.1**	**1.9**	**2.5**	**38**	
	sd	**-**	**-**	**-**	**75**	**2.2**	**0.9**	**-**	**6**	
	max	**0.9**	**3.5**	**11.5**	**540**	**9.4**	**3.6**	**2.5**	**45**	
	min	**0.9**	**3.5**	**11.5**	**366**	**3.3**	**1.5**	**2.5**	**29**	

1) less than detection limit; value is half of the detection limit

Table 12.11 Litterfall chemistry Pinus sylvestris, 1998, Lheebroekerzand.

Date yy	Code tree	Weight Total leaves gram	N-tot mg/kg	S-tot mg/kg	TOC mg/kg	P-tot mg/kg	Al mg/kg	As[1)] mg/kg	Ba mg/kg	Ca mg/kg
98	Ps26	102.0	7000	754	519000	329	215	3.5	3.0	3580
	Ps27	85.6	9000	677	533000	252	167	3.5	3.0	2020
	Ps28	68.5	7000	834	508000	290	295	3.5	6.0	4070
	Ps32	132.6	4000	783	527000	268	250	3.5	11.0	4650
	Ps33	22.2	8000	883	520000	410	172	3.5	5.0	2910
	mean	**82.2**	**7000**	**786**	**521400**	**310**	**220**	**3.5**	**5.6**	**3446**
	sd	**41.0**	**1871**	**78**	**9397**	**63**	**54**	**-**	**3.3**	**1022**
	max	**132.6**	**9000**	**883**	**533000**	**410**	**295**	**3.5**	**11.0**	**4650**
	min	**22.2**	**4000**	**677**	**508000**	**252**	**167**	**3.5**	**3.0**	**2020**
Date yy	**Code tree**	**Cd[1)] mg/kg**	**Co[1)] mg/kg**	**Cr[1)] mg/kg**	**Cu[1)] mg/kg**	**Fe mg/kg**	**K mg/kg**	**Mg mg/kg**	**Mn mg/kg**	**Na mg/kg**
98	Ps26	0.8	0.4	1.0	2.0	168	570	560	215	200
	Ps27	0.8	0.4	1.0	2.0	157	660	640	214	400
	Ps28	0.8	0.4	1.0	2.0	231	700	600	271	300
	Ps32	0.8	0.4	1.0	2.0	249	500	820	300	300
	Ps33	0.8	0.4	1.0	2.0	171	870	850	219	500
	mean	**0.8**	**0.4**	**1.0**	**2.0**	**195**	**660**	**694**	**244**	**340**
	sd	**-**	**-**	**-**	**-**	**42**	**141**	**132**	**39**	**114**
	max	**0.8**	**0.4**	**1.0**	**2.0**	**249**	**870**	**850**	**300**	**500**
	min	**0.8**	**0.4**	**1.0**	**2.0**	**157**	**500**	**560**	**214**	**200**
Date yy	**Code tree**	**Ni[1)] mg/kg**	**Pb[1)] mg/kg**	**Sb[1)] mg/kg**	**Si mg/kg**	**Sr mg/kg**	**Ti mg/kg**	**V[1)] mg/kg**	**Zn mg/kg**	
98	Ps26	0.9	9	18	800	6.3	1.5[1)]	2.5	48	
	Ps27	0.9	9	18	390	5.2	1.5[1)]	2.5	34	
	Ps28	0.9	9	18	470	8.4	4.0	2.5	55	
	Ps32	0.9	9	18	340	15.6	3.0	2.5	65	
	Ps33	0.9	9	18	450	9.7	1.5[1)]	2.5	29	
	mean	**0.9**	**9**	**18**	**490**	**9.0**	**2.3**	**2.5**	**46**	
	sd	**-**	**-**	**-**	**181**	**4.1**	**1.2**	**-**	**15**	
	max	**0.9**	**9**	**18**	**800**	**15.6**	**4.0**	**2.5**	**65**	
	min	**0.9**	**9**	**18**	**340**	**5.2**	**1.5**	**2.5**	**29**	

1) less than detection limit; value is half of the detection limit

Table 12.12 Litterfall chemistry Pinus sylvestris, 1999, Lheebroekerzand.

Date yy	Code tree	Weight total needles gram	N-tot mg/kg	S-tot mg/kg	TOC mg/kg	P-tot mg/kg	Al mg/kg	As[1)] mg/kg	Ba mg/kg	Ca mg/kg
99	Ps27	58	11000	809	522000	394	237	3.5	1[1)]	3110
	Ps32a	52.1	10000	751	526000	254	194	3.5	8	4040
	mean	**55.1**	**10500**	**780**	**524000**	**324**	**215**	**3.5**	**5**	**3575**
	sd	**4.2**	**707**	**41**	**2828**	**99**	**30**	**-**	**5**	**658**
	max	**58.0**	**11000**	**809**	**526000**	**394**	**237**	**3.5**	**8**	**4040**
	min	**52.1**	**10000**	**751**	**522000**	**254**	**194**	**3.5**	**1**	**3110**
Date yy	**Code tree**	**Cd[1)] mg/kg**	**Co[1)] mg/kg**	**Cr[1)] mg/kg**	**Cu[1)] mg/kg**	**Fe mg/kg**	**K mg/kg**	**Mg mg/kg**	**Mn mg/kg**	**Na mg/kg**
99	Ps27	0.8	0.4	1.0	2.0	140	750	660	223	280
	Ps32a	0.8	0.4	1.0	2.0	172	770	920	302	430
	mean	**0.8**	**0.4**	**1.0**	**2.0**	**156**	**760**	**790**	**262**	**355**
	sd	**-**	**-**	**-**	**-**	**23**	**14**	**184**	**56**	**106**
	max	**0.8**	**0.4**	**1.0**	**2.0**	**172**	**770**	**920**	**302**	**430**
	min	**0.8**	**0.4**	**1.0**	**2.0**	**140**	**750**	**660**	**223**	**280**
Date yy	**Code tree**	**Ni[1)] mg/kg**	**Pb[1)] mg/kg**	**Sb[1)] mg/kg**	**Si mg/kg**	**Sr mg/kg**	**Ti[1)] mg/kg**	**V[1)] mg/kg**	**Zn mg/kg**	
99	Ps27	0.9	9	18	570	5.9	1.0	2.5	51	
	Ps32a	0.9	9	18	280	14.2	1.0	2.5	65	
	mean	**0.9**	**9**	**18**	**425**	**10.0**	**1.0**	**2.5**	**58**	
	sd	**-**	**-**	**-**	**205**	**5.9**	**-**	**-**	**10**	
	max	**0.9**	**9**	**18**	**570**	**14.2**	**1.0**	**2.5**	**65**	
	min	**0.9**	**9**	**18**	**280**	**5.9**	**1.0**	**2.5**	**51**	

1) less than detection limit; value is half of the detection limit

Table 13.1: Hydrobiology of lakes, 1992-1999, Lheebroekerzand (Kliplo). Total number of organisms.

