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ABSTRACT

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The aim of this study was to perform a field experiment to collect a high quality data set suitable for validating and improving pesticide leaching models and nutrient leaching models for drained and cracking clay soils. The transport of water, bromide, nutrients and the pesticides bentazone and imidacloprid was studied on a 1.2 ha experimental plot. Moisture profiles and groundwater tables were measured, starting in November 1997. Winter wheat was sown on 23 October 1997 and harvested on 20 August 1998. Bentazone and bromide were applied at 7 April 1998; imidacloprid was applied at 27 May when the soil was almost completely covered by the crop. The amount present in soil was measured within 2 days after application (32 sampling cores) and was found to vary between 80% of the nominal dose (imidacloprid) to 110 % (for bentazone). Manuring and soil cultivations were as usual for the wheat crop. Soil profiles were sampled at eight times (16 cores at each date, last in April 1999). Drain flow was continuously recorded and the water flow proportionally sampled for analysis of the test compounds. Groundwater was sampled periodically from sets of permanently placed filters at four depths at 16 sites. Sorption isotherms of the pesticides were measured with soil from 0-25 cm. Transformation rates of the pesticides were measured at different temperatures in soil material from topsoil and subsoil layers. Soil hydraulic properties and shrinkage characteristics were measured in the laboratory. Meteorological data (i.e. rainfall, air temperature, global radiation, air humidity etc.) groundwater levels and soil temperatures at three depths were monitored continuously. After 56 days, about 80% of the bromide dose was taken up by the crop, which demonstrates that bromide is not a suitable tracer in cropped soil during the growing season. After that time the bromide was gradually released again into the soil. Preferential transport through cracks and macropores of all test compounds was measured both in summer and in winter. This resulted in the highest concentration of bromide and bentazone measured in drain water already 21 days after application following 56 mm rainfall. Imidacloprid was already detected in groundwater at 1.3-1.5 m depth, 11 days after application, following 65 mm rainfall. High peaks in nitrate concentrations in the groundwater at 1.00-1.50 m depth and in the drain water were detected within 14-18 days after the first fertilizer application, following 94 mm of rainfall. Extreme high peaks in concentrations of ortho-P and soluble organic-P were measured in the drain water at respectively 2 days and 37 after slurry application (the only phosphorus application during the experiment). For nitrate concentrations in the drain water there were indications for bypass by preferential flow of 'clean' rainwater to the drains.

Keywords: field experiment, dataset, leaching, modeling, pesticides, bentazone, imidacloprid, bromide, nitrogen, nitrate, phosphorus,phosphate, cropped soil

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# Preface

This report describes a field experiment on a drained cracking clay soil and laboratory studies that were done to collect a high quality data set for validating and improving models for simulating the leaching of pesticides and nutrients. The study started in 1997 and was funded by the Dutch Ministry of Agriculture, Nature Management and Fisheries in the frame work of the research programmes DWK 276 and DWK 317

The data have already been used in the frame work of the APECOP project (effective approaches for Assessing the Predicted Environmental COncentrations of Pesticides, a project funded by the European Union, under Key Action 1: QLK4-CT-1999-01238. The field was one of the six sites selected in Europe to provide data sets for the validation of the present FOCUS groundwater emission models and new PEC models for pesticides (Work Package 2 of APECOP; Establishment of a set of high quality datasets). Therefore, part of the reporting work was funded by the APECOP project.

Data of the pesticide part of the study were also used in preparing the thesis of Rômulo, P. Scorza Jr. (2002). Comparisons between measured and simulated pesticide leaching with PEARL and MACRO are discussed in that thesis

# Summary

A field scale leaching experiment was performed in the Netherlands on a cracking, tile drained clay soil to collect a high quality data set suitable for validation of leaching models for pesticides and nutrients. The movement of water, bromide, the nurients N and P and the herbicide bentazone and the insecticide imidacloprid was studied on a 1.2 ha field, sown with winter wheat. Bromide and bentazone were applied at 7 April and imidacloprid on 27 May. Initial soil deposition of the test compounds was measured at both times within two days after application of the compounds. Meteorological data (i.e. rainfall, air temperature, global radiation air humidity etc.) soil temperature, groundwater level and drain flow were monitored continuously. Soil profile was sampled to 1.2 m depth for moisture content and concentration profiles of the three test compounds and nutrients at eight times during the experimental period of 475 days. Concentrations in groundwater at different depths were measured periodically. Drain flow of two sets of tiles (three tiles in each set) was continuously measured and drain water was flow proportionally collected for analyses of the test compounds and nutrients. Additionally, laboratory experiments were carried out to study the transformation of the pesticides in the top layer at three temperatures and in deeper layers (including the saturated one) at ambient temperatures. The adsorption of the pesticides was studied at three temperatures in the arable layer. Soil hydraulic functions and shrinkage characteristics were also measured. The wheat crop took up a surprisingly high fraction (about 80%) of the applied bromide during the first month after application. Most of the bromide was released again into the soil at the end of September (the chopped crop remained on the field !). Three weeks after application, with 56 mm rainfall in some showers, bromide (5 mg $dm^{-3}$) and bentazone (90 µg $dm^{-3}$) were already measured in drain water. At the same time bromide and bentazone appeared in the shallow groundwater (1.0-1.2 m depth) in concentrations of about 1 mg $dm^{-3}$ and 16 µg $dm^{-3}$, respectively. The concentrations at that time were the highest measured during the whole experimental period. Imidacloprid was detected in half of the groundwater sampling filters (1.3-1.5 m depth) at concentrations of 0.05 to 0.09 µg $dm^{-3}$, after 65 mm rainfall in the 11-day period after the application on 27 May. No drain flow was measured in this period. All test compounds were measured in fairly constant concentration levels in drain water and groundwater throughout the winter period. The presence of permanent macropores (worm holes and perished roots) was attributed as the main cause for the observed preferential transport of solutes in this soil. The fast decrease of bentazone in the soil profile (0.2% left after 239 d) indicated that the degradation in the field (DT50 22 d) was clearly faster than expected from the incubation studies. After 115 days 35 % of the imidacloprid dose remained in the soil profile, which fraction remained almost constant until next spring. The field persistence of imidacloprid corresponded well with the half-lives measured in laboratory incubation studies. Extreme high peaks in concentrations of ortho-P and soluble organic-P were measured in the drain water at respectively 2 days and 37 after slurry application (the only phosphorus application during the experiment). For nitrate concentrations in the drain water there were indications for bypass by preferential flow of 'clean' rainwater to the drains.

# 1 Introduction

Leaching of pesticides and nutrients to groundwater is an important environmental aspect of the use of these chemicals in agriculture. Simulation models are applied for the description of their behaviour in many scenario computations and governmental discussions. The PEARL model (Leistra et al. 2001) is used for pesticide registration since 2001. Before 2001, the PESTLA model (Boesten & van der Linden 1991) was used for that purpose. The model ANIMO (Rijtema & Kroes, 1991; Groenendijk & Kroes 1997) is used for the simulation and prediction of nitrogen and phosphate leaching in relation to agricultural management strategy at the field and regional scale.

In the Netherlands, the registration procedure for pesticides heavily relies on the models PESTLA/ PEARL, which have been tested only on the basis of a data set obtained from a field experiment on a sand soil (van den Bosch et al. 1994). Cracking clay soils may be more worst case with respect to pesticide leaching than sandy soils. However, the validation status of PESTLA/PEARL for Dutch soils is very low as the models has never been tested on these soils. In compact, homogeneous sand soils the transport of water and dissolved compounds in the soil matrix can be described rather well with Darcy’s law and the convection–dispersion equation. However, Darcy's approach cannot describe preferential water flow through e.g. macro pores and cracks (Beven and Germann, 1982). Due to the forming of shrinkage cracks on heavier clay soils during dry periods it can not be assumed that hydrological characteristics are homogeneously. Soil cultivations like ploughing also may create macropores, whereas on the other hand cultivations disrupt existing macro pores. Deep cracks formed after long dry periods in summer may persist (partially) for longer time after rewetting in winter (Beven 1981; observations by farmers). From these observations it may be expected that fast preferential transport of water and compounds via cracks and macro pores will occur on clay soils, as well as in summer as in winter. Preferential transport in a clay soil of a bromide tracer applied in November under wet conditions was demonstrated by Hendriks et al. (1999).

As a result of the established low validation status of the pesticide leaching models and the complication of preferential flow on cracking clay soils, the Dutch Ministry of Agriculture, Nature Management and Fisheries asked Alterra (formerly SC-DLO) to conduct a field experiment to test the simulation models for leaching of pesticides on clay soil. At the same time an N-and P-desk study denoted that the environmental losses caused by preferential transport (e.g. in clay soils) should be better quantified. So, a high quality data set was also required for the validation of modelling nutrient leaching with ANIMO on soils with preferential transport.

Objective of the present study was to provide a complete and high quality data set, suitable for validating and improving simulation models describing the transport of water and the transport and transformation of pesticides and nutrients in a drained and cracking clay soil profile. The data should be obtained collected in a field grown with common agricultural crops and the field should be farmed with common

agriculture methods, including manuring and applying of fertilizer. As far as possible all input parameters for the models should be determined either via independent field or lab experiments (minimising need for parameter fitting).
A field experiment and lab experiments were set up to obtain the appropriate data set. The field experiment included a bromide tracer experiment. Two pesticides were selected: a mobile pesticide (bentazone) applied when the soil was hardly covered by the wheat crop (almost bare soil application) and a sorbed, more persistent pesticide (imidacloprid) applied onto a well developed crop that reduced initial soil deposition considerably (representative for a crop application).

The aim of this report is to describe the results of the field and lab studies in such a way that the data set is accessible to interested modellers. Thorough analyses and interpretation of the data as well as performing calculations with models and calculating water and mass balances of the bromide tracer and other compounds were out of the scope of this report.

# 2 Procedures for the field study

## 2.1 Experimental field

The field was located near the village Andelst in the province Gelderland in the middle part of The Netherlands near the river Rhine, mainstream “de Waal”. (North Latitude 51° 53' 5292", East longitude 5° 43' 4488", altitude above sea level 8.0 m). The soil is a young Holocene river bank deposit (Gendt 0 to Gendt III) of the river Rhine (Eutric Fluvisol, FAO classification 1988). The clay profile, which reaches to about 3 m depth, is underlain by a thick layer of coarse sand which is in direct contact with the nearby river and therefore acts as a natural drain. The arable layer contains on average 28% clay. The clay content increased with depth from 30% up to 40% at 1.2 m depth. The layers below 1.2 m contains higher clay contents (40-55%) and show occasionally some thin layers with peat material or sand. Detailed information on soil properties for each layer and in space is given in the Annex 42. A description of the structure and morphology of the distinguished soil layers is given in Annex 2. Holes (5-8 mm diameter) were observed frequently in the lower part of the profile during sampling (up to 1.2 m depth). The holes obviously originated from worms or decomposed tree roots The permanently reduced zone starts at about 2.20 m depth. The experimental field was situated on a drained part of a much larger field, which was formed out of two fields that were put together in the past. The field was used as arable land since an old apple orchard was grubbed out in 1977. At the original field where the present experimental field was situated, tile drains (PVC tubing) were installed about 10 years before at a depth between approximately 0.8 to 0.9 m (bottom) with a slope to a ditch at the North-east side of the field. The drain depth was provided by the farmer and checked at three sites and found to be within the given range. The drain pipes had different lengths (185-210 m), because of the triangular border shapes of the original field, and had 10 m intermediate distance (Fig 2.1). The field surface declined slightly to the ditch at the North-east side and the slope was on average 6 cm per 100 m.

The total experimental field comprised the whole catchment area of six tile drains. The exact position of the two most outer tile drains and one of the drains in the middle of the experimental part of the field was checked before the position of the sampling plots was definitively marked out. Therefore, a probe was inserted into the tile drain and the position of the pipe was followed with a detector. The outlets of the drains were coupled with PVC tubing into two sets (drain set D1 and drain set D2) with three drains each (Fig. 2.1). The discharge of each drain set was continuously recorded and the water was proportionally sampled for analysis. The catchment area of drain set 1 was **6 300 $m^2$** and that of drain set 2 was **5700 $m^2$**. To ensure full treatment of the total catchment areas, all test chemicals and nutrients were applied well beyond the borders of the catchment area halfway between each outer drain and its bordering drain outside the catchment area. Within the catchment area of the 6 drains 16 plots were marked out for sampling the soil profile and groundwater. The plots were indicated with the characters A-P (see Fig. 2.1), and were each 40 m long and 10 m wide (equal to the drain distance). For combining samples for analysis, the experimental field was divided up into four sectors (with numbers 1 to 4), which consisted of four plots each (ABCD, EFGH, IJKL, MNOP). The catchment area of drain set D1 contained the sectors S1 and S2 and so the plots A-H, and the catchment area of drain set D2 the sectors S3 and S4, with the plots I-P. Each plot was sub-divided lengthways into 13 sub-plots (not shown in Fig .2.1) with widths varying as follows: six sub-plots of 3 m wide, one middle subplot of 4 m wide, and again six sub-plots of 3 m wide. In the middle sub-plot a cluster of four groundwater sampling tubes was installed in the middle between two drains.

In the first week of October 1997, the groundwater sampling tubes were installed after the crop (potatoes) was harvested and the field was cultivated with a spring-tine cultivator in two directions to prepare a seedbed for winter wheat. Four tubes were installed in a cluster in the centre of each of the 16 marked plots A to P. The tubes were placed 0.5 m apart in a row parallel to the drains. The polyethene tubes had an inner diameter of 5.0 cm and a filter slitted tube part of 20cm) at the stoppered bottom. Holes (10 cm diameter) were drilled to the desired depths. Casing tubes were not needed because of the stiff nature of the clay and the low groundwater level at that time (about 2.5 m below soil level). The tubes were placed in the holes and filter sand was applied around the perforated filter pieces. The bore hole was further filled up with bentonite clay. The four tubes were fitted with filters at: 0.70-0.90 m; 1.00-1.20 m; 1.30-1.50 m and 1.90-2.80 m depth. The blind tube parts protruded about 0.15 m above the soil level and were closed by a lid. The closed tubes were further permanently insulated with a PVC pipe (diameter 0.12 m ; 0.3 m height and a removable lid) to prevent flow of spray liquid and water along the walls of the sampling tubes and to keep the tubes free of splashing soil particles, which favoured clean water sampling. The PVC heads over the sampling tubes were additionally covered with plastic bags during spraying of the test chemicals. The top 0.5 m of the tubes were screwed off temporarily when the field was ploughed. About 0.40 m deep trenches were dug for that handling before and after ploughing.

Filters for continuous registration of the phreatic groundwater level were placed in the plots I and O near the clusters with tubes for groundwater sampling (Fig. 2.1). The filters reached to 2.35 m depth. The tube was slitted over the entire length and surrounded by filter sand. Three tubes (2.5 cm inner diameter) were placed in the sand layer for manual registration of the piezometric level in this layer. The 1 m long filters of these tubes were positioned at 5.0 to 6.0 m depth. The tubes were sealed with Bentonite clay from 5 m depth on. In order to measure the convexity of the groundwater table a row of 12 groundwater tubes was installed perpendicular to the drains at 17 November 1997. The row of tubes was in line with the centre of the cluster of tubes of the plots A, B, I and J (Fig. 2.1). Six tubes were placed at a distance of 0.5 m of the six field drains, and another six at a distance of 1.0 m. The tubes had an inner diameter of 2.5 cm and were fitted with filters at a depth of 0.9-1.1 m.

The height of all sampling tubes, groundwater monitoring tubes, and the soil surface around the tubes was measured with a levelling instrument against one fixed point after installation (6-10-1997) and at the end of the experiment (8-05-1999).

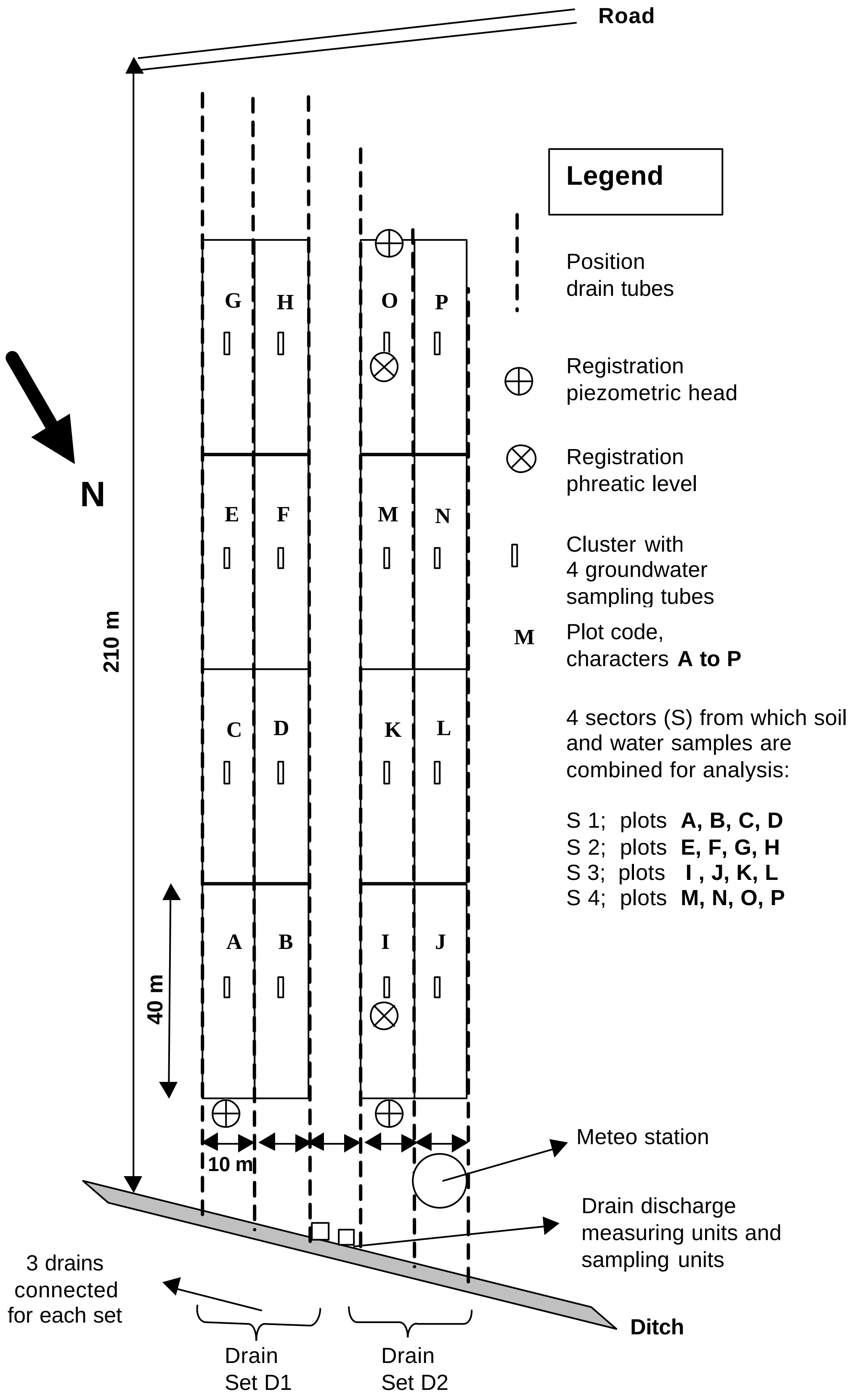


*Fig. 2.1 Scheme of the experimental field*

***Crop growing etc.***

On 23 October 1997 winter wheat (variety Vivant) was sawn with a row distance of 0.125 m. The seeds were treated before with the pesticides guazatine triacetate and antraquinone. Narrow stripes along the clusters with the sampling tubes were sown by hand and the seeds were roughly raked in. On 20 February 1998 a nitrogen fertiliser was applied (325 kg KAS $ha^{-1}$ containing 13% nitrate-N and 13% ammonium-N). The test chemicals bentazone and KBr were applied on 7 April 1998 (for details see chapter 2.2). On 8 May 1998 the crop was sprayed against fungi with Matador, a mixture of tebuconazole and triadimenol; doses of 0.250 and 0.125 kg $ha^{-1}$ respectively. On 14 May 1988 a second dose of nitrogen fertiliser (200 kg KAS $ha^{-1}$) was applied. The test chemical imidacloprid was applied on 27 May 1998.

The winter wheat crop had to remain on the field because of the use of not registered chemicals. Therefore, it was not harvested in a normal way but treated with a tractor-trailed straw chopper on 20 August 1998. The straw was further shredded and distributed with a rear-mounted rotary mower (Votex) before the application of pig slurry (23.9 $m^3$ $ha^{-1}$) on 1 September 1998. The slurry was shallowly incorporated by two rows of spring tines mounted at the applicator. The germinating wheat seeds formed a kind of green manure, which growth was stopped by spraying with Roundup (1.0 kg glyphosate $ha^{-1}$) on 22 September 1998. On 8 December 1998 the field was ploughed (0.25-0.30 m depth) after a very wet period and again winter wheat was sawn. The wet condition resulted in a very rough seedbed with clearly visible ploughed stripes. On 1 December, a 6 m stripe of the experimental part of the field (of the plots M, N, O and P) was already ploughed (but no wheat was sawn). On 17 March 1999 a nitrogen fertiliser was applied (300 kg KAS $ha^{-1}$). The field experiment was stopped at 25 May 1999 and all measuring equipment was removed.

## 2.2 Application of bromide and test chemicals

All chemicals were applied with a tractor mounted, 24 m width field boom sprayer (Delvano) provided with ceramic, 110° flat-bed nozzles (Albuz red) mounted at an intermediate distance of 0.5 m. For spraying the experimental field, the effective spray width was reduced to 20 m by closing the outer nozzles. The 20 m width matched well with the 10 m drain distance and allowed to situate the spray tracks above the drain positions and between the sampling plots (Fig. 2.1). Before spraying, the flow rate from the individual nozzles was measured at a spray pressure of 290 kPa (read on machine manometer). The average flow rate of 19 nozzles was measured in two series and was: 1.69 L $min^{-1}$, CV 4.3% and 1.69 L $min^{-1}$, CV 5.8%, respectively. The speed of the sprayer during spraying was measured several times by recording the driving time between marked points in the field with a stopwatch. With the recorded speed and the flow rate from the nozzles, the areic volumes of water (L $ha^{-1}$) were calculated. The recorded speed was very constant, CV < 1.4%. Spray tracks were prepared beforehand with a loaded sprayer. This action flattened the soil surface and resulted in a perfect horizontal spray boom position and consequently in a very even distribution of the spray liquid.

On 7 April 1998 between 14.00 and 16.20 h the test chemicals bentazone (firstly) and KBr were applied. It was cloudy, air temperature was about 10°C and there was a weak wind from the North-east, which did not disturb the spray pattern. During the early evening and following night there were periods with rain. The total of 5.6 mm rain washed bentazone and KBr probably from the wheat crop. Bentazone was applied as the formulated product Basagran P Duplo® (Luxan, the Netherlands), containing 333 g $L^{-1}$ bentazone. The concentration of bentazone in the spray liquid was estimated to be 3.50 g $L^{-1}$ on the basis of the litres formulated product added to the tank and the total volume of water in the tank. The sprayed areic volume of water was 380 L $ha^{-1}$, which gives a calculated dose of bentazone of **1.33 kg $ha^{-1}$** (based on the nominal concentration of 3.50 g $L^{-1}$). The concentration of bentazone in the spraying solution was measured in samples collected from the tank and under the outer nozzles during spraying. The measured concentration range was 2.50 to 3.80 g $L^{-1}$. The lowest value was from a sample taken from the upper layer in the tank before start of spraying when the solution was not yet mixed well.

The spray liquid of potassium bromide was prepared by pre-dissolving 139 kg KBr in warm water which was subsequently pumped into the spray tank and topped up to 940 L total volume. The estimated concentration in the spray liquid was 147.8 g $L^{-1}$; the measured concentration range was 106 to 148 g $L^{-1}$. The tractor speed was slowed down to achieve an areic volume of water of 600 L $ha^{-1}$, which gives a calculated dose of 88.7 kg $ha^{-1}$ KBr or **59.6 kg $ha^{-1}$** Br (based on the nominal concentration ).

The test chemical imidacloprid was applied on 27 May at 15.00 h. It was dry weather with a half clouded sky and a weak wind from the North-west direction. The soil surface was cracked resulting from a dry foregoing period. The spray liquid was prepared by adding 1.50 kg of the formulation ADMIRE ® (containing 70% imidacloprid) to a total tank volume of 900 L. The estimated concentration of imidacloprid in the solution was 1.166 g $L^{-1}$. The concentration range of imidacloprid in samples of the spray liquid taken before, during and after spraying was 1.20 to 1.14 g $L^{-1}$, on average 1.16 g $L^{-1}$. The tractor speed was the same as when applying KBr, resulting in an areic volume of water of 600 L $ha^{-1}$, which gives a calculated dose of imidacloprid of **0.700 kg $ha^{-1}$** (based on the nominal concentration of 1.166 g $L^{-1}$). A few raindrops fell about 1 hour after spraying. A thunderstorm (15 mm rain) followed in the evening of 28 May. The wheat crop was already well developed and had a height of 0.45 to 0.60 m. Soil coverage by the crop was about 90% at time of application. Two days later, soil samples were taken and the results showed a high soil deposition of about 80 % (paragraph 5.5).

A 7 to 12 m wide stripe along the drainage ditch (Fig. 2.1) was not sprayed with the test chemicals. Additional spraying of this stripe ("driving out stripe" from spray tracks) would have resulted in an overlap, caused by the angle of the experimental field with the ditch. The drain water collecting units and groundwater sampling tubes were shielded with plastic foil during spraying to avoid contamination. During spraying imidacloprid, plastic sheets of 0.45 x 0.45 m (with a hole in the centre) were laid on the cracked soil around the groundwater sampling tubes to avoid direct flow of the compound to the deeper layers and filters.

## 2.3 Application of nutrients and manure

Applications of nutrients and manure are summarised in table 2.1. The application of the nitrogen fertiliser KAS on 20-02-98 was the first nutrient gift after fertilisation of the preceding potato crop in Spring of 1997. The nitrogen fertiliser, containing 13% nitrate-N (m/m) and 13% ammonium-N (m/m), was applied with a common tractor-mounted spinning disc fertiliser distributor. The uniformity of the distribution was not specially measured after the applications; it met farmers practice.

*Table 2.1. Overview application of nutrients (doses kg ha$^{-1}$)*

| Date | Product | Product rate | $NO_3$-N | $NH_4$-N | Total-N | Ortho-P | Total-P | K |
|---|---|---|---|---|---|---|---|---|
|  |  |  | (kg ha$^{-1}$) |  |  |  |  |  |
| 20-02-98 | KAS | 325 kg ha$^{-1}$ | 42 | 42 | 48 | - | - | - |
| 14-05-98 | KAS | 200 kg ha$^{-1}$ | 26 | 26 | 52 | - | - | - |
| 01-09-98 | Pig slurry* | 24 m$^3$ ha$^{-1}$ | - | 116 | 144 | 12.5 | 14.9 | 156 |
| 17-03-99 | KAS | 300 kg ha$^{-1}$ | 39 | 39 | 78 | - | - | - |

* organic part of N and P in pig slurry is total-N – ($NO_3$-N + $NH_4$-N) and total-P – ortho-P respectively

Pig slurry was derived from a pig farm that used the “pulp feeding” system, which resulted in comparatively low P contents. Samples for analyses were collected during filling the application equipment. For each tank content of 16 m$^3$, 12 sub samples were automatically taken with an in-line sampler (certified product of the firm Eijkelkamp the Netherlands) and combined to one mixed sample with a total volume of 2 L. Three of these mixed samples were analysed. The average dry matter content was 48.9 kg m$^{-3}$ slurry (s.d. = 1.7), the average organic matter content 18.9 kg m$^{-3}$ slurry (s.d. = 2.1), the average total-N content 6.0 kg m$^{-3}$ slurry (s.d. = 0.3), the average total-P content 0.62 kg m$^{-3}$ slurry (s.d. = 0.01) and the average K content 6.5 kg m$^{-3}$ slurry (s.d. = 0.5).

The pig slurry was applied with a tractor-trailed vacuum spreader tank provided with two vertically mounted spreaders, which spread the slurry over a 4 to 5 m wide strip. The slurry was shallowly “incorporated” by two rows of spring tines, that were mounted at the applicator (tines 0.40 m interspace in each row, so 0.2 m net interspace, and 5 to 10 cm working depth). The straw remnants and the many wheel tracks hindered equal incorporation. An additional cultivation (about 10 cm depth) with a spring tine cultivator was carried out crosswise the previous one to improve the incorporation, which action is compulsory in The Netherlands to reduce $NH_3$ volatilisation.

## 2.4 Monitoring crop growth and crop sampling

### *Crop growth*

Due to the mild winter of 1997-1998, the wheat crop was developed well early in Spring 1998 and re-growing of the crop started early in March 1998. A soil coverage of about 17% was estimated around half February. On 30 March the crop was 7 to 10 cm high and covered about 40% of the soil surface (visual estimate). Measuring or estimating soil coverage is not a very suitable method to indicate crop development in wheat, because it is difficult to distinguish between covered and uncovered soil due to the position of the leaves. Measuring the light interception is a more practical method in a wheat crop. From 9 April on, the light interception was determined by measuring the incoming radiation (Ii) above the crop and the radiation at the soil surface (Is) under the crop. The light interception fraction ($f$) was calculated by:

$$f = 1 - \frac{Is}{Ii}$$

The light measuring probe was a 0.90 m long and 1.5 cm width stick with 128 silicium photo cells mounted on it that measured the Photosynthetic Active Radiation (PAR, 400-700 nm). The measurements were done on 12 marked spots in the experimental field on each measuring date, always around 12.00 h, because the position of the sun influences the measurement and this effect is minimal in a row crop when the sun has about its highest position. At each marked spot, 5 to 7 interception fractions were measured and the average value for the spot calculated.

Rooting depth and rooting intensity were not specially measured. They were examined visually by inspection of the sampled soil columns on 15 June and 10 August. Rooting was most intensive up to 0.30 m and decreased then rapidly with depth. Few roots were seen below 0.5 m depth, although strong individual roots were found to up till more than 1 m depth, following cracks and (worm)channels.

### *Sampling crop*

At two times the crop was sampled to determine total dry matter production and the content of Br and nutrients in the plants. The first sampling was carried out on 11 May 1998. At two spots on each of the four sectors (Fig. 2.1). Plants in one row were cut (just above the soil level) over a length of 1.0 m. The two samples per sector were bulked to one sample for determination of total dry weight yield and chemical analysis.

At the second sampling on 5 August on each plot an area of 2.5 $m^2$ was cut by hand and the total weight of the sample recorded. Fifty halms were taken from each of the 4 samples per sector to prepare a “composed” sample for each of the four sectors. Straw and grains of that composed samples were separated. The weights of both plant parts were noted and sub samples were prepared for determination of the moisture contents and chemical analysis.

## 2.5 Monitoring of meteorological data

### *Precipitation*

Measurements at the soil surface level gives more representative values than measurements at greater heights (Beese and Van de Ploeg 1978; Warmerdam 1981). For this reason it was decided to take precipitation measurements at the soil surface as final output data. However, recording rain gauges at soil level were found to be rather sensitive to flooding and contamination with e. g. soil and dust, which lead to inaccurate registration by e.g. tipping bucket types. Therefore only cumulative rainfall was measured at the soil surface and the distribution with time (resolution of about 0.20 mm) was recorded with data loggers from two rain gauges at a higher level.

Three rain gauges were installed at the meteo station on the experimental field (Fig. 2.1) on 17 November 1997. All gauges were of the Hellman type with a surface area of the aperture of 200 $cm^2$ and provided with a large collecting vessel. Cumulative precipitation was collected at the soil surface. A gauge (called gauge I) was placed in a well drained pit with a diameter of about 0.5 m. Around the gauge a metal grid (1 $m^2$) with a hole in the centre (0.30 m diameter) was placed on the soil surface to prevent splashing soil from the surface into the gauge. The grid consisted of vertical iron strips (2 mm thick and 20 mm high) with a mesh width of 30 mm. The aperture of the gauge was flush with the metal grid surface and consequently the soil surface all the time. A circle around the gauge with a diameter of about 3.5 m was kept free from vegetation. The total collected water was measured after periods of 1 to 5 weeks.

Precipitation was continuously recorded with a second gauge (gauge II), which was placed within 6 m of gauge I. Here, the surrounding was also kept free of vegetation. The aperture was located 0.4 m above the soil surface. Gauge II was provided with a tipping bucket system (Rain-o-matic) and the pulses were recorded (with clock time) with a data logger (Hobo). All the water leaving the bucket system was collected and recorded periodically (1 to 5 weeks). This system enables to re-calibrate the mm precipitation per recorded pulse for each period between the times when the data logger was read out. The mm precipitation per pulse differed slightly for each period due to contamination of the bucket with e.g. dust or changing of the balance point by mechanical causes. The precipitation data set was composed with the calibrated mm precipitation per pulse for each sampling period. A third gauge (gauge III) was placed in the wheat crop. This gauge III was also provided with a tipping bucket system, data logger and collecting vessel. The initial height was 0.3 m above soil level and the aperture was raised equal with the crop level to a maximum of 0.8 m. This gauge was installed as a spare in case of malfunction of the other recording one (gauge II) and to measure collected precipitation at crop height.

The collected precipitation of the two recording gauges II an III differed on average less than 1% over the whole experimental period. Gauge III catched on average 1.6% more rain than gauge II in the bare field at 0.4 m in the period when its aperture was about level with the surrounding crop height. However, gauge III catched 9% less precipitation than gauge I at the soil surface in that period (effect of wind).

The final time series of precipitation at the soil surface, with a resolution of individually recorded pulses, was established as follows. For each recording period of 1–5 weeks the quotient of the cumulative precipitation from the recording Hellmann gauge at 0.4 m height on bare soil (gauge II) and the cumulative precipitation from the Hellmann gauge at the soil surface (gauge I) was calculated. The mm precipitation per pulse derived from the recording Hellmann gauge (gauge II) was divided by this quotient to correct for the effect of the 0.4 m height of the recording gauge (wind drift). The average quotient for the time periods during the experimental period was 0.862 (s.d = 0.06, n = 24) with lowest quotients in periods with stormy weather.

For the period from 15-6-98 to 4-7-98 and from 29-1-99 to 26-2-99 both data loggers failed and no pulses were recorded for the gauges II and III. Only cumulative precipitation on the field was known for that periods: 46.0 and 63.5 mm, respectively. For these periods the daily distribution from the total collected precipitation on the field was estimated from the daily readings (at about 7.30 h) of a rain gauge at 1 km distance of the field. No attempts were made to make a more detailed distribution over the day. The total mm rainfall for days with lack of detailed registration was presented as one ‘pulse’ at 12.00 h in the rainfall intensity time series.

Snow and a hard wind resulted in unrealistic amounts of precipitation in the gauge at the soil surface in the measuring period from 5-1-99 to 28-1-99. For that period the cumulative precipitation of gauge II at 0.4 m height (corrected for the higher position) was taken to estimate the complete time series of precipitation.

***Data weather station ‘Haarweg’ Wageningen***

Data on parameters for calculation of potential evapotranspiration were obtained from weather station ‘Haarweg’ in Wageningen, at about 10 km distance north of the experimental field. This station is managed by Wageningen Agricultural University. The following data were obtained on a daily basis: global radiation, minimum and maximum air temperature, average vapour pressure and average wind speed at 2 m height. All parameters were measured according to WMO (WMO, 2000).

## 2.6 Monitoring soil temperature and air temperature

Equipment for measuring temperatures was installed at 19 December 1997, but several start problems caused that correct registration started after the first week of January 1998. Soil temperatures were measured in duplicate at 0.05, 0.50 and 1.0 m depth at the experimental field at a spot near the meteo field (Fig.2.1), which was grown with winter wheat and further cultivated like that in the field. Air temperature was measured at 1.5 m height in a weather cabin with walls of slatted blinds. All sensors were thermistors and the signal/temperature relation (range 0-26 °C) was measured for each number before the start of the experiment. The proper function of the thermistors that measured the air temperature was checked at some times by comparing the read out of the logger with a calibrated mercury thermometer. The thermistors that measured the soil temperature at 0.05 m depth were removed at time of ploughing and were checked before replacing them. The electronically measured temperatures deviated always less then 1.0 °C from the calibrated mercury thermometer. Temperatures were recorded every 2 h with two Tattle® data loggers, one for each set of sensors, which consisted of three soil depths and one air temperature. Every two to three weeks, data were collected from the loggers and the daily averages per sensor were computed and the minimum and maximum temperatures per day were also registrated. The final data set for the temperatures were mainly distracted from one sensor/logger combination. The output of the "spare" logger set was used to fill up some periods with missing data of the main logger set (e.g. by dead battery or communication problems). Air temperatures and soil temperatures generated by the two sensor/logger combinations differed less then 1.0 °C. This comparison formed a good check on the proper working and outcome of the temperature measurements. In the periods from 13 until 29 April 1998 and from 16 until 21 September 1998, no complete or no reliable data were obtained for the air temperatures from both loggers, due to communication problems with one of the loggers and malfunction of the air sensor of the other sensor/logger combination at the same time. Minimum and maximum air temperatures measured at the weather station "Haarweg" of the University at Wageningen (10 km distance from the field) were used to fill up the two gaps in the final data set.

## 2.7 Monitoring of groundwater level

Groundwater level (phreatic level) was measured continuously in two tubes, one on plot O and one on plot I. The loggers were of the type "Arrow 1.0/2.5" which could measure a maximum water column height of 1.0 m with an accuracy of ± 0.5 cm. The sensors were calibrated with know heights of water columns before installation and the calibration line was checked again at the end of the experiment for possible drift, which appeared to be minimal. The logger recorded the water level 10 times a day (about every 2.4 h). The data were collected from the loggers every two to three weeks and the proper working of the sensors and loggers was then checked at that time. At inspection times, the electronically measured levels differed some times slightly from the manually measured levels but always less than 3 cm. The position of the pressure sensor against the head of the groundwater tube was measured (± 1.0 cm) and adapted if needed, e.g. after great fluctuations of the groundwater level. In some periods with rapidly fluctuating water level, the water column above the position of the sensor became higher than 1.0 m and consequently the sensor were out of the correct registration range. These values were searched for and specially marked in the data sets. Problems with the sensors or troubles with the data loggers resulted in some further gaps in the continuously recorded series. Fortunately, most gaps for the two measuring series did not coincide. So, an almost continuous picture of the groundwater level can be constructed.

Periodically, the phreatic level was also measured in the 16 clusters of tubes for groundwater sampling, mainly at sampling times of groundwater and soil. The convexity of the groundwater table was periodically measured in the row of 12 tubes perpendicular to the drains in the period from 1 January until May 1998. The piezometric level was periodically measured in three tubes with a filter at 500-600 cm depth on the plots A, I and O (Fig. 2.1). The tube at plot A was destroyed by harvesting in August 1998.

All levels were measured from the head of the tube and later calculated against the soil surface by subtracting the height of the tube above the soil surface. The height of the tubes and the height of the soil surface around the tube was measured against one fixed reference point after installation (6-10-1997) and at the end of the experiment (8-05-1999). At both times, the heads of the tubes had the same levels but the levels of the soil surface around the tubes had risen (1.4 to 6.0 cm) due to the ploughing in December 1998 (soil not fully settled) and swelling of the soil matrix. The <u>average</u> of the soil surface levels at both times was used to correct the measured groundwater levels for the length of the tube that protruded above the soil surface.
The differences in the (absolute)level of the soil surface for the tubes were as follows:
(All values relative to the level near the tube for piezometric level at plot O)

| | |
|---|---|
| Phreatic level at plot O | 5 cm lower |
| Piezometric level at plot I | 18 cm lower |
| Phreatic level at plot I | 17 cm lower |
| Piezometric level at plot A | 12 cm lower |

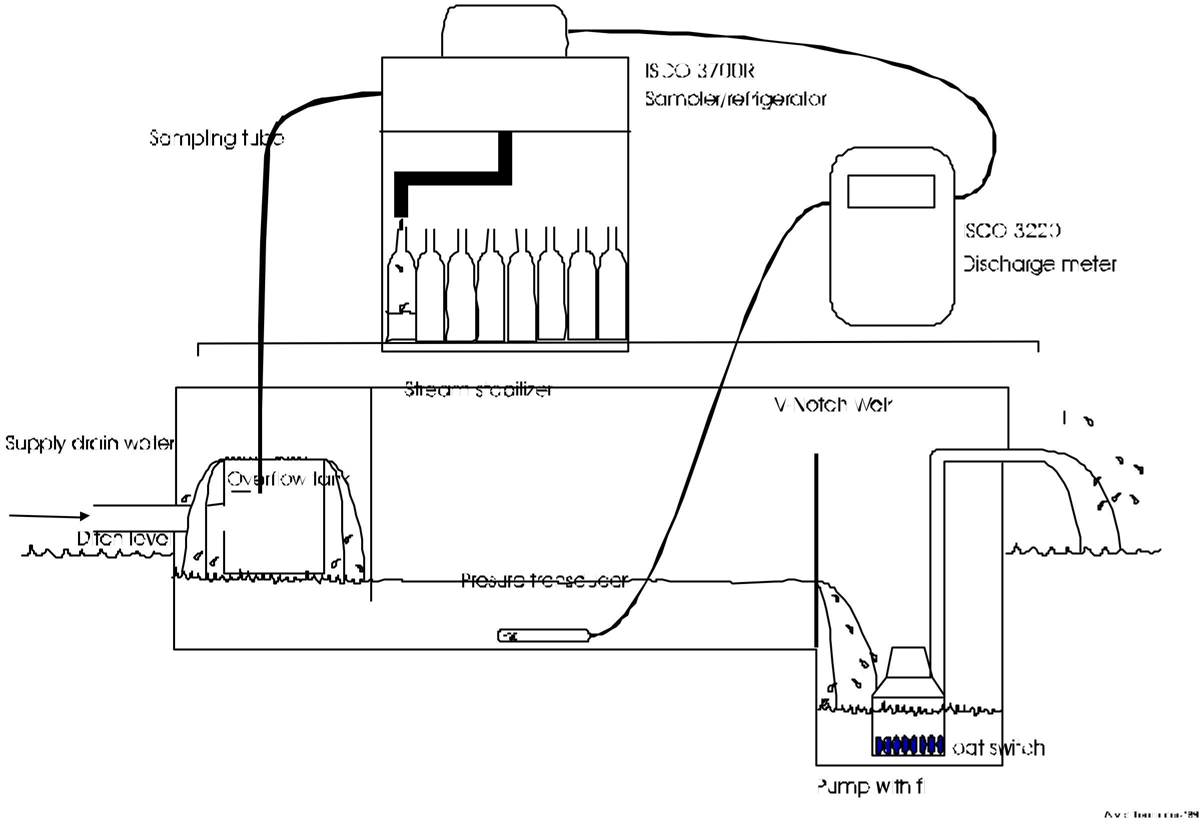


*Fig. 2.2 Scheme of drain discharge measuring construction and drain water sampling method*

## 2.8 Monitoring drain discharge

The discharge of each of the two drain sets was measured in an open channel with a V-notch sharp–crested weir with an angle of 30°. A scheme of the drain discharge measuring and sampling construction is given in Fig. 2.2. The discharge was measured with an ISCO model 3220 meter, which recorded the flow rate every 5 min by measuring the pressure head and calculating the flow rate Q with: $Q = K.H^{2.5}$ (K = a known constant depending on angle of notch and units, H = head on the weir). The weir was constructed in a rectangular stainless steel container (1.5 m long), which was anchored in the ditch and loosely covered by a lid. The weir emptied into a build-in and deepened compartment, in which a submerged pump with a float was placed to keep the water level low enough to ensure free outflow of the nappe. The outlet of the pipe, that coupled the three tile drains per drain set, emptied at the side of a 5 L 'overflow' tank that was build in the rectangular stainless steel container. The overflowing water from the 5 L tank filled the flow measuring system. The rim of the overflow tank was clearly above the maximum measurable head level of the weir but 10 cm below the level of the drain outlets so that free outflow of drain water was assumed. The head /discharge relationship of the weirs in the measuring constructions was verified in the laboratory in the 'low head' range (20 to 150 L $h^{-1}$) and found to deviate less than 15% (7-15%) of the known feeding flow. The accuracy of the higher flows was not measured but may be distracted from the specifications of the pressure sensor and the computed discharges at given heights for an "ideal" constructed 30° V-notch weir. An accuracy 5-10% seems a reasonable estimate for the higher flows. The minimum flow that was reliable measurable was set at 20 L $h^{-1}$, the maximum measurable flow was restricted by the capacity of the submersed pump. The checked capacity of the pump used for drain set 1 was 6.5 $m^3$ $h^{-1}$, and that of the pump in drain set 2 was 8.2 $m^3$ $h^{-1}$. These capacities corresponded with a discharge rate of 24.7 and 34.5 mm $day^{-1}$ for the catchment areas of drain set 1 and drain set 2, respectively. The minimum flow rates corresponded with drain discharge rates of about 0.08 mm $day^{-1}$for both drain sets. Flow rates below 0.08 mm $day^{-1}$ were considered to be not reliable measurable and consequently set at zero in the final output data.

The continuously measured flow rates (L $h^{-1}$) were stored every 5 min (point measurements) in the data loggers of the flow meters. The discharge data were captured from the loggers weekly or every two weeks, except in Summer. The V-notch weirs were then cleaned (if necessary) and the pressure sensors were calibrated against zero flow, if the discharge rates were low enough to be stopped for a short time.

Problems occurred with correct registration of the drain discharges and fully proportional sampling of the drain water during the experimental period (Table 2.2). Fortunately, one of the two drain sets was measured and sampled correctly in most of the periods with problems. Exceptions were the first weeks of January 1998 (pump failures) and between 28 Oct. and 2 Nov. 1998 after extreme rainfall and consequently extremely high discharge rates, which were beyond the measurable range.

*Table. 2.2 Notes concerning problems with registration of drain discharge and sampling of drain water*

| Period | Description of observations and problems | |
|---|---|---|
| | Drain set D1 | Drain set D2 |
| 31-12-97<br>to<br>6-01-98 | - Start drain discharge at 3 Jan 98 (visual inspection). No correct registration of discharge due to pump failure.<br>- *No correct proportional water sampling* | - Start drain discharge at 31 Dec 97 (visual inspection). No correct registration of discharge due to pump failure.<br>- *No correct proportional water sampling* |
| 6-01-98<br>to<br>12-1-98 | - Correct registration of discharge.<br>- *Correct proportional water sampling* | - No correct registration of discharge due to pump failure.<br>- *No correct proportional water sampling* |
| 6-03-98<br>to<br>8-03-98 | - Correct registration of discharge<br>- *Correct proportional water sampling* | - No correct registration of discharge due to pump failure.<br>- *No correct water sampling* |
| 26-04-98<br>to<br>4-05-98 | - Very low discharge, which could not correctly be measured.<br>- *Water in measuring equipment could be sampled manually (not proportionally)* | - Correct registration of a low drain discharge during a short period.<br>- *Correct proportional water sampling* |
| 3-09-98<br>to<br>7-09-98 | - Drain discharge occurred but no correct registration because discharge tube got disconnected during first discharge.<br>- *Manually sampling on 7-09 of remaining drain water in measuring equipment (not proportionally)* | - 3 Sept 98 (8.25 h) start drain discharge after summer period, correct registration of discharge.<br>- *Correct proportional water sampling* |
| 7-09-98<br>to<br>15-09-98 | - Tube connection repaired but data of drain discharge lost by logger problems.<br>- *Correct proportional water sampling* | - Correct registration of discharge and water sampling<br>- *Correct proportional water sampling* |
| 28-10-98<br>to<br>2-11-98 | - Periods in which discharge was slightly higher than max. pump capacity (equivalent 24.7 mm day-1); consequently underestimation of discharge<br>- *First 10%. of discharge proportionally sampled only.* | - Periods in which discharge was slightly higher than max. pump capacity (equivalent 34.5 mm day-1): consequently underestimation of discharge.<br>- *First 10%. of discharge proportionally sampled only.* |
| 1-03-99<br>to<br>9-03-99 | - Correct registration of drain discharge.<br>- *One sample bottle filled only due to leakage of sampling tube.* | - Correct registration of discharge<br>- *Correct water sampling* |

## 2.9 Sampling of drain water

The drain water for samples was pumped up from the 5 L tank that was mounted inside the stainless steel container at the end of the drain connecting tube. This intermediate ‘sampling tank’ was put in to be sure that always water of the latest and actual drain discharge was sampled, which improved correct sampling with low drain discharge rates (no mixing with water in measuring compartment with the weir). The discharge of each drain set was flow proportionally sampled with a cooled ISCO model 3700R sampler (temperature range in cooled room; 4-10°C). The sampler was steered by the ISCO 3220 flow meter. Each of the polythene sampling bottles (1 L) of the sampler was always filled in 10 steps during a time period with a total drain discharge that corresponded with a pre-set value of 0.5 (Summer), 1.0, 2.0 or 4.0 mm. Those manually set values for the “sampling command” increased with time, depending on the expected or measured drain discharge rate. The 4.0 mm value was introduced on 10-11-98, just after the very high discharge in the weeks before and the value was not changed after that time.

The sample bottles were brought to the laboratory weekly or every two weeks. The test compounds were analysed in each individual bottle or mixed samples that were proportionally composed to get samples which represented longer drain discharge periods. This was done for economic reasons. Time periods for the composition of the mixed samples varied for the test compounds and the exact periods are given with the results for each compound (in the corresponding Annexes). The time periods were chosen after preliminary interpretation of the drain discharge patterns and already existing results of analysis. Water samples were analysed directly or stored at – 20 °C for delayed analysis (for analyses of the pesticides mainly).

## 2.10 Sampling of groundwater

The sampling dates of groundwater and the type of analyses done in the collected samples are summarised in Table 2.3. In general, groundwater was withdrawn from the upper layer of the groundwater. That means, samples were taken from the shallowest of the four filter depths from which water could be collected well on all plots. Now and then one sample was withdrawn from a second, lower filter depth. Only on 4 March 1999, samples were collected from three depths on all plots and analysed. Filters were pumped dry three times, or at least 5 L water was withdrawn, before a sample was taken. Under pressure was applied to a 0.5 L glass flask and water from the filter tube was directly collected in the flask via a stainless steel tube and a short PVC connecting tube. Sub-samples for analyses of nutrients and bromide were poured out from the glass flask into polythene flasks (50 $cm^3$) in the field.

Groundwater samples for P analyses were collected in a different way to prevent oxygen inclusion, which would result in changing chemical balances, and to filter out soil particles in the field. The filter tube was emptied again after collecting the sample for pesticide analyses and a thin PVC tube was placed on the bottom of the filter. Generally, it took < 0.5 min (at the most 2 min) before enough water was in the filter to start sampling of the fresh in-flowing groundwater with a minimum of contact with air.

The PVC tube was connected to a peristaltic pump, which pressed the pumped up water through an in line 0.45 µm filter (with glass fibre pre-filter). The filtered water was collected in a polythene flask (50 $cm^3$) after sufficient flushing of the pump and filter system to remove air.

Bromide and the nutrients were analysed in each single water sample occasionally. The two pesticides were always analysed in mixed samples per sector. For this purpose, water was collected from the four filters per sector with the same depth and subsequently proportionally mixed for each sector.

*Table 2.3. Sampling dates of groundwater and performed analysis*

| **Sampling date** | **DANU *** | **Days after application of test chemicals** | | **Analyses performed** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | bentazone & bromide | imida cloprid | bromide | bentazone | imida cloprid | P-$PO_4$ | P-Total | N-$NO_3$ | N-$NH_4$ |
| 03-03-98 | 62 | -35 | | | | | | | + | + |
| 10-03-98 | 69 | -28 | | | | | | | + | + |
| 30-03-98 | 89 | -8 | | + 1) | + 1) | | | | | |
| **07-04-98** | **97** | **Appl. bentazone & Br** | | | | | | | | |
| 29-04-98 | 119 | 22 | | + | + | | + | | + | + |
| 12-05-98 | 132 | 35 | | + | | | | | + | + |
| **27-05-98** | **147** | **Appl. imidacloprid** | | | | | | | | |
| 29-05-98 | 149 | 52 | 2 | + | + | + 1) | | | + | + |
| 04-06-98 | 155 | 58 | 8 | + | + | | | | + | + |
| 09-06-98 | 160 | 63 | 13 | + | + | + | | | + | + |
| 23-06-98 | 174 | 77 | | + | | | | | + | + |
| 10-08-98 | 222 | 125 | 75 | + | + | + | | | + | + |
| 07-09-98 | 250 | 153 | 103 | + | + | + | + | + | + | + Kj) |
| 21-09-98 | 264 | 167 | 117 | + | + | + | + | + | + | + Kj) |
| 06-10-98 | 279 | 182 | | + | | | + | + | + | + |
| 20-10-98 | 293 | 196 | | + | | | | | + | + |
| 18-12-98 | 352 | 255 | 205 | + | + | + | | | + | + Kj) |
| 28-01-99 | 393 | 296 | 246 | + | + | + | + | + | + | + |
| 03-02-99 | 399 | 302 | | | | | + | + | | |
| 04-03-99 | 428 | 331 | 276 | + | + | + | | | + | + |
| 18-03-99 | 442 | 345 | 290 | | +2) | +2) | | | | |
| 20-04-99 | 475 | 378 | 328 | + | + | + | + | + | + | + Kj) |

* **DANU** = day Nr.; day 1 = 1 January 1998

1) water collected for “blank” analyses

2) only one sector (S4) sampled; to collect water for laboratory experiments

Kj) also N-Kjeldal analysis

## 2.11 Sampling of soil profiles

An overview of the soil sampling dates, including the corresponding days after application of the test chemicals, is given in Table 2.4. Soil profiles were sampled at eleven times in total of which eight times after spraying bentazone and the tracer bromide. At each sampling time, one soil core up to 1.2 m depth was taken from each of the plots A to P. The sampling sites (sub-plots) on each plot were selected randomly before the start of the experiment. A sub-plot could only be used once for soil sampling because of disturbance of the crop and soil surface around the sampling site. A special steel corer was constructed to collect soil cores in PVC tubes (liners) of 1.2 m long and 96.4 mm inner diameter. The steel core tube was provided with a sharp cutting ring with an inner diameter of 94.0 mm. The larger diameter of the PVC liner and its smooth surface resulted in only a small compaction of the soil core (10 to at the most 30 mm). The outer diameter of the cutting ring had a 20 mm larger diameter than the steel tube itself, to reduce friction between soil and tube wall during pressing the corer into the soil. The PVC liner was sticked between the cutting ring end and a removable head of the steel tube. The steel corer tube was pressed into the soil with a hydraulic wheeled excavator, which also pulled up the corer after exchanging the flat head by one with a welded ring on it for easy connecting a chain. During pulling up the corer, air pressure was applied at the lower end of the cutting ring via a 4 mm tube, which was mounted on the outside of the steel core tube. This hindered slipping out (part) of the soil core. The part of the soil core that was inside the cutting ring was pressed into the PVC liner, which was then pulled out of the steel core tube. The PVC liners with the soil cores were capped at both ends and transported in a horizontal position to the lab, where the cores were split up (within one or two days) and samples for analyses were combined (chapter 2.12).

The tracks of the excavator were situated always at the position of the drain tubes between the plots A to G, B to H, I to O and J to P (Fig.2.1). The cores were taken from a 2 m width band in the middle of the sub-plots. No special attention was given to take the cores between or in the crop rows because the first systematic samplings shortly after application (see below) showed no clear differences between the masses measured between or in the crop row.

The samplings at 8 April and 29 May 1998, shortly after spraying of the test chemicals, were done with a split-tube auger (0.3 m long, inner diameter cutting ring 95 mm; the inner diameter of the split tube was 3 mm more than that of the cutting ring to avoid compression of the soil column). The auger was pressed or hammered into the soil to 0.15 m depth. Subsequently, the auger was carefully dug out and put in a horizontal position. One half of the steel tube was then removed and the soil core was sliced up. These samplings were done to measure the initial concentration in the topsoil most accurately, specially after spraying imidacloprid on a rather developed crop. At these two times with detailed sampling two soil cores were taken on each of the plots A to P, one core between two crop rows and the other with a crop row in the centre of the corer. The above-ground crop parts were removed before with a sharp knife. At 8 April, one day after spraying bentazone and bromide and 5.6 mm rain, the total number of 32 cores were split up into 0.05 m sections in the field and each core section was put into a plastic container for individual analyses of the total soil mass. Soil samples for determination of the soil moisture content and soil bulk density were taken in steel rings (inner diameter 0.05 m, volume 100 $cm^3$) near the spots where the samples for analyses were taken. On 29 May, 2 days after application of imidacloprid and with 15 mm rain in the night before, the cores were divided into a 0.05 m top section and a 0.10 m bottom section. Each core section was put into a plastic bag in the field. The bags were transported to the lab and stored at –25°C until analysis for imidacloprid in January 1999. Each core section was dried at room temperature and then thoroughly mixed. Sub samples of 50 g soil were taken for analysis.

At 21 January 1998 (day 21), during a rainy period, the soil was sampled with a half open faced auger and only moisture contents were measured. Sampling with the volumetric soil corer was not possible because of the wet conditions and sampling could only be done to about 90 cm depth (groundwater table).

*Table 2.4. Sampling dates of the soil profile and performed analysis*

| **Sampling date** | **DANU** #) | **Days after application of test chemicals** | | **Analyses performed** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | bentazone & bromide | imidacloprid | bromide | bentazone | imida cloprid | moisture content | P-$PO_4$ | N-$NO_3$ | N-$NH_4$ |
| 27-10-97 | -65 | -131 | | | | | + scp) | | | |
| 21-01-98 | 21 | -76 | | | | | + | | | |
| 30-03-98 | 89 | -8 | | + b) | + b) | + b) | + | | | |
| 08-04-98 a) | 98 | 1 | | + | + | | + | | + | + |
| 29-04-98 | 119 | 22 | | + | + | | + | + | + | + |
| 29-05-98 a) | 149 | 52 | 2 | | | + | + | | | |
| 15-06-98 | 166 | 69 | 19 | + | + | | + | + | + | + |
| 10-08-98 | 222 | 125 | 75 | + | + | | + | + | + | + |
| 21-09-98 | 264 | 167 | 117 | + Br) | | + | + | + t) | + | + Kj) |
| 02-12-98 | 336 | 239 | 189 | + | + | + | + | + t) | + | + Kj) |
| 20-04-99 | 475 | 378 | 328 | + | | + | + | + t) | + | + Kj) |

#) **DANU** = day Nr; day 1 = 1 January 1998

scp) also used to prepare samples for soil chemical analysis by lab at Oosterbeek (4 x 30 cores of 0-20 cm layer) and oxalic extractable total P , Al and Fe

a) sampling with split tube auger to 0.15 m depth, shortly after application of the test chemicals

b) collecting soil for “blank” analyses

Br) plots A-H individually analysed for bromide

t) also P-total

Kj) also N-Kjeldahl analyses

## 2.12 Treatment of soil samples in the lab and procedure for determination of volume fraction of liquid and dry bulk density

The 16 soil cores in the PVC liners were sliced up in the lab within one to two days after collecting them in the field. The PVC tube was placed in a horizontal position in a mold and the wall was carved on both sides. The upper half of the liner was then removed and 0.10 m sections were marked with a sharp knife. The upper end of the mark stick was fixed with the (visually averaged) soil surface in the PVC tube. No correction was made for the 1 to 3 cm lowering of the soil surface inside the column during field sampling. Sometimes the initial soil surface had to be estimated by reconstruction of the soil in the top, because the soil mass flowed out due to the horizontal position when the soil was dried out or cultivated.

The so marked soil core was sliced up into 0.10 m long sections with a thin round knife, always starting at the lower end of the soil column to avoid contamination. The state of the wet clay soil in the profile of the experimental field allowed us to cut fairly exact slices, that kept their form during further handling. The total weight of each section was noted immediately to avoid evaporation of water. Subsequently, the core section was put in a vertical position and the centre was cut out with a sharp thin cutting tube (inner diameter 0.075 m). This centre core was taken for preparing samples for analyses of the test chemicals, because it can be expected that this part is not contaminated by handling during sampling in the field and in the lab. The soil of the outer part of the core section was used to determine the moisture content by drying to constant weight at 105 °C. From the total wet weight of the 0.10 m section and the moisture content of its outer part, the volume fraction of liquid and the dry bulk density were calculated. A centre core could not always be taken from the upper 0.20 m layer because of the loose structure. Part of the mixed soil mass within that core section was then separated for analyses. This method is acceptable because these layers have low risks for inter-contamination (high initial contents).

Because pesticide analysis is costly, all 16 soil columns per sampling time were not analysed individually but the corresponding layers of four cores were combined per sector (2.1). An exception was made for the columns taken on 21-9-1999. At that time soil columns taken on the plots A to H were analysed individually for bromide and nutrients. All three 0.10 m sections from the ploughed layer (0.0-0.30 m) were analysed separately. The layers 0.30-0.50 m, 0.50-0.70 m, 0.70-0.90 m and 0.90-1.20 m of each soil column were combined into one soil sample. The soil columns taken on 12 February 1999 were not all 1.2 m long. Therefore, only two 0.10 m sections (between 0.90-1.10 m) were combined to obtain the deepest soil sample at that time. The combined soil samples were dried at room temperature under an air flow, drying took one to maximal two days. The whole masses of the samples were then crushed and mixed well in a Hobart food chopper and sub samples (50 to 150 g) were taken for analysis of the test chemicals and nutrients. A sub sample (0.5 kg) was stored at –25 °C for (delayed) analyses of the pesticides and for possibly re-analysis.

## 2.13 Procedures for extraction and analysis of bromide ion

### *Soil and water*

Bromide was extracted by shaking 100 g moist soil with 100 or 150 $cm^3$ $CaCl_2$ (0.01 mol $dm^{-3}$) for 1 h. The soil water suspension was cleared by centrifugation for 10 min at a rotation frequency of 40 $s^{-1}$ and a small portion of the liquid was withdrawn for analysis. Concentration of bromide ion in the extracts was measured with HPLC using a 'Hypercil ODS' column (25 cm x 4.6 mm i.d), which was operated at room temperature and packed with octadecyl silane; 5 µm; 10% carbon. The mobile phase was water containing 0.855 g $L^{-1}$ $KH_2PO_4$, 0.715 $Na_2HPO_4$ and 0.004 M tetrabutyl ammonium dihydrogen phosphate. This method gave a good separation of the bromide peak with the nitrate peak. The flow rate of the mobile phase was 1.5 ml $min^{-1}$ and 200 µl samples were injected. Bromide ion was measured with a spectrophotometer at a wave length of 210 nm. The detection limit in soil, was 0.15 mg $kg^{-1}$ dry soil. The extraction efficiency was measured from blank soil samples spiked at 5 mg $kg^{-1}$ and found to range between 90 to 110%. Contents were not corrected for recovery. The limit of quantification (LOQ) was set at 0.3 mg $kg^{-1}$ dry soil or 0.50 mg $dm^{-3}$ soil (dry bulk density of 1.5 kg $dm^{-3}$). Note that LOQ is set higher than the detection limit because small interferring peaks in the chromatograms made exaxt quantification not always possible at lowest concentrations.

Concentration of bromide ion in groundwater and drain water samples were analysed with the same HPLC method after filtration of the samples over a 0.45 µm filter. The limit of quantification (LOQ) was 0.25 mg $L^{-1}$.

***Crop***

Crop samples were dried, pulverised and well mixed. Sub samples (5 g) were transferred into 10 ml 0.01 M HCl and stored for two weeks. The extracts were then filtered and analysed with HPLC as described for the soil samples. The extraction efficiency was not measured. Instead of recovery experiments, samples were also extracted with 0.1 M HCl after first burning of the sub samples. This method gave considerable lower bromide contents for the grains but identical values for the other crop samples. The results of the method without burning are therefore presented in this report.

## 2.14 Procedures for extraction and analysis of bentazone in soil and water

***Soil***

Bentazone was extracted by shaking 100 g to 150 g moist soil with 100 $cm^3$ $CaCl_2$ (0.01 mol $dm^{-3}$) for 1 h. The soil water suspension was cleared by centrifugation for 10 min at a rotation frequency of 40 $s^{-1}$ and 40 to 60 $cm^3$ liquid was withdrawn for analysis. Samples were directly injected into the HPLC if the concentrations in the extract were expected to be high (> 0.1 mg $L^{-1}$). The soil extracts were concentrated in case of low contents. Part of the soil extract (25 to 50 $cm^3$) was acidified by adding 1 $cm^3$ concentrated HCL (12 mol $dm^{-3}$) and bentazone was extracted by shaking with 25 $cm^3$ dichloromethane for 1 h. The dichloromethane layer was collected and evaporated under a nitrogen stream on a water bath at 40 °C. The residue was dissolved in a measured volume of acetone (± 2.5 $cm^3$), which was stored at –20 °C until analysis. For HPLC analysis, part of the acetone extract (0.2 to 0.5 $cm^3$) was evaporated in a HPLC sample vial and the residue re-dissolved by adding at first 0.2 $cm^3$ methanol and after some time 0.3 $cm^3$ HPLC water to reach a final volume of 0.5 $cm^3$. The solution was shaken and three times placed in an ultrasonic bath. The solution was further stored at room temperature for at least one day to ensure complete dissolving of bentazone from the residue matrix.

The extraction efficiency was determined for a range of concentrations in a series of experiments with soil samples of different layers during the whole experimental period. Blank soil samples (collected on 30-03-1998 before apllication of bentazone) were spiked with different masses of analytical grade bentazone. The average extraction efficiency for the method with direct HPLC analyses of the extract was 100.6% (s.d=9.4, n=45) with contents from 0.05 to 0.2 mg $kg^{-1}$. The average extraction efficiency of the method, including the volume reduction step of the extract, was 99.7% (s.d=7.9, n=24) for contents between 0.05 and 0.2 mg $kg^{-1}$, and 81.9% (s.d=5.3, n=5) for contents between 0.001 and 0.01 mg $kg^{-1}$. The measured concentration were not corrected for extraction efficiency.

### *Water*

Bentazone was extracted from groundwater and drain water using solid phase extraction. Samples of 800 $cm^3$ were first filtered over two filters (Whatman GF/D 2.7 µm and Whatman GF/C 1.2 µm) to remove soil particles. The filtrate was collected in a bottle and 40 g NaCl was dissolved. Phosphoric acid (30%) was added until pH was between 2.55 and 2.66. Subsequently, the filtrate was led through a column packed with 0.5 g Bakerbond octadecyl ($C_{18}$, 40 µm Prep LC Packing from Baker) at a flow rate of 5 $cm^3$ $min^{-1}$. The column package was pre-conditioned with two 5 $cm^3$ portions of methanol, followed by two 5 $cm^3$ portions of a sodium acetate buffer (0.025 mol $dm^{-3}$, pH 2.65). NaCl was removed from the $C_{18}$ material by one washing with 5 $cm^3$ buffer solution and the $C_{18}$ material was then dried with an air flow. Bentazone was eluted from the adsorbent with two portions of 2 $cm^3$ acetone, which were collected in a 4 $cm^3$ vial. The acetone was evaporated and the residue re-dissolved in 2.5 $cm^3$ acetone. The vials were sealed by Teflon lined screw caps and stored at -20 °C until analysis. For HPLC analysis, part of the acetone extract (0.2 to 0.5 $cm^3$) was evaporated and the residue re-dissolved in 0.5 or 1 $cm^3$ methanol/water (V/V 4/6).

The efficiency of the extraction procedure for water was determined for a range of concentrations in a number of analysis series during the experimental period. Bentazone was added to blank samples of groundwater, drain water and tap water, creating concentration in the range between 1 and 12.5 µg $dm^3$. The not spiked water samples were also analysed for control. The extraction efficiency for the method was on average 100% (s.d = 12, n=17). Concentrations of bentazone in water samples were not corrected for extraction efficiency.

### *HPLC analysis*

Bentazone concentrations were measured with HPLC. The chromatographic system consisted of a Waters$^{TM}$ 717 auto sampler, a Perkin Elmer series 410 LC pump and a Perkin Elmer LC 90 UV detector, operating at 224 nm. Separation was done at 40 °C on a Nova-Pak C18 column (150 mm length, 4.6 mm inner diameter) provided with a 20 mm long pre-column, which was packed with the same C18 material. The elution liquid (flow rate 1 $cm^3$ $min^{-1}$) was a mixture of a sodium acetate buffer in HPLC water (0.025 mol $dm^{-3}$, pH 2.65) and methanol (60/40, V/V). A volume of 20 to 100 $mm^3$ was injected. Standard solutions in the range 0.005 to 3 mg $dm^{-3}$ were prepared in HPLC water and in water/methanol (V/V, 60/40). Composition of the liquid of the samples and the standards were always kept identical. The detector signal was processed with the Multichrom® data package program. Concentrations were determined on the basis of peak heights or peak areas. The detection limit (for well quantification) of the HPLC method in soil extracts was set at 10 µg $dm^{-3}$ at a signal/noise ratio of 5. The limit of quantification (LOQ) of bentazone in water samples was set at 0.03 µg $dm^{-3}$ and in soil samples at 0.5 µg $kg^{-1}$ dry soil, corresponding with 0.8 µg $dm^{-3}$ soil (dry bulk density 1.5 kg $dm^{-3}$).

### *Stability in frozen samples*

Eleven soil samples collected on 29 - 4 - 1998 (content range 0.5 to 5 mg $dm^3$) were re-analysed after storage at –25 °C for 329 days. The average ratio between the first analysis and those after storage was on average 1.07. Bentazone analysis in groundwater and drain water samples were always performed within two weeks after collection and stored in a refrigerator until extraction.

## 2.15 Procedures for extraction and analysis of imidacloprid in soil and water

### *Soil*

Imidacloprid was extracted by shaking 100 g moist soil with 100 $cm^3$ of a mixture of acetone /water (V/V, 80/20) on a reciprocating shaker for 1 h. The supernatant liquid was poured off and cleared by centrifugation for 10 min at a rotation frequency of 40 $s^{-1}$ and a known volume of liquid (40 to 60 $cm^3$) was withdrawn. The collected sample was placed on a water bath at 40 °C and the greatest part of acetone was evaporated under an air stream. Dichloromethane (20 $cm^{-3}$) was added to the remaining liquid and the mixture was shaken for 1 h. The dichloromethane layer was transferred quantitatively into a 25 $cm^3$ tube and evaporated under an air stream. The residue was re-dissolved in 2.5 $cm^3$ acetone and stored at -20 °C until analysis by HPLC.

The extraction efficiency was determined for a range of concentrations (0.01 to 0.5 mg $kg^{-1}$) in 8 analysis series with spiked soil samples from the top layer and in one series with soil from 0.40 - 0.70 m depth. The spiked samples were stored for at least 2 h at 5°C before extraction. The average extraction efficiency of the method was 104.2% (s.d=10.5, n=32). The measured concentration in the field samples and transformation studies were not corrected for extraction efficiency.

### *Water*

Samples of 500 $cm^3$ were pre-filtered as described for bentazone analysis. The eluate was then led through a column packed with 0.75 g of the material described for the analysis of bentazone. The $C_{18}$ material was pre-conditioned with two 5 $cm^3$ portions of methanol, followed by two 5 $cm^3$ portions of HPLC water. The $C_{18}$ material was dried with an air flow after elution of the water sample. Imidacloprid was eluted from the adsorbent with two portions of 2 $cm^3$ acetone, which were collected in a 4 $cm^3$ vial. The acetone was evaporated and the residue re-dissolved in 2.5 $cm^3$ acetone. The vials were sealed by Teflon lined screw caps and stored at -20 °C until HPLC analysis.

During the analysis series, the extraction efficiency was checked from spiked tap water samples or groundwater samples (concentration range 1 or 10 µg $dm^{-3}$). The extraction efficiency of imidacloprid was on average 91.7% (s.d = 7.3; n = 17). The not spiked water samples were analysed as controls. Concentration in water samples from the experiment were not corrected for recovery.

### *HPLC analysis*

The concentration of imidacloprid in the prepared extracts was measured with HPLC after the methods described by Fernandez-Alba et al. (1996) and Yoichi Ishii et al. (1994). Part (0.2 to 0.5 $cm^3$) of the stored acetone extract of a soil sample or water sample was evaporated to dry and the residue re-dissolved in 0.5 or 1 $cm^3$ acetonitrile/water (V/V 25/75). The chromatographic system consisted of a Perkin Elmer ISS 100 autosampler, a Waters 590 pump and a LC 90 UV detector or LC 235 diode array detector, both from Perkin Elmer and operating at 270 nm. Separation was done at 40 °C on a LiChrospher® 100 RP18 column (125 mm length, 4.0 mm inner diameter) provided with a 10 mm long guard column, which was packed with the same $C_{18}$ material. The elution liquid (flow rate 1 $cm^3$ $min^{-1}$) was a mixture of acetonitrile and HPLC water (25/75, V/V). A volume of 20 to 100 µl was injected, depending on the concentration level.

Standard solutions in the range of 0.005 to 3 mg $dm^{-3}$ were prepared in a mixture of acetonitrile and HPLC water (25/75, V/V) or in pure water for measuring concentrations in the water phase with the adsorption measurements on soil (chapter 3.4). The detection limit (for well quantification of peaks) of the HPLC method was 5 µg $dm^{-3}$ at a signal/noise ratio of 5. The limit of quantification (LOQ) of imidacloprid in water samples was set at 0.05 µg $dm^{-3}$ and in soil samples at 0.6 µg $kg^{-1}$, dry soil, corresponding with 0.9 µg $dm^{-3}$ soil (dry bulk density of 1.5 kg $dm^{-3}$).

### *Stability in frozen samples*

The stability of imidacloprid in frozen soil samples was checked by re-analysing four field samples that were stored at –25 °C for 302 and 315 days. The contents after storage differed on average less than 2% from the first analysis. A 8.7 $dm^3$ groundwater sample from the experimental field was spiked with imidacloprid to 2.29 µg $dm^{-3}$. The sample was analysed (triplicate) and the remaining volume was divided over three glass flasks and three polythene flask (same types as used for storage of the field samples) and stored at –25 °C for 245 days. The measured concentrations after storage were on average 5% higher than the measured concentrations directly after addition. It was concluded that storage in deep freeze had no effects on the analysis results.

### *Check imidacloprid analysis with LC/MS*

A number of extracts were also analysed with LC-MS by RIKILT DLO , (Dr H van Rhijn personal communication) to identify imidacloprid and to confirm the HPLC-UV measurements. The HPLC separation was performed on a Merck Lichrospher RP18 column (125 x 4.6 mm) with a mobile phase of water acetonitrile (75/25, v/v) at a flow rate of 1 ml $min^{-1}$. Samples (100 µl) of analytical standards and extracts were alternately injected. The column was directly coupled to a LCQ mass spectrometer provided with an Apcl interface. The measurements were done in the $MS^2$ (tandem)mode in which the daughter ions originating from the molecule-ion are measured. Imidacloprid has four daughter ions: m/z 175, 209, 210 and m/z 212.
Quantitative measurements were made with the signal for m/z 210, whereas for identification the ratio between m/z 175.209, 212 and m/z 210 was used.
All samples fulfilled the (concept) EU criteria for tandem-MS

The results of the measurements are presented in Table 2.5. The occurrence of imidacloprid was confirmed in all samples tested. Slightly higher concentrations were measured with LC-MS, which is probably partly caused by concentrating of the small volume of the extracts during storage until LC-MS analysis.

*Table 2.5 Results analyses for imidacloprid of soil and water extracts with LC-MS*

| **Sample type and code** | **Sampling date** | **DANU *** | **Concentration measured in extract (ng $ml^{-1}$)** | |
|---|---|---|---|---|
| | | | HPLC-UV | LC-MS |
| **Drain water** | | | | |
| Set D1 | 3-300.3 | 280 | 1.11 | 1.78 |
| Set D1 | 3-383.5 | 320 | 1.82 | 0.50 (0.54) ** |
| Set D2 | 4-248.9 | 245 | 6.3 | 12.4 |
| Set D2 | 3-300.3 | 280 | 1.97 | 3.16 |
| Set D2 | 5-318.4 | 309 | 0.25 | 0.37 |
| **Groundwater** | | | | |
| Sector 3, filter 130-150 cm | 09-06-98 | 160 | 0.09 | 0.25 |
| Sector 3, filter 190-280 cm | 10-08-98 | 222 | 0.33 | 0.75 (0.83) |
| Sector 1, filter 130-150 cm | 07-09-98 | 250 | 0.36 | 0.74 |
| Sector 2, filter 130-150 cm | 07-09-98 | 250 | 0.39 | 0.73 |
| Sector 4, filter 100-120 cm | 04-03-99 | 428 | 0.42 | 0.57 (0.67) |
| **Soil** | | | | |
| Sector 1, 0.7-0.9 m | 21-09-98 | 264 | 0.20 | 0.28 (0.25) |
| Sector 3, 0.3-0.5 m | 21-09-98 | 264 | 0.20 | 0.28 |
| Sector 4, 0.5-0.7 m | 02-12-99 | 336 | 0.10 | 0.10 |

* DANU = Day Nr ; day 1 = 1 January 1998

** Values between parenthesis are duplicate measurements

## 2.16 Procedures for extraction and analysis of nutrients

### *Soil and water*

Nitrogen (N) and Phosphorus (P) compounds were extracted by shaking 100 g moist soil with 100 or 150 $cm^3$ $CaCl_2$ (0.01 mol $dm^{-3}$) for 1 h. The soil water suspension was cleared by centrifugation for 10 min at a rotation frequency of 40 $s^{-1}$ and a small portion of the liquid was withdrawn for analysis. Concentrations of nutrients in the extracts were measured with the same techniques as the concentrations in the groundwater and drain water samples. The latter samples were filtered over a 0.45 µm filter.

Ammonium ($NH_4$) was measured on the flow injection analyser (FIASTAR 5000). $NH_4$ passes a membrane and is induced a pH change in the parallel solvent. The pH influences the color of an indicator (Tecator no. 5000-0295) and this change is a measure for the concentration. For the soil samples the limit of quantification (LOQ) was set at 0.04 mg $NH_4$ $kg^{-1}$ dry soil or 0.06 mg $NH_4$ $dm^{-3}$ soil (dry bulk density of 1.5 kg $dm^{-3}$). The detection limit for the water samples was 0.05 mg $NH_4$ $L^{-1}$.

Nitrate ($NO_3$) was measured using the flow injection analyser. Nitrate is reduced to nitrite in a cadmium reductor. Nitrite formed from reduction of nitrate will form a diazo compound. This compound is coupled with N-(1-naphtyl)-Ethylene Diamine

Dihydrochloride (NED) to form a purple azo dye. This azo dye is measured at 540 nm. For the soil samples the LOQ was set at 0.04 mg $NO_3$ $kg^{-1}$ dry soil or 0.06 mg $NO_3$ $dm^{-3}$ soil (dry bulk density of 1.5 kg $dm^{-3}$). The detection limit for the water samples was 0.05 mg $NO_3$ $L^{-1}$.

Kjeldahl-N was measured after destruction according to Kjeldahl using the ammonium methode on the flow injection analyser. The LOQ for the soil samples was set at 0.03 mg Kjeldahl-N $kg^{-1}$ dry soil or 0.05 mg Kjeldahl-N $dm^{-3}$ soil (dry bulk density of 1.5 kg $dm^{-3}$). The detection limit for the water samples was 0.25 mg Kjeldahl-N $L^{-1}$.

Ortho-Phosphate ($PO_4$-P) was measured with the flow injection analyser using the molybdenum bleu method. For the soil samples the LOQ was set at 0.015 mg Ortho-P $kg^{-1}$ dry soil or 0.02 mg Ortho-P $dm^{-3}$ soil (dry bulk density of 1.5 kg $dm^{-3}$). The detection limit for the water samples was 0.025 mg Ortho-P $L^{-1}$.

Total-Phosphate was measured using the ICP-AES. The LOQ for the soil samples was set at 0.015 mg Total-P $kg^{-1}$ dry soil or 0.02 mg Total-P $dm^{-3}$ soil (dry bulk density of 1.5 kg $dm^{-3}$). The detection limit for the water samples was 0.025 mg Total-P $L^{-1}$.

***Crop***

Nutrient content in crop samples were measured according to standard methods by the Laboratory for Soil and Crop testing at Oosterbeek, The Netherlands.

## 2.17 Soil chemical properties and texture

Soil samples were taken at 5 depths for determining some soil chemical properties and texture of the soil. On 27-10-1997 soil columns were taken with the sampling procedure for soil profiles as described in section 3.11. The 16 soil columns were split up into the the layers 0-30 cm, 30-50 cm, 50-70 cm, 70-90 cm and 90-120 cm. Samples for analysis were prepared by mixing the soil per depth and per sector.

The following measurements were carried out by the Laboratory for Soil and Crop testing at Oosterbeek, The Netherlands, using standard methods:

- pH-KCL
- pH-water
- content of total phosphate
- content of total nitrogen
- content of N-mineral
- actual cationic exchange capacity
- fraction of organic matter
- fraction of organic carbon
- fraction of calcium carbonate
- fraction of clay

- fraction of silt
- fraction of sand

The resulta are presented in Annex 42.

Oxalic extractable Phosohate (total-P), Aluminium (Al) and Iron (Fe) were measured by Alterra. Extraction was with a solution containing ammoniumoxalate-monohydrate and oxalic acid-dihydrate during 2 hours. Total-P, Al and Fe were measured using ICP-AES.

# 3 Procedures for laboratory experiments

## 3.1 Measurements of soil hydraulic properties

Soil water retention curves and unsaturated hydraulic conductivity were simultaneously measured using the evaporation method of Wind (described by Stolte et al., 1997). Both characteristics were obtained by fitting the Van Genuchten functions (Van Genuchten, 1980) to the measured data using the RETC optimisation program (Van Genuchten et al., 1991). Saturated hydraulic conductivity was measured with the constant head method described by Stolte et al. 1997).

Samples for both types of measurements were taken in the same pit at a representative spot at the western side of the experimental field in May 1998. The soil profile was sampled at six depths, 11-19 cm, 22-30 cm, 36-44 cm, 61-69 cm, 96-104 cm and 131-139 cm, by pushing gently PVC cylinders (height: 8 cm; inner diameter: 10.3 cm) into the soil at the right depth. At each depth 4 undisturbed samples were taken: one pair of duplicates for each type of measurement.

During the incubation studies with the pesticides, the moisture content of topsoil at pF 2.0 was determined in triplicate of ring samples from the 0-30 cm layer with a typical bulk density of 1.40 kg $dm^{-3}$. The rings were filled in the laboratory with the soil used for the incubation studies, so these are disturbed samples. The soil was water-saturated and placed on ceramic filter plates with a hanging water column of 100 cm (pF 2.0).

## 3.2 Measurements of shrinkage characteristics

Shrinkage characteristics of soil aggregates were determined with the SARAN method as suggested by Bronswijk and Evers-Vermeer (1990) [method described by Stolte et al, 1997]. Soil samples were taken from the same pit at the same six depths and at the same time as described in chapter 3.1. At each depth about 10 soil aggregates with a diameter of 2 to 5 cm were taken from the wall of the pit. In the laboratory, for each soil layer, four of the best aggregates were saturated on a sand box, and then prepared for the determination of the shrinkage characteristic.

## 3.3 Transformation rates of the pesticides in three soil layers

***Bentazone***

The transformation rate of bentazone was measured in soil samples from the 0-30 cm, 40-70 cm and 80-120 cm layers. An overview of the performed incubation series and the specifications of each series is given in Table 2.6. Data on soil chemical characteristics and particle size distribution of the soil batches used for the studies are presented in Table 2.7. On 30-3-98, soil from the 0-30 cm layer was collected by taking 10 soil cores (inner diameter 6 cm) on each of the four sectors and mixing all 40 cores to one sample. The soil from the 40-70 cm and 80-120 cm layers was collected proportionally from 16 undisturbed soil columns, taken for determination of blanks for analysis and estimation of the soil moisture profile on 30-3-1998. At sampling time groundwater level was between 1.1 to 1.2 m, but no water flowed out of the columns. The bulked samples per layer were stored in field-moist condition at 5 °C until 12-5-1998. At that time they were placed in a cabinet at 10 °C until further treatment for incubation with bentazone. At 18-5-1998, the soil samples were gently dried at room temperature under a forced air stream while the soil was crumbled and mixed by hand and with a scoop in the mean time. Drying was continued (2.5 to 3.5 h) until the total weight of evaporated water (measured by constant weighing on a balance) corresponded with a loss of about 4 g 100 $g^{-1}$ moist soil (being the mass of water in which the pesticide was added to the incubated soil portions later). The soil of the 0-30 cm layer was further mixed in a Hobart food chopper. The soil batches of the two deeper layers were not further mixed because of the comparatively wet condition. Maximum size of some of the crumbles was 1 cm.

*Table 2.6. Characteristics of the incubation series with bentazone and imidacloprid in soils from three layers.*

| **Characteristic** | **Soil layer** | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0-30 cm | | | 40-70 cm | | 80-120 cm | |
| | 5° C | 15° C | 25° C | 10° C | 15° C | 10° C | 10° C* |
| **Bentazone** | | | | | | | |
| Average mass of dry soil (g) | 86.3 | 86.3 | 86.3 | 84.7 | 84.7 | 82.2 | 79.1 |
| Average mass of water (g) | 17.9 | 17.9 | 17.9 | 19.5 | 19.5 | 22.1 | 40.2 |
| Moisture content (g 100 $g^{-1}$) ** | 20.7 | 20.7 | 20.7 | 23.0 | 23.0 | 26.9 | Sat. |
| Added mass of pesticide (µg) | 97.7 | 97.7 | 97.7 | 9.45 | 9.45 | 0.95 | 1.66 |
| | | | | | | | |
| **Imidacloprid** | | | | | | | |
| Average mass of dry soil (g) | 66.0 | 66.0 | 66.0 | - | 72.2 | 69.7 | - |
| Average mass of water (g) | 14.5 | 14.5 | 14.5 | - | 17.4 | 19.8 | - |
| Moisture content (g 100 $g^{-1}$ )** | 22.0 | 22.0 | 22.0 | - | 24.1 | 28.3 | - |
| Added mass of pesticide (µg) | 54.6 | 54.6 | 54.6 | - | 2.18 | 2.18 | - |

* water-saturated soil

** moisture content during incubation (dry soil basis).

*Table 2.7. Characteristics of the soils used for the transformation and sorption measurements of bentazone and imidacloprid. Adsorption measurements only in soil of the 0-30 cm layer.*

| **Characteristic** | **Bentazone** | | | **Imidacloprid** | | |
|---|---|---|---|---|---|---|
| | 0-30 cm | 40-70 cm | 80-120 cm | 0-30 cm | 40-70 cm | 80-120 cm |
| pH-KCl | 7.2 | 7.4 | 7.5 | 7.1 | 7.5 | 7.6 |
| pH-$H_2O$ | 7.9 | 7.9 | 8.1 | 7.2 | 8.1 | 8.2 |
| CEC ($cmol^+$ $kg^{-1}$) | 22.4 | | | 24.2 | | |
| Organic matter (%) | 2.3 | 1.1 | 1.0 | 2.5 | 1.2 | 1.0 |
| Organic carbon (%) | 1.28 | | | 1.45 | | |
| $CaCO_3$ (%) | 0.2 | 4.8 | 5.6 | 0.2 | 2.9 | 6.6 |
| Clay (%) | 27.7 | 34.1 | 37.2 | 28.6 | 31.9 | 36.2 |
| Silt (%) | 52.9 | 50.5 | 47.1 | 54.3 | 54.1 | 48.0 |
| Sand (%) | 19.4 | 15.4 | 15.8 | 17.1 | 13.0 | 15.8 |

Portions of 100 g of moist soils from each soil layer were weighed into 0.25 L glass flasks. While the soil was added to the flasks, soil portions (10 for each batch of a soil layer) were taken periodically for determination of the average moisture content of

the soil in the flasks before adding the pesticide solutions. The flasks were pre-incubated for 7 days at the corresponding incubation temperature. On 26 May 1998, 4 ml of aqueous solutions containing bentazone were added to the glass flasks. The solution was added with a 5 ml syringe with a long thin needle, which was emptied slowly (drop wise) while rolling and shaking the flasks to get an even initial distribution of the pesticide. While dosing the flasks, 15 portions of 4 ml were taken for analysis of the dose and the average of these measured masses of bentazone are presented in Table 2.6. The average soil moisture contents during incubation were calculated from the total mass of water in the system after application of the pesticide in 4 ml water, the contents are given in Table 2.6.
The total mass of dry soil per incubation flask was very equal; CV (coefficient of variation) = 0.2 to 1.0%, and likewise the total mass of water; CV = 0.6 to 2.0%. The CV for the added mass of bentazone was between 0.3 and 1.3% for the 7 incubation series with bentazone .

The moisture contents during incubation were slightly lower (0.4 to 1.7%) in all three layers than the average contents of the soils when they were collected in the field on 30-03-1998. During two weeks before sampling, only 6 mm rain fell in small portions and the groundwater table gently fall from 80-87 cm at 15-03-1998 to 109-120 cm below soil surface at 30-03-1998. It was assumed that the measured moisture contents in the soil profile were representative for the field in equilibrium with an average water of 1.10 m, which appeared to be quite correct (see chapter 6.1)

Bentazone was also incubated in water-saturated soil from 80-120 cm depth, because this moisture condition could occur for longer times at that depth in the field during the experimental period. The water-saturated condition was obtained by adding 19 ml of a solution of bentazone in water to 100 g moist soil portions. A water layer of a few millimetres thickness resulted on top of the soils. The flasks were not air tight closed, so incubation was aerobic as was expected in the field for the upper layer of the groundwater. The dose of bentazone was increased for the saturated series to obtain comparable concentrations of bentazone in the soil-water phase (about 42 µg $L^{-1}$) similar to the other incubation series in this soil layer. Only single samples were extracted and analysed with the incubation series in the 40-70 cm layer at 10 °C at the sampling times.

The flasks with the soil portions were covered with an aluminium foil with a 2 mm hole and placed in loosely covered boxes with a water layer on the bottom to prevent evaporation of moisture from the flasks. The boxes were placed in constant temperature cabinets. The initial mass of each flask was weighted and the mass was measured again at the sampling times to estimate possible changes in the mass of liquid. At increasing time intervals duplicate samples (single for series at 10°C in 40-70 cm layer) were analysed to determine the remaining masses of bentazone or stored at –25°C for delayed analysis. Bentazone was extracted by adding 100 ml $CaCl_2$ solution to the flasks, which were then further treated as described in chapter 2.14. Extracted masses were not corrected for extraction efficiency because this was almost 100% (2.14).

### *Imidacloprid*

For several reasons, among labour capacity, incubation studies and sorption measurements with imidacloprid were started in 1999. Soils collected and prepared for the incubation studies with bentazone has been stored for a too long time at that time. For that reason fresh soils had to be collected outside the treated part of the field. Soil samples for incubation studies (and sorption experiments) with imidacloprid were collected on a 10 m wide strip land along the North side of the experimental field on 3-2-1999. This area was not sprayed with the pesticides but was further cultivated and cropped similar to that of the test area. Therefore, the soil may be seen as being representative for the experimental field.