Scientific name	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Ablabesmyia longistyla	25		22	8	8	18	64	1
Ablabesmyia monilis			1					
Ablabesmyia phatta	8	4	73	58	3	45	13	62
Ablabesmyia sp						12		46
Acilius sulcatus	31	17	42		2	33	57	
Aeshna grandis								1
Aeshna sp				1				
Aeshnidae					2	2		1
Agabus affinis			1					
Agabus undulatis						1		
Agrypnia sp		23	7	46		13	3	
Agrypnia varia	1		2	1	1			
Anabolia nervosa				1		1	1	
Anacaena limbata				1			1	
Anacaena lutescens					8			2
Anax imperator						1	1	
Anax sp								3
Anisoptera								4
Argyroneta aquatica	3	2	8	14	24	12	4	1
Arrenurus affinis	2	75	45	52	186	112	117	135
Arrenurus albator			1		1		2	
Arrenurus aquatica	4							
Arrenurus bicuspidator	2	6	4				2	1
Arrenurus compactus	2	5		5	17	6	6	8
Arrenurus crassicaudatus	2	4	1		14	3	1	
Arrenurus globator	14	18	57	31	49	80	48	72
Arrenurus leuckarti				23	4			1
Arrenurus neumani	6	53	74	109	112	135	210	130
Arrenurus robustus	1	2		2	9	6	9	2
Arrenurus sinuator								1
Arrenurus sp		3					2	2
Berosus luridus		1				1		
Berosus signaticollis					4	9		
Bidessus unistriatus	1			2	1	1		1
Callicorixa praeustra	7	22	1	5		4	1	
Cataclysta lemnata								1
Ceratopogonidae	28	163	33	72	107	133	186	87
Chaoborus obscuripes	1	3		5	8	47	123	1
Chaoborus sp	6	1	14	1		38	8	
Chaoborus flavicans			4					
Chironomus sp	32	3	1	8	1			
Cladopelma lateralis					8	9		
Cladotanytarsus sp				18				
Clinotanypus nervosus		1		1	1			
Cloeon dipterum	73	153	52	109	121	330	13	54
Cloeon sp								5
Coelambus impressopunctatus	1							
Coelambus novemlineatus	1							
Coelostoma orbiculare		1						
Coenagrion puella		6						2
Coenagrion lunulatum	2	8	3	1		7	10	12
Coenagrion pulchellum				5		9	24	3
Coenagrion sp	24			1	1			
Coenagrionidae	22	106	8	11	1	2	40	61
Coleoptera								11

Scientific name	1992	1993	1994	1995	1996	1997	1998	1999
Colymbetidae	1	10		5	1	7		8
Cordulia aenea		1	1					2
Corixa dentipes			15			1	1	
Corixa sp						61	223	
Corixa punctata	8	1	5	6		3	1	
Corixidae sp	654	248	206	129	77	13	1	52
Corynoneura gr scutellata		3	2	17		18	1	
Corynoneura scutellatum agg.								1
Cricotopus gr sylvestris			1					
Culicidae			1					
Cymatia bonsdorffi		25	19	3	3	12	3	2
Cymatia coleoptrata		24	3	3	24	80		
Cyrnus crenaticornis			1					
Cyrnus flavidus		2	4		1	1		
Cyrnus insolutus		1	3	2		1		
Dicrodentipes gr tritomus	8	15			32	81	1	
Dicrotendipes modestus exuvium		1				1	4	
Diptera			1				1	
Dytiscus lapponicus						1		
Dytiscus sp	1		5	1		7		4
Ecnomus tenellus		1	2	14	1		2	
Enallagma cyathigerum	18	30	10			91	65	3
Endochironomus albipennis	3	16	21	274	243	244	88	8
Endochironomus dispar	9		3	2		3		1
Endochironomus sp								1
Endochironomus tendens	5	111	21	91	11	62	70	21
Enochrus affinis	2	3	1	4	14			
Enochrus coarctatus	1	1	3	1		1	1	
Enochrus ochropterus							2	
Eylais sp			3				5	
Eylais extendens				1				
Forelia liliacea	186	75	34	84	13	16	56	4
Forelia variegator					1			
Gerris argentatus					2			
Gerris lacustris					1			2
Gerris odontogaster					2	1		3
Gerris sp				1			1	
Glaenocorisa propinqua	1	1		2	1	16		
Glyphotaelius pellucidus		1						
Glyptotendipes gripekoveni							2	
Glyptotendipes paripes	2				3	25	71	
Glyptotendipes sp	26	88	52	61	5	15	1	
Graphoderus sp larve							7	
Graptodytes pictus	1	5	6	2	4		2	3
Gyraulus albus				1				
Gyrinus marinus	11	110	1	8	1	5		
Gyrinus minutes					1	2	2	
Gyrinus sp larve	2		1	1		1	9	1
Gyrinus substriatus		1						
Haliplus flavicollis		1	3		1		1	1
Haliplus sp		2	4	1	1	4		
Haliplus immaculatus		1						
Haliplus lineatocollis					1			
Haliplus ruficollis	1				1			
Hebrus pusillus	1		1					1
Hebrus ruficeps	1		12	1	2			
Heliodidae	4		1					

Scientific name	1992	1993	1994	1995	1996	1997	1998	1999
Helius sp								1
Helobdella stagnalis				3				
Helochares punctatus	1	1		1	1		2	
Helophorus brevipalpis	1				1			2
Helophorus gr flavipes					1			
Hesperocorixa sahlbergi			1	7	10		2	
Hesperocorixa castanea	6			28	12	54		10
Hesperocorixa linnei				2	1	4	2	
Holocentropus dubius		1	3	9	4	1	3	11
Holocentropus picicornis			1				1	
Holocentropus stagnalis			1					
Hydracarina						2		
Hydrachna sp	2	13	11	3	1	11	1	
Hydrachna conjecta							1	
Hydrachna cruenta	1	4	11	3		1	6	
Hydrachna skorikowi				1				
Hydrachna testacea					1			
Hydrobius fuscipes				1				
Hydrochus carinatus		1		4	4		1	
Hydrodroma despiciens	492	365	350	441	1216	820	330	268
Hydrodroma sp								1
Hydroglyphus pusillus				2				
Hydrometra gracilenta				2	1			
Hydrometra stagnorum	1							
Hydroporidae	2							
Hydroporus erythrocephalus	1				1	1		
Hydroporus gyllenhalii	2							
Hydroporus planus				1				
Hydroporus pubescens				2	2			
Hydroporus tristis					2			
Hydroporus umbrosus		7	7	2	31	8	2	
Hydroptila sp							1	
Hydryphantes dispar							2	
Hygrobia hermanni		1					1	
Hygrotus inaequalis	2	4	5	16	68	29	5	1
Hyphydrus ovatus		2	7			9	1	
Ilybius sp							7	
Ilyocoris cimicoides		9	5	24	4	6	6	
Ischnura elegans	2					3		
Laccobius minutus						1	2	
Laccophilus minitus	1			4	1	1		
Lepidoptera	1							
Leptophlebia vespertina	19	17	1	10	93	10		7
Libellula quadrimaculata	1	1	1	5		8	1	4
Libellulidae	5	5	4	21	15	79	7	22
Limnephilidae		1			17			
Limnephilus centralis	1							
Limnephilus decipiens	3					3		
Limnephilus flavicornis/marmoratus	3	10		8	1	3		1
Limnephilus rhombicus				1				
Limnephilus stigma			2					
Limnephilus subcentralis	3	6	1	1		1		
Limnephilus sp							1	
Limnophyes sp			1	1				
Limnesia connata	34	5	32	1		1	13	5
Limnesia fulgida					1		1	
Limnesia koenikei					1			