The transformation of imidacloprid was measured in soil samples from the 0-30 cm, 40-70 cm and 80-120 cm layers. An overview of the performed incubation series and the specific characteristics of each series is given in Table 2.6. Data on soil chemical and particle size distribution of the soil batches used for the studies are presented in Table 2.7. The 0-30 cm layer was sampled by taking soil cores (3 cm diameter) at 30 sites. Soil from the 40-70 cm layer and the 80-120 cm layer was collected at 10 sites. A hole was drilled at each site with an auger (Edelman type, 11 cm diameter) to the top of the layer to be sampled. Soil was then collected with a smaller auger (6 cm) until the lower depth of the layer was reached. Careful handling enabled to collect soil, that was not contaminated with material from other depths. The soil cores were bulked per layer and stored at 10° C until further preparation for incubation. The soils of the three layers were gently air dried to the desired moisture loss and crumbled and mixed as described for bentazone. The mixed samples were stored for at least one day to promote equal moisture distribution before weighing moist soil portions into the incubation flasks. In contrast to the incubations with bentazone, no pre-incubation period was put into practice. This because the soil samples were freshly collected in the field and then stored at 10°C shortly. On 9 and 10 February 1999, 1 or 2 days after preparation of the soils, imidacloprid was applied. 4 ml of aqueous solutions, containing analytical grade imidacloprid at appropriate concentrations, were added to the glass flasks as described with the bentazone incubations. The applied masses of imidacloprid were checked by analysing 4 portions of the 4 ml doses for the incubation series in soil from the 0-30 cm layer (CV= 0.2%) and two portions of the 4 ml doses for the two deeper layers. The averages of the measured masses are presented in Table 2.6. At increasing time intervals duplicate samples were analysed to determine the remaining masses of bentazone or withdrawn flasks were stored at –25°C for delayed analysis. Imidacloprid was extracted by adding 100 cm$^3$ of a mixture of acetone /water (V/V, 80/20) to the flasks that were than shaken for 1 h. Samples were further treated as described in chapter 2.15. Extracted masses were not corrected for extraction efficiency because this was on average around 100%.

## 3.4 Measurements of sorption of the pesticides in soil water suspensions.

### *Bentazone*

From preliminary experiments it was known that the sorption of bentazone to the Andelst clay soil was very low (bentazone could be extracted with water with about 100% efficiency). Lowering of the concentration in the water phase in a batch equilibrium study would be hardly measurable and consequently lead to inaccurate sorption values. It was decided to prove the low sorption with an adapted batch study with 4 concentration levels (4 replicates each) with a minimum water/soil ratio (about 1:1) at only one temperature. The soil for this study was taken from the same batch as that used for the incubation study with bentazone in the 0-30 cm layer; properties are presented in Table 2.6. A mass of 50.0 g moist soil was added to centrifuge tubes with a volume of 80 ml. The moisture content of the soil was measured by drying three soil portions at 105 °C and was found to be on average 0.1615 kg $kg^{-1}$. Then 40.08 ml (s.d 0.05, n = 16) of one of the four bentazone solutions (in $CaCl_2$, 0.01 mol $dm^{-3}$) was added to the centrifuge tubes (4 replicates for each concentration). The added solutions were prepared from one stock solution. The concentrations of the four solutions were measured in triplicate and found to be: 0.136, 0.650, 2.71 and 13.7 mg $dm^{-3}$. The tubes contained on average 43.06 g (s.d 0.01, n = 16) solid phase and 47.03 g (s.d 0.05, n = 16) liquid phase. The centrifuge tubes were closed with glass stoppers and placed on a rotating disk, which was at an angle of 1.4 rad. The disk was placed in a cabinet with a constant temperature of 20 °C. The rotating frequency of the disk was 0.3 $s^{-1}$. After rotating for 24 h, the stoppers were replaced by aluminium foil and the tubes were centrifuged for 20 min at a rotation frequency 33 $s^{-1}$. This was done in a Varifuge 3.2RS Heraeus centrifuge that was kept at the same temperature as in the cabinet. The concentration of bentazone in the water layer was measured in duplicate by direct injection of the liquid in the HPLC or after 10 times dilution with $CaCl_2$ solution (0.01 mol $dm^{-3}$). Concentration of bentazone in extracts of blank soil was < 5 µg $dm^{-3}$.

### *Imidacloprid*

The sorption of imidacloprid was determined at 5, 15 and 25 °C with soil from the 0-30 cm layer, collected on 3-2-1999, which was also used for the degradation studies with imidacloprid; properties are presented in Table 2.6. Solutions of imidacloprid with measured concentrations (duplicate) of 0.106, 1.07 and 10.6 mg $dm^{-3}$ were made in $CaCl_2$ (0.01 mol $dm^{-3}$). A mass of 50 g moist soil was added to centrifuge tubes with a volume of 80 ml. The moisture content of the soil was measured by drying 10 soil portions at 105 °C and was found to be 0.159 kg $kg^{-1}$. Then 50.15 ml (s.d = 0.13, n = 27) of the three imidacloprid solutions was added to the centrifuge tubes (triplicate for each concentration). Each tube contained on average 43.14 g (s.d = 0.009, n = 27) solid phase and 57.01 g (s.d = 0.18, n = 27) liquid phase. The centrifuge tubes were closed with glass stoppers and placed on a rotating disk, which was placed for 24 h in a cabinet with a constant temperature of 5, 15 or 25 °C. The centrifuge tubes were further treated as described for bentazone. The concentration of imidacloprid in the water layer was measured by direct injection of the liquid in the HPLC or after 10 times dilution with a $CaCl_2$ solution (0.01 mol $dm^{-3}$). Concentration of imidacloprid in extracts of blank soil was < 5 µg $dm^{-3}$.

### *Desorption of aged imidacloprid*

Desorption of aged imidacloprid residues by water was measured during the transformation study in soil from the 0-30 cm layer at 25 °C to assess effects of long-term sorption kinetics. After 12, 41, 89, 166 and 285 days incubation time, portions (40-50 g) of the total mass of the soil (about 100 g) in the incubated flasks were transported into centrifuge tubes of the type that were also used with the batch-sorption studies. Triplicate samples were prepared at each sampling time. To these soil portions an equal mass (W/W) of $CaCl_2$ (0.01 mol $dm^{-3}$) was added. Subsequently the centrifuge tubes were closed with glass stoppers and treated as described with the bentazone and imidacloprid sorption experiment. After centrifugation, the concentration of imidacloprid in the supernatant water layer was measured by direct injection of samples on the HPLC. The total mass of dry soil in the centrifuge tube was determined by drying the tube with soil at 105 °C. The remaining mass of soil in the incubation flask was extracted by adding 100 $cm^3$ of a mixture of acetone/water (V/V, 80/20) to the flask, which was then shaken for 1 h. Samples were further treated for analysis as described in chapter 2.15. Extracted masses were not corrected for extraction efficiency because that was on average around 100%. The initial mass of imidacloprid in the centrifuge tube was calculated from the mass of dry soil that was weighted into the centrifuge tube and the measured content of imidacloprid in the soil by extraction with acetone/water. It was assumed that masses of imidacloprid in the two soil portions were proportionally with the masses of soil. The total mass of water in the centrifuge tube was calculated from the mass of $CaCl_2$ solution added plus the mass of water present in the soil portion that was transferred into the tube. The water content of the soil (mass of water) was known at the start of the incubation and corrected for losses (0 to max 0.9 g) by evaporation during the incubation period (controlled by weighing).

# 4 Numerical descriptions of the results in the files and on cd

The results of the study are available in digital form on a CD entitled ‘Experimental fiel Field Andelst, the Netherlands 1997-1999. This CD is part of this report. The format and the names of the files used to describe the data are based on Van Geelen (1995) who developed it for data sets on nitrate leaching. His format is an improved version of the format set up by Kragt & Jansen (1991). We had to modify the format of Van Geelen (1995) for a number of files and to define additional files with additional formats because his format did not apply fully to studies with pesticides. The files should be self-explanatory. The greatest part of the results described in the files will be described graphically in the chapters 5 and 6. There is (or should be) a 1:1 correspondence of the graphical and numerical results.

Table 4.1 gives an overview of the files and their contents. The first part of each file can be found in the annexes as described in Table 4.1. The names of the variables in the files consist of the two-character codes explained in Annex 1.

Note that the standard error of all measured profiles (bulk density, moisture, solute concentrations) are standard errors of the average, which equals the standard deviations of the individuals divided by the square root of total number of observations. We did so because our samples were not uniform as described in paragraph 2.11: e.g. individual moisture profiles from 16 plots were measured at each sampling time whereas the samples from plots within one sector (see Fig. 2.1) were mixed before pesticide analysis (resulting in four measured profiles).

*Table 4.1. Explanation of the contents of the files on the data set (CD) ‘Experimental field Andelst the Netherlands 1997-1999’. The first page of each file is given in the indicated number of the Annex*

| Name of file | NR Annex | Description of content |
|---|---|---|
| NLA00.BEA | 4 | Adsorption of bentazone to soil of layer 0-30 cm |
| NLA00.BET | 5 | Bentazone transformation in soil of layer 0-30 cm, soil of layer 40-70 cm, soil of layer 80-120 cm and water-saturated subsoil of layer 80-120 cm |
| NLA00.CDC | 6 | Cumulative and daily drain discharges |
| NLA00.CLI | 7 | Meteorological data measured by weather station “Haarweg” in Wageningen. Daily average of: air humidity, wind speed, global radiation and air temperature. |
| NLA00.CRL | 8 | Data on crop growth (Light interception) |
| NLA00.CRY | 9 | Dry matter production of crop and bromide and nutrients (N and P) in crop parts |
| NLA00.D1BR | 10 | Concentration of bromide (BR) in water of drain set D1 |
| NLA00.D1NT | 11 | Concentration of nutrient compounds (N and P) in water of drain set D1 |
| NLA00.D1PE | 12 | Concentration of pesticides (PE) bentazone , imidacloprid) in water of drain set D1 |
| NLA00.D2BR | 13 | Concentration of bromide (BR) in water of drain set D2 |
| NLA00.D2NT | 14 | Concentration of nutrient compounds (N and P) in water of drain set D2 |
| NLA00.D2PE | 15 | Concentration of pesticides (PE) bentazone , imidacloprid) in water of |

| | | |
|---|---|---|
| | | drain set D2 |
| NLA00.DDC | 16 | Discharge of drain set D1 and drain set D2, at 5 min resolution |
| NLA00.DLI | 17 | Instantaneous measurements of water level in drainage ditch |
| NLA00.GAN | 18 | Ammonium-N (NH4-N) concentrations in groundwater |
| NLA00.GBE | 19 | Bentazone (BE) concentrations in groundwater |
| NLA00.GBR | 20 | Bromide (BR) concentrations in groundwater |
| NLA00.GIM | 21 | Imidacloprid (IM) concentrations in groundwater |
| NLA00.GLC | 22 | Continuous measurements of groundwater levels (phreatic) on plot I & O |
| NLA00.GLD | 23 | Daily averages of continuous measurements of groundwater levels (phreatic) on plot I and O |
| NLA00.GLI | 24 | Groundwater levels (phreatic), instantaneous measurements in clusters of groundwater sampling tubes on each sector |
| NLA00.GKN | 25 | Kjeldahl-N concentrations in groundwater |
| NLA00.GNN | 26 | Nitrate-N (NO3-N) concentrations in groundwater |
| NLA00.GPP | 27 | Ortho-P (PO4-P) concentrations in groundwater |
| NLA00.GTP | 28 | Total-P concentrations in groundwater |
| NLA00.IMA | 29 | Adsorption isotherms of imidacloprid (three temperatures, layer 0-30 cm) |
| NLA00.IMD | 30 | De-sorption of aged imidacloprid in soil of layer 0-30 cm |
| NLA00.IMT | 31 | Imidacloprid transformation in soil of layer 0-30 cm, soil of layer 40-70 cm, subsoil of layer 80-120 cm. |
| NLA00.MBE | 32 | Areic mass of bentazone (BE) in the soil on sampling times |
| NLA00.MBR | 33 | Areic mass of bromide (BR) in the soil on sampling times |
| NLA00.MIM | 34 | Areic mass of imidacloprid (IM) in the soil on sampling times |
| NLA00.PDY | 35 | Daily precipitation at soil level |
| NLA00.PIT | 36 | Precipitation intensity, with clock time for each recorded pulse representing each about 0.2 mm precipitation. |
| NLA00.PLI | 37 | Piezometric levels in the aquifer: instantaneous measurements at three plots |
| NLA00.SAN | 38 | Ammonium N (NH4-N) content profiles in soil |
| NLA00.SBD | 39 | Soil dry bulk density profiles |
| NLA00.SBE | 40 | Bentazone content profiles in soil |
| NLA00.SBR | 41 | Bromide content profiles in soil |
| NLA00.SCP | 42 | Soil chemical data and particle size distribution |
| NLA00.SHC | 43 | Soil hydraulic conductivity |
| NLA00.SHP | 44 | Soil hydraulic parameters (van Genuchten parameters) |
| NLA00.SIM | 45 | Imidacloprid content profiles in soil |
| NLA00.SMM | 46 | Soil moisture profiles (mass fractions) |
| NLA00.SMV | 47 | Soil moisture profiles (volume fractions) |
| NLA00.SKN | 48 | Kjeldahl-N content profiles in soil |
| NLA00.SNN | 49 | Nitrate-N content (NO3-N) content profiles in soil |
| NLA00.SPP | 50 | Phosphate-P (PO4-P) content profiles in soil |
| NLA00.SOX | 51 | Oxalic extractable P, Al and Fe in soil |
| NLA00.STP | 52 | Total-P content profiles in soil |
| NLA00.STE | 53 | Daily average soil temperature at 3 depths and daily min. & max. air temperature at the experimental field |
| NLA00.SWR | 54 | Soil water retention characteristics |

# 5 Results of the field study

## 5.1 Time series of meteorological data, soil temperature, groundwater level and drain discharge

***Time series of meteorological data***

Figure 5.1.1 shows the daily precipitation and cumulative precipitation as measured at the experimental field, starting on 17 November 1997. 1998 was a year with much more precipitation than the long-year average for the region. September, October, and to a lesser extent also November had exceptional high rainfall.

Average daily air temperatures measured at the experimental field were in the range between – 6 and 24 °C (Fig. 5.1.2). Winters of 1997/1998 and 1998/1999 were both very mild with only a few short frost periods. Fig 5.1.3 shows the differences between the minimum and maximum air temperatures at 1.5 m height as measured at the experimental field at Andelst and at the weather station ‘Haarweg’ in Wageningen. The maximum temperatures at Andelst were quite analogous to that in Wageningen. The minimum temperatures differed somewhat more as could be expected because the field at Andelst was arable land with cropped and not cropped periods whereas the field in Wageningen was a lawn, which affected radiation during the night. These observations indicate that the measurements at the weather station at Wageningen are rather representative for the field at Andelst.

Daily global radiation, average air humidity and average wind speed were not measured at the experimental field, but derived from the weather station ‘Haarweg’ in Wageningen at 10 km distance. The values are given in Annex 7 starting at 1 November 1997. The minimum and maximum air temperatures at Wageningen are also presented in Annex 7.

Daily average soil temperatures at 5 cm depth were close to the average air temperatures and sporadically fell below zero °C. (Fig. 5.1.4.).

***Groundwater level***

Figure 5.1.5 shows the fluctuation of the groundwater level in time. The level varied from about 40 cm depth during a very wet period in the first week of November 1998 to about 190 cm depth in dry periods in Summer and Autumn. The convexity of the groundwater table was measured at 11 times until 12 May 1998 drains (see chapter 2.1 and 2.7). The levels in the middle between two drains were always less than 3 cm higher than the levels near the drains (tubes at 0.5 to 1m distance). Only at 8-03-1998 (day 67) the level in the middle between the drains was 4 to 17 cm higher. This was after a period with high rainfall in the preceeding days (77 mm in 5 days), wich resulted in high water tables of about 45 cm below soil surface. (about 40 cm above drain depth).

The piezometric level followed the phreatic level closely and was generally slightly lower. The ditch level was extremely low (almost dry ditch) at the start of the experiment in 1977 due to the low groundwater level in the whole region following a dry summer and autumn in 1997. The maximum ditch level measured was 102 cm below soil surface, but it is possible that it was somewhat higher during short periods in November 1998 with very high discharge by the region.

### *Drain discharge*

Figures 5.1.6 shows the daily and the cumulative drain discharge for both drain sets D1 and D2 (Annex 6). The values are based on the detailed measurements of the flow rate per 5 min (Annex 16). For a few short periods data of one of the two drain sets were missing: set D1: 3-15 Sept. 1998; set D2: 6-12 Jan. and 6-8 March 1998. For these periods the incomplete data set was completed by taking the data of the other, complete set and adjusting these with the average ratio (D1/D2) between the discharge of both drain sets. This average ratio of 0.8 was calculated via linear regression based on all available daily averages of the two drain sets (when complete for the whole day period for both sets). The average of the cumulative discharge of the two drain sets was weighted by the area of the catchment area of both drain sets. (See section 2.1)

Drain discharge was low during the winter time in the beginning of 1998. Two short periods with drain discharge occurred before application of the test chemicals. Only at 7 March (day 66) drain discharge was considerable (20-25 mm). During summer the groundwater table was (far) below the drain level and consequently there was no drain discharge. Only a very low discharge was measured after heavy rainfall for drain set D2 between 26 and 28 April 1998 (day 115–117). With the first heavy rains at 14 September (day 257) drain discharge started again and discharge continued most of the time until the end of the experimental period at 3 April 1999 (day 458). Drain discharge was considerable in the first half of the winter, because of the heavy rains that lasted until the end of 1998. Especially in the period 28 October (day 301) until 12 November (day 316) precipitation was excessive, and consequently drain discharge was extremely high. At two days, 28 October (day 301) and 1 November (day 305), drain discharge was higher than the maximum capacity of the pumps. For these events drain discharge could not be measured (see Table 2.2). Therefore discharge was estimated to be equal to the maximum pump capacity of 24.7 mm $day^{-1}$ and 34.5 mm $day^{-1}$ for drain set D1 and drain set D2, respectively (see also Fig. 5.1.8). The maximum pump capacity is a realistic estimation of the discharge at that moment because only a very restricted outflow of water from the closed container was possible. The total drain discharge during the 450 days experimental period mounted up to 400 mm for set D1, 520 mm for set D2 (average 460 mm).

In general the two drain sets showed the same pattern for the drain discharge. But, despite the smaller catchment area (5700 $m^2$ for set D2 against 6300 $m^2$ for set D1), the drain outflow of set D2 was always higher than that of set D1. The average ratio between the discharge of set D1 and set D2 was 0.8. This ratio was very constant for the events with high drain discharges. Drain D2 always started discharging earlier than set D1 and kept on discharging for a longer period as well.

At some times these differences between drain set D1 and D2 can be attributed to local differences in the response of the phreatic groundwater level to the regional hydrological influences. In the description of the soil profile (see section “experimental field and application of chemicals”), we mentioned the thick layer of coarse sand at about 3 m depth. This sand layer underlies the clay profile and is in direct contact with the river Rhine and it acts as a natural drain. We observed that this sand layer starts shallower in part of the catchment area of drain set D2 than in the catchment area of D1. This resulted in higher hydraulic conductivities for the subsoil below drain set D2 than below drain set D1. Therefore, the phreatic groundwater levels within the catchment area of drain set D2 responded stronger to the piezometric groundwater levels, which are strongly governed by regional hydrological components like the level of the river Rhine and other water courses. In conclusion, the higher hydraulic conductivities for the subsoil below drain set D2 than below drain set D1 may probably be one of the causes for the larger total drain discharge of drain set 2 than drain set 1. In addition, the enterence resistances of the drains of set 2 may for some reason be smaller than those of drain set 1. A substancial variability of drain discharges at field scale is not uncommon for Dutch soils that are known to be quite heterogeneous due to irregularly shaped sedimentation patterns (Stuyt, 1992)

Fig. 5.1.7 and Fig. 5.1.8 show the reaction of the groundwater table and the drain discharge on the precipitation for two periods with heavy rainfall. In both periods the groundwater table responded very fast to precipitation with a high intensity. Drain discharge started as soon as the groundwater level raised to the level of the drains (0.80-0.90 m below soil surface). In the first period, around 14 September (day 257), the drains were able to transport all the excess precipitation, resulting in a groundwater level equal to or slightly higher than drain depth (Fig. 5.1.7). In the second period, from 27 October (day 300) until 12 November (day 316), recharge of groundwater was too high to be drained immediately by the drains resulting in groundwater levels up to 0.5 m above drain level. In this period, peaks in the drain discharge corresponded strongly with peaks in the precipitation and in the groundwater level (Fig. 5.1.8). At 28 October (day 301) and 1 November (day 305) the peaks in drain discharge are cut off, indicating the periods where the drain discharge was set to the maximum pump capacity (see Table 2.2).

Table 5.1.1 gives the precipitation, drain discharge and the excess drain discharge (drain discharge minus precipitation) for both drain sets, cumulated over the periods 26 October 1998 (day 299) until 4 November (day 308), and 4 November until 12 November (day 316). Table 5.1.1 shows that in these periods 18 to 48% of the drain discharge can not be explained by the precipitation. Other sources of groundwater recharge contributed substantially to the drain discharge at that time. Upward seepage was likely the most important source, as in this period the water level in the nearby river was rather high. Fig. 5.1.5 shows that the two piezometric levels at day 306 were higher than the phreatic level, which support this interpretation. Another possible source was lateral groundwater flow from adjacent fields with a higher groundwater level.

Clear indications for runoff were never observed. Even on 7 March 1998 (day 66) and 14 and 15 September 1998 (days 257 and 258), with 45 mm or more rainfall in the preceeding 24 h, no ponding was observed at field inspections.

*Table 5.1.1. Precipitation, drain discharge and excess drain discharge (drain discharge minus precipitation) for the periods 26 October (day 299) until 4 November (day 308), and 4 November until 12 November (day 316). All values in mm. Values between brackets are excess drain discharge as % of drain discharge.*

| Period (day number) | Precipitation | Drain set D1 | | Drain set D2 | |
|---|---|---|---|---|---|
| | | Drain discharge | Excess drain discharge | Drain discharge | Excess drain discharge |
| 299-308 | 115.2 | 140.5 | 25.3 (18) | 170.6 | 55.4 (32) |
| 308-316 | 38.5 | 54.5 | 16.0 (29) | 74.4 | 35.9 (48) |
| 299-316 | 153.7 | 195.0 | 41.3 (21) | 245.0 | 91.3 (37) |

## 5.2 Bulk density and soil moisture profiles

### *Bulk density*

Dry bulk density profiles and soil moisture profiles were measured to 1.2 m depth at nine times. The bulk density was fairly constant with depth below the maximum depth of cultivation (about 30 cm). Ploughing in December 1998 resulted in a clear change in the bulk densities for the 0-30 cm layer. Two typical bulk density profiles are shown in Fig 5.2.1, which show clearly the effect of ploughing. The measured bulk densities for the 0-10 cm layers have some uncertainty at all times, which is caused by the arbitrarily definition of the location of the soil surface level in the sampling tube at time of slicing the soil columns (see chapter 2.12 for details). It is proposed that the real bulk density for the 0-10 cm layer is slightly under- estimated. The broader range of soil bulk densities sometimes found at 110-120 cm is caused by the loss of soil at the bottom of the soil cores during pulling up. This was specially the case at 2 December 1998 (day 336) when soil sampling was done at high groundwater level.

### *Soil moisture profiles*

Figure 5.2.2 shows the volume fractions of liquid at all times when the profile was sampled, except the two samplings with the spilt tube auger (to 15 cm depth) after spraying of the chemicals (8 April and 29 May 1998). At 21 January 1998 (day 21), during a rainy period, the soil was sampled with a half open faced auger and only moisture contents were measured. At that time, sampling with the volumetric soil corer was not possible because of the wet conditions and sampling could only be done to about 90 cm depth (high groundwater table). This time showed the wettest soil profile sampled. The sampling at day 222 (10 August 1998) showed the lowest moisture contents for the top 50 cm of the profile. The top soil was dried out and showed cracks at that time. However, the sampling at 15 June (day 166) showed lower moisture contents at greater depths (below 60 cm) but higher contents in the top 50 cm. A period with dry and warm weather during the weeks before 15 June resulted in a high evapo-tranpiration, which had dried out the profile. However, about 24 mm rainfall during 2 days just before sampling at 15 June had rewetted the upper part of the soil profile.

On day 264 (21 Sept.) the toplayer was very wet because of the high rainfall in the week before and the loose crumbly soil stucture that was caused by the cultivations at application of the pig slurry. Moreover the field was grown with germinated wheat which formed a kind of green “carpet”. At day 336 (2 December 1998) the field was sampled after a frost period, at sampling the top layer was still frozen.

## 5.3 Concentrations of bromide ion in soil, groundwater and drain water

***Bromide masses***

The average areic mass of bromide in soil at the first sampling time (on 8 April, = day 98; one day after application) was 53.4 kg ha$^{-1}$, which is 90 % of the applied mass of 59.6 kg ha$^{-1}$ (Fig 5.3.1). The first sampling was performed with a split-tube auger (9.5 cm diameter, 15 cm sampling depth). The total mass of wet soil in each of the three layers per column was extracted and the measured masses of Br in each layer were summed and the total areic mass was determined. So, soil mass or soil bulk density was not involved in the calculations of the areic mass at the first sampling time. This is in contrast to the other sampling times where the masses per volume were calculated from the Br concentration (mg dm$^{-3}$ soil) and the soil bulk density. The mass of bromide in soil had decreased dramatically at the second sampling time (29 April, = day 119), but a crop sampling at 11 May (= day 131) showed that about 80% of the bromide was taken up by the wheat crop (Fig. 5.3.1). Dry matter production and contents in crop are presented in Annex 9. A second and more extensive crop sampling on 5 August (= day 217) showed that the mass of bromide in the crop had decreased drastically. Soil samplings after that time showed that the mass of bromide in the soil profile had increased again. Apparently the bromide was taken up by the fast growing crop, in the period after application until about half May (day 97 until day 135) and was thereafter released again to the soil profile.

It is known that older plant parts (leaves, roots, fruits) tend to release electrolytes (like potassium) because cell membranes become more permeable. Rain can leach considerable amounts of ions from crops to the soil (Baker & Hall, 1988). There is no specific information for Br$^{-}$ but there are no reasons to suppose that this statement would be invalid for this ion. So our interpretation is that bromide was taken up by the wheat crop in the period of leaf development, whereas it was leached from the crop in the period of seed filling and ripening. Considerable uptake of bromide in plants and subsequent release into the soil during decay of the plant parts was also observed in studies with grass (Owens et al. 1985) and potato (Kung 1990). These observations seriously hamper the use of bromide as a tracer for soil water flow in cropped soil. However, in the present study the behaviour of bromide in the soil profile may be useful to test the solute transport model in autumn and winter, using the soil profile measured after harvest on 21 September1998 (= day 264) as an initial condition.

### *Concentrations in soil*

The average bromide concentration profiles at sampling dates are presented in Fig. 5.3.2. The profiles clearly show the initial decrease (day 119 to day 166) and subsequent increase (day 222) of the concentration in the top 20 cm layer. The leaching of bromide between 10 Aug. (day 222) and 21 Sept. (day 264) by the heavy rainfall (about 250 mm) is clearly represented by the two bromide profiles. On 21 September. the soil cores collected on the plots A-H were analysed individually and the results are given in Table 5.3.1 and the profiles are presented in Fig. 5.3.3.

*Table 5.3.1 Bromide concentrations (mg $dm^{-3}$ soil) in individully analysed cores taken at day 264 (21 September)*

| Depth (cm) | Average plots A-H | Average field (16 cores) | Plot A | Plot B | Plot C | Plot D | Plot E | Plot F | Plot G | Plot H |
|---|---|---|---|---|---|---|---|---|---|---|
| 0-10 | 7.62 | 5.92 | 7.69 | 3.59 | 19.19 | 0.01 | 4.68 | 6.48 | 7.22 | 5.84 |
| 10-20 | 5.65 | 7.31 | 12.29 | 6.06 | 3.87 | 0.36 | 9.34 | 5.08 | 15.75 | 12.52 |
| 20-30 | 4.66 | 6.00 | 10.35 | 4.66 | 3.17 | 0.48 | 8.94 | 5.75 | 8.42 | 7.13 |
| 30-50 | 3.69 | 4.03 | 4.24 | 5.43 | 2.36 | 2.74 | 2.52 | 3.51 | 3.66 | 6.08 |
| 50-70 | 2.94 | 2.85 | 1.34 | 3.35 | 2.04 | 5.02 | 1.01 | 2.42 | 1.30 | 3.50 |
| 70-90 | 1.33 | 1.35 | 0.54 | 1.55 | 1.06 | 2.18 | 0.64 | 1.14 | 0.69 | 1.33 |
| 90-120 | 0.88 | 0.93 | 0.46 | 0.86 | 0.84 | 1.37 | 0.61 | 0.77 | 0.49 | 0.84 |

The profiles on plot C (deep leaching) and plot D (major mass still in top 10 cm) differed considerably from the other 6 and from the general pattern of the field average. However, it is assumed that this great spread is more representative for the 21 Sept. sampling rather then for all other sampling times, because of the following observations. The straw remnants on the soil surface were not equally distributed after the application of the pig slurry. Small “bumps” of straw remained besides places without straw and “invisible” tracks were present due to the pig slurry applicator and the subsequent crosswise cultivation with a spring tine cultivator (see section 2.3). During the first weeks after these actions this may have resulted in an irregular water infiltration on the sampling spots, shielding by straw or water collection of water at depressions in tracks.

At the first (deep) profile sampling on 29 April (day 119) most concentrations beneath 20 cm depth were below the limit of quantification, except for the layer 70 to 90 cm. Only one soil sample at 70-90 cm had a concentration of 1.6 mg $dm^{-3}$, the other three samples were below the LOQ (= 0.5 mg $dm^{-3}$) or slightly above. Probably some showers (total 56 mm) in the weeks before sampling on 29 April (22 days after application) caused preferential transport of bromide to that depth. Drain water collected in that period showed high concentrations of bromide (about 5 mg $dm^{-3}$, see Fig. 5.3.5) and high concentrations also of the pesticide bentazone (Fig 5.4.4). Concentrations in the soil system corresponding with 5 mg $dm^{-}3$ in the liquid phase at 29 April were only found in the top 10 cm layer. This is also a strong evidence for preferential transport of bromide through the soil profile. Concentrations in groundwater at 1.0-1.2 m depth were about 1.0 mg $dm^{-3}$ at that time (Fig. 5.3.4). Apparently the fast transported bromide was redistributed in the soil around the drain depth. The groundwater table had moved upwards to about 0.8 m depth at that time (see Fig 5.1.5).

### *Groundwater and drain water*

The spatial variability of bromide concentrations in groundwater was small for the entire experimental period (Fig.5.3.4). Already 22 days after application bromide was measured at 1.0-1.2 m depth at a concentration of about 1 mg $dm^{-3}$. About 56 mm of rainfall was measured in that period. The bromide concentrations at 1.0-1.2 m and 1.3-1.5 m depth increased to a maximum of about 4 mg $dm^{-3}$ until day 352. Thereafter, the concentrations decreased slightly and remained about 3 mg $dm^{-3}$ until the end of the experiment. For the deep layer (1.9-2.8 m), low concentrations bromide of about 0.15 mg $dm^{-3}$ were measured at two times (day 149 and 222) when the groundwater table was low and other filters could not be sampled. At day 428 all groundwater filters were sampled and the concentration in water from the deepest filter had increased to about 1.5 mg $dm^{-3}$. The bromide concentrations in groundwater were generally somewhat lower than in drain water in periods when the groundwater table was clearly below drain depth. This is probably caused by diluting after preferential flow reaches the groundwater table but perhaps even more by the sampling method of the groundwater. The sampling method leads to mixing of water from at least more than the filter length (20 cm). After about day 300, in periods when the groundwater table fluctuated at the depth of the drain tubes (Fig 5.1.5), bromide concentrations in groundwater (at 1.0-1.5 m) and drain water (Fig 5.3.5) were quite identical (3-4 mg $dm^{-3}$). This confirms the lesser effect of dilution in groundwater in that case.

Bromide concentrations in water from drain set D1 and drain set D2 were remarkably close during the entire experimental period and the variation of these concentrations in time was small (Fig. 5.3.5). Already on 29 April (day 118; 21 days after application) almost the highest bromide concentrations were measured in a very low discharge of drain set D2 (0.4 mm). In total 56 mm rain fell in that period. The bromide concentration of 5 mg $dm^{-3}$ corresponds to only about 0.4% of the applied amount. The discharge of water of drain set D1 was too small to be detectable. However, some water could be collected, which showed a concentration that was almost equal to that in drain set D2. These high concentrations in drain water, 21 days after application, may be attributed to preferential transport

The concentrations in drain water were rather independent of the average drain fluxes in the periods wherein the water samples for analysis were composed (Fig. 5.3.5). Only in periods with very high drain discharges, bromide concentrations tended towards some decrease. A remarkable low bromide concentration (and also bentazone, Fig. 5.4.4) was measured in the discharge of drain set D2 between 6–10 November (day 309-313). Re-analysis of the prepared water samples gave the same results. The drain discharge (44.6 mm) in the 4 days sampling period was the highest of all sampling periods in that very wet month. So, dilution could be a reason for this remarkable low concentration. However, this is in contrast to the general picture that showed no correlation between concentration and flux. Therefore, a mistake with preparing the sample for analysis may be also not excluded. A check of the raw data could not exclude nor confirm abnormalities in sample preparation.

## 5.4 Concentrations of bentazone in soil, groundwater and drain water

***Bentazone masses***

The recovered areic masses of bentazone in the soil are presented in Fig. 5.4.1. On 8 April, one day after application, on average 1.4 kg ha$^{-1}$ of bentazone was recovered, which is about 10% higher than the nominal applied amount of 1.33 kg ha$^{-1}$ This deviation is quite within the acceptable variation for field studies. The average masses of the four sectors were quite similar at each sampling time, except for the second sampling time on 29 April (day 119), when a relatively high mass was recovered in the four soil cores from Sector 3. No explanation could be given for this outlier. The decline of bentazone proceeded fast and approximately exponentially with time. On 2 December 1998 (day 336) contents in almost all soil samples (except some samples from the 0-20 cm layer) were below the LOQ (0.8 µg dm$^{-3}$ soil), which means that less than 0.5% of the dose was left.

***Concentration in soil***

At day 119 (22 days after application with 56 mm rainfall), most of the bentazone was found in the top 30 cm of the soil profile (Fig. 5.4.2), but concentrations of 2 µg dm$^{-3}$ were measured already between 70 and 90 cm depth. At day 166 (15 June) concentration in the top 10 cm had drastically decreased by degradation and leaching to the lower part of the ploughed layer. At day 222 (10 August), just before harvesting of the crop, concentrations in the top 50 cm had decreased further and no clear leaching occurred between day 166 and 222 with 83 mm rainfall but distinct evapo-transpiration. Between day 222 and day 336 (2 Dec. '98) concentrations in the 30-90 cm layer decreased with about a factor 10 to below the LOQ. From the incubation studies in soil from the 40-70 cm and 80-120 cm, layers half-lives of about 100 and 600 days can be deduced, respectively. So the observed decrease of the concentrations in the 30-90 cm layer has to be attributed mainly to the leaching of bentazone by the 550 mm rain that fell between day 222 and 336.

***Concentrations in groundwater***

Already 22 days after application (day 119) bentazone was measured in groundwater at 1.0-1.2 m depth at a concentration of about 16 µg dm$^{-3}$ (Fig. 5.4.3). At Day 119 bentazone concentrations in soil below 90 cm depth were demonstrated to be present, but below the limit of quantification (0.8 µg dm$^{-3}$). This corresponds with a maximum bentazone concentration of 2 µg dm$^{-3}$ in the soil pore water. Hence, the bentazone concentration of 16 µg dm$^{-3}$ found in groundwater was eight times higher than that in soil below 90 cm depth or about 5 times higher then in the soil at 70-90 cm depth (groundwater level at day 119 had raised to about 75 cm shortly). So, the not sorbed bentazone showed the same fast preferential transport as the bromide ion with 56 mm rainfall in the 22 days period. 20 mm of the 56 mm rain fell two days and four days before sampling. After day 119, groundwater level sank considerably (Figure 5.1.5) and concentrations in groundwater collected from the deeper filters decreased drastically. Concentrations increased again (sampling at day 250) after heavy rainfall in the first week of September. Thereafter concentrations remained rather constant between 1 and 2 µg dm$^{-3}$ (Fig. 5.4.3).

### *Concentrations in drain water*

Bentazone concentrations in water of drain set D1 and drain set D2 are given in Fig. 5.4.4. The sampling periods and sample composition for analysis are given in detail in Table 5.4.1 and Table 5.4.2, respectively. Bentazone concentrations in both drain sets were remarkably close to each other at all sampling dates and concentrations showed no correlations with average drain flux in the sampling periods (as observed for bromide also). Far the highest bentazone concentrations (about 90 µg dm$^{-3}$) occurred already 21 days after application, simultaneously with the highest concentration in groundwater at that time (29 April; day 119). The drain discharge of drain set 2 was only 0.4 mm, which would correspond with about 0.02% of the applied amount. The discharge of drain set D1 was too low to be measurable. However, some water could be collected and the concentration was almost equal to that in drain set D2. The bentazone concentration of 2 µg dm$^{-3}$ soil that was measured between 70 and 90 cm depth at day 119 (Fig. 5.4.2) corresponds with 5 µg dm$^{-3}$ in the liquid phase

*Table 5.4.1. Concentration of bentazone and imidacloprid in drain water of drain set D1*
*Shadowed values are analysed in proportionally combined samples of the discharge in the sampling period*

| Date Start | Date End | Day Nr start *) | Day Nr end | Discharge (mm) | Bentazone (µg dm$^{-3}$) | Imidacloprid (µg dm$^{-3}$) |
|---|---|---|---|---|---|---|
| 4-26 | 4-28 | 115.059 | 117.705 | a) | 91.4 | **b)** |
| 9-07 | 9-07 | 249.500 | 249.500 | a) | 11.0 | 3.76 |
| 9-14 | 9-15 | 256.576 | 257.073 | a) | 1.4 | 4.33 |
| 9-15 | 9-15 | 257.073 | 257.566 | a) | 1.2 | 2.57 |
| 9-15 | 9-18 | 257.566 | 260.771 | 9.7 | 1.5 | **c)** |
| 10-08 | 10-13 | 280.330 | 285.681 | 4.3 | 6.4 | 1.11 |
| 10-14 | 10-15 | 286.017 | 287.743 | 7.1 | 4.8 | |
| 10-15 | 10-27 | 287.743 | 299.646 | 13.7 | 4.1 | |
| 10-27 | 10-28 | 299.646 | 300.299 | 7.9 | 3.2 | |
| 10-28 | 10-28 | 300.299 | 300.490 | 4.7 | 2.2 | 2.10 |
| 11-03 | 11-04 | 306.500 | 307.455 | 10.0 | 2.7 | 0.45 |
| 11-04 | 11-06 | 307.455 | 309.181 | 10.0 | 3.3 | 1.30 |
| 11-06 | 11-10 | 309.181 | 313.733 | 38.6 | 2.5 | 0.70 |
| 11-10 | 11-17 | 313.733 | 320.358 | 23.4 | 4.6 | |
| 11-17 | 12-28 | 320.358 | 361.878 | 21.0 | 3.4 | 1.82 |
| 12-28 | 1-19 | 361.878 | 383.479 | 18.1 | 2.7 | |
| 1-19 | 3-15 | 383.479 | 438.208 | 58.6 | 1.9 | 0.05 |

***)** Day 1 = 1 January 1998
a) no measurable discharge or not correct measurement
b) before application of imidacloprid
c) not analysed

This reveals that the bentazone concentration of 90 µg dm$^{-3}$ found in drain water at day 119 (Figure 5.4.4) was 18 times higher than could be found in the soil liquid phase at the drain depth (i.e. 80-90 cm). Concentrations in the soil system that correspond with 90 µg dm$^{-3}$ in the liquid phase at day 119 were only found at the top 50 cm. This is evidence for preferential transport of bentazone to the drain depth, which probably must be attributed to permanent macro pores. Clear cracking of the soil was not observed in the period between application and sampling at day 119. The bentazone concentration in drain water was about six times higher than found in groundwater at day 119, probably because water leaching downward via preferential flow paths was diluted after reaching the groundwater. At the other sampling times, concentration in drain water was slightly higher (about two times) than in groundwater (as with bromide). Generally, bentazone and bromide leaching to drains and to groundwater were found to be consistent. So bentazone behaviour confirms that of bromide.

*Table 5.4.2 . Concentration of bentazone and imidacloprid in drain water of drain set D2*
*Shadowed values are analysed in proportionally combined samples of the discharge in the sampling period*

| **Date Start** | **Date End** | **Day Nr start *)** | **Day Nr end** | **Discharge (mm)** | **Bentazone (µg dm$^{-3}$)** | **Imidacloprid (µg dm$^{-3}$)** |
|---|---|---|---|---|---|---|
| 4-26 | 4-28 | 115.059 | 117.705 | 0.41 | 89.0 | **b)** |
| 9-03 | 9-06 | 245.351 | 248.916 | 4.98 | 10.7 | 6.3 |
| 9-14 | 9-14 | 256.576 | 256.809 | 2.52 | 1.81 | 6.43 |
| 9-14 | 9-14 | 256.809 | 256.906 | 2.49 | | 5.79 |
| 9-14 | 9-14 | 256.906 | 256.990 | 2.53 | | 5.71 |
| 9-14 | 9-15 | 256.990 | 257.073 | 2.64 | 1.59 | 5.23 |
| 9-15 | 9-15 | 257.073 | 257.139 | 2.14 | | 4.69 |
| 9-15 | 9-16 | 257.622 | 258.354 | 6.01 | 3.20 | **c)** |
| 9-16 | 9-26 | 258.354 | 268.559 | 10.0 | 3.95 | **c)** |
| 10-08 | 10-13 | 280.264 | 285.500 | 6.53 | 9.88 | 1.97 |
| 10-13 | 10-17 | 285.500 | 289.854 | 10.8 | 7.63 | |
| 1017 | 10-27 | 289.854 | 299.642 | 17.0 | 6.33 | |
| 10-27 | 10-28 | 299.642 | 300.292 | 9.53 | 3.35 | |
| 10-28 | 10-28 | 300.292 | 300.503 | 7.12 | 4.01 | 0.45 |
| 11-03 | 11-04 | 306.500 | 307.302 | 11.3 | 4.25 | 0.57 |
| 11-04 | 11-06 | 307.302 | 309.500 | 19.2 | 3.92 | 0.53 |
| 11-06 | 11-10 | 309.500 | 313.361 | 44.6 | 0.69 | 0.25 |
| 11-10 | 11-15 | 313.361 | 318.424 | 28.8 | 4.38 | |
| 11-15 | 12-20 | 318.424 | 353.434 | 26.7 | 4.69 | 0.32 |
| 12-20 | 1-16 | 353.434 | 380.850 | 33.5 | 4.16 | |
| 1-16 | 3-01 | 380.850 | 424.740 | 20.2 | 5.19 | 0.53 |
| 3-01 | 3-03 | 424.740 | 426.139 | 21.9 | 3.66 | 0.40 |
| 3-03 | 4-03 | 426.139 | 457.500 | 28.3 | 3.56 | 0.22 |

***)** Day 1 = 1 January 1998
b) before application of imidacloprid
c) not analysed

The bentazone concentration in drain water between day 337 and 427 remained at around 4 µg dm$^{-3}$ (Fig. 5.4.4) whereas the concentration in soil was below the limit of quantification of 0.8 µg dm$^{-3}$ for the entire soil profile. A concentration of 0.8 µg dm$^{-}$

$^{3}$ soil implies maximum bentazone concentration of 2 μg dm$^{-3}$ in soil pore water, which is about two times lower than measured in drain water. Therefore the source of the bentazone in the drain between day 337 and 427 is not clear. As the concentrations in groundwater are lower than in drain water the source has to be found in the unsaturated zone. It is possible that the top layer contained a higher total concentration than we could extract with one hour shaking with 0.01 M $CaCl_2$ solution. It was checked that this procedure gave good recoveries for freshly applied bentazone. However, this is not a guarantee for aged residues (Smith, 1981) and slow sorption may have occurred that was not detected via our extraction method. Between rainfall events there was time available (usually one week) for desorption equilibration, which may have led to concentrations of about 5 μg dm$^{-3}$ in the pore water of the top layer, the layer with initially far the highest concentration for “uploading” the soil matrix with bentazone. This may have acted as the source for the drain water concentrations. However, this explanation is speculative as no measurable sorption of bentazone was detected in the 24 h adsorption isotherm study (see section 6.4).

## 5.5 Concentrations of imidacloprid in soil, groundwater and drain water

### *General*

For several reasons, among laboratory capacity, chemical analyses of soil and water samples for imidacloprid could start only in January 1999. Samples were stored in freezers (temperature < 20°C) and possible transformation during storage was checked. Storage was  found to have not effected the results (see section 2.15). Fourteen extracts were also analysed with LC/MS to confirm the HPLC - UV measurements (Table 2.5; section 2.15)

### *Imidacloprid masses*

The recovered masses of imidacloprid in soil are presented in Fig. 5.5.1. On 29 May 2 days after application on average 0.55 kg ha$^{-1}$ of imidacloprid was recovered from the soil (0-15 cm depth). This demonstrates that about 80% of the 0.7 kg ha$^{-1}$ applied had reached the soil by direct deposition at spraying and by wash-off by the 15 mm of rainfall that fell about 1.5 d after application (see section 2.2 for details). At the other three sampling times (to 1.2 m depth) almost equal remaining masses were recovered ($0.25 \pm 0.02$ kg ha$^{-1}$). So between the end of May and the second sampling on 21 September a decrease of about 55% was observed, but in the subsequent half year (winter period with an average a soil temperature of 5 °C ) no further decrease was measured. This field persistence corresponds reasonably well with the laboratory incubation study at 5 °C with topsoil (section 6.3; Fig 6.3.3) which indicate a half-life for imidacloprid of > 500 days at 5 °C.

### *Concentration in soil*

Fig. 5.5.2 shows the concentration profiles of imidacloprid in soil at the sampling times The highest concentrations were found in the top 5-10 cm until the field was ploughed (25 to 30 cm deep) on 2 December 1998 (day 336) just after the third sampling time. Ploughing caused the more equal distribution of imidacloprid concentrations over the arable layer as measured at the last sampling time at 20 April 1999 (day 475). Already at the first deep sampling time (21 September; day 264) imidacloprid had been transported to 70–90 cm depth, so at the drain depth. At later sampling times, concentrations below the ploughed layer (> 30 cm) showed a clear increase. This was probably caused by the high rainfall, which was much higher than the average for the experimental region in autumn and winter. (Fig. 5.1.1)

***Concentration in groundwater***

Concentrations of imidacloprid in groundwater are presented as a function of time in Fig. 5.5.3. On 29 May (day 149; two days after application) groundwater samples collected at 1.9-2.8 m depth had no detectable imidacloprid ($<0.05$ μg $dm^{-3}$), which demonstrates the quality of the sampling procedure in a recently sprayed field. At a few times there was a rather large spatial variability but generally variability was low for a field study. Only one analysis could be done from groundwater collected at 1.0-1.2 m depth at day 250 and also of groundwater collected at 1.3-1.5 m depth at day 442. The other filters at mentioned depths delivered not enough water for sampling at that time. At day 352, water from filters at 1.0-1.2 (hide in Fig. 5.5.3) and 1.3-1.5 m depth were on average about the limit of quantification. This is probably caused by the extreme high rainfall in the preceding period. Concentrations in drain water were also very low at that time (Fig. 5.5.4). At day 428, three filter depths could be well sampled and analysed. There was a consistency in the trend of decreasing imidacloprid concentration as a function of depth, probably by dilution.

On 9 June (day 160), only 11 days after application, concentrations of below LOQ (= 0.05μg $dm^{-3}$) to 0.088 μg $dm^{-3}$ were measured in water collected at 1.3-1.5 m depth from the upper layer of the (risen)groundwater table. Within these 11 days, about 65 mm of rain fell, which was sufficient to transport imidacloprid to 1.3-1.5 m depth. This rapid breakthrough of imidacloprid can only be explained by preferential transport of this compound in the soil, particularly because imidacloprid is a sorbed compound (see section 6.4 and Fig 6.4.2) Imidacloprid was applied after a preceding period with no rainfall but with high evapo-transpiration, which had resulted in a distinct cracking of the soil. (section 2.2., application imidacloprid) The cracks probably accounted for a fast transport of imidacloprid through the soil until about the depth of the cracks. Permanent macro pores in the deeper subsoil contributed probably more for the further fast transport to greater depths. Holes (5–8 mm diameter) were often observed over tens of centimetres in the lower part (up to 1.2 m depth) of the soil columns taken for soil analysis. These permanent “canals” obviously originated from worms or decomposed tree roots from the former apple trees.

The sharp increase of the measured concentration at day 250 took place simultaneously with the start of drain flow (Fig. 5.1.6) and with the highest concentration in drain water (Fig. 5.5.4). Concentrations in the upper layer of the groundwater were always much lower (an order of magnitude) than in drain water. This may be expected because of dilution, but it also indicates that a considerable fraction of the fast transported imidacloprid has been directly transported to the drains.

***Concentration in drain water***

Composition of samples for analyses depended more or less on the results obtained for bentazone. Discharge periods for which samples for bentazone analysis were combined were now split up and individually analysed for imidacloprid. The reverse was true for periods in which bentazone concentrations were rather equal. Water samples for analyses were prepared from the stored samples (-20 °C). The drain discharge periods of drain set D1 and D2 for which samples for analysis were composed (proportionally) are given in detail in Table 5.4.1 and Table 5.4.2, respectively (see section 5.4, bentazone in drainwater). The total number of analyses per drain set diferred a few due to the problems with the sampling equipments and different discharge volumes (see section 2.8). Plots of concentration in drain water against average drain flux (mm day$^{-1}$) in the sampling period showed no correlation for both drain sets, as was noted already with bromide and bentazone.

The highest imidacloprid concentrations in drain water (Fig. 5.5.4) occurred in the first discharge between day 248 and 258 (Fig.5.1.6 and Fig. 5.1.7), after high rainfall in the first week of September 1998 (Fig. 5.1.1). Thereafter the concentrations decreased sharply and remained relatively low (below 2.0 μg dm$^{-}$3) for the remaining period of the experiment. The average concentration was about 5 μg dm$^{-3}$ between day 248 and 258. Assuming, sorption equilibrium using a Freundlich coefficient of 0.75 dm$^{3}$ kg$^{-1}$ (this value is based on a $K_F$ value of 1.5 dm$^{3}$ kg$^{-1}$, which can be derived from the adsorption measurements for the top layer; see section 6.4) a concentration of 5 μg dm$^{-3}$ in water corresponds to about 0.02 mg dm$^{-3}$ in the soil system. Fig. 5.5.2 shows that such contents were found only in the top 20 cm at day 264, which indicates that the drain water concentrations for this period resulted from preferential transport. Apparently, imidacloprid was transported preferentially with the water flow via cracks and macro pores. An average imidacloprid concentration of about 1 μg dm$^{-3}$ in the drain water as found between day 287 and 337 (Fig. 5.5.4) corresponds with about 0.004 mg dm$^{-3}$ of imidacloprid in soil, which is about four times the concentrations measured at 70-90 cm depth and shallower in the soil at day 336 (Fig. 5.5.2). Hence, the concentrations in deep layers cannot explain the drainage water concentrations for this period. Probably, these higher imidacloprid concentrations in drain water between day 287 and 337 were also the result of preferential transport. High rainfall occurred in this period and craks were no longer visible, which show clear evidence of preferential flow through permanent macro pores.

## 5.6 Concentrations of nutrients in soil, groundwater and drain water

### 5.6.1 Nitrogen

The results of the measurements of nitrogen compounds in soil, groundwater and drain discharge are presented in Annexes 11, 14, 18, 25, 26, 38, 48 and 49. Because nitrate was the sole N-compound that was measured in substantial quantities only the results of the nitrate measurements are discussed here. Kjeldahl-N and ammonium concentrations respectively were mostly rather low and generally very low because of the favourable conditions for the oxygen demanding processes mineralisation and nitrification in the unsaturated top 1 meter of the macroporous clay soil

### *Concentrations in soil*

There was a strong distinction between the nitrate concentrations in the soil above and below 30 cm of depth (Fig. 5.6.1). The cultivated layer above the plough pan at about 30 cm depth (see Annex 2) contained the highest concentrations. This cultivated layer contained also the most organic matter, total-N and mineral-N (Annex 42) due to ploughing down of manure and crop remnants in the past. Other reasons for the higher concentrations above the plough pan are that the plough pan may have acted as a barrier for the transport of nitrate downwards and that the cultivated layer in general was the most aerobic layer where conditions for mineralisation and nitrification were better and denitrification was less than in the soil profile below the plough pan.

The highest concentrations in the top layer up to almost 25 mg $NO_3$-N $dm^{-3}$ soil were found at day 475 due to the fertilizer application 34 days before at 17-03-1999, and also mineralization and nitrification of organic matter from the slurry applied at 01-09-1998 (see table 2.1). Fertilization was 39 kg $NO_3$-N $ha^{-1}$ and 39 kg $NH_4$-N $ha^{-1}$, while the areic mass of $NO_3$-N in the top 30 cm at day 475 was about 60 kg $ha^{-1}$. Conditions during those 34 days were apparantly such that ammonium fertilizer was nitrificated (hardly any ammonium was present in this layer; see Annex 38), relatively little nitrate was denitrificated and taken up by the crop (crop growth was low at that stage), and little nitrate was transported to deeper layers (concentrations below the plough pan were in the order of those at day 336). The second highest concentrations in the top layer were found at day 119, 68 days after the fertilizer application at 20-02-1998. These high concentrations can not entirely be attributed to this fertilization, since at day 98 (47 days after fertilization) nitrate concentrations were much lower, probably due to denitrification because of wet conditions in this top layer and leaching out of this layer in the period day 58-69 with high and intensive rainfall (see further ***Groundwater and drain water)***. The high concentrations at day 119 must have been the result of mineralization of soil organic matter and old manure, and nitrification of fertilizer ammonium (at day 98 ammonium concentrations were relatively high). The extreme low concentrations at day 166 were probably caused by crop uptake. In the period between day 119 and day 166 crop growth was the highest (see Fig. 5.7.1). Transpiration was about 160 mm in this period, while in the period before day 119 transpiration was only 28 mm (from calculations with the SWAP model). At the end of the growing season crop uptake was strongly decreased resulting in an increase of the nitrate concentrations in the top layer at day 222 due to high mineralization and nitrification of N from organic matter in this warm period.

In the soil profile below the plough pan, nitrate-N concentrations were around 5 mg $dm^{-3}$ soil. An exception were the very low concentrations at day 166 that must be attributed to crop uptake. The other exception was the high concentrations at day 119 that coincided with the high concentrations in the top layer at that day. These high concentrations below the plough pan may have been the result of the production of nitrate by mineralisation and nitrification, and chromatographic transport of nitrate from the ploughed layer downwards. But possibly preferential transport played a role as well in causing these high concentrations. Indications for this process are the higher standard errors of the average concentrations than at other days (Annes 49) and the strong indications for preferential flow of bromide and bentazone at this day (see 5.3 and 5.4).

### *Groundwater and drain water*

The spatial variability of nitrate concentrations in the groundwater was rather low for the entire experimental period (Fig. 5.6.2). In general, concentrations were between 10 and 30 mg $NO_3$-N $dm^{-3}$. There appears to be a relation with depth: the concentrations in the deeper filters were lower than those in the shallower filters, with some exceptions for the filters at 100-120 and 130-150 cm depth. This relation corresponds with the same relation for the concentrations in the soil profile. There was also a relation with fertilization events. The highest concentration of nearly 50 mg $NO_3$-N $dm^{-3}$ (standard error 2.2 mg $NO_3$-N $dm^{-3}$) was found in the shallowest filters at day 69, 18 days after the fertilizer application of 20-02-1998. This concentration corresponds with a concentration in the soil of 22.5 mg $NO_3$-N $dm^{-3}$ soil (volumic water content at saturation = 0.45) which is extremely high in comparison with the concentration profiles in the soil of Fig. 5.6.1. Possibly preferential flow of rain water containing fertilizer nitrate leached out of the top layer played a role in causing these high concentrations. Rainfall in the period between fertilization and groundwater sampling amounted to 94 mm, concentrated in the 11 days just before the sampling date of day 69. Also after the fertilizer application of 14-05-1998 and the slurry application of 01-09-1998 nitrate concentrations were relatively high. During the winter of 1998/1999 concentrations decreased gradually.

The nitrate concentrations in the drain discharge were in general around 10 mg $NO_3$-N $dm^{-3}$ (Fig. 5.6.3). This is about a factor 1.5-2 lower than the concentrations in the soil water and groundwater of the same dates, indicating that the drain discharge was a mixture of ‘clean’ rain water and nitrate containing soil water and groundwater. This could be an indication for preferential flow of clean rain water through macropores. However, this hypothesis is not directly supported by the bromide concentrations in ground and drain water (see 5.3). There was a clear relation between fertilization events and nitrate concentrations in the drain discharge. The highest peak concentrations of 25-32 mg $NO_3$-N $dm^{-3}$ in the drain discharge of drain set D1 in the period day 65-68 corresponded with the fertilizer application of 20-02-1998 and the period with high and intensive rainfall between day 58 and day 69. These peak concentrations were possibly caused by preferential flow of nitrate from fertilizer leached out of the top 30 cm of the soil profile. Due to pump failure the drain discharge of drain set D2 could not be registrated and sampled in this period (see table 2.2). Also the drain discharge of both drain sets shortly after the slurry application at day 244 showed some peak concentrations.

### 5.6.2 Phosphorus

The results of the measurements of phosphorus compounds in soil, groundwater and drain discharge are presented in Annexes 11, 14, 27, 28, 50 and 52. Because of indications of very low concentrations in ground and drain water at the beginning of the experiment, the frequency of measurements in ground and drainwater of P-compounds was low until the slurry application at 01-09-1998, which was the sole phosphorus fertilization during the experiment (see table 2.1). When results are presented for total-P and ortho-P in the same sample and the total-P concentrations are lower than the ortho-P concentrations, the results of ortho-P are the most reliable. In these cases the results of total-P are most likely underestimated because of precipitation of P-compounds during conservation of the sample for total-P analysis. In the ortho-P analysis precipitated ortho-P was dissolved by acidifying the sample which is part of the analysis procedure.

***Concentrations in soil***

Like for nitrogen there was a strong distinction between the phosphorus concentrations in the soil above and below 30 cm of depth (Fig. 5.6.1). The cultivated layer above the plough pan at about 30 cm depth contained the highest concentrations. This cultivated layer contained also the most organic matter and oxalic extractable P (Annex 42 and 49) due to ploughing down of manure and crop remnants in the past. The sum of oxalic extractable aluminium and iron, which is an indication for the potention for phosphate sorption at the soil complex, was also the largest in this layer.

Ortho($PO_4$)-P concentrations were around 0.1-0.15 mg $PO_4$-P $dm^{-3}$ soil (Fig. 6.5.4). Higher concentrations were found in early spring in both years (day 119 and day 475). Possibly because of the combination of reduced conditions due to high moisture contents, and low crop uptake. Lower concentrations occurred at day 166 probably due to crop uptake (see also 5.6.1). $PO_4$-P concentrations below the plough pan were generally below the limit of quantification (0.02 mg $PO_4$-P $dm^{-3}$ soil). The only exception was day 119 when the relatively high concentrations in the top layer gradually decreased downwards in the profile below this layer. This is an indication of leaching down of the $PO_4$-P in solution from the top layer.

Total-P concentrations were above $PO_4$-P concentrations at only one occasion: day 264, 20 days after the application of slurry at 01-09-1998. At this day soluble organic-P in the top layer amounted to 0.16-1.04 mg P $dm^{-3}$ soil, or 50-86% of the total-P in solution. This organic-P orginated from the organic P-compounds in the slurry that were not yet mineralised at that day. Part of this soluble organic-P had leached down to the soil layers below the top layer were the concentrations gradually decreased to concentrations of 0.025 mg P $dm^{-3}$ soil.

***Groundwater and drain water***

Concentrations of P-compounds in groundwater were very low, around the detection limit of 0.025 mg P dm$^{-3}$, except for the period shortly after slurry aplication (Fig. 5.6.5) when concentrations were higher, up to 0.3 mg P dm$^{-3}$. Spatial variability was very high in that period. This can be explained by the spatial variability in application of the slurry (see 5.3). In addition preferential flow may have caused this variability in concentrations. At day 250 P in the groundwater was mainly soluble organic-P while at day 264 $PO_4$-P was the main compound, possibly due to mineralisation of soluble organic-P. However, this peak in the $PO_4$-P concentration in the filters at 100-120 cm depth was not confirmed by the concentrations in the soil profile (Fig. 5.6.4). After slurry application the P concentrations decreased in a relatively short period to concentrations just above the detection limit

Concentrations of P-compounds in the drain discharge were also generally rather low (between detection limit of 0.025 mg P dm$^{-3}$ and 0.3 mg P dm$^{-3}$). Exceptions were the high concentrations shortly after the slurry application at day 244. An extreme high $PO_4$-P concentration of 1.57 mg P dm$^{-3}$ was measured in drain set D2 at day 246, two days after the slurry application. At day 247 this concentration had decreased to 0.7 mg P dm$^{-3}$ and at day 248 to 0.25 mg P dm$^{-3}$. This peak concentration can only be attibuted to a short event of preferential flow. In drain set D1 a similar preferential flow event may have happened but could not be registrated. Drain discharge occurred also at day 246 until day 250 but could not be measured and automatically sampled because of technical problems (see table 2.2). At day 249 the drain discharge was manual sampled. Concentrations of $PO_4$-P were 0.36-0.54 mg P dm$^{-3}$. In comparison with the concentration in drain set D2 at day 248 of 0.25 mg $PO_4$-P dm$^{-3}$ these concentrations are rather high which could be an indication that at the beginning of this discharge period concentrations may have been as high as or even higher than the peak concentration in the discharge of drain set D2 at day 246. Total-P was not measured in the discharge of both drain sets in this period, but could have been (much) higher than $PO_4$-P concentrations. Soluble organic-P is more mobile than $PO_4$-P that can be adsorbed to the soil complex. An indication for this is another preferential flow event in drain set D1 at day 281. Total-P concentrations were high and rapidly decreased in the days after. About 80% of the peak concentrations was soluble organic-P. These peak concentrations must have been caused by preferential flow of soluble organic-P from slurry. In the period day 384-418 an extreme peak of 1.96 mg $PO_4$-P dm$^{-3}$ occurred in drain set D1. Drain discharge was only 6 mm in these 34 days. Therefore it is not clear if this peak concentration can be attributed to preferential flow. In drain set D2 no peak concentration was measured.

## 5.7 Crop growth and dry matter production

The results of the measurements of light interception in the wheat crop are presented in Table 5.7.1. On 9 April, the measured interception was clearly higher than on 17 April, which is not expected in a growing crop. A delayed effect of the application of KBr and bentazone on 7 April may have affected leaf position and leaf surface and consequently the light interception on 17 April. However, an interception fraction of 0.70 is unrealistic high for a winter wheat crop on 9 April as can be deduced also from other measurements (Fig. 5.7.1). Despite no indications were found of malfunction of the equipment or unsuitable measuring conditions, the value for interception on 9 April may be seen as an outliner.

*Table. 5.7.1. Light interception fraction (f) by the wheat crop in time*

| Date | Average *f* (dimensionless) | Standard error [*)] |
|---|---|---|
| 03-03-1998 | 0.10 [a)] | |
| 30-03-1998 | 0.40 [a)] | |
| 09-04-1998 | 0.70 | 0.009 |
| 17-04-1998 | 0.63 | 0.011 |
| 30-04-1998 | 0.79 | 0.008 |
| 11-05-1998 | 0.89 | 0.006 |
| 19-05-1998 | 0.93 | 0.006 |
| 25-05-1998 | 0.92 | 0.005 |
| 15-06-1998 | 0.90 [a)] | |
| 10-07-1998 | 0.50 [a)] | |

[*)] standard error (se) of the average of all 71 to 83 measurements each date

[a)] estimated values

Light interception measurements were not performed during the whole crop growing period. Fig. 5.7.1 presents the results of more completely measured growth curves for winter wheat based on measurements of light interception or LAI (Leaf Are Index) on experimental fields in 1983 and 1984 in The Netherlands (results obtained by personal communication H.G. Smid; Plant Research International, PRI, Wageningen). The light interception was calculated by:

$$\% \text{ interception} = 100*(1-\exp(0.6*\text{LAI}))$$

(litterature: vanKeulen and Wolf, 1986; van Laar et al., 1992)
in cases where only LAI was measured. The measured light interceptions at Andelst are also given in the figures as well as the additional values (estimated), based on visually observations of soil coverage on some dates and expert judgement (J.H. Smelt and H.G. Smid, PRI). Due to the weather conditions in 1998, all wheat crops in the region of the experimental field ripened earlier (1 to 2 weeks) than the long-year average. Reduction of the fraction of green leaves and ripening started earlier on the experimental field than other wheat crops in the region. This was probably caused by an attack of leaf fungi and the combined doses of bentazone and bromide, which resulted in a great number of yellowing leaves in the last part of April and May. Based hereon we estimated that light interception was about 90% at 15 June and 50% at 10 July at the field at Andelst.

The dry matter production of the crop at the two sampling times, 11 May and at 5 August just before harvesting, is given in Annex 9. The dry matter production at the two sampling times reflect well the visible differences between the 4 sectors in the course of the crop growth. The growh of the winter wheat on Sector 3 and to a lesser extent on Sector 4 was always less than compared to Sector 1 and 2. The reason for the differences is not known.

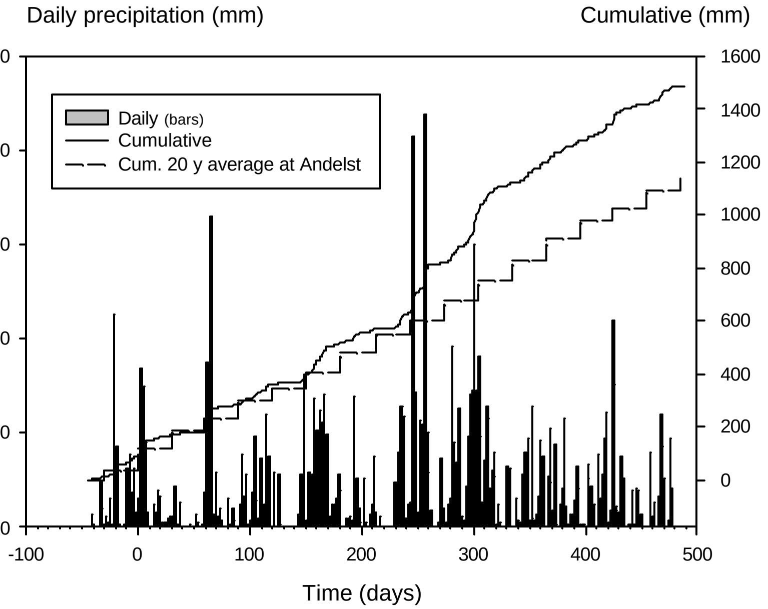


*Fig. 5.1.1 Daily and cumulative precipitation as a function of time, measured at the experimental field at Andelst. (bars and solid line) Values represent precipitation at the soil surface, which were calculated with a correction factor from measurements at 0.4 m height. The dashed step line (monthly periods) represents a 20-year average measured at 0.5 km distance of the experimental field. (personal communication J.H. Smelt 2001). Time zero corresponds with 0.00 h at 1 January 1998*

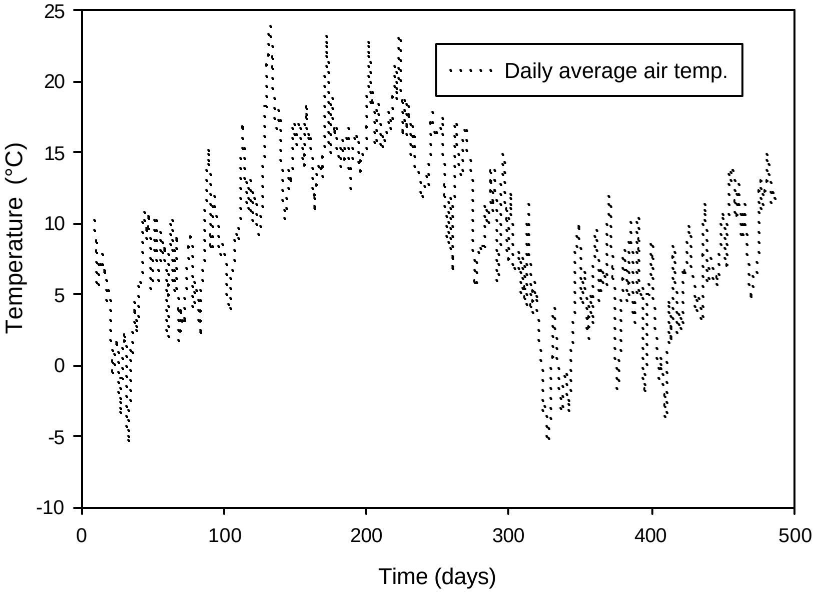
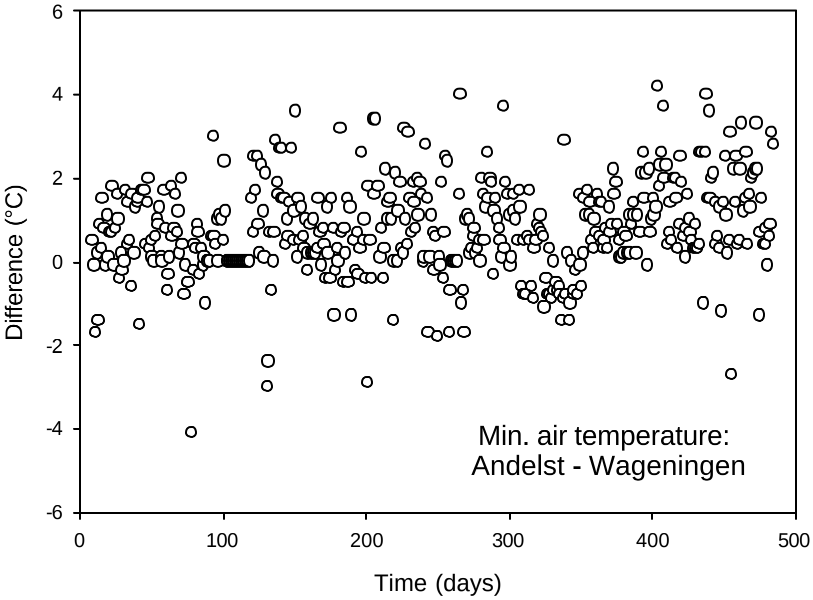


*Fig.5.1.2. Daily average air temperature as a function of time, measured at the experimental field at Andelst. Time zero corresponds with 0.00 h at 1 January 1998*



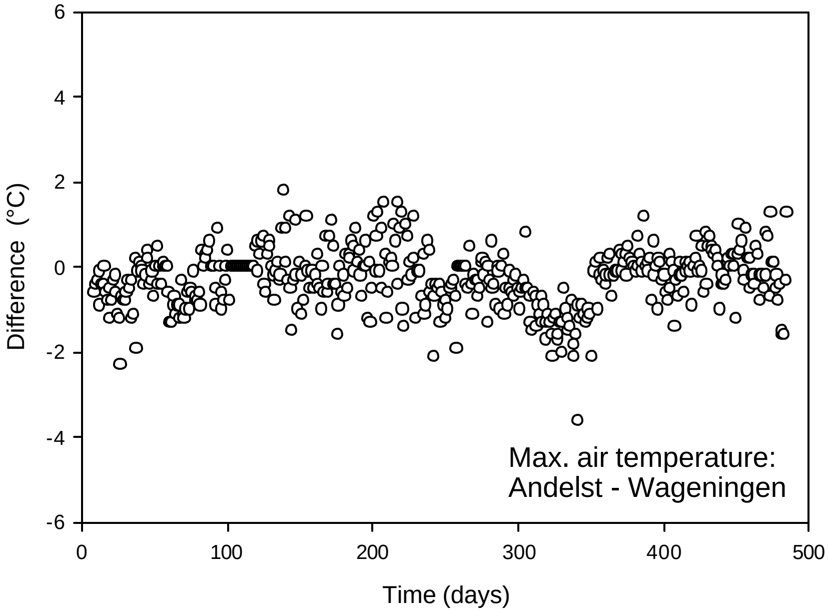


*Fig. 5.1.3. Differences between minimum and maximum daily air temperatures as measured at the experimental field at Andelst and the weather station 'Haarweg' in Wageningen at 10 km distance. Time zero corresponds with 0.00 h at 1 January 1998*

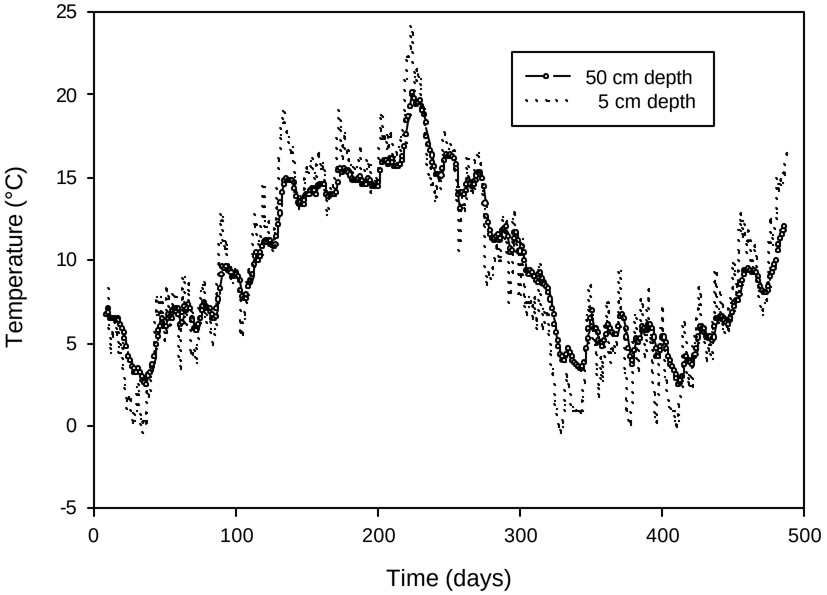


*Fig. 5.1.4. Daily average soil temperatures at 5 cm and 50 cm depth as measured at the experimental field at Andelst. Time zero corresponds with 0.00 h at 1 January 1998*

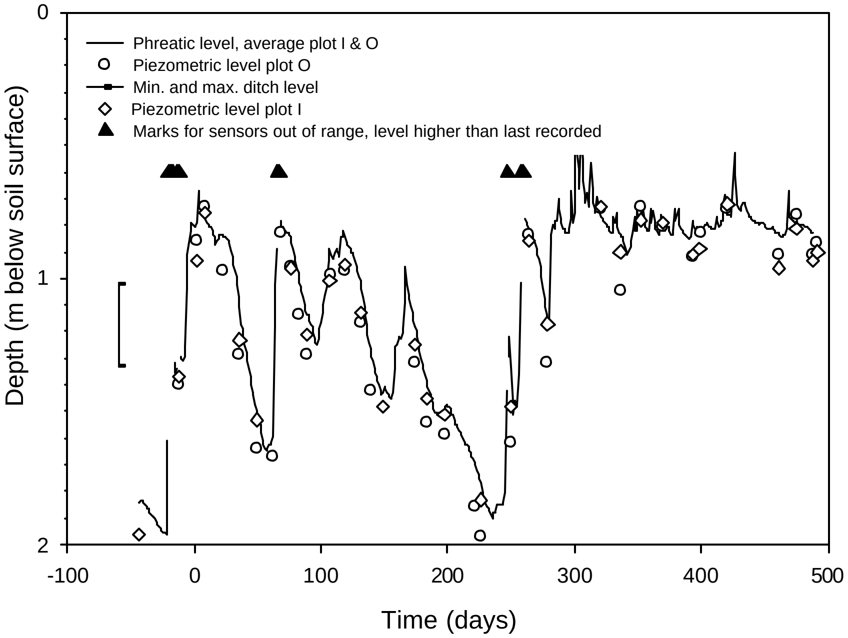


*Fig.5.1.5. Daily average groundwater level at the experimental field at Andelst. The solid line is the average value of continuous measurements in the two groundwater filter tubes (Annex 23). Triangles mark days wherein both sensors became out of range, groundwater level may have been (much) higher for a short time. Diamonds and open circles gives the instantaneous measurements of the piezometric level in the groundwater tubes at plot* ***I*** *and* ***O****. The values for the piezometric level at plot I are corrected for the 18 cm lower soil surface level than at plot* ***O*** *(chapter 2.7). Time zero corresponds with 0.00 h at 1 January 1998*

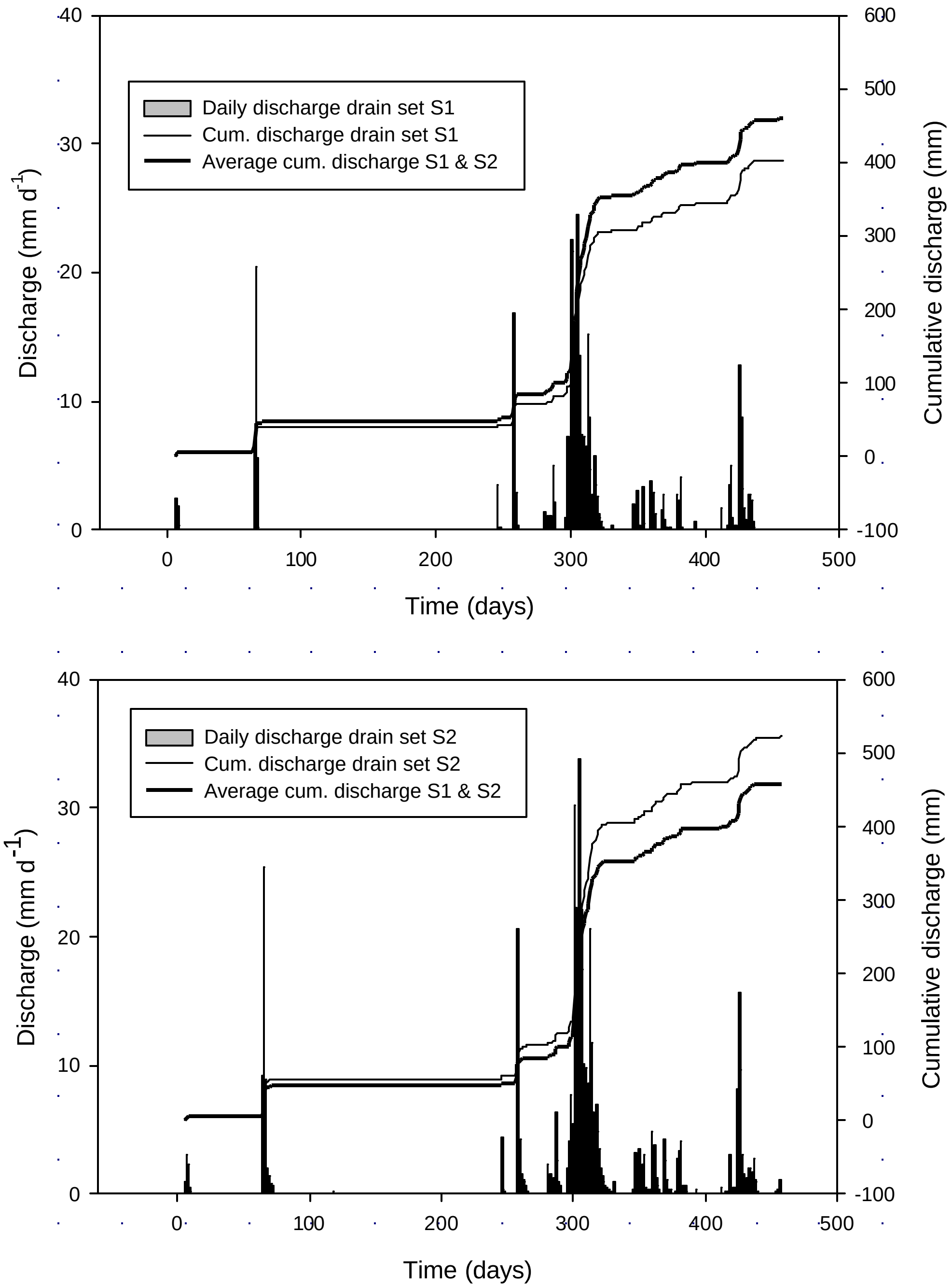


*Fig 5.1.6 Daily discharges and cumulative discharges of both drain sets.*
*For a few short periods with missing data of one of the drain sets (D1: 3-15 Sept. 1998; D2: 6-12 Jan. and 6-8 March 1998) the incomplete data set was completed by taking the data of the complete set adjusted with the average ratio between the discharge of both drain sets (D1/D2 = 0.80). The average cumulative discharge was weighted by the area of the catchment area of both drain sets. Time zero corresponds with 0.00 h at 1 January 1998.*

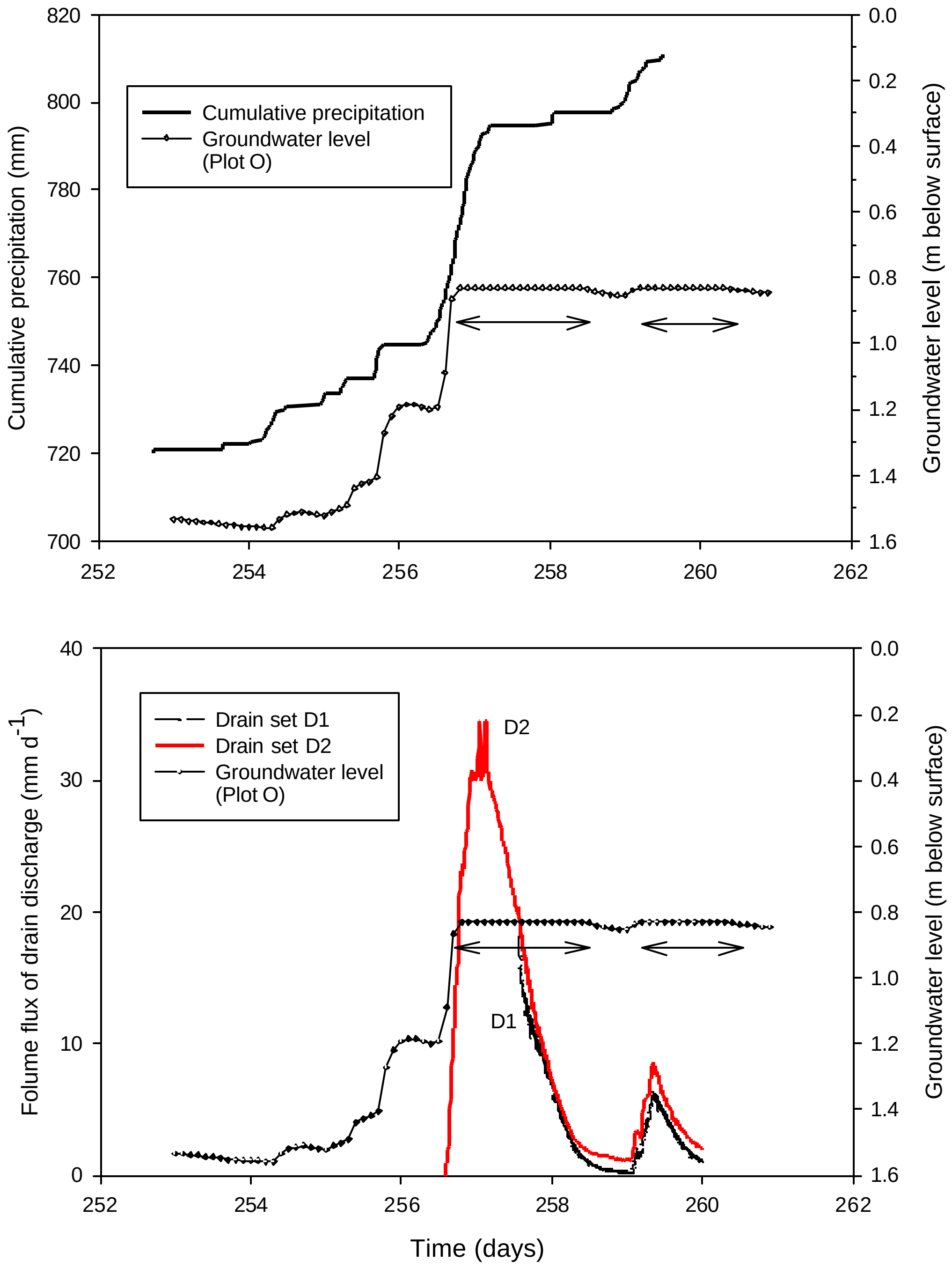


*Fig. 5.1.7. Cumulative precipitation, groundwater level and drain discharge for the period between 10 September (day 253) until 17 September 1998(day 260) with heavy rainfall at the experimental field at Andelst. The horizontal arrows indicate periods wherein groundwater sensors became out of range. Therefore, groundwater level may have been higher than the 0.83 m presented in the figure. Note that soil surface at plot I is 0.12 m lower than at plot O, of wich the groundwaterwater level is given in the figure.*

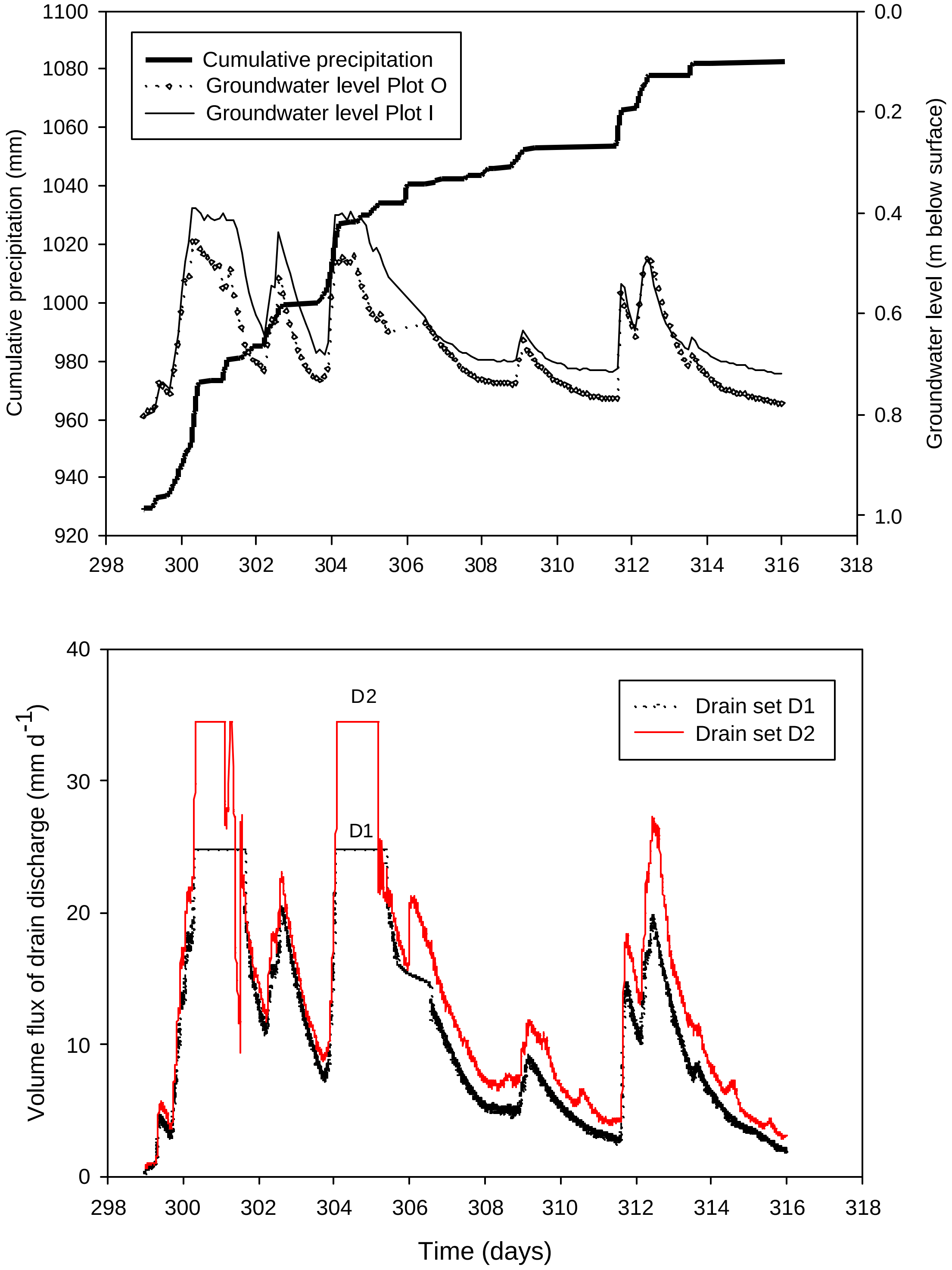


*Fig. 5.1.8. Cumulative precipitation, groundwater level and drain discharge for the period between 27 October (day 300) until 12 November (day 316) with extreme rainfall at the experimental field at Andelst. Note that soil surface at plot I was 0.12 m lower than at plot O. The figure is not corrected for this difference.*

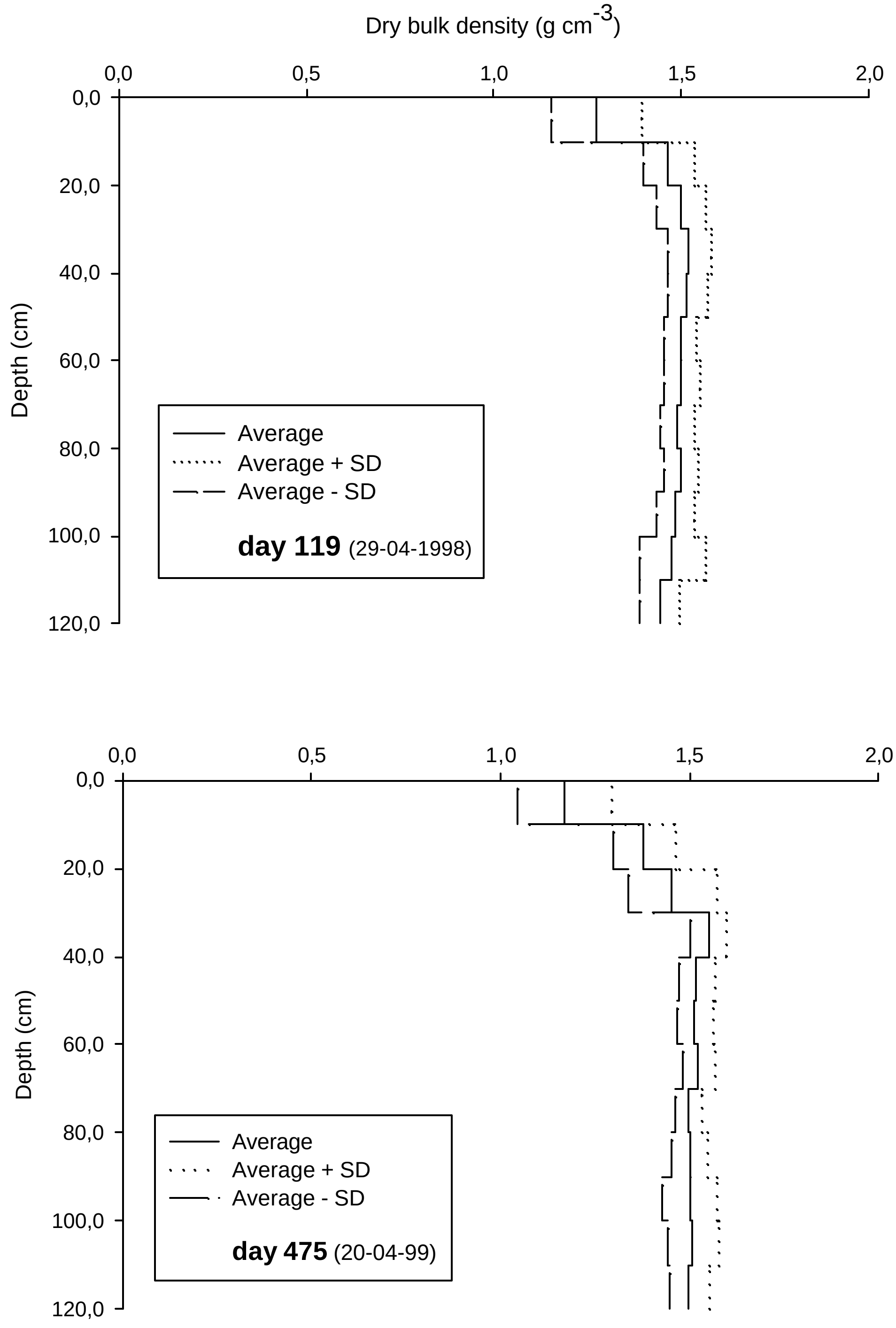


*Fig. 5.2.1. Typical dry bulk density profiles as measured at the experimental field at Andelst at day 119 (before ploughing) and day 475 (5 months after ploughing). Time zero corresponds with 0:00 h at 1 January 1998*