Scientific name	1992	1993	1994	1995	1996	1997	1998	1999
Limnesia maculata			1					
Limnesia undulata		1		2	2		2	
Limnophyes sp					2			
Lumbriculus variegatus	5	16	15	2	2	12	4	
Micronecta sp								2
Microtendipes gr chloris	23					44	2	
Microtendipes sp					5			
Microvelia reticulata	3	5	7	36	170	13	26	134
Microvelia sp	3							
Mideopsis orbicularis						1		
Mystacides sp				1		2	1	
Naididae		1					1	
Natarsia sp	2	3	5		2			
Nepa cinerea		1	1					
Noterus crassicornis	2	21	8	20	30	27	27	8
Notonecta glauca	1	1	14	5	5	17	7	1
Notonecta obliqua	9	5	9	5	4	9	3	1
Notonecta sp	56	1	30	52		21	29	43
Notonecta viridis		1			1	1		
Oecetis furva	7		5	4		2	6	12
Oecetis lacustris	1			1				
Oecetis ochracea				1		1		
Oligotricha striata	1	2	3	1	4	2	2	
Orthetrum cancellatum						1	4	
Oxus nodigerus						2		
Panisopsis vigilans		1	2					
Parachironomus gr arcuatus			3	4				
Paralimnophyes hydrophilus	3		1	1				
Paratanytarsus sp				2				
Paretendipes nudisquama		1	1			3		
Peltodytes caesus							1	1
Pentaneurini sp.	1	1	13	3		4		
Phaenopsectra sp							2	
Phalacrocera replicata			2		1			
Phryganea sp	6	16	5					
Phryganea bipunctata				3	6	9	3	1
Phryganeidae					1			
Phyrrhosama nymphula					2			
Pionidae			3	1		8	103	
Piona carnea					1	73	50	2
Piona conglobata	4		32	7			8	7
Piona pusilla	269	128	30	44	9	13	79	21
Piona rotundoides								13
Pionidae								3
Plea minutissima		5		1	2	2	8	12
Polycelis tenuis	1	2	1	1	1		1	2
Polypedilum cultellatum							2	
Polypedilum gr nubeculosum						6		
Polypedilum gr sordens	10	101	191	187	39	71	136	258
Polypedilum sp								1
Polypedilum uncinatum	73	7	28	14	4		20	29
Procladius sp	38	299	35	32	729	71	49	1
Psectrocladius bisetus		5				2		
Psectrocladius gr psilopterus		52	16	75	1	11	3	7
Psectrocladius oligosetus					1			
Psectrocladius platypus	23	45	198	134	11	30	62	50
Psectrocladius psilopterus	8		8	3	3		13	

Scientific name	1992	1993	1994	1995	1996	1997	1998	1999
Psectrocladius gr sordillus/limbatellus							4	
Pseudochironomus prasinatus	17	4						
Pyrrhosoma nymphula	3	16	6	7	2		16	6
Ranatra linearis	6	2		2	9	9	3	
Rhanthus exsoletus	1	2				3		
Rhantus sp	6		25				45	
Rhantus suturellus					1		29	
Sialis lutaria	7	15	5	43	73	80		
Sigara distincta	76	4	7	6	61	66	25	
Sigara falleni		19		1	13	28		
Sigara lateralis				3	4	16	3	
Sigara limitata		1			6	12		
Sigara nigrolineata	1					2		
Sigara scotti	63	195	96	41	253	435	20	1
Sigara semistriata	1	6		20	23	14	1	3
Sigara striata				1	2		1	
Sigara sp								3
Stenochrinomus sp			1					
Tabanidae						1		
Tanypodinae								1
Tanytarsus sp	36	6	2		350	1306	3	
Tanytarsus gr gregarius						2	4	
Tanytarsus nemorosus						3	11	
Telmatopelia nomotum	2							
Theromyzon tessulatum							1	
Tiphys scaurus						1		
Tipulidae						1		
Triaenodes bicolor	178	67	87	105	102	162	189	254
Tribelos intextus	3	7		2	14	143	45	
Trichostegia minor		3						
Tubificidae				2			1	1
Vejdovskyella comata						1		
Zygoptera								25
Total number of organisms	**2778**	**2979**	**2240**	**2785**	**4581**	**5642**	**3021**	**2065**
Total number of species	**106**	**108**	**108**	**120**	**116**	**125**	**121**	**89**

Table 13.2: Hydrobiology of lakes, 1997, 1998 and 1999, Lheebroekerzand (Kliplo). Chlorophyll-data.

Date yymmdd	Chlorophyll-A µg/l
970218	-
970528	-
970805	88.65
971119	9.16
980210	29.28
980520	8.14
980818 (a)	6.39
980818 (b)	25.53
981117	4.33
990203	1.11
990511	222
9908	-
9911	-

Table 14.1: Forest damage, 1997, Lheebroekerzand, data RIVM-ECO. Tree class, diameter and height of the trees.

Date yy	Tree number	Tree class	Diameter in cm	Height in m
97	1A	3	24.4	14.5
	2	2	29.6	19.3
	3	2	35.7	16.8
	4	2	26.3	20.7
	5	2	26.9	16.7
	6	1	30.2	16.2
	7	2	28.0	14.3
	8	2	25.5	13.9
	9	1	31.4	17.5
	10	1	30.9	18.6
	11	1	32.5	18.7
	12	1	31.0	17.9
	13	3	22.3	14.8
	14	2	27.5	17.1
	15A	1	30.2	20.0
	16	2	32.8	18.6
	17	2	38.8	19.7
	18	2	24.4	16.3
	19A	2	25.5	16.3
	20A	2	33.9	18.6
	21	2	39.0	19.3
	22	2	33.4	18.3
	23	2	28.0	16.7
	24	2	32.1	19.3
	25	1	40.7	19.5

Tree number with A: new tree; first tree with corresponding number died.
Tree class: 1: dominant; 2: codominant; 3: subdominant; 4: suppressed.
Diameter of stem at breast height; ± 1.30 m.

*Table 14.2: Forest damage, 1998, Lheebroekerzand, data SBB and RIVM-ECO.
Tree class, diameter, height, crown height and crown width of the trees.*

Date yy	Tree number	Tree class	Diameter in cm	Height in m	Crown height in m	Crown width in m
98	1A	2	24.0	13.5	5.0	5.7
	2	1	29.7	18.7	9.4	7.4
	3	1	36.0	16.5	8.3	6.7
	4	1	26.5	18.7	9.7	4.5
	5	2	26.8	16.6	8.6	4.5
	6	2	30.3	15.7	9.2	5.4
	7	3	27.8	13.7	9.9	5.5
	8	3	25.8	13.7	8.7	4.7
	9	1	31.6	17.3	10.3	6.0
	10	2	31.0	18.0	11.8	6.4
	11	2	33.0	18.1	11.5	5.5
	12	1	31.5	18.0	10.5	5.7
	13	3	22.0	13.7	6.9	4.6
	14	2	27.8	16.9	8.1	5.8
	15A	2	30.5	21.3	11.5	7.3
	16	1	32.8	18.2	9.7	6.0
	17	1	39.0	19.9	13.1	8.9
	18	3	25.0	15.5	8.0	5.6
	19A	3	25.8	15.7	5.5	5.5
	20A	1	34.8	17.9	8.3	8.0
	21	1	39.0	21.7	13.0	6.8
	22	1	33.4	18.2	9.8	8.0
	23	2	28.2	16.0	8.1	5.7
	24	1	31.8	19.7	10.2	4.7
	25	1	41.0	19.7	10.7	5.9

Tree number with A: new tree; first tree with corresponding number died.
Tree class: 1: dominant; 2: codominant; 3: subdominant; 4: suppressed.
Diameter of stem at breast height; ± 1.30 m.