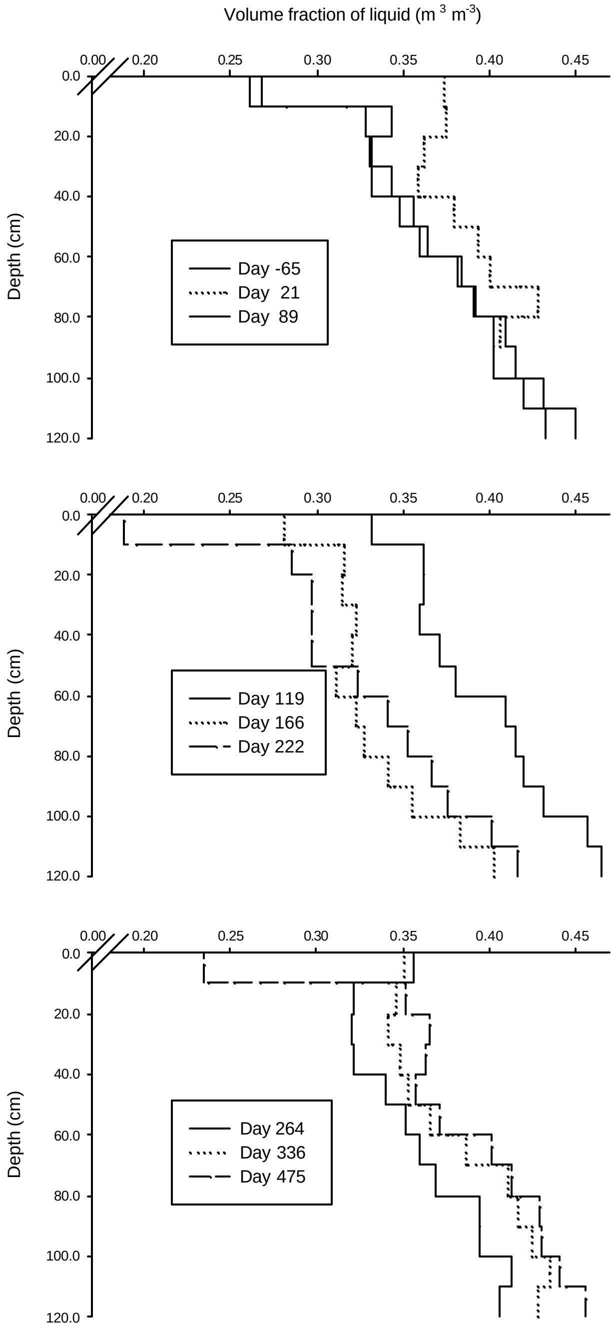


*Fig 5.2.2 Average volume fraction of water as a function of depth measured at the experimental field in Andelst, the Netherlands at indicated days. Time zero corresponds with 0:00 h at 1 January 1998.*

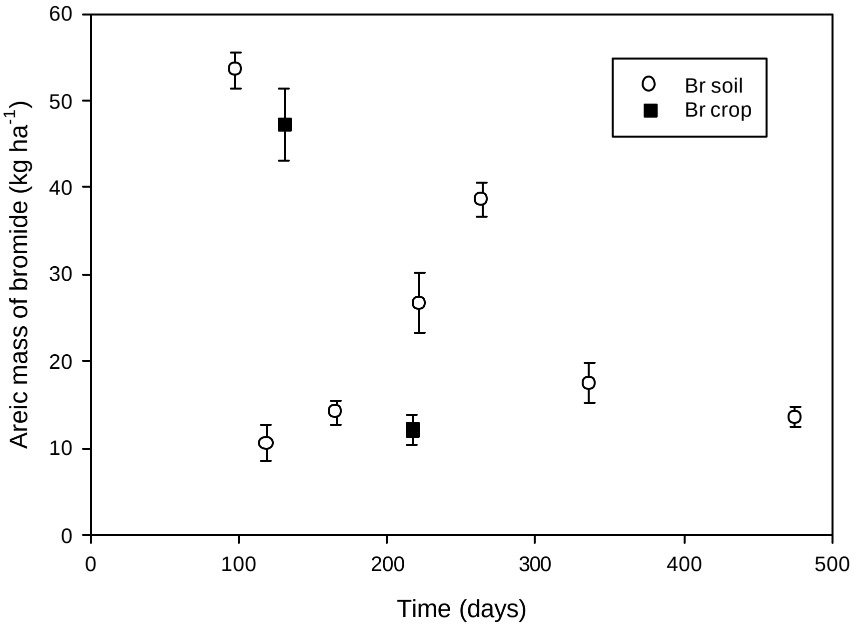


*Fig. 5.3.1 Areic mass of bromide in soil and crop as measured at the experimental field in Andelst, the Netherlands. Time zero is 0:00 h at 1 January 1998. Points represent the averages of 31 soil cores at the first sampling time (= day 98) and 4 analyses (mixed samples of 16 columns) at the other times (also 4 for crop samples). Bars represent the standard error.*

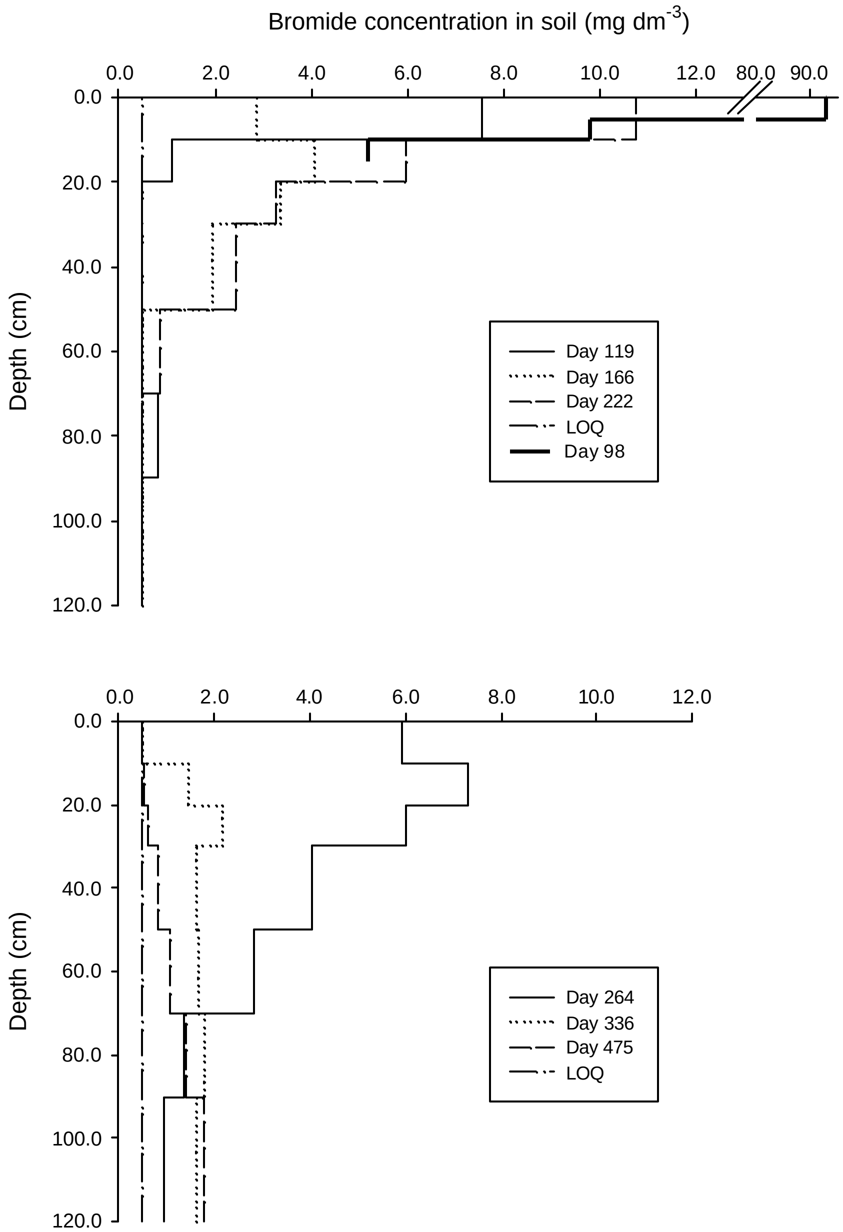


*Fig 5.3.2 Average concentrations of bromide as function of depth measured at the experimental field in Andelst, the Netherlands at indicated days. Time zero corresponds with 0:00h at 1 January 1998. Limit of Quantification (LOQ) is indicated in the figures with a vertical dash-dot line.*

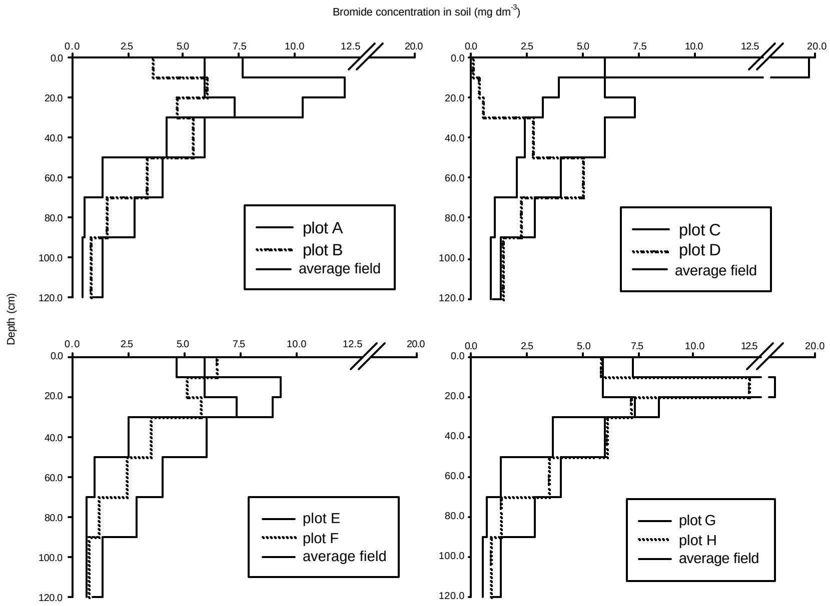


*Fig 5.3.3 Measured bromide concentration profiles in eight individual soil cores collected on indicated plots. Sampling date 21 September 1998 (day 264). The thick solid line represents the field-average based on 10 analyses (8 individually analysed profiles and 2 profiles prepaired by mixing soil samples of 4 cores for each profile; see paragraph 2.12).*

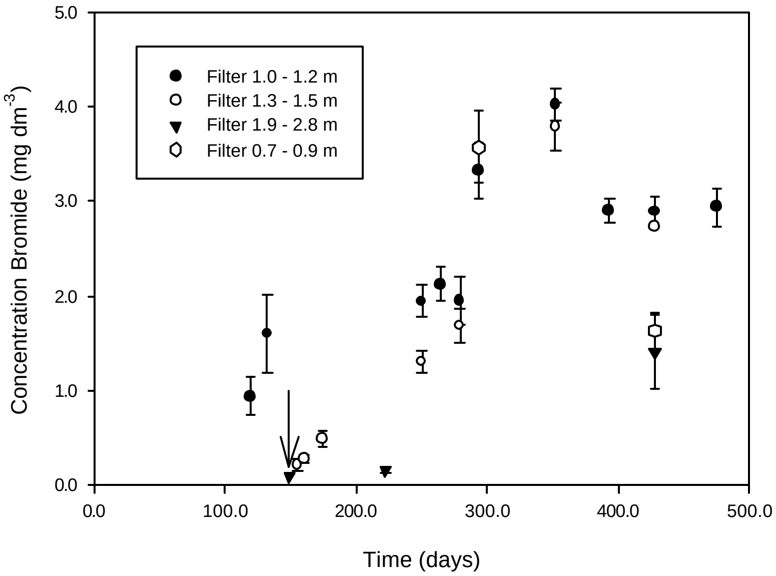


*Fig. 5.3.4 Average bromide concentrations in groundwater at different depths and sampling dates as measured at the experimental field in Andelst, the Netherlands. Time zero is 0:00 h on 1 January 1998. Points are the averages and bars represent the standard errors. At day 149 concentrations at 1.9-2.8 m (with arrow) were below LOQ = 0.25 mg dm $^{-3}$.*

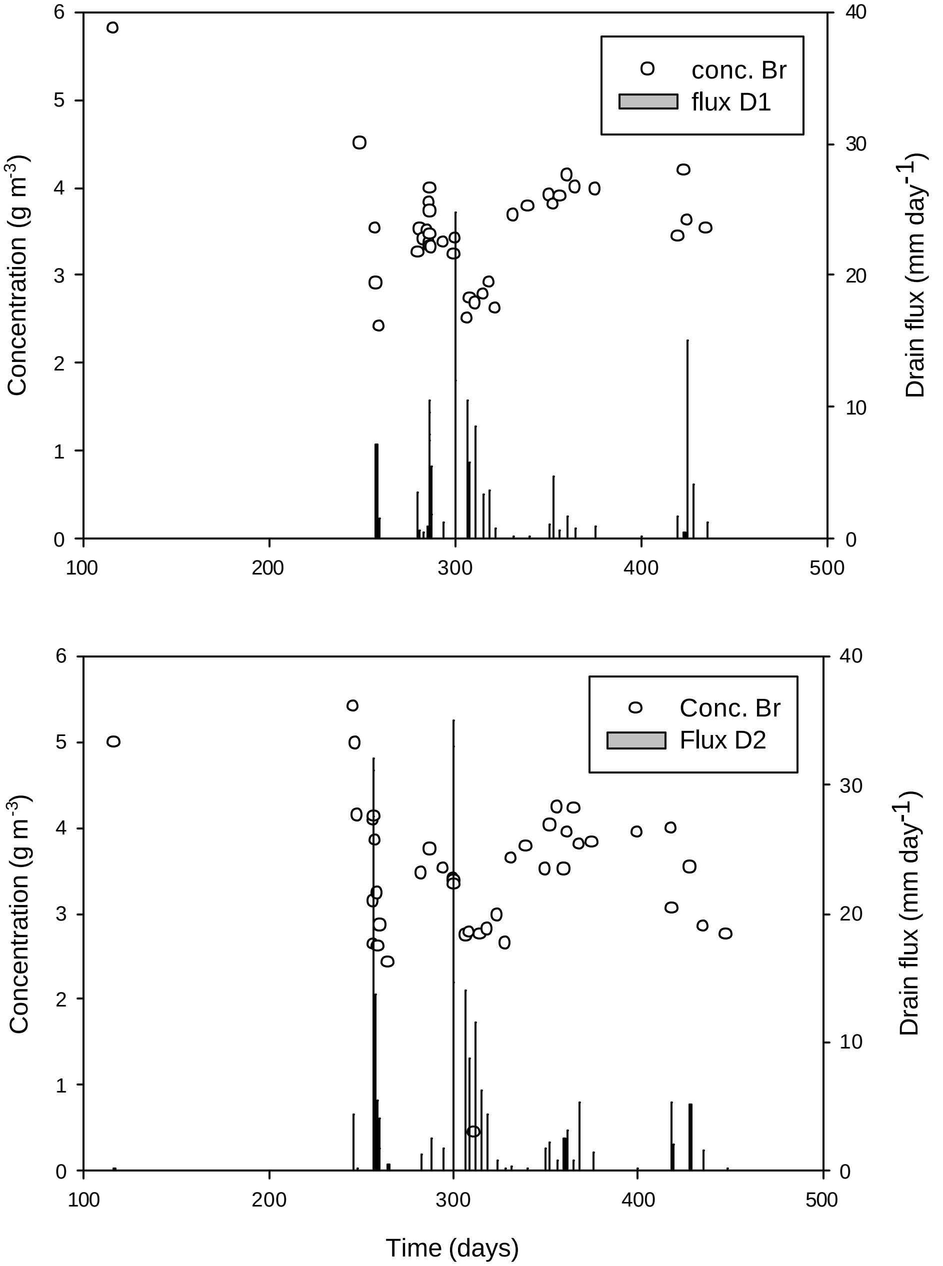


*Fig. 5.3.5 Concentration of bromide in water of drain set D1 and drain set D2 as a function of time measured at the experimental field in Andelst, the Netherlands. Drain flux (vertical bars) represents the calculated average flux for the sampling period. Time zero is 0:00 h on 1 January 1998.*

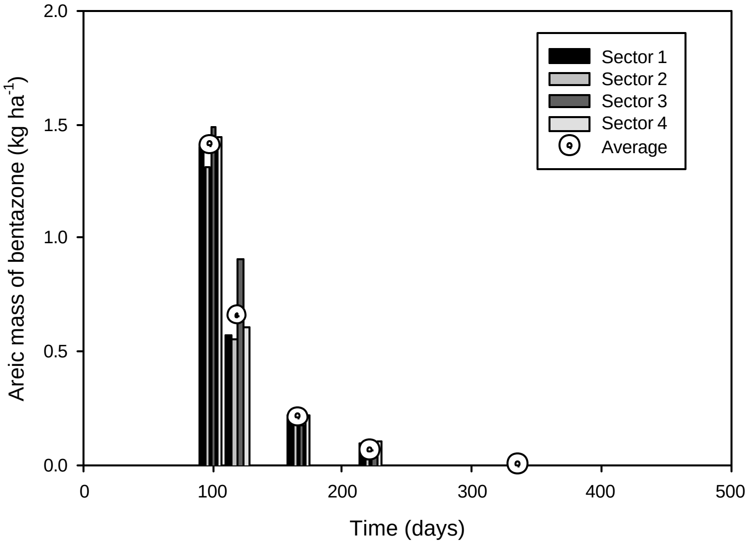


*Fig.5.4.1. Areic mass of bentazone in soil, measured at the experimental field in Andelst, the Netherlands. Time zero is 0:00 h on 1 January 1998. Points are the averages for each sampling time and the bars give the values for each sector.*

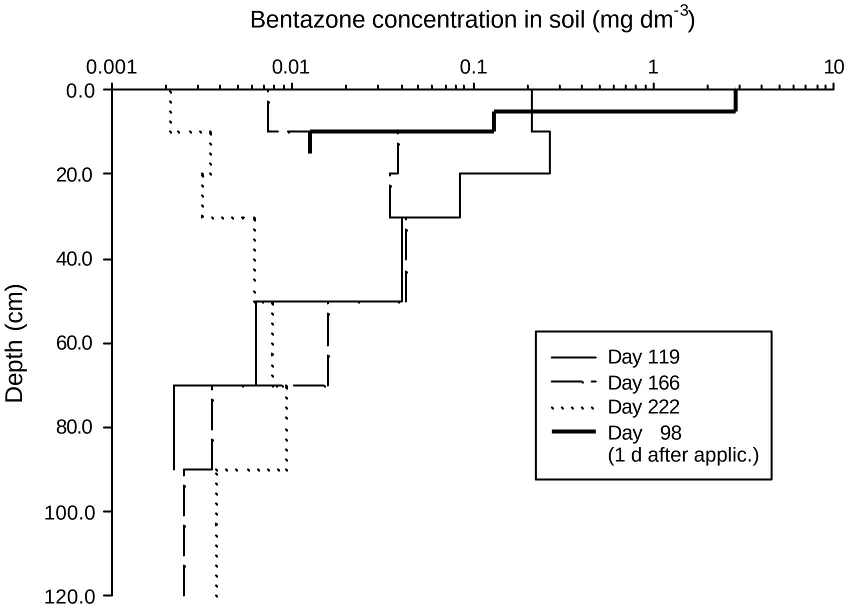


*Fig. 5.4.2 Average concentrations of bentazone in soil as measured at the experimental field in Andelst, the Netherlands. Time zero is 0:00h on 1 January 1998.. At 2 Dec. 1998 (day 336), contents in all layers were near or below the limit of quantification (LOQ = 0.0008 mg dm$^{-3}$) bentazone was only detectable in the 10-20 cm soil layer, but the average was below LOQ.*

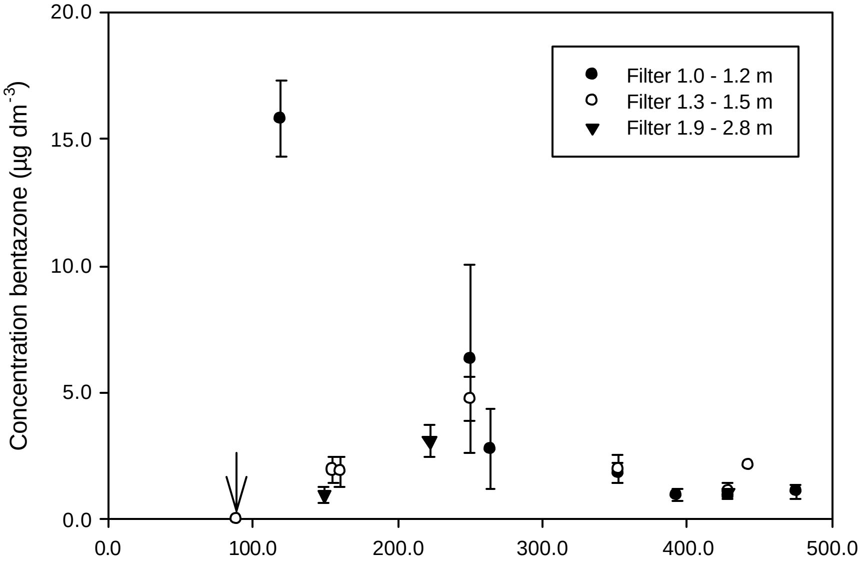


*Fig. 5.4.3 Bentazone concentrations in groundwater at different depths and sampling dates as measured at the experimental field in Andelst, the Netherlands. Time zero is 0:00h on 1 January 1998. Points are the averages and bars are the standard errors. Point at day 89 (with arrow) is a sampling before application (blank) with concentrations below LOQ = 0.05 µg dm $^{-3}$.*

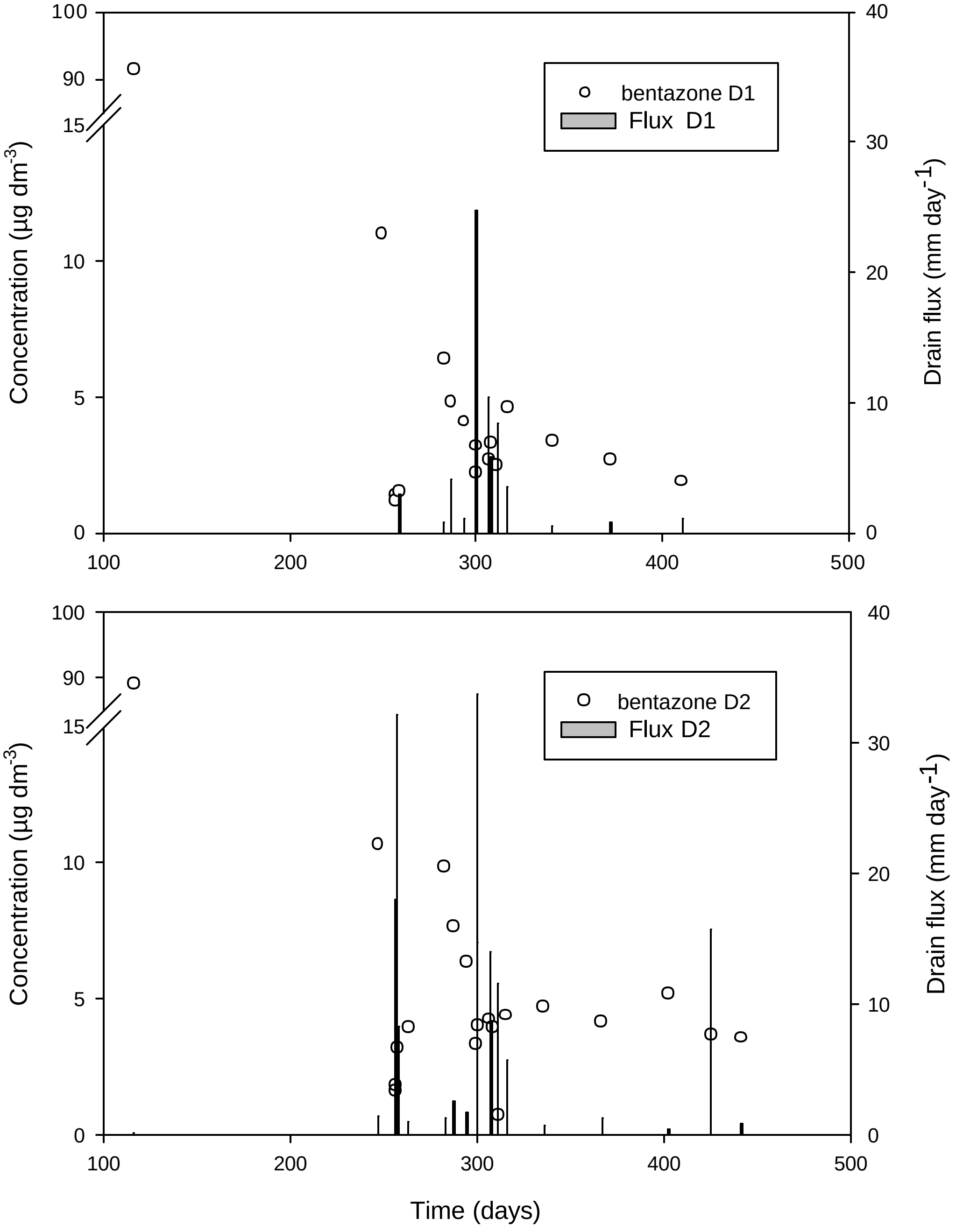


*Fig. 5.4.4 Bentazone concentrations in water of drain set D1 and drain set D2 as a function of time as measured at the experimental field in Andelst, the Netherlands. Time zero is 0:00h on 1 January 1998. Note that the left vertical axis is interrupted. Drain flux (vertical bars) represents the calculated average flux for the sampling period*

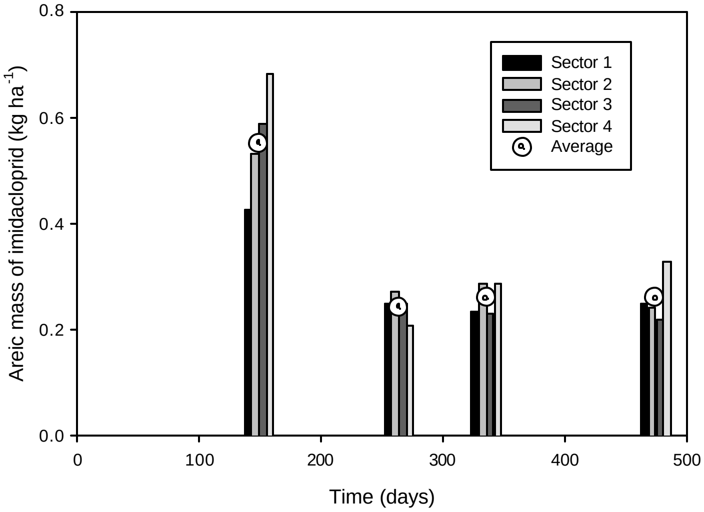


*Fig.5.5.1. Areic mass of imidacloprid in soil as measured at the experimental field in Andelst, the Netherlands. Time zero is 0:00h on 1 January 1998. Points are the averages for each sampling time and the bars give the values for each of the fourn sectors.*

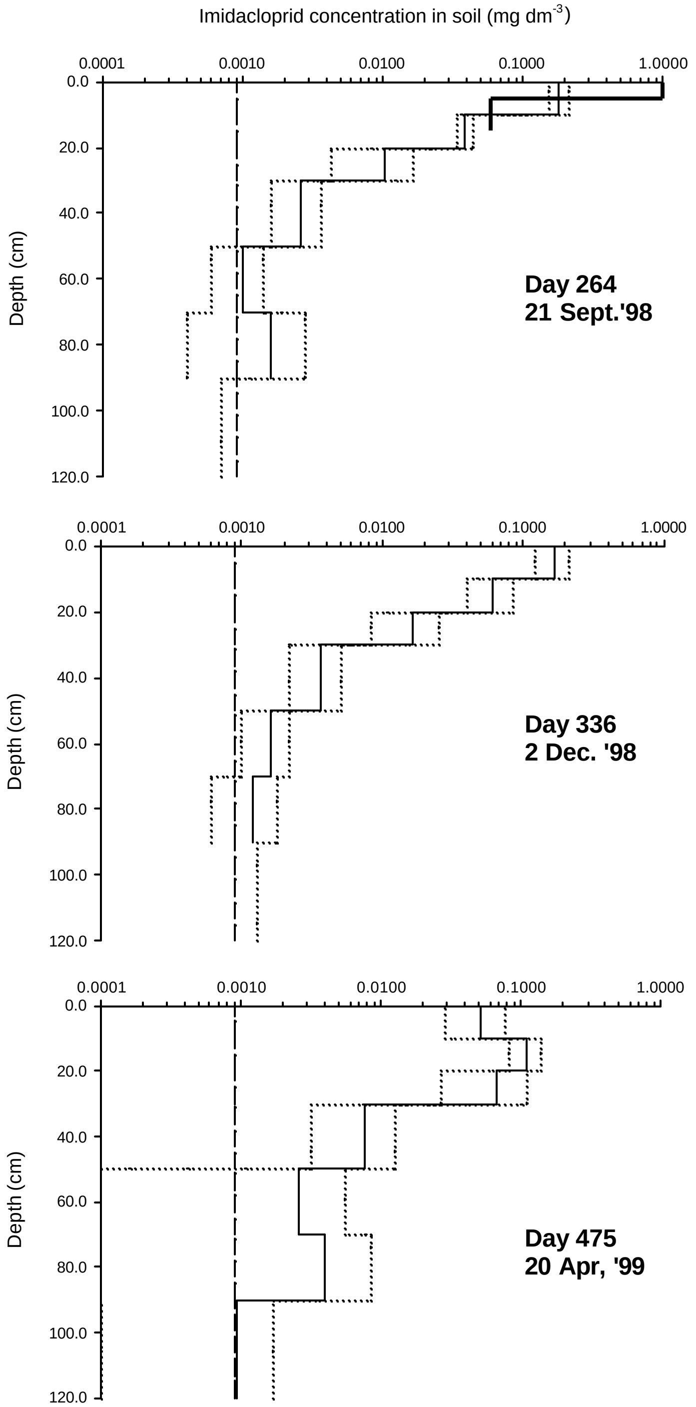


*Fig. 5.5.2 Concentration profiles of imidacloprid in soil at the Andelst field, the Netherlands. Dotted lines represent average plus or minus two times the standard error. The thick solid line in the figure for day 264 gives the results of the sampling at two days after application.Time zero is 0:00h on 1 January 1998.*

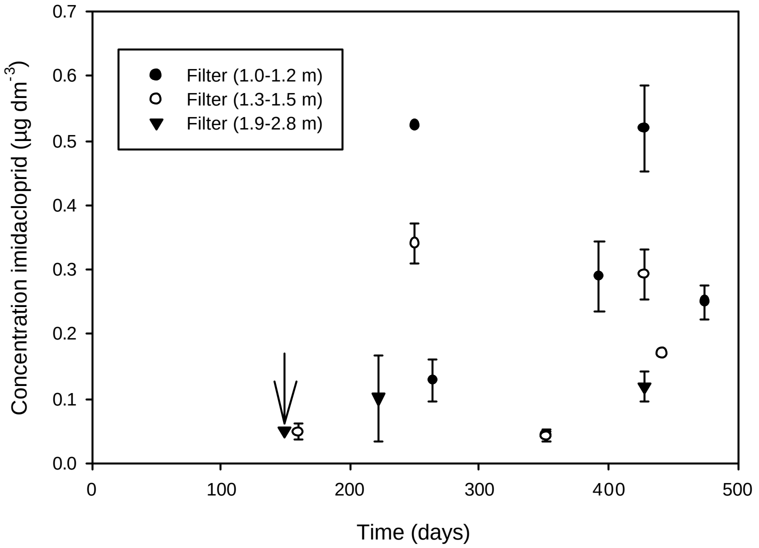


*Fig. 5.5.3 Imidaclprid concentrations in groundwater at different depths and sampling dates as measured at the experimental field in Andelst, the Netherlands. Time zero is 0:00h on 1 January 1998. Points are the averages and bars are the standard errors. Point at day 149 (with arrow) is a sampling before application (blank) with concentrations below LOQ = 0.05 µg dm*$^{-3}$.

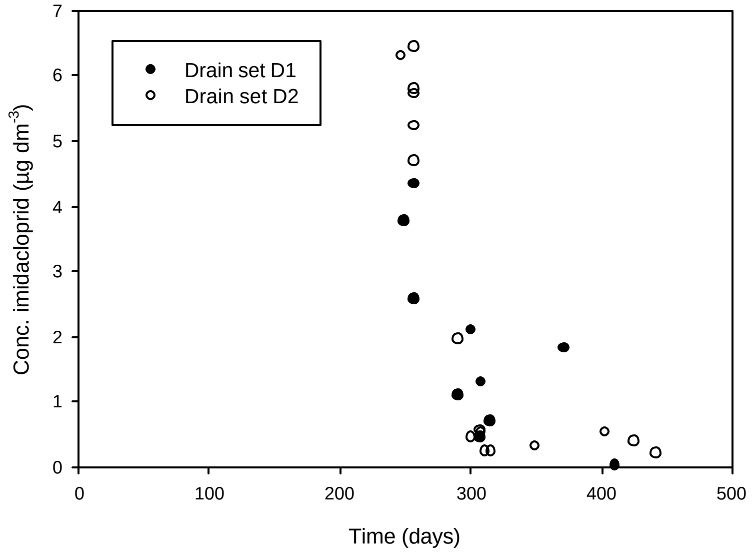


*Fig. 5.5.4 Imidacloprid concentrations in drain water as a function of time as measured at the experimental field in Andelst, the Netherlands. Time zero is 0:00h on 1 January 1998.*

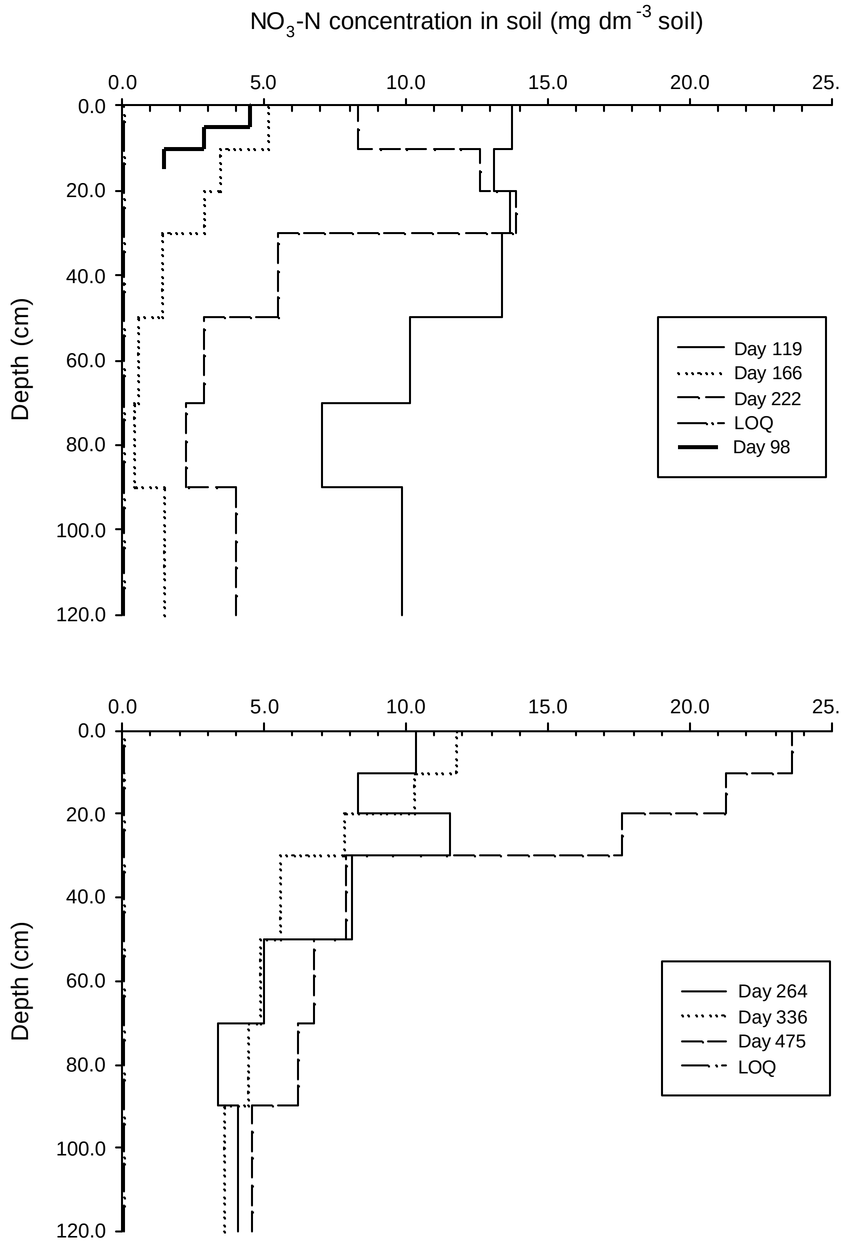


*Fig 5.6.1 Average concentrations of nitrate-N in soil as function of depth measured at the experimental field in Andelst, the Netherlands at indicated days (see Annex 49). Time zero corresponds with 0:00h at 1 January 1998. Limit of Quantification (LOQ) is indicated in the figures with a vertical dash-dot line.*

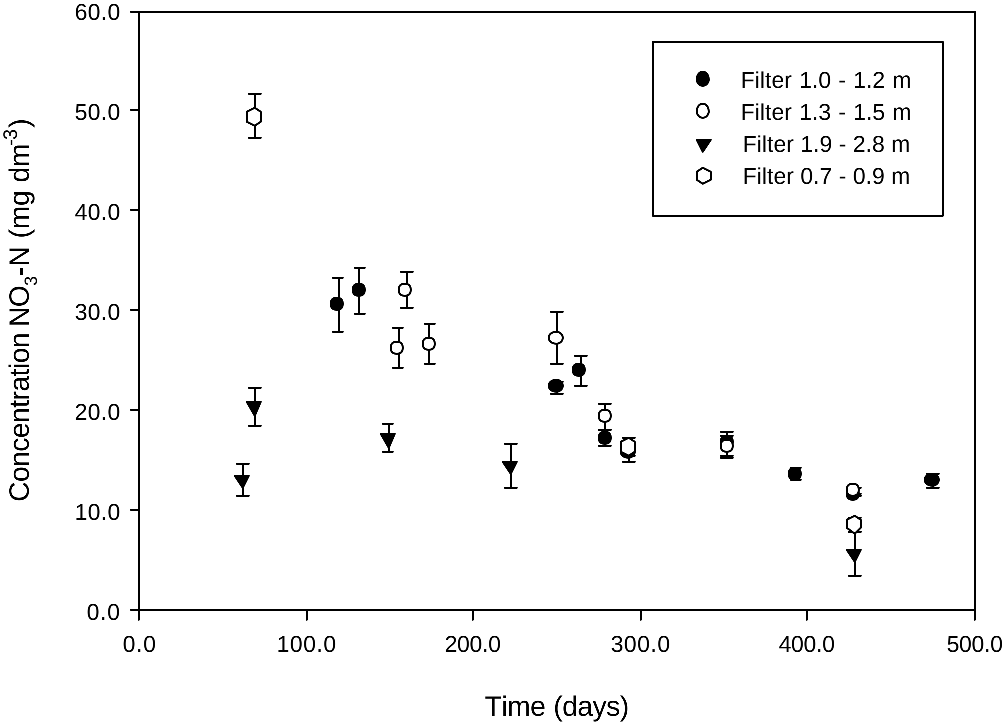


*Fig. 5.6.2 Average nitrate-N concentrations in groundwater at different depths and sampling dates as measured at the experimental field in Andelst, the Netherlands (see Annex 26). Time zero is 0:00 h on 1 January 1998. Points are the averages and bars represent the standard errors.*

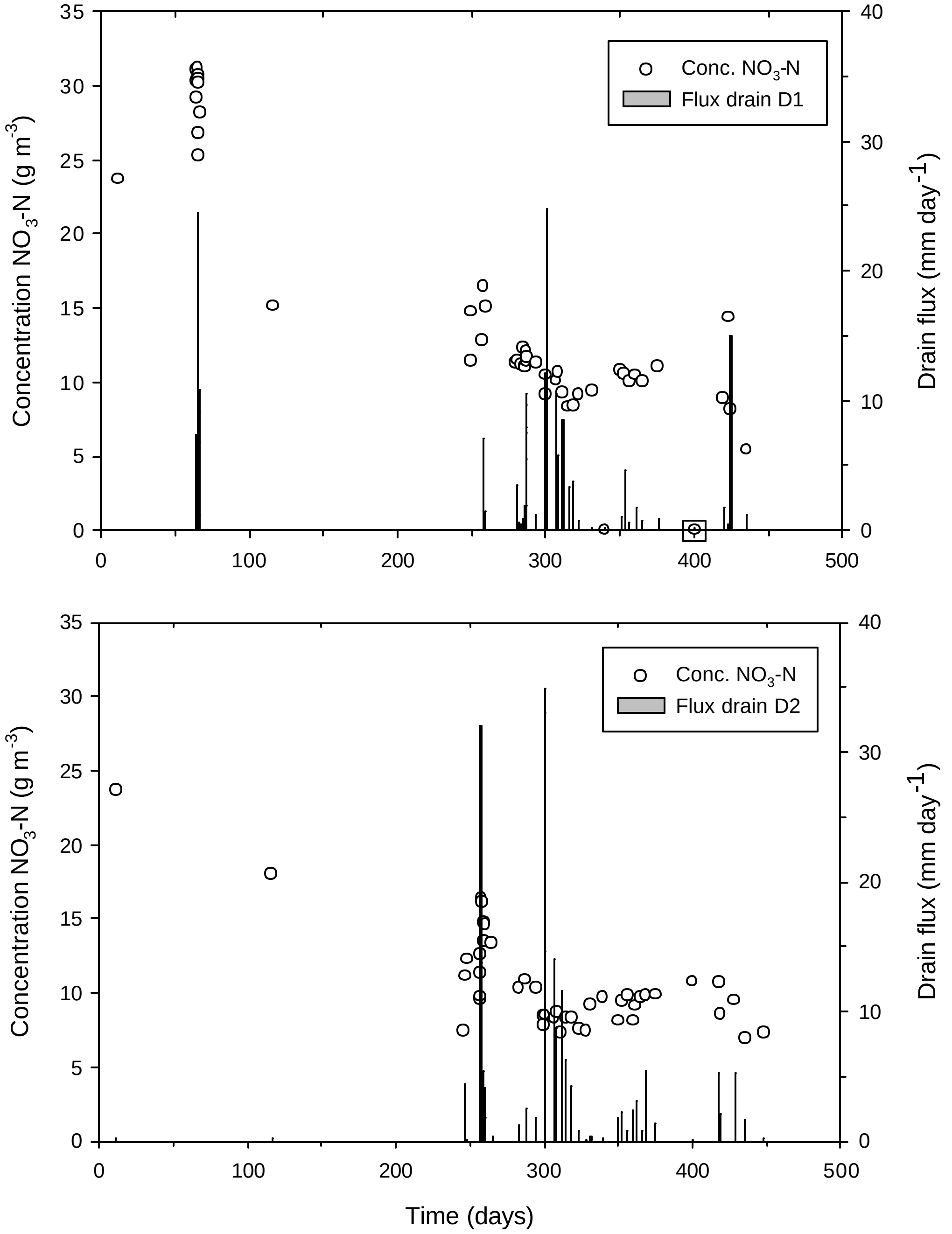


*Fig. 5.6.3 Concentration of nitrate-N in water of drain set D1 and drain set D2 as a function of time measured at the experimental field in Andelst, the Netherlands. Drain flux (vertical bars) represents the calculated average flux for the sampling period (see Annexes 11 and 14). Time zero is 0:00 h on 1 January 1998. At day 400 concentration in Drain set 1(in square box) was below LOQ ( 0.01 mg $dm^{-3}$).*