Table 14.3: Forest damage, 1999, Lheebroekerzand, data SBB and RIVM-ECO. Tree class, diameter, height, crown height and crown width of the trees.

Date	Tree number	Tree class	Diameter in cm	Height in m	Crown height in m	Crown width in m
99	1A	2	24.3	13.7	3.9	5.80
	2	1	29.8	18.7	8.7	5.65
	3	1	36.2	16.5	6.6	8.05
	4	2	26.6	19.2	7.0	5.55
	5	1	26.8	16.7	7.0	5.08
	6	1	30.6	15.9	7.7	6.23
	7	2	27.8	14.2	8.7	6.30
	8	3	25.7	14.2	7.8	5.03
	9	1	31.2	17.7	9.0	5.60
	10	1	31.2	19.2	11.3	5.60
	11	1	33.0	18.2	10.1	5.35
	12	1	31.5	17.7	8.5	5.23
	13	3	22.2	13.7	5.9	4.90
	14	2	27.8	16.7	5.0	5.45
	15A	2	30.4	21.7	10.2	7.78
	16	1	33.0	18.2	7.9	7.20
	17	2	39.0	20.2	10.0	7.18
	18	2	25.0	15.0	5.9	6.63
	19A	2	26.0	16.2	4.2	4.70
	20A	1	34.0	19.2	8.0	6.70
	21	1	39.2	21.2	11.7	8.05
	22	2	33.2	17.7	7.6	7.80
	23	1	28.3	15.8	6.5	6.35
	24	1	31.6	19.0	7.8	4.83
	25	1	41.4	20.2	10.4	6.25

Tree number with A: new tree; first tree with corresponding number died.
Tree class: 1: dominant; 2: codominant; 3: subdominant; 4: suppressed.
Diameter of stem at breast height; ± 1.30 m.

Table 14.4: Forest damage, 1997, Lheebroekerzand, data RIVM-ECO. Canopy cover and needle characteristres.

Date yy	Tree number	Canopy cover	Needle coverage	Needle length	Needles on ground	Twigs on ground	Secondary shoots
97	1A	2	2	1	2	1	1
	2	1	4	1	2	1	1
	3	2	4	2	2	1	1
	4	2	3	1	2	1	1
	5	2	3	1	2	1	1
	6	1	3	1	2	2	1
	7	2	3	1	2	1	1
	8	1	3	1	2	1	1
	9	2	3	1	2	1	1
	10	2	1	1	2	1	1
	11	2	4	2	2	1	1
	12	1	4	2	2	1	1
	13	1	2	1	2	1	1
	14	2	3	1	2	1	1
	15A	2	3	1	2	1	1
	16	1	4	1	2	1	1
	17	1	5	1	2	1	1
	18	2	3	1	2	1	1
	19A	1	4	1	2	1	1
	20A	2	3	1	2	1	1
	21	2	4	1	2	1	1
	22	1	4	1	2	1	1
	23	1	2	1	2	1	1
	24	2	3	1	2	1	1
	25	2	3	1	2	1	1

Tree number with A: new trees, the first tree with the corresponding number died

Canopy cover 1: dense, 2: partial, 3: thin

Needle coverage 1: 0-100%, 2: 100-150 %, 3: 150-200%, 4-9: 450-500% 10: >500%

Needle lenght 1: needles not shorter, 2: needles shorter

Green needles on ground 1: none, 2: 1-5, 3: 5-50, 4: >50 per A4

Green twigs on ground 1 : none , 2: max.1, 3: 1-5, 4: >5 per m2

Sec. shoots 1: none, 2: 1-5, 3: > 5 per branch

Table 14.5: Forest damage, 1998, Lheebroekerzand, data SBB. Canopy cover and needle characteristres.

Date yy	Tree number	Canopy cover	Needle coverage	Needle year	Needle length	Needles on ground	Twigs on ground	Secondary shoots
98	1A	2	3	3	1	2	1	1
	2	1	3	2	1	2	1	1
	3	1	3	2	1	2	1	1
	4	1	3	2	1	2	1	1
	5	2	3	3	1	2	1	1
	6	1	3	3	1	2	1	1
	7	2	3	3	1	2	1	1
	8	2	3	3	1	2	1	1
	9	2	4	3	1	2	1	1
	10	2	3	3	1	2	1	1
	11	1	3	2	2	1	1	1
	12	1	3	2	1	2	1	1
	13	2	3	2	1	2	1	1
	14	2	3	2	1	1	1	1
	15A	1	3	2	1	2	1	1
	16	1	3	2	1	1	1	1
	17	1	3	2	1	2	1	1
	18	2	3	3	1	2	1	1
	19A	2	3	3	1	2	1	1
	20A	2	3	3	1	1	1	1
	21	1	3	2	1	2	1	1
	22	2	3	2	1	2	1	1
	23	2	3	2	1	2	1	1
	24	2	3	2	1	2	1	1
	25	2	3	2	1	2	1	1

Tree number with A: new trees, the first tree with the corresponding number died
Canopy cover 1: dense, 2: partial, 3: thin
Needle coverage 1: 0-100%, 2: 100-150 %, 3: 150-200%, 4-9: 450-500% 10: >500%
Needle year 1: mean 1 yr, 2: mean 2 year etc.
Needle lenght 1: needles not shorter, 2: needles shorter
Green needles on ground 1: none, 2: 1-5, 3: 5-50, 4: >50 per A4
Green twigs on ground 1 : none , 2: max.1, 3: 1-5, 4: >5 per m2
Sec. shoots 1: none, 2: 1-5, 3: > 5 per branch

Table 14.6: Forest damage, 1999, Lheebroekerzand, data SBB. Canopy cover and needle characteristres.

Date	Tree number	Canopy cover	Needle coverage	Needle year	Needle length	Needles on ground	Twigs on ground	Secondary shoots
99	1A	2	4	3	1	2	1	1
	2	2	3	2	1	2	1	1
	3	1	3	2	1	2	1	1
	4	2	3	2	1	2	1	1
	5	2	3	2	1	2	1	1
	6	2	3	2	1	2	1	1
	7	2	3	2	1	2	1	1
	8	2	4	3	1	2	1	1
	9	2	4	3	1	2	1	1
	10	2	3	2	2	2	1	1
	11	2	3	2	1	2	1	1
	12	2	3	2	2	2	1	1
	13	2	3	2	1	2	1	1
	14	2	3	2	1	2	1	1
	15A	2	3	2	1	2	1	1
	16	2	3	2	1	2	1	1
	17	1	4	3	1	2	1	1
	18	2	3	2	1	2	1	1
	19A	2	3	2	1	2	1	1
	20A	2	3	2	1	2	1	1
	21	2	4	3	1	2	1	1
	22	1	3	2	1	1	1	1
	23	2	3	2	1	1	1	1
	24	2	2	2	1	1	1	1
	25	2	3	2	1	1	1	1

Tree number with A: new trees, the first tree with the corresponding number died
Canopy cover 1: dense, 2: partial, 3: thin
Needle coverage 1: 0-100%, 2: 100-150 %, 3: 150-200%, 4-9: 450-500% 10: >500%
Needle year 1: mean 1 yr, 2: mean 2 year etc.
Needle lenght 1: needles not shorter, 2: needles shorter
Green needles on ground 1: none, 2: 1-5, 3: 5-50, 4: >50 per A4
Green twigs on ground 1 : none , 2: max.1, 3: 1-5, 4: >5 per m2
Sec. shoots 1: none, 2: 1-5, 3: > 5 per branch

Table 15.1: Vegetation, 1999, Lheebroekerzand, data Alterra. Number, height,.diameter and vitality of the trees.

Species	**number of living trees/ha**	**average height in m**	**average diameter in cm**	**number of trees with a good vitality/ha**	**number of trees with a normal vitality/ha**	**number of trees with a bad vitality/ha**
Amelanchier spp.	3.6	6.8	5.5	0.0	3.6	0.0
Betula pendula	238.2	9.7	8.7	0.0	203.6	7.3
Fagus sylvatica	1.8	15.0	20.0	0.0	1.8	0.0
Frangula alnus	18.2	7.0	5.6	0.0	9.1	0.0
Juniperus communis	27.3	5.7	6.7	0.0	7.3	3.6
Picea abies	83.6	14.3	19.0	0.0	67.3	16.4
Pinus nigra	12.7	15.6	29.0	0.0	12.7	0.0
Pinus sylvestris	1670.9	11.2	16.7	3.6	1456.4	200.0
Prunus serotina	83.6	7.0	6.1	0.0	67.3	0.0
Quercus robur	307.3	10.3	15.3	3.6	267.3	29.1
Quercus rubra	14.5	14.4	33.1	1.8	10.9	1.8
Sorbus spp.	25.5	6.0	6.2	0.0	14.5	7.3

Table 15.2: Vegetation, 1999, Lheebroekerzand, data Alterra. Average coverageof species per layer in %..

Species	tree layer	herb layer	schrub layer	moss layer
Agrostis capillaris		2.5		
Amelanchier lamarckii		2.5	8	
Betula pendula	10	2.5	2.5	
Brachythecium rutabulum				2.5
Calluna vulgaris		2.5		
Campylopus introflexus				2.5
Carex		2.5		
Ceratocapnos claviculata		2.5		
Deschampsia flexuosa		20		
Dicranella heteromalla				2.5
Dicranum scoparium				2.5
Dryopteris dilatata		2.5		
Empetrum nigrum		31		
Erica tetralix		2.5		
Eurhynchium praelongum				2.5
Fagus sylvatica		2.5		
Galium saxatile		2.5		
Hypnum jutlandicum				10
Ilex aquifolium		2.5		
Juniperus communis			2.5	
Lonicera periclymenum		2.5		
Molinia caerulea		13		
Orchis		2.5		
Picea abies	37	2.5	2.5	
Pinus sylvestris	30	2.5	8	
Plagiothecium undulatum				2.5
Pleurozium schreberi				18
Polytrichum formosum				2.5
Polytrichum juniperinum				2.5
Prunus serotina	18	2.5	2.5	
Pseudoscleropodium purum				2.5
Quercus robur	22	2.5	10	
Quercus rubra	29	2.5	2.5	
Rhamnus frangula		2.5	2.5	
Rubus fruticosus		2.5		
Rumex acetosella		2.5		
Salix			5	
Sorbus aucuparia	10	2.5	2.5	
Sphagnum				2.5

Table 16.1: Epiphytes on pine Pinus sylverstris (per tree), 1999, Lheebroekerzand. Epiphytes coverage in mm.

Species	**Ps28**	**Ps33**	**Ps35**	**Ps36**	**Ps37**	**Ps38**	**Ps39**	**Ps40**	**Ps41**	**Ps42**	**Ps43**	**Ps44**	**Ps45**	**Ps46**	**Ps47**	**Ps48**
Chaenotheca ferruginea	25	21	18						5							38
Cladonia macilenta									26							
Cladonia merochlorophaea									63	4		2				
Hypogymnia physodes				1	15	7	3	2			74	13		62	4	53
Hypocenomyce scalaris	1								3				6		32	
Lecanora aitema									5							
Lecanora conizaeoides	6	9	23	7	2	2	27	2	10	14	38	33	42	24	46	15
Lepraria incana	367	750	268	3	219	124	296	147	121	358	79	139	281	96	459	113
Micarea denigrata													9			
Trapeliopsis granulosa										13		41				
Circumference tree in mm	1690	1610	2000	760	810	1070	1180	850	1620	1470	1080	1090	1410	1180	1510	1470
Height of tape in cm	120	120	138	135	127	137	164	162	120	120	120	120	120	120	120	120

Table 16.2: Epiphytes on Quercus robur (per tree), 1999, Lheebroekerzand.
Epiphytes coverage in mm.

Species	**Qr06**	**Qr11**	**Qr12**	**Qr13**	**Qr14**	**Qr15**	**Qr16**	**Qr17**	**Qr18**	**Qr19**	**Qr20**	**Qr21**	**Qr22**	**Qr23**	**Qr24**	**Qr25**
Dimerella pineti			197		108		181	18	132				178	569	23	184
Hypogymnia physodes		4	5	17				6	24	54	67	28				
Lecanora expallens		26	67		3	8		76	36			43				
Lepraria incana	610	92	117	609	490	135	315	247	415	271	219	112	511	424	117	787
Micarea prasina						35	148									8
Parmelia subaurifera								2								
Circumference tree in mm	810	970	1090	1310	1370	1140	1290	1400	2300	1100	1700	990	1340	1180	800	1740
Height of tape in cm	120	137	120	119	133	148	132	118	120	116	122	131	120	120	120	120

Table 16.3: Epiphytes on pine Pinus sylvestris (per tree), 1999, Lheebroekerzand. Vitality classes for epifytic lichens.

Species	**Ps28**	**Ps33**	**Ps35**	**Ps36**	**Ps37**	**Ps38**	**Ps39**	**Ps40**	**Ps41**	**Ps42**	**Ps43**	**Ps44**	**Ps45**	**Ps46**	**Ps47**	**Ps48**
Chaenotheca ferruginea	1	1	1						1							1
Cladonia macilenta									1							
Cladonia merochlorophaea									1	1		2				
Hypogymnia physodes				3	3	4	2	4			3	2		3	3	4
Hypocenomyce scalaris	1								4				1		1	
Lecanora aitema									4							
Lecanora conizaeoides	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Lepraria incana	1	1	3	1	2	3	3	2	1	1	1	1	2	1	3	1
Micarea denigrata													2			
Trapeliopsis granulosa										1		1				

1 = 0% dead

2 = 0-10% dead

3 = 10-50% dead

4 = 50-99% dead

5 = 100% dead

Table 16.4: Epiphytes on oak Quercus robur (per tree), 1999, Lheebroekerzand. Vitality classes for epifytic lichens.

Species	**Qr06**	**Qr11**	**Qr12**	**Qr13**	**Qr14**	**Qr15**	**Qr16**	**Qr17**	**Qr18**	**Qr19**	**Qr20**	**Qr21**	**Qr22**	**Qr23**	**Qr24**	**Qr25**
Dimerella pineti			1		1		1	1	1				1	1	1	1
Hypogymnia physodes		4	4	3				2	2	2	4	4				
Lecanora expallens		1	1		1	1		1	1			1				
Lepraria incana	1	1	1	2	3	2	2	2	1	3	2	1	1	1	1	1
Micarea prasina						1	1									1
Parmelia subaurifera								1								

1 = 0% dead

2 = 0-10% dead

3 = 10-50% dead

4 = 50-99% dead

5= 100% dead

Table 16.5: Species list of epifytes on Pinus sylvestris (per tree) on trunk (50-200 cm), 1999, Lheebroekerzand.