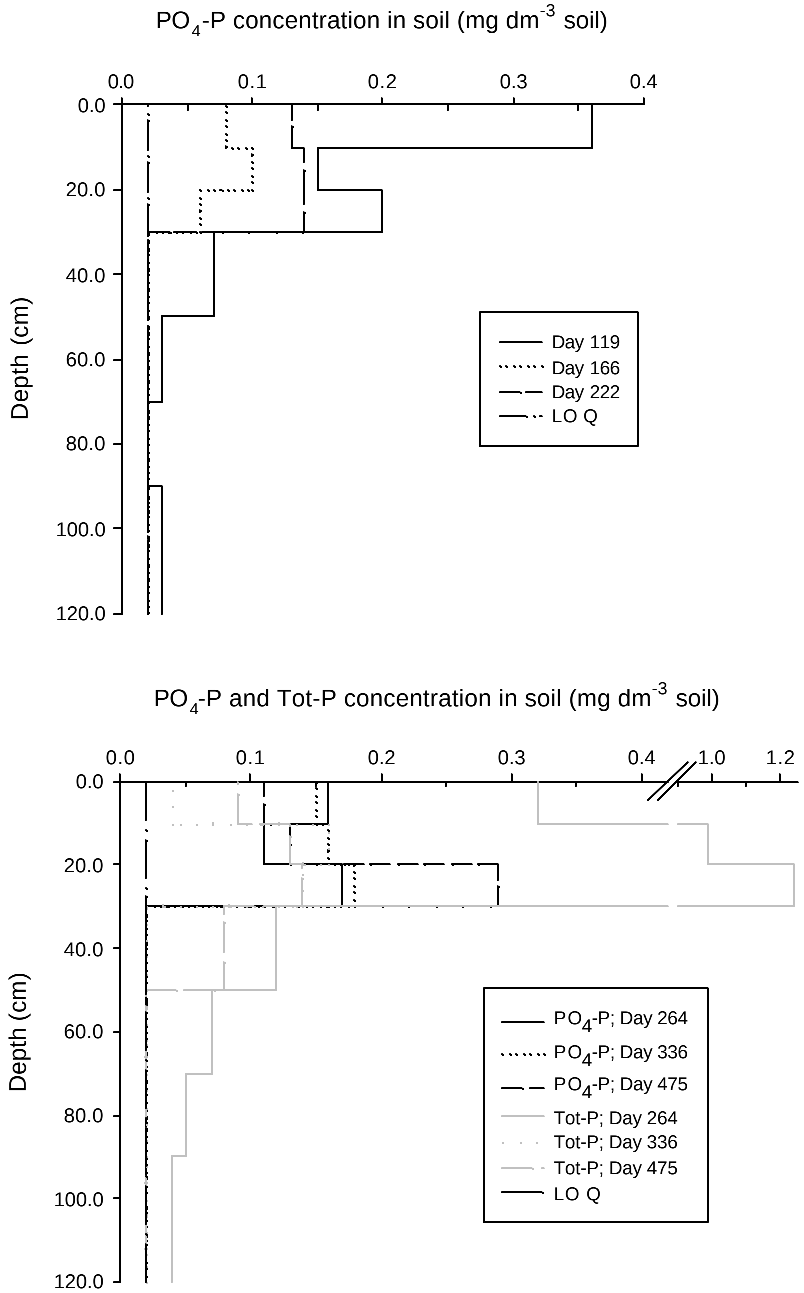


*Fig 5.6.4 Average concentrations of phosphorus ($PO_4$-P and Total-P) in soil as function of depth measured at the experimental field in Andelst, the Netherlands at indicated days (see Annexes 50 and 52). Time zero corresponds with 0:00h at 1 January 1998. Limit of Quantification (LOQ) is indicated in the figures with a vertical dash-dot line.*

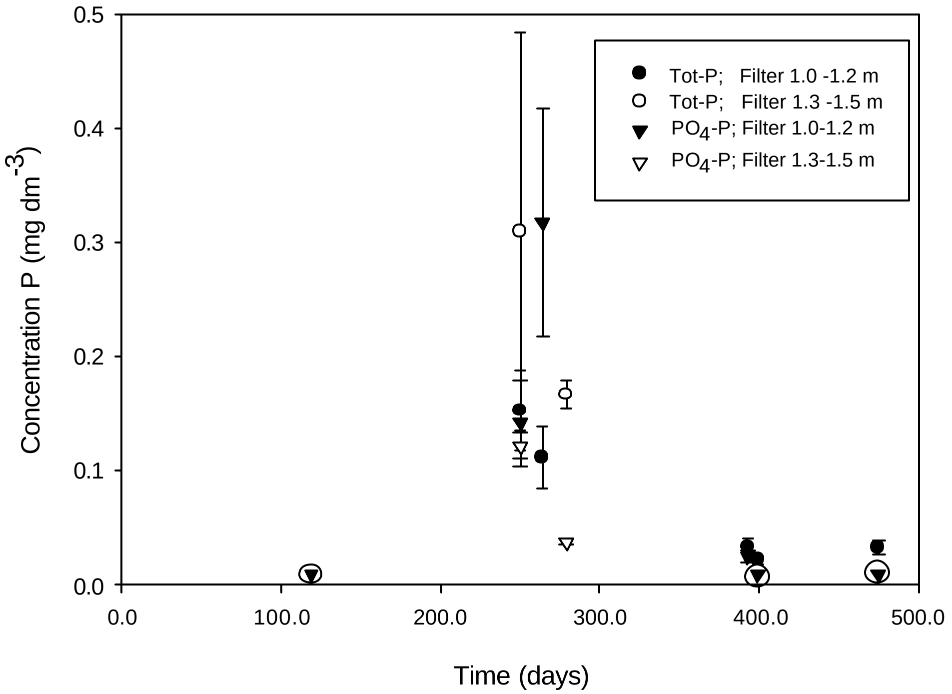


*Fig. 5.6.5 Average concentrations of phosphorus (Total-P and PO$_4$-P) in groundwater at different depths and sampling dates as measured at the experimental field in Andelst, the Netherlands (see Annexes 27 and 28). Time zero is 0:00 h on 1 January 1998. Points are the averages and bars represent the standard errors. Symbols in cirkels represent concentrations below LOQ (0.025 mg dm $^{-3}$).*

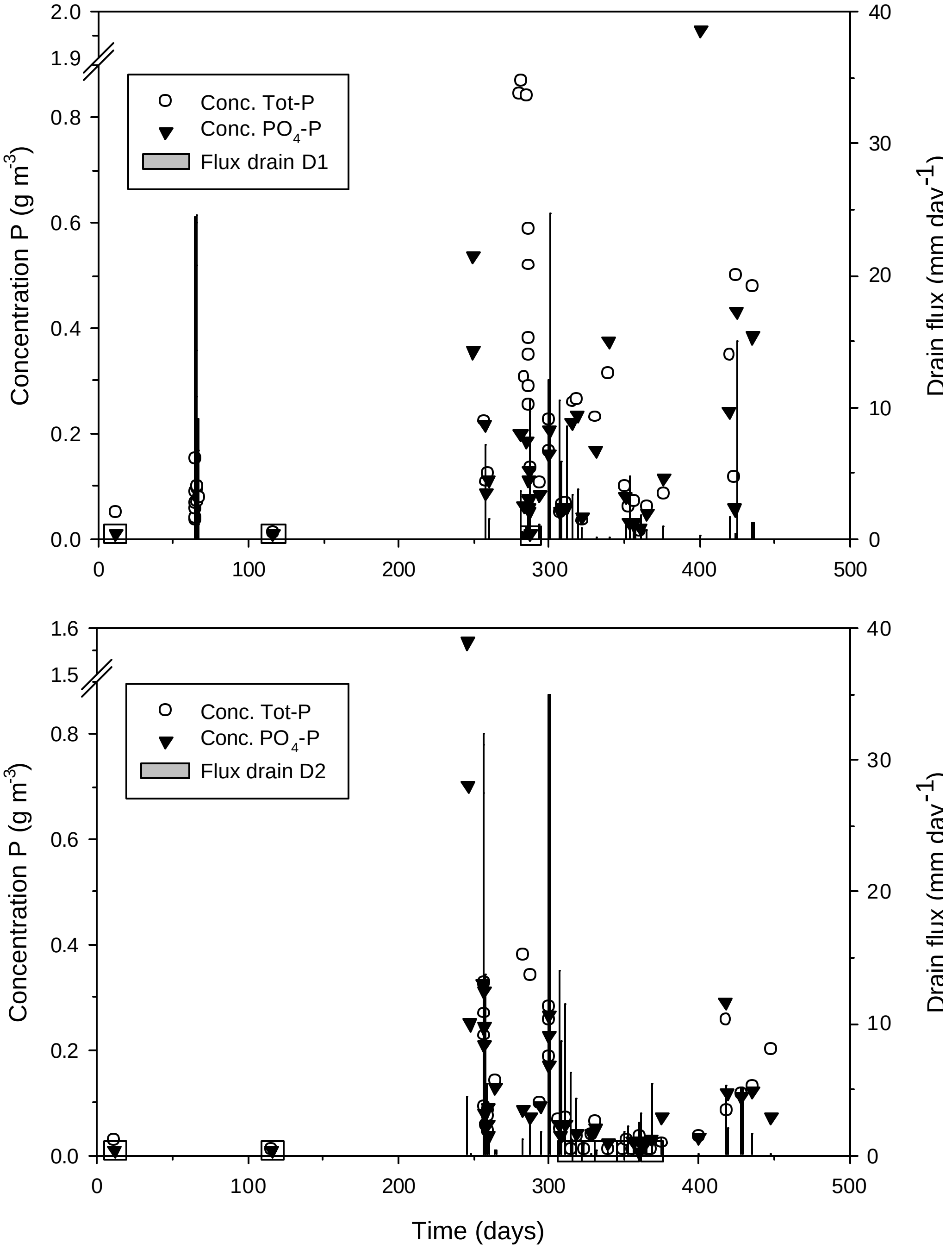
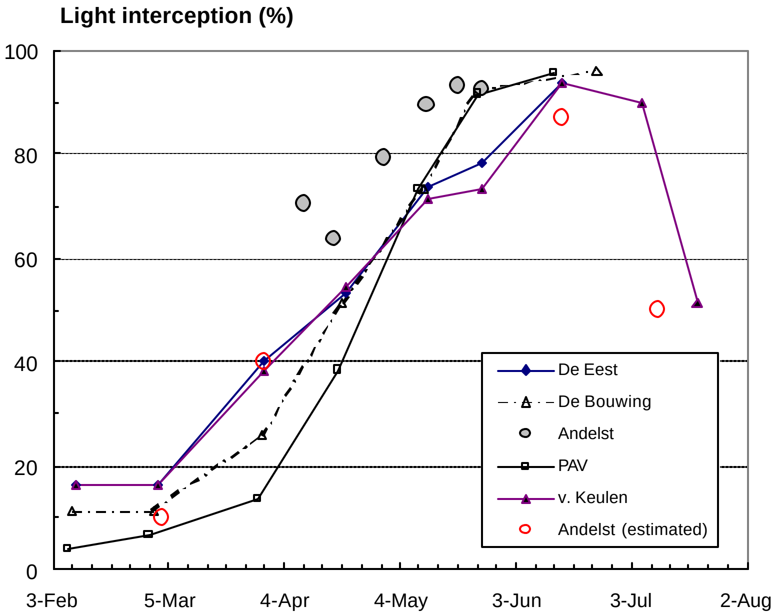


*Fig. 5.6.6 Concentration of phosphorus (Total-P and PO$_4$-P) in water of drain set D1 and drain set D2 as a function of time measured at the experimental field in Andelst, the Netherlands (see Annexes 11 and 14). Drain flux (vertical bars) represents the calculated average flux for the sampling period. Time zero is 0:00 h on 1 January 1998. Symbols in squares represent concentrations below LOQ (0.025 mg dm $^{-3}$).*



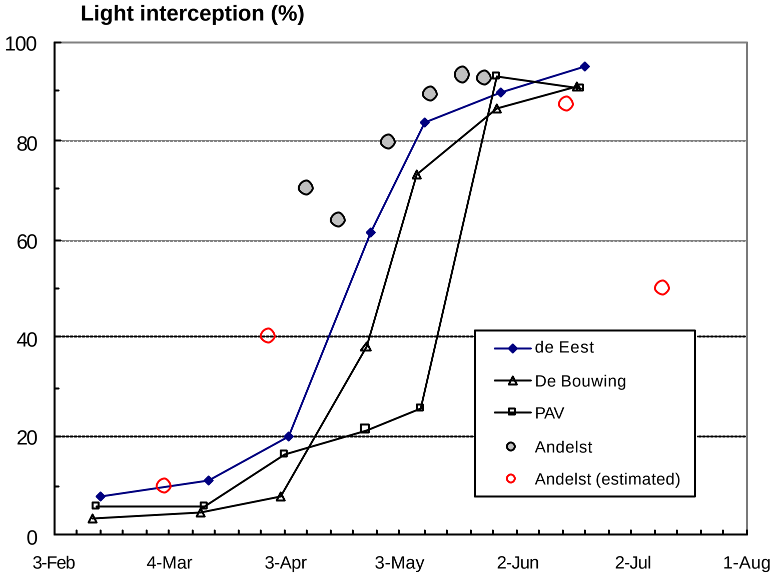


*Fig 5.7.1. Light interception measurements for the field at Andelst and measured curves for winter wheat as were measured in 1983 and 1984 on experimental farms in The Netherlands. Open circles (0) represent estimated values for the field at Andelst*

# 6 Results of the laboratory studies

## 6.1 Soil hydraulic functions

Figure 6.1.1 show that the volume fraction of liquid near saturation increases with increasing depth, because of the increase of clay content with depth. In the pressure head range of -1 to about -500 the water retention characteristics differ little between the two duplicates of each depth, as well for the measured values as the fitted lines. For most field conditions this is the relevant range of pressure heads. An exception form the samples 4 and 14 from a depth of 61-69 cm. The results of these two duplicates differ considerably. On the basis of (qualitative) observations during the experiments, sample 14 is considered to be the better sample. The same applies for sample 16 versus its duplicate sample 6 (131-139 cm depth).

During the incubation studies with the pesticides, the moisture content of topsoil at pF 2.0 was determined in triplicate of ring samples from the 0-30 cm layer with a typical bulk density of 1.40 kg dm$^{-3}$. The rings were filled in the laboratory with the soil used for the incubation studies, so these are disturbed samples. The soil was water-saturated and placed on ceramic filter plates with a hanging water column of 100 cm (pF 2.0). The measured moisture content after equilibration was 24.0 kg kg$^{-1}$ dry soil (s.d = 0.29, n = 3). This is fairly equal to the values from the pF curves measured for this layer.

The relationship between the hydraulic conductivity and the pressure head shows considerable scatter (Fig. 6.1.2). Because of this, the Van Genuchten fits of the hydraulic conductivity function are rather poor. For the fitting the measured saturated conductivity was taken into account. For the samples 4, 14, 5, 15 and 6 the measured saturated conductivity is extremely high for a clay soil (Annex 44). These high values are most likely caused by macropores such as worm holes. Macropores were observed in some samples. In these cases, much lower values for the saturated hydraulic conductivity were considered in the fitting procedure.

It should be considered that the samples were taken at one spot at the Western side of the experimental field. It can be questioned whether the obtained hydraulic characteristics are representative for the average characteristics of the field. Because the average of the measured dry bulk densities (Annex 39) of the four sectors show small standard errors and also the standard deviations of the average textural fractions (Annex 42) are rather small it is expected that the heterogenity of the field concerning the hydraulic characteristics is moderate, and that the measured hydraulic characteristics may be representative for the hydraulic properties of the field.

Furthermore it should be considered that the measured water retention characteristic represents the ‘field water retention characteristic’ and not the ‘soil matrix water retention characteristic’. During the measurements the soil samples shrink because of water loss. The water retention (pF) curve is calculated on the basis of a fixed volume (the initial volume of the sample which is the volume of the PVC cylinder) and not on the basis of the decreasing volume of the shrinking sample. So the resulting pF curve represents the volume of the shrunken matrix as well as that of the shrinkage cracks, which is the total volume in the field. To obtain the matrix pF curve the field pF curve should be corrected for shrinkage with the shrinkage characteristic. The matrix pF curve is much steeper than the field pF curve (since the shrinkage cracks contain no water the volumic water content of the matrix is greater than the field volumic water content). It depends on the application which curve should be used.

## 6.2 Soil shrinkage characteristics

Figure 6.2.1 show the shrinkage characteristics for four increasing depths. Void ratio and moist ratio increase with depth, accordingly to the increase of the clay content with depth. Duplicates have about similar shrinkage characteristics, with the standard division in a `normal', a `residual' and a `zero shrinkage' phase (this counts also for the depths that are not shown in Fig. 6.2.1). Samples 4, 14 and 6, 16 show also some 'structural' shrinkage. Exceptions to this general behaviour of clay soil aggregates are samples 2 and 12 (22-30 cm depths; the plough pan). These samples show little 'normal' shrinkage and total shrinkage is considerable less than for the other samples.

## 6.3 Transformation rates of the pesticides

### *Bentazone*

The results of the incubation studies with bentazone in the 0-30 cm layer show that soil temperature has a distinct effect on the transformation rate with a very slow rate at 5 °C (Fig. 6.3.1). The slight slow down in the transformation rate after about 150 d at 25 °C is probably attributable to a decreasing microbial activity in the incubated soil with time. The effect of temperature is also distinct in soil from the 40-70 cm layer (Fig. 6.3.1). The slower transformation at 15 °C in the 40-70 cm layer than in the 0-30 cm layer is probably the effect of lower microbial activity in the deeper layer as well as the effect of the 10 times lower initial content of bentazone in the 40-70 cm layer.

Figure 6.3.2 shows the results of bentazone transformation in soil from the 80-120 cm layer at 10 °C. The transformation is slower than in soil from the 40-70 cm layer at 10 °C, which may be the combined effect of lower microbial activity and the 10 times lower content in the deepest layer. Water-saturation had obviously no measurable effect on the transformation rate. The very low concentration caused more scatter in the analysis results, which hinders accurate estimation of transformation rates.

### *Imidacloprid*

The results of the incubation studies in the 0-30 cm layer at three temperatures are presented in Fig. 6.3.3. The transformation rate of imidacloprid in the topsoil is considerable slower as compared to the rates for bentazone at the same temperature. A similar effect of temperature was seen as with the bentazone transformation series.

A distinct slowing down of the transformation rate of imidacloprid was seen at 25 °C after about two months incubation time. This may be attributed to a decreasing microbial activity or the effect of an increasing adsorption with time, which makes the compound less available for degradation. The incubation series at 5 and 15 °C show some times greater variability between sampling times than between the duplicate samples; this indicate systematic differences between analysis procedures at the different times. This is possible in view of the efficiency of the extraction and analysis procedure measured for the total experimental period (104.2% , s.d 10.5%), for which the results were not corrected.

Figure 6.3.4 shows that the decline of imidacloprid in soil of the 40-70cm layer at 15 °C is somewhat slower than that in the topsoil at 15 °C. The difference is less pronounced as compared to that for bentazone. There was no measurable decrease of imidacloprid in soil of the 80-120 cm layer at 10 °C.

## 6.4 Sorption of the pesticides in soil water suspensions

### *Bentazone*

It was expected that bentazone would be very weakly sorbed by the clay soil of the experimental field, resulting in a minor decrease of the concentration of bentazone in the liquid phase. The differences between the initial concentration (calculated from the dose) and the measured concentrations are presented as percentage of the initial concentrations and that values are plotted in Fig 6.4.1. It is clear that there was no decrease of the concentration of bentazone after 24 h equilibrium time, therefore no sorption of bentazone. The figure point even more to the opposite: an increase of the concentration as a result of anion exclusion. However, the scatter in the measuring results makes accurate estimation of the percentage anion exclusion impossible. A check of the laboratory analysis learned that it can not be excluded that the spread is partly caused by laboratory procedures. New experiments would be needed to demonstrate anion exclusion with bentazone in this soil.

### *Imidacloprid*

The sorption isotherms for imidacloprid are shown in Fig. 6.4.2. Imidacloprid is clearly sorbed by the clay soil of the experimental field. The isotherms show the normal picture of increasing sorption with decreasing temperature.

## 6.5 Long-term sorption of imidacloprid

Fig 6.5.1 shows that the variability between aged-residue sorption points was usually small at a given sampling time, except after 41 days. Comparison with the batch adsorption points in the graph shows that the extent of sorption after 285 days was only slightly higher. So this study showed a small effect of long-term sorption equilibration. This was expected because strongest effects of long-term sorption kinetics can be expected for compounds with short half-lives (Boesten , 1987) whereas imidacloprid is very persistent. Further quantitative interpretation of sorption kinetics is outside the scope of this report.

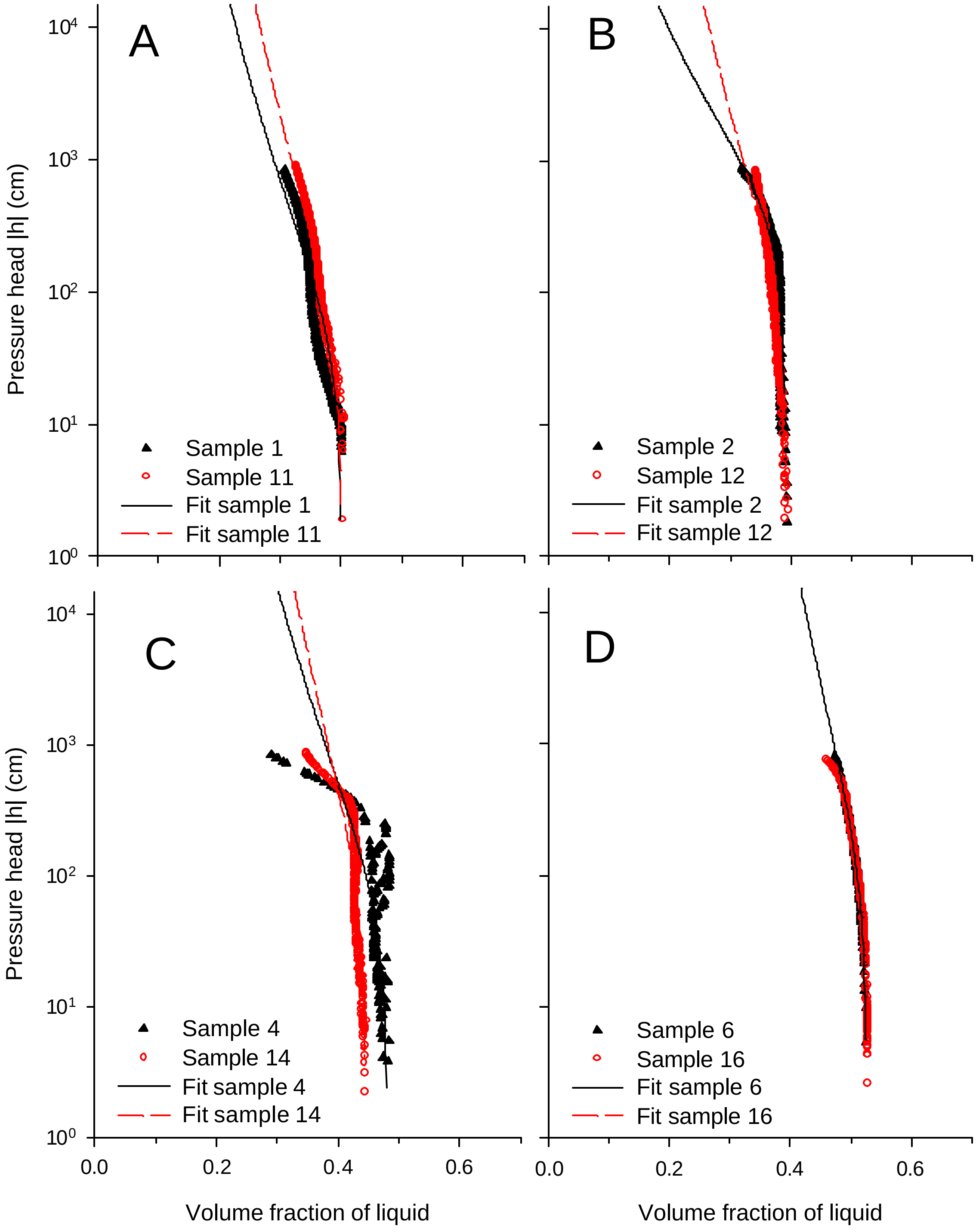


*Fig. 6.1.1. Relationship between pressure head and volume fraction of liquid as measured on samples from experimental field Andelst. . Part A: samples 1 and 11: 11-19 cm depth; Part B: samples 2 and 12: 22-30 cm (plough pan); Part C: samples 4 and 14: 61-69 cm; Part D: samples: 6 and 16: 131-139 cm.*
*The symbols are duplicate samples measured with the evaporation method. The solid and dotted line are the Van Genuchten fits (Annex 44). Sample numbers indicate to the corresponding SMNU number in and Annex 54 consequently the results were obtained on the same sample.*

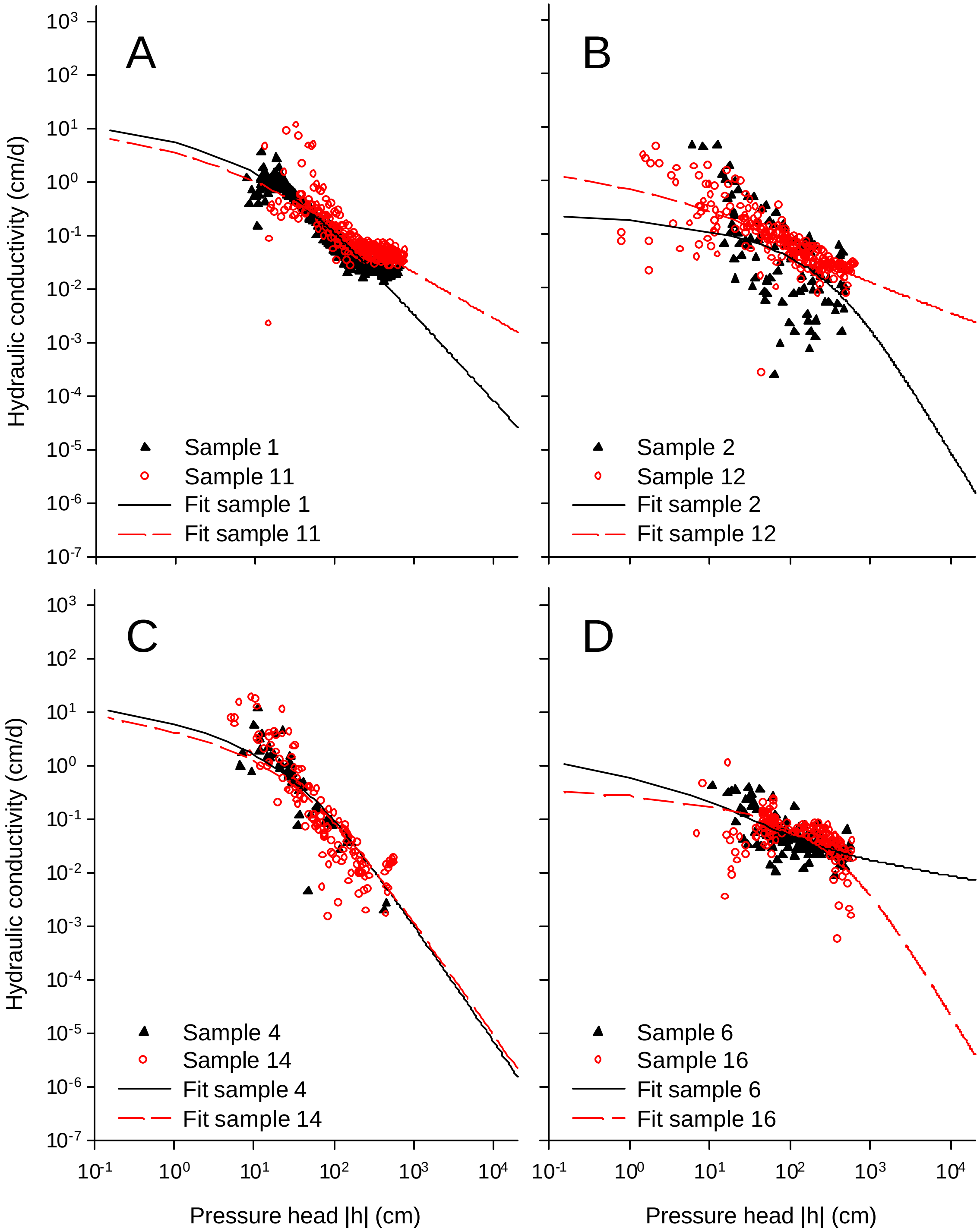


*Fig. 6.1.2. Hydraulic conductivity as a function of pressure head as measured on samples from experimental field Andelst. . Part A: samples 1 and 11: 11-19 cm depth; Part B: samples 2 and 12: 22-30 cm (plough pan); Part C: samples 4 and 14: 61-69 cm; Part D: samples: 6 and 16: 131-139 cm.*
*The symbols are duplicate samples measured with the evaporation method. The solid and dotted line are the Van Genuchten fits (Annex 44). Sample numbers indicate to the corresponding SMNU number in Annex 43 and Annex 44, consequently the results were obtained on the same sample.*

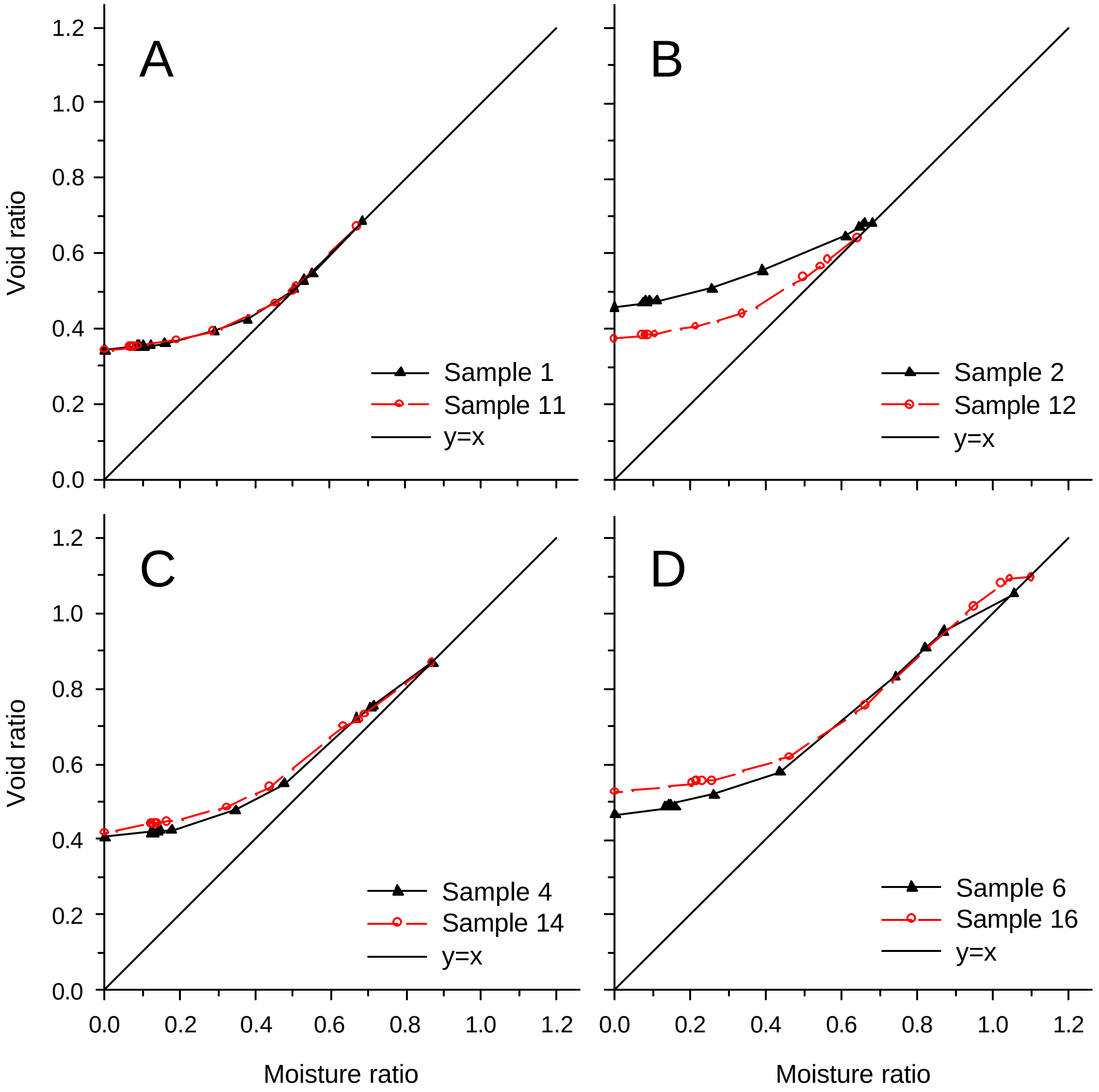


*Fig. 6.2.1. Shrinkage characteristics, expressed as void ratio as a function of moisture ratio, as measured on aggregates of experimental field Andelst. Part A: aggregate samples 1 and 11: 11-19 cm depth; Part B: samples 2 and 12: 22-30 cm (plough pan); Part C: samples 4 and 14: 61-69 cm; Part D: samples: 6 and 16: 131-139 cm.*

*Moisture ratio: volume of water / volume of solids;*

*Void ratio: volume of pores / volume of solids;*

*Highest value of moisture ratio expresses (near) saturated conditions.*

*Samples show (most of) the four phases of the typical shrinkage characteristic of clay aggregates (after Bronswijk, 1988):*

1) *structural shrinkage (only samples 4, 14 and 6, 16; ): near saturation, large water filled pores are emptied without causing any decrease of volume. This causes the normal shrinkage line to move tot the left of the 1:1-line;*
2) *normal shrinkage (line on or parallel at the 1:1-line) volume decrease of aggregates is equal to loss moisture loss, aggregates remain fully saturated;*
3) *residual shrinkage (curved line): volume decrease is less than moisture loss;*
4) *zero shrinkage (horizontal line): no more volume change when moisture decreases.*

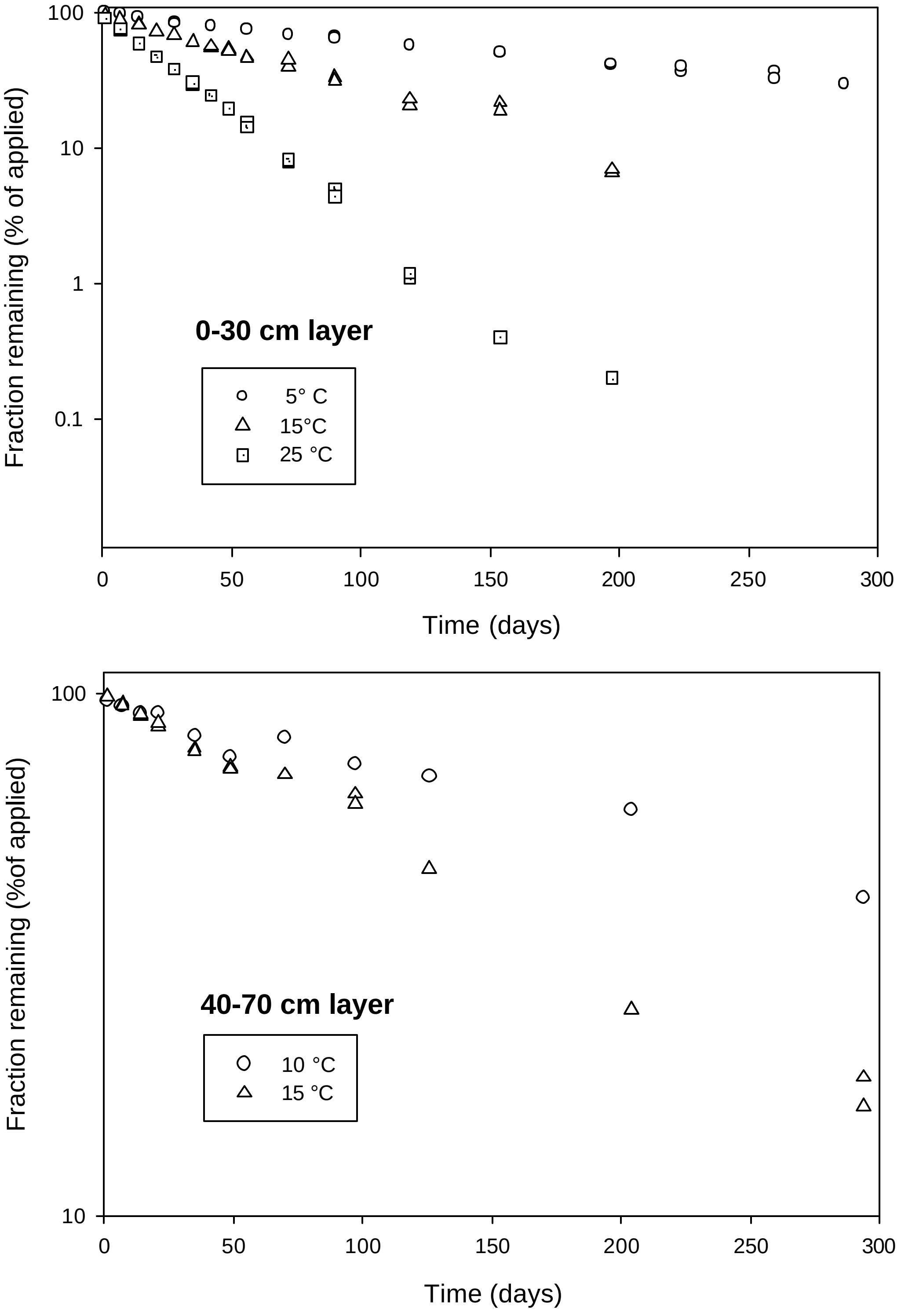


*Fig. 6.3.1 Remaining fractions of bentazone as a function of incubation time as measured in laboratory incubations at indicated temperatures with soil collected from the 0-30 and 40-70 cm layers of the experimental field at Andelst*

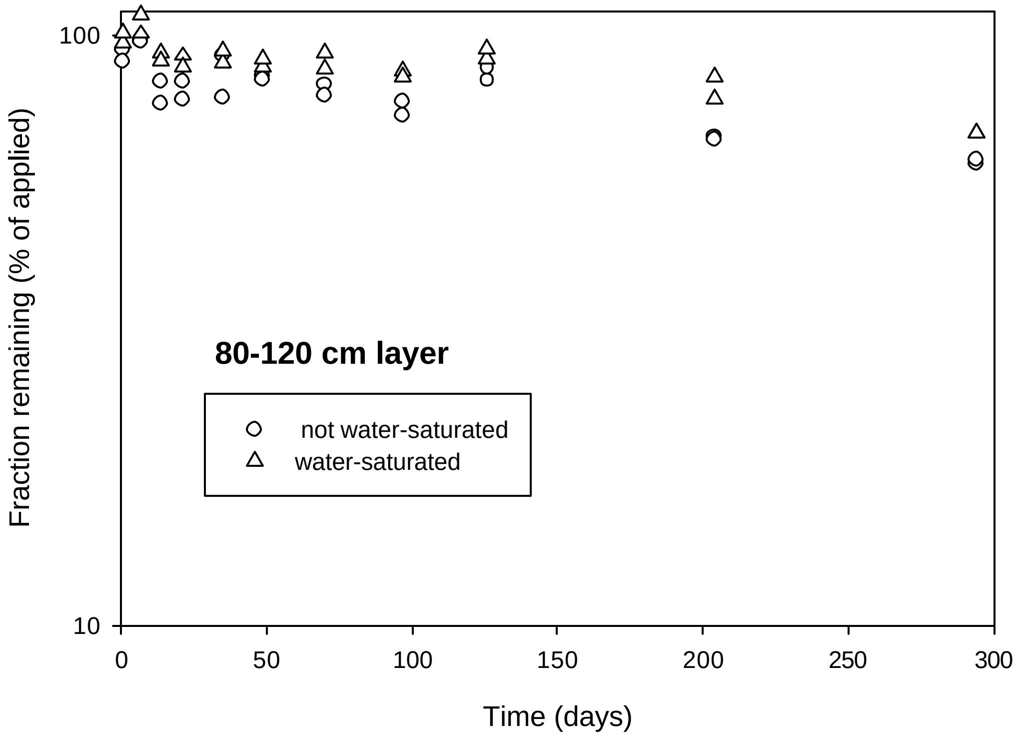


*Fig. 6.3.2 Remaining fractions of bentazone as a function of incubation time as measured in laboratory incubations at 10 °C with soil collected from the 80-120 cm layer of the experimental field at Andelst. Soil was incubated either moist (not water-saturated) or water-saturated.*

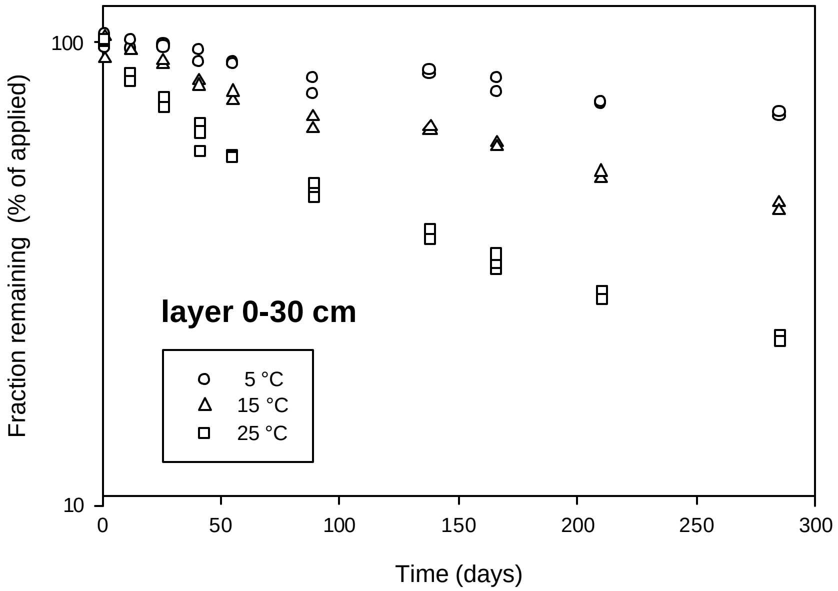


*Fig. 6.3.3 Remaining fractions of imidacloprid as a function of incubation time as measured in laboratory incubations at indicated temperatures with soil collected from the 0-30 layer of the experimental field at Andelst*

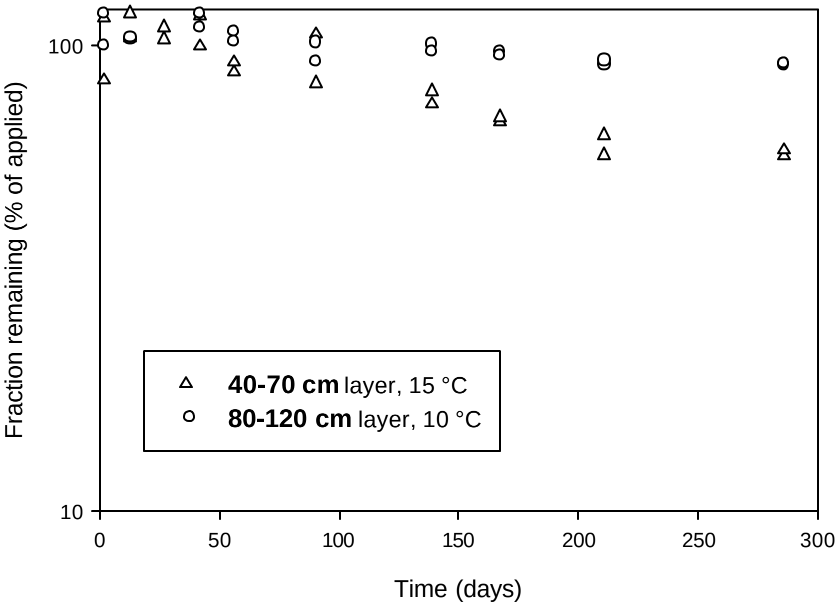


*Fig. 6.3.4 Remaining fractions of imidacloprid as a function of incubation time as measured in laboratory incubations at indicated temperatures with soil collected from the 40-70 and 80-120 cm layers of the experimental field at Andelst*

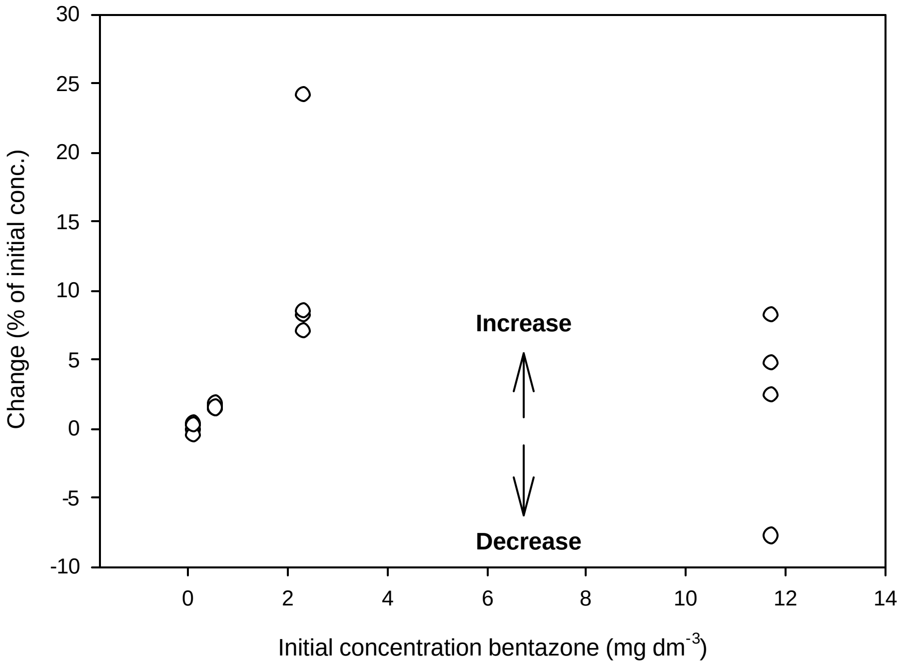


*Fig. 6.4.1 Change in initial concentration of bentazone in the batch sorption experiment with soil from the 0-30 cm layer of the field at Andelst*