Species	**Ps28**	**Ps33**	**Ps35**	**Ps36**	**Ps37**	**Ps38**	**Ps39**	**Ps40**	**Ps41**	**Ps42**	**Ps43**	**Ps44**	**Ps45**	**Ps46**	**Ps47**	**Ps48**
Chaenotheca ferruginea	V	V	V						V		V				V	V
Cladonia glauca					V			V	V				V	V		V
Cladonia macilenta									V				V			V
Cladonia merochlorophaea									V	V		V		V		
Dimerella pineti	V	V	V													
Hypogymnia physodes	V		V	V	V	V	V	V	V	V	V	V	V	V	V	V
Hypocenomyce scalaris	V								V	V	V	V	V	V	V	
Lecanora aitema	V								V	V	V	V	V	V	V	V
Lecanora conizaeoides	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
Lepraria incana	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
Micarea denigrata										V		V	V			
Micarea prasina	V		V		V								V			
Trapeliopsis granulosa										V		V				
Trapeliopsis flexuosa									V							

V= present

Table 16.6: Species list of epifytes on Quercus robur (per tree) on trunk (50-200 cm), 1999, Lheebroekerzand.

Species	**Qr06**	**Qr11**	**Qr12**	**Qr13**	**Qr14**	**Qr15**	**Qr16**	**Qr17**	**Qr18**	**Qr19**	**Qr20**	**Qr21**	**Qr22**	**Qr23**	**Qr24**	**Qr25**
Buellia griseovirens												V				
Chaenotheca ferruginea									V							
Cladonia chlorophaea		V							V		V					
Cladonia floerkeana														V		
Dimerella pineti			V		V		V	V	V	V	V		V	V	V	V
Evernia prunastri				V					V			V				
Hypogymnia physodes	V	V	V	V		V		V	V	V	V	V			V	
Lecanora conizaeoides												V				
Lecanora expallens		V	V		V	V		V	V	V	V	V	V	V		
Lecanora pulicaris								V								
Lepraria incana	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
Micarea prasina		V				V	V		V				V	V	V	V
Parmelia subaurifera								V								

V= present

Table 16.7: Species list of epifytes on Pinus sylvestris (per tree) on branches till 200 cm, 1999, Lheebroekerzand.

Species	**Ps28**	**Ps33**	**Ps35**	**Ps36***	**Ps37***	**Ps38***	**Ps39***	**Ps40***	**Ps41***	**Ps42***	**Ps43***	**Ps44***	**Ps45***	**Ps46***	**Ps47**	**Ps48***
Chaenotheca ferruginea		V	V													
Cladonia chlorophaea			V													
Cladonia glauca	V		V													
Cladonia macilenta	V		V												V	
Cladonia merochlorophaea	V															
Dimerella pineti		V	V													
Hypogymnia physodes	V	V	V												V	
Hypocenomyce scalaris		V														
Lecanora aitema			V												V	
Lecanora conizaeoides		V	V												V	
Lepraria incana	V	V	V												V	
Micarea prasina		V	V													
Placynthiella icmalea		V	V													
Trapeliopsis granulosa	V		V													
Xanthoria polycarpa	V															

V= present

* = no branches < 200 cm

Table 16.8: Species list of epifytes on Quercus robur (per tree) on branches till 200 cm, 1999, Lheebroekerzand.

Species	**Qr06**	**Qr11**	**Qr12**	**Qr13**	**Qr14**	**Qr15**	**Qr16**	**Qr17**	**Qr18**	**Qr19**	**Qr20**	**Qr21**	**Qr22**	**Qr23**	**Qr24**	**Qr25**
Arthonia radiata								V								
Bacidia delicata																V
Bacidia neosquamulosa	V															V
Buellia griseovirens									V				V			
Buellia punctata							V	V	V							V
Candelariella reflexa	V						V		V		V					V
Cladonia chlorophaea	V	V						V	V		V					
Cladonia coniocraea		V														
Cladonia floerkeana														V		
Dimerella pineti			V		V		V	V	V				V	V	V	V
Evernia prunastri	V		V	V	V		V		V		V		V			V
Fellhanera viridisorediata	V	V					V				V		V	V	V	
Gyalideopsis anastomosans							V		V		V					
Hypogymnia physodes	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
Hypogymnia tubulosa				V	V		V	V								V
Lecanora chlarotera								V								
Lecanora expallens								V	V			V				
Lecanora hageni																V
Lecanora pulicaris								V	V			V				
Lecanora symmicta									V							
Lecidella elaeochroma								V	V			V	V			V
Lepraria incana	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
Micarea prasina		V				V			V	V	V		V	V		V
Parmelia caperata				V												
Parmelia exasperatula	V			V	V		V		V		V					V

Species	**Qr06**	**Qr11**	**Qr12**	**Qr13**	**Qr14**	**Qr15**	**Qr16**	**Qr17**	**Qr18**	**Qr19**	**Qr20**	**Qr21**	**Qr22**	**Qr23**	**Qr24**	**Qr25**
Parmelia revoluta	V				V		V									
Parmelia saxatilis									V							
Parmelia subrudecta	V												V			
Parmelia sulcata	V	V	V	V	V	V	V	V	V		V		V	V	V	V
Parmelia subaurifera	V	V	V	V	V	V	V	V	V		V		V	V	V	V
Parmelia ulophylla											V					
Physcia adscendens	V										V		V			
Physcia tenella	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
Placynthiella icmalea								V								
Platismatia glauca								V								
Pseudevernia furfuracea									V							
Ramalina farinacea				V			V				V					
Trapeliopsis granulosa									V							
Xanthoria candelaria	V		V								V					V
Xanthoria parietina							V		V							V
Xanthoria polycarpa		V	V	V	V	V		V	V		V	V				V

V=present

Table 17.1: Leafminers on birch Betula pendula (per tree), 1997, Lheebroekerzand.

Species	Number of mines per tree					
	Bp01	Bp02	Bp03	Bp04	Bp05	Total per species
Stigmella continuella	-	-	-	1	-	1
Stigmella sakhalinella	2	-	1	2	-	5
Fold/pleat miners	-	2	1	-	1	4
Unidentified miners	1	-	1	-	7	9
Total per tree	**3**	**2**	**3**	**3**	**8**	**19**
Number of infected leaves	**3**	**2**	**3**	**3**	**8**	**19**

Table 17.2: Leafminers on beech Fagus sylvatica (per tree), 1997, Lheebroekerzand.

Species	Number of mines per tree					
	Fs01	Fs02	Fs03	Fs04	Fs05	Total per species
Stigmella hemargyrella	1	1	1	-	-	3
Stigmella tityrella	12	6	10	3	1	32
Phyllonorycter maestingella	5	9	6	8	6	34
Total per tree	**18**	**16**	**17**	**11**	**7**	**69**
Number of infected leaves	**18**	**15**	**16**	**11**	**7**	**67**

Table 17.3: Leafminers on oak Quercus robur (per tree), 1997, Lheebroekerzand.

Species	Number of mines per tree										
	Qr01	Qr02	Qr03	Qr04	Qr05	Qr06	Qr07	Qr08	Qr09	Qr10	Total per species
Buccalatrix ulmella	1	9	1	1	1	-	-	-	-	1	14
Ectoedemia albifasciella	16	1	11	4	5	2	-	7	5	8	59
Ectoedemia subbimacuella	3	7	1	4	1	8	-	-	1	-	25
Stigmella roborella	-	-	-	3	1	-	1	-	-	1	6
Tischeria dodoneae	1	-	-	-	-	-	-	1	-	-	2
Tischeria ekebladella	-	-	-	-	1	2	-	6	-	1	10
Fold/pleat miners	3	-	-	16	10	6	6	5	3	2	51
Unidentified miners	8	2	18	28	16	6	10	8	7	5	108
Total per tree	**32**	**19**	**31**	**56**	**35**	**24**	**17**	**27**	**16**	**18**	**275**
Number of infected leaves	**25**	**14**	**31**	**45**	**30**	**24**	**11**	**23**	**14**	**17**	**234**

Table 18.1: Monitoring of butterflies, 1997, Lheebroekerzand. Total number of organisms.

Scientific name	**Week-number**															**Total**	**Total**
	26	**27**	**28**	**28**	**29**	**30**	**31**	**32**	**32**	**33**	**34**	**36**	**37**	**38**	**39**	**number**	**number per week per ha**
Vanessa atalanta	-	-	-	-	1	-	-	-	1	1	1	5	-	1	1	11	2.67
Celastrina argiolus	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	2	0.48
Maniola jurtina	-	1	-	5	-	-	-	-	-	2	-	-	-	-	-	8	1.94
Heodes tityrus	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2	0.48
Gonepteryx rhamni	-	-	-	-	-	-	-	3	-	1	-	-	1	-	1	6	1.45
Inachis io	-	-	-	-	-	-	3	9	4	1	-	-	2	-	-	19	4.61
Callophrys rubi	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	0.48
Ochlodes venata	1	-	1	1	3	-	-	-	1	1	-	-	-	-	-	8	1.94
Pieris napi	-	-	-	-	-	-	-	-	1	2	4	-	-	-	-	7	1.70
Aglais urticae	-	-	-	-	-	-	-	-	-	1	9	7	4	1	1	23	5.58
Lycaena phlaeas	-	-	-	-	2	-	1	-	-	2	-	3	1	3	5	17	4.12
Pyronia tithonus	-	-	-	-	1	1	1	-	3	3	-	-	-	-	-	9	2.18
Vacciniina optilete	6	1	1	7	3	-	-	-	-	-	-	-	-	-	-	18	4.36
Boloria aquilonaris	3	7	5	13	2	-	-	-	-	-	-	-	-	-	-	30	7.27
Thymelicus lineola	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.24
Pieris rapae	-	-	-	1	4	2	-	-	-	1	2	-	-	-	-	10	2.42
Pieris brassicae	-	-	-	-	1	-	1	-	4	1	-	-	3	-	-	10	2.42
Hesperia comma	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.24
Total number of Butterflies																**185**	**44.61**

Table 18.2: Monitoring of butterflies, 1998, Lheebroekerzand total number of organisms.

Scientific name	**Week-number** 14	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**29**	**29**	**30**	**30**	**32**	**33**	**34**	**38**	**Total number**	**Total number per week per ha**
Vanessa atalanta	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	1	3	0.50
Celastrina argiolus	-	-	-	-	-	-	1	-	-	-	-	-	1	-	2	-	1	-	-	-	5	0.83
Maniola jurtina	-	-	-	-	-	-	-	-	-	-	-	-	3	2	-	1	-	1	-	-	7	1.16
Heodes tityrus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	3	0.50
Gonepteryx rhamni	1	-	-	1	4	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1	9	1.49
Inachis io	1	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	0.83
Thymelicus sylvestris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.17
Callophrys rubi	-	-	-	-	9	3	2	-	3	-	-	-	-	-	-	-	-	-	-	-	17	2.81
Ochlodes venata	-	-	-	-	-	-	-	-	-	-	-	6	3	1	-	1	-	-	-	-	11	1.82
Pieris brassicae	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.33
Pieris napi	-	-	-	-	-	-	2	1	-	-	-	-	1	-	-	1	-	1	1	-	7	1.16
Pieris rapae	-	-	-	1	1	1	1	1	-	-	-	-	-	2	1	1	-	1	-	-	10	1.65
Aglais urticae	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.17
Lycaena phlaeas	-	-	-	-	-	-	3	1	-	2	-	-	2	-	-	2	3	-	2	-	15	2.48
Pyronia tithonus	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	3	-	-	1	-	5	0.83
Vacciniina optilete	-	-	-	-	-	-	-	-	1	1	13	5	1	-	-	-	-	-	-	-	21	3.47
Boloria aquilonaris	-	-	-	-	-	-	-	-	-	-	3	2	2	-	1	-	-	-	-	-	8	1.32
Total number of Butterflies																					**130**	**21.49**

Table 18.3: Monitoring of butterflies, 1999, Lheebroekerzand total number of organisms.

Scientific name	**Week-number**																									**Total**	**Total**
	13	**15**	**16**	**17**	**19**	**20**	**21**	**21**	**22**	**23**	**24**	**24**	**25**	**25**	**26**	**26**	**27**	**27**	**29**	**29**	**31**	**34**	**35**	**36**	**37**	**number**	**number per week per ha**
Vanessa atalanta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	3	2	-	9	1.31
Celastrina argiolus	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	0.29
Maniola jurtina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2	0.29
Gonepteryx rhamni	1	-	1	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	5	0.73
Inachis io	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	1	-	-	7	1.02
Thymelicus sylvestris	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	3	0.44
Callophrys rubi	-	-	-	1	2	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	0.73
Ochlodes venata	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	-	3	1	-	-	-	-	-	-	-	7	1.02
Pieris brassicae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	1	1	1	-	-	-	6	0.87
Pieris napi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	2	0.29
Pieris rapae	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	2	6	0.87
Lycaena phlaeas	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-	-	1	-	-	-	4	0.58
Pyronia tithonus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	3	0.44
Vacciniina optilete	-	-	-	-	-	-	-	-	-	-	4	2	1	1	-	3	-	1	-	-	-	-	-	-	-	12	1.75
Boloria aquilonaris	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	1	1	-	-	-	-	-	-	-	-	5	0.73
Thymelicus lineola	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.15
Total number of Butterflies																										**79**	**11.49**

Table 18.4: Weather conditions during observations of butterflies.