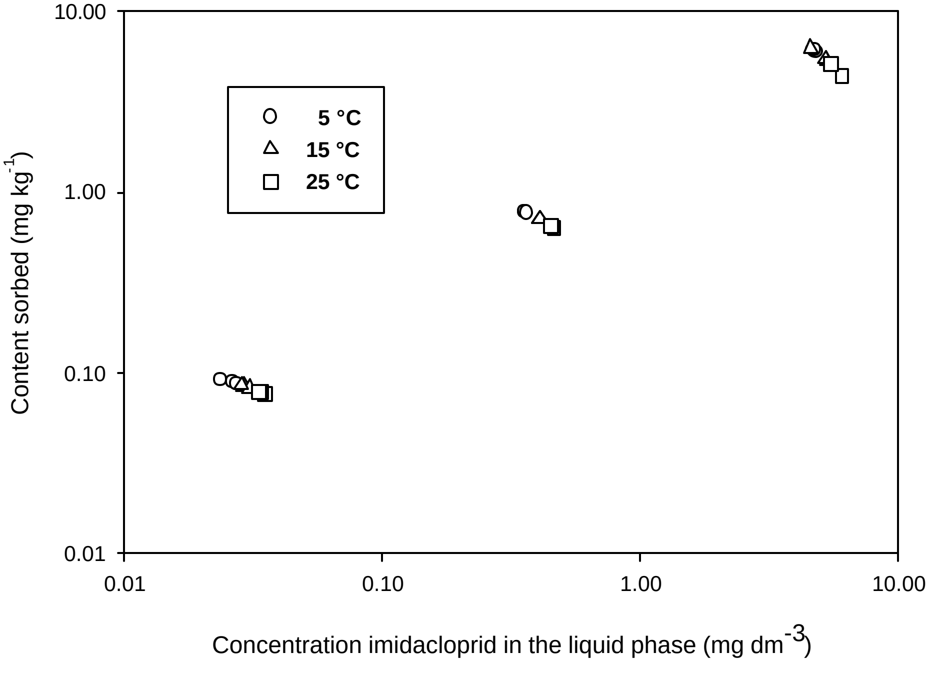


*Fig. 6 4.2 Sorption isotherms as measured for imidacloprid at 5, 15, and 25 °C in soil from the 0-30 cm layer of the field at Andelst*

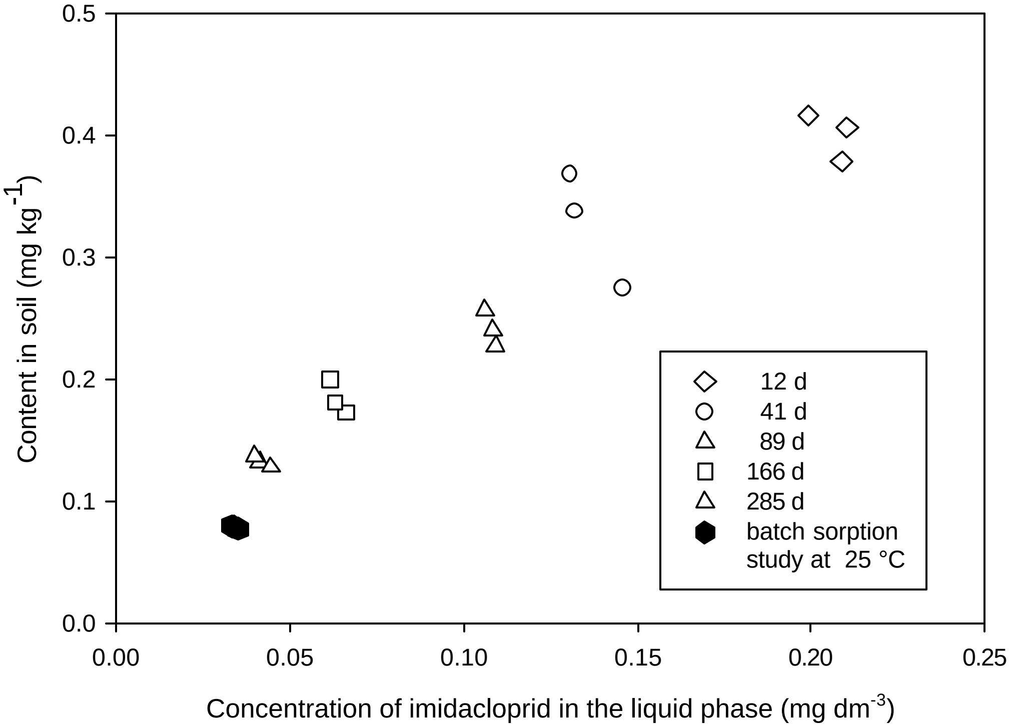


*Fig. 6.5.1 Concentration of imidacloprid in the liquid phase versus the content in the soil phase at five indicated times after application of the pesticide in the incubation series at 25 °C (de-sorption study). The value obtained with the batch sorption study at the same temperature and a similar low concentration level is shown for comparison.*

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***1 CD with all files***

# Annex 1 Explanation of the 2-character codes to describe the names of the variables in the files

| | |
|---|---|
| AE | = Areic |
| AI | = Air |
| AL | = Aluminium |
| AN | = Ammonium-N |
| AV | = Average |
| BD | = Bulk density |
| BE | = Bentazone |
| BR | = Bromide ion |
| CC | = Calcium carbonate |
| CD | = Conductivity (hydraulic) |
| CL | = Clay |
| CO | = Concentration |
| CR | = Crop |
| CT | = Content |
| CU | = Cumulative |
| D1 | = Drain (set) 1 |
| D2 | = Drain (set) 2 |
| DA | = Day |
| DC | = Discharge |
| DP | = Depth |
| DR | = Drain |
| DY | = Daily |
| EC | = Cationic exchange capacity |
| EN | = End |
| EQ | = Equilibrium |
| EV | = Event |
| FR | = Fraction |
| GL | = Global |
| GR | = Grains |
| GW | = Groundwater |
| HA | = Halms |
| HD | = Head |
| HM | = Air humidity |
| HO | = Hour |
| HY | = Hydraulic |
| IM | = Imidacloprid |
| IN | = Initial |
| KC | = KCl |
| KN | = N-Kjeldahl |
| LA | = Layers |
| LI | = Liquid phase |
| LO | = Lower |
| LV | = Level |
| MA | = Maximum |
| MC | = Matrix |

| | |
|---|---|
| ME | = Measured |
| MH | = Month |
| MI | = Minimum |
| MM | = Moisture mass fraction |
| MN | = Minute |
| MO | = Moisture (content) |
| MV | = Moisture volume fraction |
| MS | = Mass |
| NM | = N-mineral |
| NN | = Nitrate- N ($NO_3$) |
| NU | = Number |
| OB | = Observations |
| OC | = Organic carbon |
| OM | = Organic matter |
| OX | = Oxalic extractable |
| OR | = Origin |
| PE | = Pesticides |
| PF | = pF |
| PH | = pH |
| PP | = $PO_4$ |
| PR | = Precipitation (rainfall) |
| PS | = Pressure |
| PZ | = Piezometric level |
| RA | = Radiation |
| RE | = Replicate |
| S1 | = Sector 1 of the field |
| S2 | = Sector 2 of the field |
| S3 | = Sector 3 of the field |
| S4 | = Sector 4 of the field |
| SA | = Sand |
| SC | = Second |
| SD | = Standard deviation |
| SE | = Standard error of average |
| SI | = Silt |
| SM | = Sample |
| SO | = Soil |
| SR | = Saturated |
| ST | = Start |
| TE | = Temperature |
| TI | = Time |
| TN | = Total N |
| TP | = Total-P |
| TT | = Total |
| UP | = Upper |
| VA | = Vapour |
| WA | = Water |
| WS | = Wind speed |
| YR | = Year |

# Annex 2 Description of soil structure and morphology

| Depth (cm) | Description |
|---|---|
| 0- 12 | Strongly developed, fine (2-5 mm), subangular blocky with a macroporosity (4). Lots of biological activity. |
| 12-26 | Moderate developed, medium (5- 10 mm), angular blocky with a macroporosity (3). Lots of biological activity. |
| 26-34 | Strongly developed, coarse (10-20 mm), angular blocky with a microporosity (1). (ploughpan). |
| 36-43 | Strongly developed, medium (20-50 mm), rough prisms composed of strongly developed, coarse (10-20 mm), angular blocky with a macroporosity (3). |
| 43-65 | Moderate developed, medium (20-50 mm), rough prisms composed of moderate developed, coarse (10-20 mm), angular blocky with a macroporosity (3). |
| 65-80 | Moderate developed, coarse (50-100 mm), rough prisms composed of weakly developed coarse (10-20 mm) angular blocky with a macroporosity (4). |
| 80-100 | Moderate developed, very coarse (>100 mm), smooth prisms composed of moderate developed, medium (20-50 mm) prisms with a macroporosity (3). A few big pores on the fractures. |
| 100-125 | Strongly developed, coarse (50-100 mm), smooth prisms composed of moderate developed, medium (20-50 mm), prisms with a microporosity (1). |
| 125-140 | Weakly developed, very coarse (>100 mm), smooth prisms composed of weakly developed, fine (2-5 mm), angular blocky with a microporosity (l). |

| LEGEND | | | |
|---|---|---|---|
| (sub)angular blocky | Size | Prisms Size | Structure grade |
| very fine | <5 mm | <10 mm | 1. Very weakly |
| fine | 5-10 mm | 10-20 mm | 2. Weakly |
| medium | 10-20 mm | 20-50 mm | 3. Moderate |
| coarse | 20-50 mm | 50-100 mm | 4. Strong |
| very coarse | >50 mm | >100 mm | 5. Very strong |

**Porosity Class**

1 Weak macroporosity; fracture with smooth micro relief

2 Weakly heterogeneous porosity; fracture with a rough micro relief

3 Moderate macroporosity; fracture with a smooth micro relief

4 Moderate heterogeneous porosity; fracture with rough micro relief

5 Strong macroporosity; fracture with a rough micro relief

# Annex 3 Soil and crop management parameters etc.

## Soil and crop management parameters

| Date | Description of activities |
|---|---|
| 1 Oct. 1997 | Chisel ploughing diagonal over the field after harvesting of the potato crop in the last week of September |
| 23 Oct. 1997 | Seedbed preparation with rototiller and crumbler roller and sowing winter wheat, all in one combined track |
| 20 Feb. 1998 | Application of nitrogen fertiliser (325 kg $ha^{-1}$ KAS) |
| 7 April 1998 | Spraying herbicide Basagran P duplo® containing test chemical bentazone |
| 7 April 1998 | **Spraying test chemical K Br** |
| 8 May 1998 | Spraying fungicide Matador ® ; 1L $ha^{-1}$ (tebuconazool + triadimenol) |
| 14 May 1998 | Application of nitrogen fertiliser (200 kg $ha^{-1}$ KAS) |
| 27 May 1998 | **Spraying test chemical imidacloprid; product formulation Admire®** |
| 20 Aug. 1998 | Wheat crop treated with a tractor-trailed straw chopper, whole crop remained on the field |
| 1 Sept. 1998 | Further shredding and distributing of the wheat crop remnants with rotary mower (Votex® ) |
| 1 Sept. 1998 | Application of pig slurry (23.9 $m^3$ $ha^{-1}$), which was subsequently incorporated (not very homogeneously) with a spring tine cultivator to approximately 0.10 m depth |
| 22 Sept. 1998 | Spraying Roundup® (a.i. glyphosate) for killing germinated wheat |
| 8 Dec. 1998 | Ploughing of the experimental field (0.25-0.30 m depth) |
| 8 Dec. 1998 | Seedbed preparation with rototiller and crumbler roller and sowing winter wheat, all in one combined track. Soil was wet and seedbed remained very roughly with clearly visible ploughed stripes |
| 17 March 1999 | Application of nitrogen fertiliser (300 kg $ha^{-1}$ KAS) |

# Annex 4 Content of the ASCII file NLA00.BEA

```
*File:            NLA00.BEA
*Code:            ASCII
*Access:          sequential
*Author:          L.J.T. van der Pas, J.H. Smelt
*Version:         1.0
*Date:            20 March 2001
*Source:          Measurements by Alterra
*                   Sorption of bentazone to soil of the 0-30 cm layer
*                   at 20°C, Andelst, The Netherlands
*
*       Description of the quantities and their units:
*       INCOBE = Initial concentration of bentazone (mg dm**[-3]) in the
*                liquid phase. INCOBE was calculated by dividing the mass
*                of bentazone added by the total volume of liquid in the
*                system (value round off to three digits)
*       EQCOBE = Concentration of bentazone (mg dm**[-3]) measured in
*                the liquid phase after 24 h equilibration
*
*       System properties:
*           Mass of dry soil        = 43.06 g (sd=0.01 g, n=16)
*                                 sd = standard deviation
*           Mass of total liquid phase  = 47.03 g (sd=0.05 g, n=16)
*
*         EQCOBE in blank soil was <0.005 mg dm**[-3]
*
* INCOBE  EQCOBE
************************************************************************
    11.7    10.8
    11.7    12.0
    11.7    12.6
    11.7    12.3
*
    2.31    2.87
    2.31    2.50
    2.31    2.51
    2.31    2.47
*
   0.554   0.563
   0.554   0.564
   0.554   0.562
   0.554   0.562
*
   0.116   0.116
   0.116   0.116
   0.116   0.115
   0.116   0.116
```

# **Annex 5 Contents of the ASCII file NLA00.BET** (first part only)

```
*File:          NLA00.BET
*Code:          ASCII
*Access:        sequential
*Author:        L.J.T. van der Pas
*Version:       1.0
*Date:          24 Feb 2001
*Source:        Measurements by Alterra
*                 Transformation of bentazone in soil from three
*                 layers, field Andelst, The Netherlands
*
*       Description of the quantities and their units
*       YR    = Year
*       MH    = Month
*       DA    = Day within month
*       TI    = Time (days) elapsed since application of the chemical
*       UPDP  = Upper boundary (cm) of the layer
*       LODP  = Lower boundary (cm) of the layer
*      MOST  = Soil moisture status at start:(0) not saturated (1) water-saturated
*       TE    = Temperature (degree Celsius) during incubation
*       MSBE  = Mass of bentazone (micro g) remaining
*                     Mass was not corrected for extraction efficiency
*                     (being about 100%, see report) with all incubation series
*
*       System properties: layer 0-30 cm
*           Mass of dry soil        = 86.3 g
*           Mass of water           = 17.9 g
*           Mass of bentazone added = 97.7 micro g
*           Bentazone was applied on 26 May 1998.
*
*       System properties: layer 40-70 cm
*           Mass of dry soil        = 84.7 g
*           Mass of water           = 19.5 g
*           Mass of bentazone added =  9.45 micro g
*           Bentazone was applied on 19 May 1998
*
*       System properties: layer 80-120 cm NOT water saturated
*           Mass of dry soil        = 82.2 g
*           Mass of water           = 22.1 g
*           Mass of bentazone added = 0.950 micro g
*           Bentazone was applied on 19 May 1998
*
*       System properties: layer 80-120 cm water saturated
*           Mass of dry soil        = 79.1 g
*           Mass of water           = 40.2 g
*           Mass of bentazone added = 1.66 micro g
*           Bentazone was applied on 19 May 1998
*
*  YR  MH  DA   TI  UPDP  LODP   TE MOST  MSBE
********************************************************
 1998   5  27    1     0    30    5    0 100.0
 1998   5  27    1     0    30    5    0  99.7
 1998   6   2    7     0    30    5    0  95.2
 1998   6   2    7     0    30    5    0  96.0
 1998   6   9   14     0    30    5    0  90.8
 1998   6   9   14     0    30    5    0  90.1
 1998   6  23   28     0    30    5    0  83.1
 1998   6  23   28     0    30    5    0  81.4
 1998   7   7   42     0    30    5    0  78.7
 1998   7   7   42     0    30    5    0  78.1
 1998   7  21   56     0    30    5    0  74.7
 1998   7  21   56     0    30    5    0  74.1
 1998   8   6   72     0    30    5    0  68.4
 1998   8   6   72     0    30    5    0  67.5
 1998   8  24   90     0    30    5    0  65.6
 1998   8  24   90     0    30    5    0  63.4
 1998   9  22  119     0    30    5    0  56.5
 1998   9  22  119     0    30    5    0  55.7
 1998  10  27  154     0    30    5    0  49.1
 1998  10  27  154     0    30    5    0  49.9
```

# Annex 6 Content ASCII file NLA00.CDC (first part only)

```
*File:    NLA00.CDC
*Code:    ASCII
*Access:  Sequential
*Author:  R.F.A. Hendriks
*Version: 1.0
*Date:    14 april 2001
*Source:  Measurements by ALTERRA
*           Cumulative drain discharge (mm) of Drain Set 1 and Drain Set 2
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR       = Year
*         MH       = Month
*         DA       = Day within month
*         DANU     = Day number (value is 1 at 1 January 1998)
*         DYDRDCD1 = Daily drain discharge (mm) of Drain Set 1 (Catchment area = 6300 m**[2])
*         DYDRDCD2 = Daily drain discharge (mm) of Drain Set 2 (Catchment area = 5700 m**[2])
*         CUDRDCD1 = Cumulative drain discharge (mm) of Drain Set 1
*         CUDRDCD2 = Cumulative drain discharge (mm) of Drain Set 2
*         AVCUDRDC = Average cumulative drain discharge (mm),weighted by area of catchment area of Drain Set 1 & 2
*
*         Note: for a few short periods with missing data of one of the drain sets (Drain set 1: 3-15 Sept. 1998;
*               Drain set 2: 6-12 Jan. and 6-8 March 1998) the incomplete data set was completed by taking the data
*               of the other, complete set adjusted with the average ratio between the discharge of both drain sets
*               (set 1/set 2 = 0.80).
*
* YR   MH   DA DANU   DYDRDCD1 DYDRDCD2  CUDRDCD1 CUDRDCD2 AVCUDRDC
*******************************************************************************************************************
1998    1    6    6       0.83     0.98      0.83     0.98     0.90
1998    1    7    7       2.50     3.12      3.32     4.10     3.69
1998    1    8    8       1.82     2.27      5.14     6.37     5.73
1998    1    9    9       0.40     0.49      5.54     6.87     6.17
1998    1   10   10       0.11     0.14      5.65     7.01     6.30
1998    1   11   11       0.00     0.00      5.65     7.01     6.30
1998    1   12   12       0.00     0.01      5.65     7.02     6.30
1998    1   13   13       0.00     0.01      5.65     7.03     6.30
1998    1   19   19       0.00     0.00      5.65     7.03     6.30
1998    1   20   20       0.00     0.03      5.65     7.06     6.32
1998    3    5   64       0.00     0.00      5.65     7.06     6.32
1998    3    6   65       7.08     9.18     12.73    16.23    14.39
1998    3    7   66      20.37    25.46     33.10    41.70    37.18
1998    3    8   67       5.60     8.85     38.70    50.55    44.33
1998    3    9   68       0.21     2.02     38.90    52.57    45.39
1998    3   10   69       0.00     1.48     38.90    54.04    46.09
1998    3   11   70       0.00     1.34     38.90    55.39    46.73
1998    3   12   71       0.00     0.74     38.90    56.13    47.08
1998    3   13   72       0.00     0.63     38.90    56.76    47.38
1998    4   25  115       0.00     0.00     38.90    56.76    47.38
1998    4   26  116       0.00     0.09     38.90    56.84    47.42
1998    4   27  117       0.00     0.09     38.90    56.93    47.47
1998    4   28  118       0.00     0.24     38.90    57.17    47.58
1998    9    2  245       0.00     0.00     38.90    57.17    47.58
1998    9    3  246       3.58     4.47     42.48    61.64    51.58
1998    9    4  247       0.24     0.30     42.72    61.94    51.85
1998    9    5  248       0.16     0.20     42.87    62.13    52.02
1998    9    6  249       0.01     0.02     42.89    62.15    52.04
```

# Annex 7  Content of ASCII file NLA00.CLI (first part only)

```
*File:    NLA00.CLI
*Code:    ASCII
*Access:  Sequential
*Author:  R.F.A. Hendriks
*Version: 1.0
*Date:    22 February 2001
*Source:  Measurements by Wageningen University
*           weather station 'Haarweg'
*           Wageningen, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         GLRA   = Global radiation (kJ m**[-2] d**[-1])
*        AITEMI = minimum air temperature (deg. Celcius at 1.5 m height)
*        AITEMA = maximum air temperature
*         AVVAPS = Average water vapoure pressure (kPa)
*         AVWS   = Average windspeed at 2 m height(m s**[-1])
*
* YR   MH   DA  DANU   GLRA  AITEMI AITEMA  AVVAPS    AVWS
*************************************************************************
1997   11    1   -60    2684   -3.4    4.6    0.64    1.46
1997   11    2   -59    3062   -0.3    3.6    0.65    1.28
1997   11    3   -58    2383    3.2    9.2    0.76    2.82
1997   11    4   -57    6967    0.7    8.3    0.56    4.79
1997   11    5   -56    4673    5.3   15.1    1.1     3.39
1997   11    6   -55    3009    9.9   13.4    1.19    2.83
1997   11    7   -54     679    7.7   13.8    1.12    5.62
1997   11    8   -53    3126    8.2   12.4    0.94    5.08
1997   11    9   -52    4263      8   12.4    0.93    4.46
1997   11   10   -51    2890    6.9     12    0.93    4.51
1997   11   11   -50    1263    5.4    8.7    0.9     3.46
1997   11   12   -49    3164    0.1    8.1    0.83    1.18
1997   11   13   -48    1734    3.3    6.4    0.81    2.33
1997   11   14   -47    2492    3.3    7.8    0.82    2.75
1997   11   15   -46     666    6.9   10.2    1.05    2.77
1997   11   16   -45    1354    6.6   11.2    1.11    2.74
1997   11   17   -44    4928    2.5      9    0.74    4.34
1997   11   18   -43    5054    1.5    8.7    0.64    5.16
1997   11   19   -42    5003    0.7    5.4    0.48    5.28
1997   11   20   -41    1562    0.5    6.5    0.64    4.95
1997   11   21   -40    1032      5    9.1    0.95    2.09
1997   11   22   -39    3158    4.3   10.8    0.87    1.74
1997   11   23   -38    1032    4.4    6.6    0.85    2.09
1997   11   24   -37    3158      2    4.5    0.68    1.74
1997   11   25   -36    3496    1.7    6.2    0.66    3.89
1997   11   26   -35    2265   -0.6    6.9    0.68    3.29
1997   11   27   -34     872    3.8    5.4    0.74    4.28
1997   11   28   -33     970    4.3    8.7    0.91    3.67
1997   11   29   -32    2300    8.1   11.4    1.03    3.53
1997   11   30   -31     615    4.8      9    0.95    2.77
1997   12    1   -30    4068   -0.7    7.7    0.65    1.15
1997   12    2   -29    1404    0.8    3.3    0.59    2.99
1997   12    3   -28    2810   -2.1    4.9    0.58    1.95
1997   12    4   -27    1607   -5.3    3.2    0.57    1.59
1997   12    5   -26    1801   -5.3      4    0.57    1.64
1997   12    6   -25     735   -0.1    5.3    0.62    5.01
1997   12    7   -24    1615    1.2    5.2    0.63    3.48
```

# Annex 8  Contents of the ASCII file NLA00.CRL

```
*File:        NLA00.CRL
*Code:        ASCII
*Access:      sequential
*Author:      J.H. Smelt
*Version:     1.0
*Date:        30 March 2001
*Source:      Measurements by Alterra
*             Light interception by winter wheat crop, field at Andelst, The Netherlands
*
*      Description of the quantities and their units:
*      YR    = Year
*      MH    = Month
*      DA    = Day within month
*      FR01  = fraction of light interception fraction at spot 1 (dimensionless)
*      FR02  = fraction of light interception fraction at spot 2
*      FR03  = fraction of light interception fraction at spot 3
*      FR04  = fraction of light interception fraction at spot 4
*      FR05  = fraction of light interception fraction at spot 5
*      FR06  = fraction of light interception fraction at spot 6
*      FR07  = fraction of light interception fraction at spot 7
*      FR08  = fraction of light interception fraction at spot 8
*      FR09  = fraction of light interception fraction at spot 9
*      FR10  = fraction of light interception fraction at spot 10
*      FR11  = fraction of light interception fraction at spot 11
*      FR12  = fraction of light interception fraction at spot 12
*                    5 to 7 interception measurements were done per spot
*      AVFR  = Average light interception fraction of all observations
*      SEFR  = standard error of the average light interception fraction
*      NUOB  = Number of total observations
*
*
*  YR   MH   DA    FR01    FR02    FR03    FR04    FR05    FR06    FR07    FR08    FR09   FR010   FR11    FR012    AVFR     SEFR   NUOB
***************************************************************************************************************************************
 1998    4    9   0.764   0.735   0.771   0.742   0.664   0.654   0.611   0.634   0.733   0.599   0.745   0.787   0.704   0.0095     71
 1998    4   17   0.607   0.520   0.662   0.718   0.712   0.615   0.629   0.615   0.536   0.565   0.723   0.735   0.632   0.0106     76
 1998    4   30   0.842   0.808   0.857   0.873   0.794   0.713   0.737   0.711   0.753   0.739   0.809   0.893   0.792   0.0077     83
 1998    5   11   0.951   0.904   0.917   0.948   0.911   0.825   0.855   0.799   0.860   0.849   0.946   0.965   0.892   0.0065     82
 1998    5   19   0.950   0.946   0.946   0.983   0.963   0.892   0.876   0.874   0.891   0.918   0.954   0.988   0.932   0.0063     83
 1998    5   25   0.955   0.946   0.950   0.978   0.927   0.874   0.887   0.851   0.906   0.902   0.964   0.985   0.924   0.0052     83
```

# Annex 9 Content of ASCII file NLA00.CRY

```
*File:         NLA00.CRY
*Code:         ASCII
*Access:       sequential
*Author:       J.H. Smelt, R.F.A. Hendriks
*Version:      1.0
*Date:         17 April 2003
*Source:       Measurements by Alterra
*                 Dry matter production of crop and Br and nutrients (N and P) content in crop parts
*
*      Description of the quantities and their units:
*      YR      = Year
*      MH     = Month
*      DA     = Day within month
*      OR     = origin of sample:
*                  1 = sector 1, 2 = sector 2, 3= sector 3, 4 = sector 4
*      DMTT   = Total mass of dry matter           (kg ha**[-1])
*      DMHA   = Mass of dry matter of halms        (kg ha**[-1])
*      DMGR   = Mass of dry matter of grains       (kg ha**[-1])
*      BRCOTT  = Br content of total plant         (mg kg**[-1])
*      BRCOHA  = Br content of halms               (mg kg**[-1])
*      BRCOGR  = Br content of grains             mg kg**[-1])
*      MSBRTT  = Mass of bromide in total crop     (kg ha**[-1])
*      MSBRHA  = Mass of bromide in halms          (kg ha**[-1])
*      MSBRGR  = Mass of bromide in grains         (kg ha**[-1])
*      MSTNTT  = Mass of total-N in total crop     (kg ha**[-1])
*      MSTNHA  = Mass of total-N in halms          (kg ha**[-1])
*      MSTNGR  = Mass of total-N in grains         (kg ha**[-1])
*      MSTPTT  = Mass of total-P in total crop     (kg ha**[-1])
*      MSTPHA  = Mass of total-P in halms          (kg ha**[-1])
*      MSTPGR  = Mass of total-P in grains         (kg ha**[-1])
*
*      -999   = code for unknown values
*
* YR MH  DA OR   DMTT  DMHA  DMGR  BRCOTT BRCOHA BRCOGR  MSBRTT MSBRHA MSBRGR  MSTNTT MSTNHA MSTNGR  MSTPTT MSTPHA MSTPGR
*************************************************************************************************************************
1998  5  11  1   5103  -999  -999   10777   -999   -999    54.0   -999   -999     144   -999   -999      27   -999   -999
1998  5  11  2   5030  -999  -999   10841   -999   -999    52.0   -999   -999     140   -999   -999      24   -999   -999
1998  5  11  3   2827  -999  -999   12727   -999   -999    35.2   -999   -999      80   -999   -999      14   -999   -999
1998  5  11  4   4013  -999  -999   12377   -999   -999    47.7   -999   -999     110   -999   -999      20   -999   -999
*
1998  8   5  1  11388  6269  5119    -999   1508    367    11.3    9.5    1.9     165     61    104      33     13     20
1998  8   5  2  12099  6602  5497    -999   1914    368    14.7   12.6    2.0     177     63    114      31      9     21
1998  8   5  3  10209  5653  4556    -999   1629    370    10.9    9.2    1.7     148     55     93      31     12     20
1998  8   5  4  10057  5693  4364    -999   1752    377    11.6   10.0    1.6     142     52     89      29     10     19
```

# Annex 10 Content of ASCII file NLA00.D1BR

```
*File:    NLA00.D1BR
*Code:    ASCII
*Access:  Sequential
*Author:  R.F.A. Hendriks
*Version: 1.0
*Date:    30 January 2001
*Source:  Measurements by ALTERRA
*           Concentration of Bromide (Br) in the drain discharge of Drain Set D1
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*
*            m.i.= measurement interval, is a multiple of 5 min [0.0035 d]
*
*         YRST   = Year at start of measurement interval (m.i).
*         MHST   = Month at start of m.i.
*         DAST   = Day within month at start of m.i.
*         YREN   = Year at end of m.i.
*         MHEN   = Month at end of m.i.
*         DAEN   = Day within month at end of m.i.
*         CUTIST = Cumulative time (d) at start of m.i. (value is 0.000 at 1 January 1998 0.00 h)
*         CUTIEN = Cumulative time (d) at end of m.i. (value is 0.000 at 1 January 1998 0.00 h)
*         COBRD1 = Concentration of Br (g m**[-3] water) in  the drain discharge of Drain Set D1 for the m.i.
*         DRDCD1 = Drain discharge (mm) of Drain Set D1 for the m.i. (Catchment area = 6300 m**[2])
*         -9.99  = Code for unknown values
*
*       The sampling and discharge measurements did not result in continuous series because of
*       interruptions in drainflow measurements or flow proportional sampling (details are described
*       in Table 2.2 in Alterra Report 289).
*       Consequently, total bromide load can not be determined exactly, estimates have to be made for the
*       missing periods.
*
*       At 26 April 1998 very low (not measurable) drain discharge but manual sampling possible
*       At 7 September1998 no registration of discharge, manual sampling of water in flow measuring
*       system was possible
*
*       "blank" drain water not available, assumed to be identical as blank groundwater(< 0.25 (g m**[-3])
*
* YRST MHST DAST   YREN MHEN DAEN    CUTIST   CUTIEN    COBRD1   DRDCD1
************************************************************************************************************
  1998   4   26    1998   4   28    115.059  117.705      5.81     0.00
  1998   9    7    1998   9    7    249.500  249.500      4.50     0.00
  1998   9   14    1998   9   15    256.576  257.566      3.53    -9.99
  1998   9   15    1998   9   16    257.566  258.431      2.91     6.16
  1998   9   16    1998   9   18    258.431  260.771      2.42     3.50
  1998  10    8    1998  10    8    280.330  280.632      3.26     1.07
  1998  10    8    1998  10   10    280.632  282.424      3.52     1.06
  1998  10   10    1998  10   12    282.424  284.517      3.41     1.07
  1998  10   12    1998  10   13    284.517  285.681      3.51     1.07
  1998  10   14    1998  10   14    286.017  286.535      3.36     0.98
  1998  10   14    1998  10   14    286.535  286.670      3.33     1.01
  1998  10   14    1998  10   14    286.670  286.767      3.83     1.02
  1998  10   14    1998  10   14    286.767  286.872      3.99     1.01
  1998  10   14    1998  10   15    286.872  287.000      3.73     1.02
  1998  10   15    1998  10   15    287.000  287.184      3.46     1.00
  1998  10   15    1998  10   15    287.184  287.743      3.32     1.06
  1998  10   15    1998  10   27    287.743  299.646      3.38    13.73
  1998  10   27    1998  10   28    299.646  300.299      3.24     7.88
  1998  10   28    1998  10   28    300.299  300.490      3.42     4.73
  1998  11    3    1998  11    4    306.500  307.455      2.51    10.00
  1998  11    4    1998  11    6    307.455  309.181      2.74    10.01
  1998  11    6    1998  11   10    309.181  313.733      2.68    38.62
  1998  11   10    1998  11   14    313.733  317.205      2.78    11.68
  1998  11   14    1998  11   17    317.205  320.358      2.92    11.69
  1998  11   17    1998  11   20    320.358  323.823      2.62     2.57
  1998  11   26    1998  11   29    329.962  332.505      3.68     0.39
  1998  11   29    1998  12   14    332.505  347.035      3.79     2.05
  1998  12   15    1998  12   19    348.972  352.781      3.91     3.97
  1998  12   19    1998  12   20    352.781  353.646      3.81     4.05
  1998  12   20    1998  12   26    353.646  359.556      3.90     3.95
  1998  12   26    1998  12   28    359.556  361.878      4.14     4.01
  1998  12   28    1999   1    4    361.878  368.444      4.00     4.80
  1999   1    4    1999   1   19    368.444  383.479      3.98    13.29
  1999   1   19    1999   2   22    383.479  417.976     -9.99     6.30
  1999   2   22    1999   2   27    417.976  422.188      3.44     7.11
  1999   2   27    1999   3    1    422.188  424.580      4.20     1.00
  1999   3    1    1999   3    1    424.580  424.993      3.63     6.21
  1999   3    1    1999   3    9    424.993  432.580     -9.99    31.02
  1999   3    9    1999   3   15    432.580  438.208      3.53     6.99
```

# **Annex 11 Content of ASCII file NLA00.D1NT** (only the first part)

```
*File:    NLA00.D1NT
*Code:    ASCII
*Access:  Sequential
*Author:  R.F.A. Hendriks
*Version: 1.0
*Date:    17 April 2003
*Source:  Measurements by ALTERRA
*           Concentration of nutrient compounds (N and P) in the drain discharge of Drain Set D1
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*
*            m.i.= measurement interval, is a multiple of 5 min [0.0035 d]
*
*          YRST   = Year at start of measurement interval (m.i).
*          MHST   = Month at start of m.i.
*          DAST   = Day within month at start of m.i.
*          YREN   = Year at end of m.i.
*          MHEN   = Month at end of m.i.
*          DAEN   = Day within month at end of m.i.
*          CUTIST = Cumulative time (d) at start of m.i. (value is 0.000 at 1 January 1998 0.00 h)
*          CUTIEN = Cumulative time (d) at end of m.i. (value is 0.000 at 1 January 1998 0.00 h)
*          COAND1 = Concentration NH4-N (g m**[-3] water) in  the drain discharge of Drain Set D1 for the m.i.
*          CONND1 = Concentration NO3-N (g m**[-3] water) in  the drain discharge of Drain Set D1 for the m.i.
*          COKND1 = Concentration Kjeldahl-N (g m**[-3] water) in  the drain discharge of Drain Set D1 for the m.i.
*          COPPD1 = Concentration PO4-P (g m**[-3] water) in  the drain discharge of Drain Set D1 for the m.i.
*          COTPD1 = Concentration Tot-P (g m**[-3] water) in  the drain discharge of Drain Set D1 for the m.i.
*          DRDCD1 = Drain discharge (mm) of Drain Set D1 for the m.i. (Catchment area = 6300 m**[2])
*          -8.88  = Code for unknown values
*          -9.99   =   Values   below   the   detection   limit   of   0.01   g   NO3-N,   0.038   g   NH4-N,   and
*                          0.025 g PO4-P or Tot-P m**[-3] water.
*
*        The sampling and discharge measurements did not result in continuous series because of
*        interruptions in drainflow measurements or flow proportional sampling (details are described
*        in Table 2.2 in Alterra Report 289).
*        Consequently, total nutrient compounds loads can not be determined exactly, estimates have
*        to be made for the missing periods.
*
*        At 26 April 1998 very low (not measurable) drain discharge but manual sampling possible
*        At 7 September1998 no registration of discharge, manual sampling of water in flow measuring
*        system was possible
*
*
* YRST MHST DAST   YREN MHEN DAEN    CUTIST   CUTIEN    COAND1   CONND1   COKND1   COPPD1   COTPD1   DRDCD1
************************************************************************************************************
  1998   1   12    1998   1   12     11.566   11.639     0.17    23.71     0.67   -9.990    0.050     0.00
  1998   3    6    1998   3    6     64.438   64.656    -9.99    28.42    -8.88   -8.880   -9.990     1.24
  1998   3    6    1998   3    6     64.656   64.774     0.10    29.86    -8.88   -8.880    0.057     1.23
  1998   3    6    1998   3    6     64.774   64.851    -9.99    30.06    -8.88   -8.880    0.042     1.23
  1998   3    6    1998   3    6     64.851   64.910    -9.99    30.60    -8.88   -8.880    0.037     1.22
  1998   3    6    1998   3    6     64.910   64.962    -9.99    31.00    -8.88   -8.880    0.073     1.22
  1998   3    6    1998   3    7     64.962   65.007    -9.99    31.07    -8.88   -8.880    0.043     1.15
  1998   3    7    1998   3    7     65.007   65.045    -9.99    31.09    -8.88   -8.880    0.097     1.05
  1998   3    7    1998   3    7     65.045   65.083    -9.99    31.04    -8.88   -8.880    0.083     1.04
  1998   3    7    1998   3    7     65.083   65.135     0.04    31.30    -8.88   -8.880    0.058     1.24
  1998   3    7    1998   3    7     65.135   65.191    -9.99    31.10    -8.88   -8.880    0.118     1.28
  1998   3    7    1998   3    7     65.191   65.247    -9.99    31.01    -8.88   -8.880    0.080     1.27
  1998   3    7    1998   3    7     65.247   65.299    -9.99    31.19    -8.88   -8.880    0.067     1.23
  1998   3    7    1998   3    7     65.299   65.351    -9.99    31.13    -8.88   -8.880    0.093     1.24
  1998   3    7    1998   3    7     65.351   65.399    -9.99    31.32    -8.88   -8.880    0.300     1.17
  1998   3    7    1998   3    7     65.399   65.455     0.05    31.00    -8.88   -8.880    0.148     1.36
  1998   3    7    1998   3    7     65.455   65.510    -9.99    30.86    -8.88   -8.880    0.081     1.30
  1998   3    7    1998   3    7     65.510   65.569    -9.99    30.80    -8.88   -8.880    0.071     1.28
  1998   3    7    1998   3    7     65.569   65.632    -9.99    30.73    -8.88   -8.880    0.052     1.25
  1998   3    7    1998   3    7     65.632   65.701    -9.99    30.62    -8.88   -8.880    0.071     1.27
```

# Annex 12  Content of ASCII file NLA00.D1PE

```
*File:    NLA00.D1PE
*Code:    ASCII
*Access:  Sequential
*Author:  R.F.A. Hendriks, J.H. Smelt
*Version: 1.0
*Date:    30 January 2001
*Source:  Measurements by ALTERRA
*           Concentration of the pesticides bentazone (BE) and imidacloprid (IM)
*            in the drain discharge of Drain Set D1
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*
*              m.i.= measurement interval, is a multiple of 5 min [0.0035 d]
*
*         YRST   = Year at start of measurement interval m.i.
*         MHST   = Month at start of m.i.
*         DAST   = Day within month at start of m.i.
*         YREN   = Year at end of m.i.
*         MHEN   = Month at end of m.i.
*         DAEN   = Day within month at end of m.i.
*         CUTIST = Cumulative time (d) at start of m.i. (value is 0.000 at 1 January 1998 0.00 h)
*         CUTIEN = Cumulative time (d) at end of m.i. (value is 0.000 at 1 January 1998 0.00 h)
*         COBED1 = Concentration of bentazone (µg dm**[-3] water)in the drain discharge of
*                  Drain Set D1 for the m.i.
*         COIMD1 = Concentration of imidacloprid (µg dm**[-3] water)in the drain discharge of
*                  Drain Set D1 for the m.i.
*         DRDCD1 = Drain discharge (mm) of Drain Set D1 for the m.i. (Catchment area = 6300 m**[2])
*         -9.99  = Code for unknown values or not analysed
*
*
*       The sampling and discharge measurements did not result in continuous series because of
*       interruptions in drainflow measurements or flow proportional sampling (details are described
*       in Table 2.2 in Alterra Report 289).
*       Consequently, total pesticide load can not be determined exactly, estimates have to be made
*       for the missing periods.
*
*       NOTE: for some successive time periods, water samples were proportionally combined to one sample
*       for analyses. These periods can be identified because they have exactly the same concentration.
*       See also table 5.4.1 in Report 289
*
*       At 26 April 1998 very low (not measurable) drain discharge but manual sampling was possible
*       At 7 September 1998 no registration of discharge,
*       manual sampling of water in flow measuring system was possible
*
*       "blank" drainwater was not analysed, assumed to be the same as blank groundwater,
*       which had concentrations below limits of quantification in water,
*       0.03 (µg dm**[-3] for bentazone and 0.05 (µg dm**[-3]for imidacloprid
*
* YRST MHST DAST   YREN MHEN DAEN    CUTIST   CUTIEN    COBED1   COIMD1   DRDCD1
**********************************************************************************
  1998   4   26    1998   4   28    115.059  117.705     91.40    -9.99     0.00
  1998   9    7    1998   9    7    249.500  249.500     11.00     3.76     0.00
  1998   9   14    1998   9   15    256.576  257.073      1.40     4.33    -9.99
  1998   9   15    1998   9   15    257.073  257.566      1.20     2.57    -9.99
  1998   9   15    1998   9   18    257.566  260.771      1.50    -9.99     9.66
  1998  10    8    1998  10   13    280.330  285.681      6.40     1.11     4.26
  1998  10   14    1998  10   15    286.017  287.743      4.80     1.11     7.11
  1998  10   15    1998  10   27    287.743  299.646      4.10     1.11    13.73
  1998  10   27    1998  10   28    299.646  300.299      3.20     1.11     7.88
  1998  10   28    1998  10   28    300.299  300.490      2.20     2.10     4.73
  1998  11    3    1998  11    4    306.500  307.455      2.70     0.45    10.00
  1998  11    4    1998  11    6    307.455  309.181      3.30     1.30    10.01
  1998  11    6    1998  11   10    309.181  313.733      2.50     0.70    38.62
  1998  11   10    1998  11   17    313.733  320.358      4.60     0.70    23.37
  1998  11   17    1998  12   28    320.358  361.878      3.40     1.82    20.99
  1998  12   28    1999   1   19    361.878  383.479      2.70     1.82    18.09
  1999   1   19    1999   3   15    383.479  438.208      1.90     0.05    58.63
```

# Annex 13  Content of ASCII file NLA00.D2BR (only the first part)

```
*File:    NLA00.D2BR
*Code:    ASCII
*Access:  Sequential
*Author:  R.F.A. Hendriks
*Version: 1.0
*Date:    30 January 2001
*Source:  Measurements by ALTERRA
*           Concentration of Bromide (Br) in the drain discharge of Drain Set D2
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*
*            m.i.= measurement interval, is a multiple of 5 min [0.0035 d]
*
*         YRST   = Year at start of measurement interval (m.i.)
*         MHST   = Month at start of m.i.
*         DAST   = Day within month at start of m.i.
*         YREN   = Year at end of m.i.
*         MHEN   = Month at end of m.i.
*         DAEN   = Day within month at end of m.i.
*         CUTIST = Cumulative time (d) at start of m.i. (value is 0.000 at 1 January 1998 0.00 h)
*         CUTIEN = Cumulative time (d) at end of m.i. (value is 0.000 at 1 January 1998 0.00 h)
*         COBRD2 = Concentration of Br (g m**[-3] water) in  the drain discharge of Drain Set D2 for the m.i.
*         DRDCD2 = Drain discharge (mm) of Drain Set D2 for the m.i. (Catchment area = 5700 m**[2])
*
*       The sampling and discharge measurements did not result in continuous series because of
*       interruptions in drainflow measurements or flow proportional sampling (details are described
*       in Table 2.2 in Alterra Report 289).
*       Consequently, total bromide load can not be determined exactly, estimates have to be made for the
*       missing periods.
*
*       "blank" drainwater not available, assumed to be identical as blank groundwater(< 0.25 (g m**[-3])
*
* YRST MHST DAST   YREN MHEN DAEN    CUTIST   CUTIEN    COBRD2   DRDCD2
***********************************************************************************************************
  1998   4   26    1998   4   28    115.059  117.705      5.00     0.41
  1998   9    3    1998   9    4    245.351  246.420      5.41     4.76
  1998   9    4    1998   9    5    246.420  247.072      4.98     0.01
  1998   9    5    1998   9    6    247.072  248.916      4.14     0.21
  1998   9   14    1998   9   14    256.576  256.830      2.64     3.01
  1998   9   14    1998   9   14    256.830  256.941      3.14     3.05
  1998   9   14    1998   9   15    256.941  257.038      4.08     3.02
  1998   9   15    1998   9   15    257.038  257.139      4.13     3.24
  1998   9   15    1998   9   15    257.622  257.840      3.85     2.98
  1998   9   15    1998   9   17    257.840  259.056      3.23     4.10
  1998   9   17    1998   9   17    259.056  259.587      2.61     2.89
  1998   9   17    1998   9   17    259.587  259.729      2.85     0.58
  1998   9   17    1998   9   19    259.729  261.003      2.86     2.31
  1998   9   19    1998   9   26    261.003  268.559      2.43     3.15
  1998  10    8    1998  10   13    280.264  285.500      3.47     6.53
  1998  10   13    1998  10   17    285.500  289.854      3.75    10.82
  1998  10   17    1998  10   27    289.854  299.642      3.53    17.03
  1998  10   27    1998  10   28    299.642  300.292      3.41     9.53
  1998  10   28    1998  10   28    300.292  300.424      3.38     4.36
  1998  10   28    1998  10   28    300.424  300.503      3.33     2.76
  1998  11    3    1998  11    4    306.500  307.302      2.74    11.27
  1998  11    4    1998  11    6    307.302  309.500      2.78    19.16
  1998  11    6    1998  11   10    309.500  313.361      0.44    44.57
  1998  11   10    1998  11   13    313.361  316.188      2.75    17.55
  1998  11   13    1998  11   17    316.188  320.472      2.81    18.48
  1998  11   17    1998  11   23    320.472  326.524      2.98     5.17
  1998  11   23    1998  11   27    326.524  330.021      2.65     0.43
  1998  11   27    1998  11   29    330.021  332.654      3.64     1.09
  1998  11   29    1998  12   13    332.654  346.549      3.78     3.22
  1998  12   15    1998  12   18    348.781  351.316      3.51     4.49
  1998  12   18    1998  12   20    351.316  353.434      4.03     4.63
  1998  12   20    1998  12   26    353.434  359.260      4.24     4.62
  1998  12   26    1998  12   28    359.260  361.149      3.51     4.60
```