Week number	Observation Date yymmdd	Temperature °C	Clouds* code 0-8	Wind speed Beaufort
26	970625	19	4	3
27	970702	21	4	3
28	970709	22	6	2
28	970712	24	0	2
29	970719	22	4	4
30	970723	21	4	2
31	970730	23	4	2
32	970804	28	4	3
32	970809	27	4	3
33	970817	26	0	2
34	970824	27	0	1
36	970905	22	4	2
37	970910	20	4	4
38	970919	20	4	3
39	970926	21	0	1
14	980330	18	0	2
16	980417	11	4	4
17	980423	20	0	4
18	980502	19	0	3
19	980509	19	0	3
20	980515	21	0	4
21	980519	22	2	4
22	980527	20	2	3
23	980606	26	2	2
24	980613	17	4	4
25	980620	24	2	2
26	980627	19	4	4
29	980717	20	0	4
29	980717	20	4	2
30	980720	24	0	2
30	980725	20	4	3
32	980809	20	2	3
33	980818	20	4	3
34	980904	18	4	3
38	980920	20	4	2
13	990401	18	1-4	2
15	990416	12	4-8	3
16	990425	17	1-2	2
17	990502	17	1-4	2
19	990515	18	1-2	3
21	990526	19	0	3
21	990527	24	0	1
23	990607	17	6-8	3
24	990616	19	1-8	2
24	990619	22	0	2
25	990621	21	4-8	3
25	990626	23	0	3
26	990703	26	2-8	2
26	990703	25	2-8	3
27	990709	21	2-8	2
27	990711	23	0	3
29	990719	24	0	2
29	990725	23	3-8	3
31	990804	26	6-8	1
34	990828	20	0	1
35	990904	22	0	2
36	990911	20	0	1
37	990918	23	2-8	2

* 0 = no clouds, 1 = 1/8 part of the sky with clouds, 2 = 2/8 part of the sky with clouds, …….., 8 = completely overcasted.

Appendix II List of participating organizations and contact persons

Monitoring Programme	Organization	Contact person
Inventory of butterflies	De vlinderstichting	K. Veling
	Postbus 506	0317 424224
	6700 AM WAGENINGEN	
	Davidshoeve 1	J. Kleine
	7991 PB Dwingeloo	0521-597565
	Levimaat 13	K. van Eerde
	7991 EB Dwingeloo	0521-593907
Inventory of leafminers	Insecten Onderzoekbureau Donner	J.H. Donner
	Slaperstraat 54	075 6842723
	1511 CJ Oostzaan	
Inventory of birds	SOVON	A.J. van Dijk
	Rijksstraatweg 178	024 6843753
	6573 DG BEEK-UBBERGEN	
	SBB	P. Kerssies
	Postbus 1	0528-248851
	7933 ZG PESSE	
Inventory of plants/vegetation	Alterra	S. Clerkx
	Postbus 47	0317 477923
	6700 AA Wageningen	
Air chemistry	RIVM-LLO	A. Stolk
	Postbus 1	030 2742412
	3720 BA BILTHOVEN	
Precipitation chemistry , Climate	RIVM-ECO	M. Wolters
Lake water chemistry	Postbus 1	030-2742549
Metal chemistry of mosses	3720 BA BILTHOVEN	
Throughfall and stemflow		
Foliage and litterfall chemistry		
Soil chemistry	RIVM-LBG	M. Groot
	Postbus 1	030-2743518
	3720 BA Bilthoven	
	RIVM-ECO	A. de Groot
	Postbus 1	030-2742419
	3720 BA Bilthoven	
Groundwater chemistry	RIVM-LBG	H. Prins
	Postbus 1	030 2743347
	3720 BA BILTHOVEN	

Monitoring Programme	Organization	Contact person
Hydrobiology of lakes	Waterschap Reest en Wieden Postbus 120 9740 AC MEPPEL	M. Fagel 0522-276813
	RIVM-LWD Postbus 1 3720 BA BILTHOVEN	T. Ietswaart 030 2743794
Forest damage	SBB Postbus 1 7933 ZG PESSE	P. Kerssies 0528-248851
	RIVM-ECO Postbus 1 3720 BA BILTHOVEN	M.Wolters 030-2742549
Trunk epiphytes	Lychenologisch Onderzoekbureau Nederland (LON) Goudvink 47 3766 WK Soest	C. van Herk 035-6018541

Appendix III List of abbreviations

ALTERRA	Green World Research
BMP	Broedvogel Monitoring Project
CCE	Coordination Centre for Effects
CLRTAP	Convention on Long-Range Transboundary Air Pollution
COUNTRY CODES	
AT	Austria
BY	Belarus
CA	Canada
CH	Switzerland
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
GB	United Kingdom
IE	Ireland
IS	Iceland
IT	Italy
LT	Lithuania
LV	Latvia
NL	the Netherlands
NO	Norway
PL	Polen
PT	Portugal
RU	Russian Federation
SE	Sweden
DGM	Directoraat Generaal Milieu
ECN	Energieonderzoek Centrum Nederland
EMEP	European Monitoring and Evaluation Programme
GTOS	Global Terrestrial Observing System
ICP-IM	International Cooperative Programme on Integrated Monitoring (on Air Pollution Effects on Ecosystems)
IFEF	Indicators of Forest Ecosystem Functioning
IKC	Informatie en Kenniscentrum
-NBLF	Natuur, Bos, Landschap en Fauna
ILTER	International Long Term Ecological Research Network
IM	Integrated Monitoring
IMP	Integrated Monitoring Programme
KvI	Klimaatverandering en Industrie
LIFE	Financial Instrument for the Environment of the European Union.
LRTAP	Long-Range Transboundary Air Pollution
LON	Lichenologisch Onderzoekbureau Nederland

MONITORING PROGRAMME CODES

AM	Meteorology
AC	Air Chemistry
DC	Precipitation Chemistry
MC	Metal Chemistry of Mosses
TF	Throughfall Chemistry
SF	Stemflow Chemistry
SC	Soil Chemistry
SW	Soil water Chemistry
GW	Groundwater Chemistry
RW	Runoff water Chemistry
LC	Lake water Chemistry
FC	Foliage chemistry
LF	Litterfall Chemistry
RB	Hydrobiology of streams
LB	Hydrobiology of lakes
FD	Forest Damage
VG	Vegetation
EP	Trunk Epiphytes
AL	Aerial green algae
MB	Microbial decomposition
BB	Inventory of Birds
BV	Inventory of vegetation

MNV	Bureau Milieu Natuurverkenning (Centre for Environmental Forecasting)
-MNV-CCE	Bureau Milieu Natuurverkenning - Coordination Centre for Effects (Centre for Environmental Forecasting - Coordination Centre for Effects)
NFP	National Focal Point
NoLIMiTS	Networking of Long-term Integrated Monitoring in Terrestrial System
POPs	Persistent Organic Pollutant
RIVM	Rijksinstituut voor Volksgezondheid en Milieuhygiëne (National Institute for Public Health and Environmental Protection)
-ECO	Laboratorium voor Ecotoxicologie (Laboratory for Ecotoxicology)
-LAC	Laboratorium Anorganische Chemie (Laboratory of Inorganic Chemistry)
-LCB	Laboratorium voor Controle Biologische Produkten (Laboratory for the Control of Biological Products
-LBG	Laboratorium voor Bodem- en Grondwateronderzoek (Laboratory of Soil and Groundwater Research)
-LLO	Laboratorium Luchtonderzoek (Laboratory of Air Research)
-LWD	Laboratorium voor Water en Drinkwateronderzoek (Laboratory of Water and Drinking-Water Research)
SBB	Staats Bosbeheer (State Forestry Service)
SOP	Standard Operating Procedure
SOVON	Samenwerkende Organisaties Vogelonderzoek Nederland (Cooperative Organizations for Bird Research in The Netherlands)
TA	Toxicity Assessment
TFM	Task Force Mapping
TINEA	Stichting faunistisch onderzoek Microlepidoptera TINEA (Society Faunistic Research Microlepidoptera TINEA)
UN-ECE	United Nations Economic Commitee for Europe