# **Annex 14 Content of ASCII file NLA00.D2NT** (only the first part)

```
*File:    NLA00.D2NT
*Code:    ASCII
*Access:  Sequential
*Author:  R.F.A. Hendriks
*Version: 1.0
*Date:    17 April 2003
*Source:  Measurements by ALTERRA
*           Concentration of nutrient compounds (N and P) in the drain discharge of Drain Set D2
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*
*            m.i.= measurement interval, is a multiple of 5 min [0.0035 d]
*
*         YRST   = Year at start of measurement interval (m.i).
*         MHST   = Month at start of m.i.
*         DAST   = Day within month at start of m.i.
*         YREN   = Year at end of m.i.
*         MHEN   = Month at end of m.i.
*         DAEN   = Day within month at end of m.i.
*         CUTIST = Cumulative time (d) at start of m.i. (value is 0.000 at 1 January 1998 0.00 h)
*         CUTIEN = Cumulative time (d) at end of m.i. (value is 0.000 at 1 January 1998 0.00 h)
*         COAND2 = Concentration NH4-N (g m**[-3] water) in  the drain discharge of Drain Set D2 for the m.i.
*         CONND2 = Concentration NO3-N (g m**[-3] water) in  the drain discharge of Drain Set D2 for the m.i.
*         COKND2 = Concentration Kjeldahl-N (g m**[-3] water)in the drain discharge of Drain SetD2 for the m.i.
*         COPPD2 = Concentration PO4-P (g m**[-3] water) in  the drain discharge of Drain Set D2 for the m.i.
*         COTPD2 = Concentration Tot-P (g m**[-3] water) in  the drain discharge of Drain Set D2 for the m.i.
*         DRDCD2 = Drain discharge (mm) of Drain Set D2 for the m.i. (Catchment area = 5700 m**[2])
*         -8.88  = Code for unknown values
*         -9.99  = Values below the detection limit of 0.038 g NH4-N, 0.25 g Kj-N and
*                    0.025 g PO4-P or Tot-P m**[-3] water.
*
*       The sampling and discharge measurements did not result in continuous series because of
*       interruptions in drainflow measurements or flow proportional sampling (details are described
*       in Table 2.2 in Alterra Report 289).
*       Consequently, total nutrient compounds loads can not be determined exactly, estimates have
*       to be made for the missing periods.
*
*
* YRST MHST DAST   YREN MHEN DAEN    CUTIST   CUTIEN    COAND2   CONND2   COKND2   COPPD2   COTPD2   DRDCD2
************************************************************************************************************
  1998   1   12    1998   1   12     11.566   11.639      0.12    23.66    -9.99   -9.990    0.030     0.02
  1998   4   26    1998   4   28    115.059  117.705      0.18    18.00    -8.88   -9.990   -9.990     0.41
  1998   9    3    1998   9    4    245.351  246.422      1.93     7.45     1.19    1.570   -8.880     4.76
  1998   9    4    1998   9    5    246.422  247.072      0.66    11.14     1.19    0.701   -8.880     0.01
  1998   9    5    1998   9    6    247.072  248.916      0.20    12.28     1.19    0.250   -8.880     0.21
  1998   9   14    1998   9   14    256.576  256.691      0.08    10.29     4.30    0.388    0.411     0.48
  1998   9   14    1998   9   14    256.691  256.733     -9.99     9.90    -8.88    0.296    0.297     0.54
  1998   9   14    1998   9   14    256.733  256.764     -9.99     9.52    -8.88    0.283    0.279     0.51
  1998   9   14    1998   9   14    256.764  256.785     -9.99     9.16    -8.88    0.399    0.382     0.44
  1998   9   14    1998   9   14    256.785  256.809      0.42     8.70    -8.88    0.308    0.290     0.56
  1998   9   14    1998   9   14    256.809  256.830      0.08     9.78    -8.88    0.290    0.290     0.49
  1998   9   14    1998   9   14    256.830  256.851     -9.99     9.65    -8.88    0.317    0.324     0.50
  1998   9   14    1998   9   14    256.851  256.851      0.05     9.50    -8.88    0.323    0.355     0.00
  1998   9   14    1998   9   14    256.851  256.889     -9.99     9.47    -8.88    0.288    0.302     1.00
  1998   9   14    1998   9   14    256.889  256.906     -9.99     9.98    -8.88    0.289    0.314     0.50
  1998   9   14    1998   9   14    256.906  256.924     -9.99     9.81    -8.88    0.355    0.356     0.52
  1998   9   14    1998   9   14    256.924  256.941     -9.99    10.19    -8.88    0.295    0.311     0.53
  1998   9   14    1998   9   14    256.941  256.958     -9.99    10.66    -8.88    0.279    0.330     0.52
  1998   9   14    1998   9   14    256.958  256.972     -9.99    11.65    -8.88    0.203    0.226     0.42
  1998   9   14    1998   9   14    256.972  256.990     -9.99    11.47    -8.88    0.277    0.298     0.53
  1998   9   14    1998   9   15    256.990  257.007     -9.99    11.29    -8.88    0.236    0.260     0.52
```

# Annex 15  Content of ASCII file NLA00.D2PE

```
*File:    NLA00.D2PE
*Code:    ASCII
*Access:  Sequential
*Author:  R.F.A. Hendriks, J.H. Smelt
*Version: 1.0
*Date:    30 January 2001
*Source:  Measurements by ALTERRA
*          Concentration of the pesticides bentazone (BE) and imidacloprid(IM)
*          in the drain discharge of Drain Set D2
*         Andelst, The Netherlands
*
*        Description of the quantities and their units
*
*            m.i.= measurement interval, is a multiple of 5 min [0.0035 d]
*
*        YRST   = Year at start of measurement interval m.i.
*        MHST   = Month at start of m.i.
*        DAST   = Day within month at start of m.i.
*        YREN   = Year at end of m.i.
*        MHEN   = Month at end of m.i.
*        DAEN   = Day within month at end of m.i.
*        CUTIST = Cumulative time (d) at start of m.i.(value is 0.000 at 1 January 1998 0.00 h)
*        CUTIEN = Cumulative time (d) at end of m.i. (value is 0.000 at 1 January 1998 0.00 h)
*        COBED2 = Concentration of bentazone (µg dm**[-3] water)in the drain discharge of
*                  Drain Set D2 for the m.i.
*        COIMD2 = Concentration of imidacloprid (µg dm**[-3] water)in the drain discharge of
*                  Drain Set D2 for the m.i.
*       DRDCD2 = Drain discharge (mm) of Drain Set D2 for the m.i.
*                   (Catchment area = 5700 m**[2])
*        -9.99  = Code for unknown values
*
*      The sampling and discharge measurements did not result in continuous series because of
*      interruptions in drainflow measurements or flow proportional sampling (details are
*      described in Table 2.2 in Alterra Report 289).Consequently, total pesticide load can not
*      be determined exactly, estimates have to be made for the missing periods.
*
*      NOTE: for some successive time periods, water samples were proportionally combined to
*      one sample for analysis. These periods can be identified because they have exactly the
*      same concentration. See also table 5.4.2 in Report 289
*
*      "blank" drainwater was not analysed, assumed to be the same as blank groundwater,
*      which had concentrations below limits of quantification (LOQ)in water,
*      0.03 (µg dm**[-3] for bentazone and 0.05 (µg dm**[-3]for imidacloprid
*
* YRST MHST DAST   YREN MHEN DAEN    CUTIST   CUTIEN    COBED2   COIMD2   DRDCD2
*******************************************************************************************
  1998   4   26    1998   4   28    115.059  117.705     89.00    -9.99     0.41
  1998   9    3    1998   9    6    245.351  248.916     10.70     6.30     4.98
  1998   9   14    1998   9   14    256.576  256.809      1.81     6.43     2.52
  1998   9   14    1998   9   14    256.809  256.906      1.81     5.79     2.49
  1998   9   14    1998   9   14    256.906  256.990      1.81     5.71     2.53
  1998   9   14    1998   9   15    256.990  257.073      1.59     5.23     2.64
  1998   9   15    1998   9   15    257.073  257.139      1.59     4.69     2.14
  1998   9   15    1998   9   16    257.622  258.354      3.20    -9.99     6.01
  1998   9   16    1998   9   26    258.354  268.559      3.95    -9.99    10.00
  1998  10    8    1998  10   13    280.264  285.500      9.88     1.97     6.53
  1998  10   13    1998  10   17    285.500  289.854      7.63     1.97    10.82
  1998  10   17    1998  10   27    289.854  299.642      6.33     1.97    17.03
  1998  10   27    1998  10   28    299.642  300.292      3.35     1.97     9.53
  1998  10   28    1998  10   28    300.292  300.503      4.01     0.45     7.12
  1998  11    3    1998  11    4    306.500  307.302      4.25     0.57    11.27
  1998  11    4    1998  11    6    307.302  309.500      3.92     0.53    19.16
  1998  11    6    1998  11   10    309.500  313.361      0.69     0.25    44.57
  1998  11   10    1998  11   15    313.361  318.424      4.38     0.25    28.79
  1998  11   15    1998  12   20    318.424  353.434      4.69     0.32    26.73
  1998  12   20    1999   1   16    353.434  380.850      4.16     0.32    33.56
  1999   1   16    1999   3    1    380.850  424.740      5.19     0.53    20.23
  1999   3    1    1999   3    3    424.740  426.139      3.66     0.40    21.95
  1999   3    3    1999   4    3    426.139  457.500      3.56     0.22    28.33
```

# Annex 16 Content of ASCII file NLA00.DDC (only the first part)

```
*File:    NLA00.DDC
*Code:    ASCII
*Access:  Sequential
*Author:  R.F.A. Hendriks
*Version: 1.0
*Date:    12 February 2001
*Source:  Measurements by ALTERRA
*           Drain discharge (mm) of Drain Set 1 and Drain Set 2
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YRST   = Year at start of measurement interval (m.i.)
*                   (Normally m.i. is 5 min [0.0035 d]; in case of no or unknown flow m.i.
*                  can be a multiple of 5 min)
*         MHST   = Month at start of m.i.
*         DAST   = Day within month at start of m.i.
*         YREN   = Year at end of m.i.
*         MHEN   = Month at end of m.i.
*         DAEN   = Day within month at end of m.i.
*         CUTIST = Cumulative time (d) at start of m.i.(value is 0.000 at 1 January 1998 0.00 h,
*                  and is a multiple of 0.0035 d (5 min) and is rounded of to 3 decimals)
*         CUTIEN = Cumulative time (d) at end of m.i. (idem value treatment as with start)
*         DRDCD1 = Drain discharge (mm) of Drain Set 1 for the m.i.(Catchment area = 6300 m**[2])
*         DRDCD2 = Drain discharge (mm) of Drain Set 2 for the m.i.(Catchment area = 5700 m**[2])
*         0.0003 = Minimum value (mm per 5 min) of reliable measurements for Drain Set 1 and 2
*                  (Measurements lower than this value are set to 0.0000)
*         0.0860 = Value equal or larger than measurable maximum for Drain Set 1:
*                      i.e. value = or > 0.0860 mm in 5 min
*         0.1199 = Value equal or larger than measurable maximum for Drain Set 2:
*                      i.e. value = or > 0.1199 mm in 5 min
*        -9.9999 = Code for unknown values
*
* YRST MHST DAST   YREN MHEN DAEN    CUTIST   CUTIEN    DRDCD1   DRDCD2
*************************************************************************************************
  1998   1    6    1998   1    6      5.594    5.632    0.0000   0.0000
  1998   1    6    1998   1    6      5.632    5.635    0.0000   0.0073
  1998   1    6    1998   1    6      5.635    5.639    0.0000   0.0117
  1998   1    6    1998   1    6      5.639    5.642    0.0000   0.0117
  1998   1    6    1998   1    6      5.642    5.646    0.0000   0.0116
  1998   1    6    1998   1    6      5.646    5.649    0.0000   0.0117
  1998   1    6    1998   1    6      5.649    5.653    0.0000   0.0113
  1998   1    6    1998   1    6      5.653    5.656    0.0000   0.0110
  1998   1    6    1998   1    6      5.656    5.660    0.0110   0.0113
  1998   1    6    1998   1    6      5.660    5.663    0.0112   0.0113
  1998   1    6    1998   1    6      5.663    5.667    0.0111   0.0113
  1998   1    6    1998   1    6      5.667    5.670    0.0110   0.0109
  1998   1    6    1998   1    6      5.670    5.674    0.0108   0.0108
  1998   1    6    1998   1    6      5.674    5.677    0.0108   0.0098
  1998   1    6    1998   1    6      5.677    5.681    0.0108   0.0105
  1998   1    6    1998   1    6      5.681    5.684    0.0101   0.0106
  1998   1    6    1998   1    6      5.684    5.688    0.0096   0.0105
  1998   1    6    1998   1    6      5.688    5.691    0.0104   0.0105
  1998   1    6    1998   1    6      5.691    5.694    0.0104   0.0103
  1998   1    6    1998   1    6      5.694    5.698    0.0103   0.0102
  1998   1    6    1998   1    6      5.698    5.701    0.0102   0.0102
  1998   1    6    1998   1    6      5.701    5.705    0.0102   0.0103
  1998   1    6    1998   1    6      5.705    5.708    0.0101   0.0096
  1998   1    6    1998   1    6      5.708    5.712    0.0101   0.0101
  1998   1    6    1998   1    6      5.712    5.715    0.0100   0.0101
  1998   1    6    1998   1    6      5.715    5.719    0.0099   0.0100
  1998   1    6    1998   1    6      5.719    5.722    0.0097   0.0092
  1998   1    6    1998   1    6      5.722    5.726    0.0099   0.0099
  1998   1    6    1998   1    6      5.726    5.729    0.0097   0.0098
  1998   1    6    1998   1    6      5.729    5.733    0.0096   0.0097
  1998   1    6    1998   1    6      5.733    5.736    0.0096   0.0097
  1998   1    6    1998   1    6      5.736    5.740    0.0088   0.0097
  1998   1    6    1998   1    6      5.740    5.743    0.0078   0.0096
```

# Annex 17  Content of ASCII file NLA00.DLI

```
*File:    NLA00.DLI
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie, R.F.A. Hendriks
*Version: 1.0
*Date:    16 November 2000
*Source:  Measurements by ALTERRA
*           Ditch water Levels: Instantaneous measurements
*           Andelst, The Netherlands
*
*         Description of the quantities and their units:
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         DWLV   = Ditch water level (m below soil surface)
*         HYHDDB = Hydraulic head under the ditch bottom (m below soil surface)
*
* YR   MH   DA  DANU      DWLV  HYHDDB
*******************************************************************************
1998    1   12    12      1.33    1.15
1998    1   19    19      1.21    1.19
1998    1   22    22      1.21    1.19
1998    1   26    26      1.22    1.18
1998    2    2    33      1.24    1.21
1998    2    5    36      1.24    1.21
1998    2    9    40      1.25    1.24
1998    2   16    47      1.26    1.25
1998    2   18    49      1.26    1.27
1998    2   23    54      1.27    1.26
1998    3    2    61      1.26    1.30
1998    3    3    62      1.27    1.29
1998    3    9    68      1.12    1.06
1998    3   10    69      1.14    1.10
1998    3   16    75      1.20    1.21
1998    3   17    76      1.23    1.20
1998    3   23    82      1.17    1.17
1998    3   24    83      1.11    1.10
1998    3   30    89      1.10    1.11
1998    4   17   107      1.11    1.10
1998    4   24   114      1.11    1.09
1998    4   29   119      1.11    1.06
1998    5   12   132      1.12    1.10
1998    5   29   149      1.15    1.18
1998    6   23   174      1.14    1.12
1998    7    3   184      1.15    1.17
1998    7   16   197      1.15    1.20
1998    8   10   222      1.17    1.23
1998    8   14   226      1.22    1.28
1998    9    7   250      1.15    1.16
1998    9   21   264      1.07    1.05
1998   10    6   279      1.14    1.14
1998   10   20   293      1.09    1.08
1998   11   17   321      1.02    0.99
1998   12   18   352      1.24    1.15
1999    1    5   370      1.23    1.12
1999    1   28   393      1.27    1.16
1999    2    3   399      1.29    1.22
1999    2   25   421      1.20    1.12
1999    3    4   428      1.07    1.01
1999    3   18   442      1.26    1.25
1999    4    6   461      1.31    1.25
1999    4   20   475      1.03    1.00
1999    5    3   488      1.07    1.05
1999    5    7   492      1.03    1.01
```

# Annex 18 Content of ASCII file NLA00.GAN

```
*File:    NLA00.GAN
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie; R.F.A. Hendriks
*Version: 1.0
*Date:    7 June 2001
*Source:  Measurements by ALTERRA
*           Concentration of Ammonium-N (NH4-N) in groundwater
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         NUFI   = Number of filters sampled
*         UPDP   = Upper boundary of the filter (cm below soil surface)
*         LODP   = Lower boundary of the filter (cm below soil surface)
*         COANS1 = Concentration of NH4-N (g m**[-3] water) for Sector 1;
*                  in general average of 4 observations (1 observation per plot);
*                  at 04-03-1999: for the filters at depth's of 100-120, 130-150 and 190-280 cm,
*                  values are for mixed samples obtained from the 8 plots in the Sectors 1 and 2
*         COANS2 = Concentration of NH4-N (g m**[-3] water) for Sector 2;
*                  in general average of 4 observations (1 observation per plot);
*                  at 04-03-1999: for the filters at depth's of 100-120, 130-150 and 190-280 cm,
*                  values are for mixed samples obtained from the 8 plots in the Sectors 1 and 2
*         COANS3 = Concentration of NH4-N (g m**[-3] water) for Sector 3;
*                  in general average of 4 observations (1 observation per plot);
*                  at 04-03-1999: for the filters at depth's of 100-120, 130-150 and 190-280 cm,
*                  values are for mixed samples obtained from the 8 plots in the Sectors 3 and 4
*         COANS4 = Concentration of NH4-N (g m**[-3] water) for Sector 4;
*                  in general average of 4 observations (1 observation per plot);
*                  at 04-03-1999: for the filters at depth's of 100-120, 130-150 and 190-280 cm,
*                  values are for mixed samples obtained from the 8 plots in the Sectors 3 and 4
*         AVCOAN = Average concentration of NH4-N (g m**[-3] water)
*         SECOAN = Standard error (g m**[-3] water) of the average concentration of NH4-N
*         NUOB   = Number of observations for calculation of AVCOAN and SECOAN
*         -8.88  = Code for unknown values
*         -9.99  = Values below the detection limit of 0.038 g NH4-N (0.05 g NH4) m**[-3] water.
*                  For calculation of the average contents (AVCOAN) this value is set at
*                  0.02 g NH4-N m**[-3] water.
*
* YR   MH   DA  DANU   NUFI  UPDP  LODP    COANS1  COANS2  COANS3  COANS4    AVCOAN  SECOAN  NUOB
***************************************************************************************************
1998    3    3    62      1   190   280      0.07    0.07    0.16    0.07      0.09    0.03    15
1998    3   10    69      2    70    90      0.06    0.04    0.04   -9.99      0.05    0.01    16
1998    3   10    69      2   190   280     -9.99    0.04    0.11    0.05      0.06    0.02    15
1998    4   29   119      1   100   120      0.10    0.05    0.04    0.06      0.06    0.01    16
1998    5   12   132      1   100   120      0.04    0.83   -9.99   -9.99      0.23    0.20    16
1998    5   29   149      1   190   280     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99    15
1998    6    4   155      1   130   150     -9.99   -9.99   -9.99   -8.88     -9.99   -9.99     6
1998    6    9   160      1   130   150     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99    16
1998    6   23   174      1   130   150     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99    16
1998    8   10   222      1   190   280     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99    15
1998    9    7   250      2   100   120     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     8
1998    9    7   250      2   130   150     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99    16
1998    9   21   264      1   100   120     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99    16
1998   10    6   279      2   100   120     -9.99   -9.99    0.05   -8.88      0.04    0.02     7
1998   10    6   279      2   130   150     -9.99   -9.99    0.04   -9.99     -9.99    0.01    16
1998   10   20   293      2    70    90      0.04    0.04   -9.99   -9.99     -9.99    0.01     9
1998   10   20   293      2   100   120      0.04    0.05   -9.99   -9.99     -9.99    0.01    16
1998   12   18   352      2   100   120      0.20   -9.99    0.04   -9.99      0.07    0.04    15
1998   12   18   352      2   130   150      0.19   -9.99   -9.99   -9.99      0.06    0.05    15
1999    1   28   393      1   100   120     -9.99    0.04    0.05   -9.99     -9.99    0.01    15
1999    3    4   428      4    70    90      0.05    0.05    0.04    0.07      0.05    0.01    16
1999    3    4   428      4   100   120      0.05    0.05    0.08    0.08      0.06    0.02     2
1999    3    4   428      4   130   150      0.05    0.05    0.09    0.09      0.07    0.02     2
1999    3    4   428      4   190   280      0.04    0.04    0.05    0.05      0.04    0.01     2
1999    4   20   475      1   100   120     -9.99   -9.99    0.07   -9.99     -9.99    0.01    16
```

# Annex 19 Content of ASCII file NLA00.GBE

```
*File:    NLA00.GBE
*Code:    ASCII
*Access:  Sequential
*Author:  J.H. Smelt & L.J.T. van der Pas
*Version: 1.1
*Date:    14 February 2002
*Source:  Measurements by ALTERRA
*           Concentration of bentazone(BE)in groundwater
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         NUFI   = Number of filter depths analysed at DANU
*         UPDP   = Upper boundary of the filter (cm below soil surface)
*         LODP   = Lower boundary of the filter (cm below soil surface)
*         COBES1 = Concentration of BE (µg dm**[-3] water) for Sector 1
*         COBES2 = Concentration of BE (µg dm**[-3] water) for Sector 2
*         COBES3 = Concentration of BE (µg dm**[-3] water) for Sector 3
*         COBES4 = Concentration of BE (µg dm**[-3] water) for Sector 4
*         AVCOBE = Average concentration of bentazone (µg dm**[-3] water)
*         SECOBE = Standard error (µg dm**[-3] water) of the average concentration of bentazone
*         NUOB   = Number of observations (analyses) for calculation of AVCOBE and SECOBE
*         -8.88  = Code for unknown values (e. g. no water could be sampled)
*         -9.99  = Values below the limit of quantification of 0.03 µg dm**[-3] water.
*                    For calculation of the average concentrations (AVCOBE) this value is
*                    set at 0.015 µg dm**[-3] water to get realistic averages.
*
*       On 4 June 1998 it was not possible to collect enough water from all 4 filters at 130-150 cm depth
*       at each sector. In total five filters could be sampled situated in the sectors 1,2 and 3.
*       Each sample was analysed.
*       On 18-03-1999 water samples collected at sector 4 only, from all 4 tubes (water used for lab studies)
*
*       Concentrations were not corrected for extraction efficiency, which was on average 100 %
*       (standard deviation =12; n=17)
*
*       "Blank" groundwater samples, collected 30-03-98, had concentrations below limit of quantification
*
*  YR    MH    DA   DANU   NUFI   UPDP   LODP    COBES1   COBES2   COBES3   COBES4   AVCOBE   SECOBE   NUOB
**************************************************************************************************************
 1998     3    30     89      1    130    150     -9.99    -9.99    -9.99    -9.99    -9.99    -9.99       4
 1998     4    29    119      1    100    120     17.56    11.30    17.47    16.73    15.77     1.50       4
 1998     5    29    149      1    190    280      0.21     0.89     1.66     1.11     0.97     0.30       4
 1998     6     4    155      1    130    150      0.62     2.51     2.76    -8.88     1.96     0.52       5
 1998     9     6    160      1    130    150      1.08     1.36     3.66     1.54     1.91     0.59       4
 1998     8    10    222      1    190    280      4.73     2.77     3.39     1.55     3.11     0.66       4
 1998     9     7    250      2    100    120     -8.88     2.62    10.08    -8.88     6.35     3.73       2
 1998     9     7    250      2    130    150      4.59     3.05     7.30     4.16     4.77     0.90       4
 1998     9    21    264      1    100    120      0.69     0.69     2.48     7.40     2.82     1.58       4
 1998    12    18    352      2    100    120      1.14     1.34     2.09     2.78     1.84     0.38       4
 1998    12    18    352      2    130    150      1.11     1.10     2.73     3.11     2.01     0.53       4
 1999     1    28    393      1    100    120      0.56     0.55     1.54     1.26     0.98     0.25       4
 1999     3     4    428      3    100    120      0.58     0.74     1.21     1.46     1.00     0.20       4
 1999     3     4    428      3    130    150      0.72     0.72     1.34     1.86     1.16     0.27       4
 1999     3     4    428      3    190    280      1.21     1.00     1.18     0.87     1.07     0.08       4
 1999     3    18    442      1    130    150     -8.88    -8.88    -8.88     2.14     2.14     0.00       1
 1999     4    20    475      1    100    120      0.48     0.99     1.37     1.61     1.11     0.25       4
```

# Annex 20 Content of ASCII file NLA00.GBR

```
*File:    NLA00.GBR
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie; R.F.A. Hendriks
*Version: 1.0
*Date:    6 June 2001
*Source:  Measurements by ALTERRA
*           Concentration of Bromide (Br) in groundwater
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         NUFI   = Number of filters sampled
*         UPDP   = Upper boundary of the filter (cm below soil surface)
*         LODP   = Lower boundary of the filter (cm below soil surface)
*         COBRS1 = Concentration of Br (g m**[-3] water) for Sector 1;
*                  in general average of 4 observations (1 observation per plot);
*                  at 04-03-1999: for the filters at depth's of 100-120, 130-150 and 190-280 cm,
*                  values are for mixed samples obtained from the 8 plots in the Sectors 1 and 2
*         COBRS2 = Concentration of Br (g m**[-3] water) for Sector 2;
*                  in general average of 4 observations (1 observation per plot);
*                  at 04-03-1999: for the filters at depth's of 100-120, 130-150 and 190-280 cm,
*                  values are for mixed samples obtained from the 8 plots in the Sectors 1 and 2
*         COBRS3 = Concentration of Br (g m**[-3] water) for Sector 3;
*                  in general average of 4 observations (1 observation per plot);
*                  at 04-03-1999: for the filters at depth's of 100-120, 130-150 and 190-280 cm,
*                  values are for mixed samples obtained from the 8 plots in the Sectors 3 and 4
*         COBRS4 = Concentration of Br (g m**[-3] water) for Sector 4;
*                  in general average of 4 observations (1 observation per plot);
*                  at 04-03-1999: for the filters at depth's of 100-120, 130-150 and 190-280 cm,
*                  values are for mixed samples obtained from the 8 plots in the Sectors 3 and 4
*         AVCOBR = Average concentration of Br (g m**[-3] water)
*         SECOBR = Standard error (g m**[-3] water) of the average concentration of Br
*         NUOB   = Number of observations for calculation of AVCOBR and SECOBR
*         -8.88  = Code for unknown values
*         -9.99  = Values below LOQ = 0.25 g Br m**[-3] water. For calculation of
*                  the average contents (AVCOBR) this value is set at 0.125 g Br m**[-3] water.
*
* YR   MH   DA   DANU   NUFI  UPDP  LODP    COBRS1  COBRS2  COBRS3  COBRS4    AVCOBR  SECOBR  NUOB
***************************************************************************************************
1998    4   29    119      1   100   120      0.92    0.42    1.03    1.37      0.94    0.20    16
1998    5   12    132      1   100   120      1.83    0.69    1.86    2.04      1.60    0.41    16
1998    5   29    149      1   190   280     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99    15
1998    6    4    155      1   130   150     -8.88   -8.88    0.21   -8.88      0.21    0.06     4
1998    6    9    160      1   130   150      0.33    0.20    0.30    0.30      0.28    0.05    16
1998    6   23    174      1   130   150      0.44    0.24    0.72    0.54      0.49    0.09    16
1998    8   10    222      1   190   280     -9.99   -9.99    0.27   -9.99      0.16    0.04    15
1998    9    7    250      2   100   120      0.98    1.74    2.25    2.10      1.94    0.17     8
1998    9    7    250      2   130   150      1.36    1.06    1.58    1.20      1.30    0.11    16
1998    9   21    264      1   100   120      1.89    1.74    2.51    2.34      2.12    0.18    16
1998   10    6    279      2   100   120      1.04    2.00    2.39   -8.88      1.95    0.26     8
1998   10    6    279      2   130   150      1.79    1.76    1.66    1.54      1.68    0.18    14
1998   10   20    293      2    70    90      5.18    3.20    3.44    2.27      3.57    0.38    10
1998   10   20    293      2   100   120      3.61    2.92    3.65    3.21      3.32    0.29    15
1998   12   18    352      2   100   120      4.13    4.02    3.94    4.00      4.02    0.16    16
1998   12   18    352      2   130   150      4.31    3.39    3.50    3.85      3.78    0.25    15
1999    1   28    393      1   100   120      2.76    3.02    3.30    2.54      2.90    0.12    16
1999    3    4    428      4    70    90      1.05    2.01    1.82    1.65      1.63    0.19    16
1999    3    4    428      4   100   120      2.74    2.74    3.05    3.05      2.89    0.16     2
1999    3    4    428      4   130   150      2.74    2.74    2.72    2.72      2.73    0.01     2
1999    3    4    428      4   190   280      1.81    1.81    1.02    1.02      1.41    0.40     2
1999    4   20    475      1   100   120      2.34    3.01    3.39    3.02      2.94    0.20    16
```

# Annex 21 Content of ASCII file NLA00.GIM

```
*File:    NLA00.GIM
*Code:    ASCII
*Access:  Sequential
*Author:  J.H. Smelt & L.J.T. van der Pas
*Version: 1.1
*Date:    14 February 2002
*Source:  Measurements by ALTERRA
*           Concentration of imidacloprid (IM) in groundwater
*            Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         NUFI   = Number of filter depths analysed at DANU
*         UPDP   = Upper boundary of the filter (cm below soil surface)
*         LODP   = Lower boundary of the filter (cm below soil surface)
*         COIMS1 = Concentration of IM (µg dm**[-3] water) for Sector 1
*         COIMS2 = Concentration of IM (µg dm**[-3] water) for Sector 2
*         COIMS3 = Concentration of IM (µg dm**[-3] water) for Sector 3
*         COIMS4 = Concentration of IM (µg dm**[-3] water) for Sector 4;
*                 (mixed water sample of only 3 filter tubes instead of 4 as general)
*         AVCOIM = Average concentration of imidacloprid (µg dm**[-3] water)
*         SECOIM = Stand. error(µg dm**[-3] water) of the average concentration of imidacloprid
*         NUOB   = Number of observations (analyses) for calculation of AVCOIM and SECOIM
*        -8.888  = Code for unknown values (e. g. no water could be sampled)
*        -9.999  = Values below the limit of quantification (LOQ) set at 0.05 µg dm**[-3] water.
*                  For calculation of the average concentrations (AVCOIM) this value is
*                  set at 0.025 µg dm**[-3] water to get realistic averages.
*
*      "Blank" groundwater samples, collected on 30-03-98, had concentrations below limit of
*      quantification, like first (deep)groundwater samples after application on 29 May 1998
*
*      On 7 September 1998 it was only possible to collect enough water from the four filters at
*      100-120 cm depth within Sector 3. On 18-03-1999 water samples collected at sector 4 only;
*      from all 4 tubes (water used for lab studies)
*
*      Concentrations were not corrected for extraction efficiency, which was on average 91.7 %
*      (sd=10.5; n=32, sd = standard deviation)
*
*  YR   MH   DA  DANU  NUFI  UPDP  LODP   COIMS1  COIMS2  COIMS3  COIMS4  AVCOIM  SECOIM   NUOB
*************************************************************************************************
 1998    5   29   149     1   190   280   -9.999  -9.999  -9.999  -9.999  -9.999  -9.999      4
 1998    6    9   160     1   130   150   -9.999  -9.999   0.088   0.052   0.048   0.013      4
 1998    8   10   222     1   190   280   -9.999  -9.999   0.331  -9.999   0.101   0.067      4
 1998    9    7   250     2   100   120   -8.888  -8.888   0.524  -8.888   0.524   0.000      1
 1998    9    7   250     2   130   150    0.363   0.391  -8.888   0.266   0.340   0.032      3
 1998    9   21   264     1   100   120   -9.999   0.170   0.202   0.114   0.128   0.034      4
 1998   12   18   352     2   100   120    0.071   0.051  -9.999  -9.999   0.043   0.009      4
 1998   12   18   352     2   130   150    0.050  -9.999  -9.999   0.062   0.041   0.008      4
 1999    1   28   393     1   100   120    0.466   0.173   0.264   0.260   0.291   0.054      4
 1999    3    4   428     3   100   120    0.738   0.404   0.512   0.421   0.519   0.067      4
 1999    3    4   428     3   130   150    0.427   0.236   0.242   0.261   0.292   0.039      4
 1999    3    4   428     3   190   280    0.196   0.122   0.073   0.087   0.119   0.024      4
 1999    3   18   442     1   130   150   -8.888  -8.888  -8.888   0.171   0.171   0.000      1
 1999    4   20   475     1   100   120    0.301   0.228   0.174   0.294   0.249   0.026      4
```

# **Annex 22 Content of ASCII file NLA00.GLC** (only the first part)

```
*File:    NLA00.GLC
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie, R.F.A. Hendriks
*Version: 1.1
*Date:    16 April 2003
*Source:  Measurements by ALTERRA
*           Groundwater Levels (phreatic): Continuous measurements
*           Andelst, The Netherlands
*
*         Description of the quantities and their units:
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         CUTI   = Cumulative time (value is 0.0 at 1 January 1998 0 h)
*         GWLVPI = Groundwater level (m below soil surface), for Plot I
*         GWLVPO = Groundwater level (m below soil surface), for Plot O
*
*                  NOTE Soil surface at Plot I was 0.12 m lower than at plot O
*
*         -99.0 = Code for unknown value (failure datalogger or other reasons)
*         -88.0 = Code for sensor groundwater level out of measurable range.
*                 Means that actual GW level was HIGHER than last recorded
*                 value during subsequent period, marked with code -88.0
*
*    YR       MH      DA    CUTI   WLVPI  GWLVPO
******************************************************************************
    1997      11      17   -44.4   1.784 -99.000
    1997      11      17   -44.3   1.784 -99.000
    1997      11      17   -44.2   1.784 -99.000
    1997      11      17   -44.1   1.784 -99.000
    1997      11      18   -44.0   1.784 -99.000
    1997      11      18   -43.9   1.781 -99.000
    1997      11      18   -43.8   1.781 -99.000
    1997      11      18   -43.7   1.781 -99.000
    1997      11      18   -43.6   1.781 -99.000
    1997      11      18   -43.5   1.777 -99.000
    1997      11      18   -43.4   1.777 -99.000
    1997      11      18   -43.3   1.777 -99.000
    1997      11      18   -43.2   1.777 -99.000
    1997      11      18   -43.1   1.777 -99.000
    1997      11      19   -43.0   1.777 -99.000
    1997      11      19   -42.9   1.773 -99.000
    1997      11      19   -42.8   1.773 -99.000
    1997      11      19   -42.7   1.773 -99.000
    1997      11      19   -42.6   1.773 -99.000
    1997      11      19   -42.5   1.773 -99.000
    1997      11      19   -42.4   1.770 -99.000
    1997      11      19   -42.3   1.773 -99.000
    1997      11      19   -42.2   1.770 -99.000
    1997      11      19   -42.1   1.773 -99.000
    1997      11      20   -42.0   1.773 -99.000
    1997      11      20   -41.9   1.770 -99.000
    1997      11      20   -41.8   1.770 -99.000
    1997      11      20   -41.7   1.770 -99.000
    1997      11      20   -41.6   1.770 -99.000
    1997      11      20   -41.5   1.770 -99.000
    1997      11      20   -41.4   1.770 -99.000
    1997      11      20   -41.3   1.770 -99.000
    1997      11      20   -41.2   1.773 -99.000
```

# **Annex 23  Content of ASCII file NLA00.GLD** (only the first part)

```
*File:    NLA00.GLD
*Code:    ASCII
*Access:  Sequential
*Author:  R.F.A. Hendriks
*Version: 1.1
*Date:    16 March 2003
*Source:  Measurements by ALTERRA
*           Groundwater Levels (phreatic): Daily averages of continuous measurements
*           Andelst, The Netherlands
*
*         Description of the quantities and their units:
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         AVGWLV = Average groundwater level (m below soil surface);
*                     daily average of the levels below soil surface on plot I and O,
*                    computed using the continuous measurements;
*                    correction made for differences of the soil surface
*                     (plot I: + 0.06 m, plot O: - 0.06 m)
*        -88.000 = Code for sensor groundwater level out of measurable range.
*                 Means that actual GW level that day or part of day was
*                 HIGHER than last recorded value
*
*     YR      MH      DA    DANU  AVGWLV
*************************************************************************************
    1997      11      17     -44   1.844
    1997      11      18     -43   1.839
    1997      11      19     -42   1.833
    1997      11      20     -41   1.831
    1997      11      21     -40   1.844
    1997      11      22     -39   1.852
    1997      11      23     -38   1.857
    1997      11      24     -37   1.863
    1997      11      25     -36   1.868
    1997      11      26     -35   1.877
    1997      11      27     -34   1.886
    1997      11      28     -33   1.892
    1997      11      29     -32   1.894
    1997      11      30     -31   1.904
    1997      12       1     -30   1.917
    1997      12       2     -29   1.924
    1997      12       3     -28   1.933
    1997      12       4     -27   1.943
    1997      12       5     -26   1.950
    1997      12       6     -25   1.953
    1997      12       7     -24   1.955
    1997      12       8     -23   1.952
    1997      12       9     -22   1.959
    1997      12      10     -21   1.608
    1997      12      11     -20 -88.000
    1997      12      12     -19 -88.000
    1997      12      13     -18 -88.000
    1997      12      14     -17 -88.000
    1997      12      15     -16   1.320
    1997      12      16     -15   1.352
    1997      12      17     -14   1.337
    1997      12      18     -13 -88.000
    1997      12      19     -12 -88.000
    1997      12      20     -11   1.298
    1997      12      21     -10   1.303
    1997      12      22      -9   1.307
    1997      12      23      -8   1.297
```

# Annex 24 Content of ASCII file NLA00.GLI

```
*File:    NLA00.GLI
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie, R.F.A. Hendriks
*Version: 1.0
*Date:    3 December 2000
*Source:  Measurements by ALTERRA
*           Groundwater Levels (phreatic): Instantaneous measurements in 4 clusters of
*           4 groundwater sampling tubes per sector
*           Andelst, The Netherlands
*
*         Description of the quantities and their units:
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         GWLVS1 = Groundwater level (m below soil surface), average for Sector 1
*         GWLVS2 = Groundwater level (m below soil surface), average for Sector 2
*         GWLVS3 = Groundwater level (m below soil surface), average for Sector 3
*         GWLVS4 = Groundwater level (m below soil surface), average for Sector 4
*         AVGWLV = Average groundwater level (m below soil surface)
*         SEGWLV = Standard error (m) of the groundwater level
*         NUOB   = Number of observations
*
*      no correction made for differences between level of soil surface
*
* YR   MH   DA  DANU  GWLVS1  GWLVS2  GWLVS3  GWLVS4   AVGWLV  SEGWLV  NUOB
*********************************************************************************
1997   11   17   -44    1.88    1.96    1.83    1.99     1.91   0.020    15
1997   12   19   -12    1.33    1.34    1.26    1.34     1.32   0.008    31
1998    1    8     8    0.75    0.73    0.73    0.77     0.74   0.004    63
1998    1   21    21    0.82    0.78    0.78    0.84     0.81   0.012    16
1998    1   22    22    0.84    0.80    0.80    0.86     0.82   0.005    62
1998    2    5    36    1.10    1.10    1.02    1.14     1.08   0.010    47
1998    2   18    49    1.39    1.44    1.32    1.48     1.40   0.014    28
1998    3    3    62    1.52    1.58    1.45    1.61     1.52   0.018    18
1998    3    7    66    0.52    0.48    0.50    0.47     0.50   0.012     9
1998    3   10    69    0.79    0.77    0.78    0.83     0.79   0.004    63
1998    3   17    76    0.84    0.80    0.80    0.85     0.82   0.005    63
1998    3   24    83    0.98    0.98    0.91    1.02     0.97   0.008    47
1998    3   30    89    1.09    1.11    1.02    1.14     1.09   0.008    46
1998    4   17   107    0.91    0.92    0.84    0.91     0.89   0.007    48
1998    4   24   114    0.92    0.90    0.85    0.93     0.90   0.006    47
1998    4   29   119    0.82    0.79    0.79    0.85     0.81   0.005    63
1998    5   12   132    1.02    1.02    0.96    1.06     1.01   0.007    47
1998    5   19   139    1.24    1.25    1.18    1.30     1.24   0.010    31
1998    5   29   149    1.40    1.43    1.34    1.46     1.41   0.011    29
1998    6    9   160    1.25    1.29    1.23    1.34     1.28   0.015    16
1998    6   15   166    1.17    1.22    1.14    1.25     1.20   0.015    16
1998    6   23   174    1.16    1.16    1.09    1.22     1.16   0.010    31
1998    7    3   184    1.36    1.39    1.30    1.45     1.37   0.012    31
1998    7   16   197    1.45    1.51    1.42    1.52     1.47   0.012    26
1998    8   10   222    1.65    1.71    1.58    1.76     1.67   0.021    15
1998    8   14   226    1.72    1.79    1.65    1.85     1.75   0.023    15
1998    9    7   250    1.20    1.15    0.95    1.21     1.11   0.023    39
1998    9   21   264    0.80    0.78    0.79    0.83     0.80   0.004    63
1998   10    6   279    1.15    1.15    1.07    1.21     1.14   0.009    41
1998   10   20   293    0.86    0.82    0.82    0.88     0.84   0.005    60
1998   12   18   352    0.77    0.75    0.77    0.80     0.77   0.004    63
1999    1    5   370    0.75    0.74    0.75    0.79     0.76   0.004    63
1999    1   28   393    0.77    0.74    0.75    0.79     0.76   0.005    47
1999    2    3   399    0.81    0.78    0.79    0.83     0.80   0.005    47
1999    2   25   421    0.76    0.73    0.75    0.79     0.76   0.004    47
1999    3    4   428    0.71    0.70    0.71    0.74     0.71   0.004    63
1999    3   18   442    0.78    0.75    0.77    0.81     0.78   0.005    47
1999    4    6   461    0.85    0.80    0.81    0.85     0.83   0.005    47
1999    4   20   475    0.79    0.75    0.77    0.82     0.78   0.005    46
1999    5    3   488    0.85    0.82    0.81    0.86     0.83   0.005    47
1999    5    7   492    0.84    0.81    0.78    0.82     0.81   0.004    63
```

# Annex 25 Content of ASCII file NLA00.GKN

```
*File:    NLA00.GKN
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie; R.F.A. Hendriks
*Version: 1.0
*Date:    7 June 2001
*Source:  Measurements by ALTERRA
*           Concentration of Kjeldahl-N (Kj-N) in groundwater
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         NUFI   = Number of filters sampled
*         UPDP   = Upper boundary of the filter (cm below soil surface)
*         LODP   = Lower boundary of the filter (cm below soil surface)
*         COKNS1 = Concentration of Kj-N (g m**[-3] water) for Sector 1;
*                  07-09-1998: value is for mixed samples from the 16 plots in the Sectors 1-4
*                  21-09-1998 and 20-04-1998: value is for mixed samples from the 4 plots in Sector 1
*                  18-12-1998: value is for mixed samples from the 8 plots in the Sectors 1-2
*         COKNS2 = Concentration of Kj-N (g m**[-3] water) for Sector 2;
*                  07-09-1998: value is for mixed samples from the 16 plots in the Sectors 1-4
*                  21-09-1998 and 20-04-1998: value is for mixed samples from the 4 plots in Sector 2
*                  18-12-1998: value is for mixed samples from the 8 plots in the Sectors 1-2
*         COKNS3 = Concentration of Kj-N (g m**[-3] water) for Sector 3;
*                  07-09-1998: value is for mixed samples from the 16 plots in the Sectors 1-4
*                  21-09-1998 and 20-04-1998: value is for mixed samples from the 4 plots in Sector 3
*                  18-12-1998: value is for mixed samples from the 8 plots in the Sectors 3-4
*         COKNS4 = Concentration of Kj-N (g m**[-3] water) for Sector 4;
*                  07-09-1998: value is for mixed samples from the 16 plots in the Sectors 1-4
*                  21-09-1998 and 20-04-1998: value is for mixed samples from the 4 plots in Sector 4
*                  18-12-1998: value is for mixed samples from the 8 plots in the Sectors 3-4
*         AVCOKN = Average concentration of Kj-N (g m**[-3] water)
*         SECOKN = Standard error (g m**[-3] water) of the average concentration of Kj-N
*         NUOB   = Number of observations for calculation of AVCOKN and SECOKN
*         -9.99  = Values below the detection limit of 0.25 g Kj-N m**[-3] water.
*                  For calculation of the average contents (AVCOKN) this value is set at
*                  0.10 g Kj-N m**[-3] water.
*
* YR   MH   DA  DANU   NUFI  UPDP  LODP    COKNS1  COKNS2  COKNS3  COKNS4    AVCOKN  SDCOKN  NUOB
***************************************************************************************************
1998    9    7   250      1   130   150      2.36    2.36    2.36    2.36      2.36    0.00     1
1998    9   21   264      1   100   120      1.18    0.10    2.82    0.42      1.13    0.61     4
1998   12   18   352      2   100   150      1.14    1.14    0.82    0.82      0.98    0.16     2
1999    4   20   475      1   100   120     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
```

# Annex 26 Content of ASCII file NLA00.GNN

```
*File:    NLA00.GNN
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie; R.F.A. Hendriks
*Version: 1.0
*Date:    7 June 2001
*Source:  Measurements by ALTERRA
*           Concentration of Nitrate-N (NO3-N) in groundwater
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         NUFI   = Number of filters sampled
*         UPDP   = Upper boundary of the filter (cm below soil surface)
*         LODP   = Lower boundary of the filter (cm below soil surface)
*         CONNS1 = Concentration of NO3-N (g m**[-3] water) for Sector 1;
*                  in general average of 4 observations (1 observation per plot);
*                  at 04-03-1999: for the filters at depth's of 100-120, 130-150 and 190-280 cm,
*                  values are for mixed samples obtained from the 8 plots in the Sectors 1 and 2
*         CONNS2 = Concentration of NO3-N (g m**[-3] water) for Sector 2;
*                  in general average of 4 observations (1 observation per plot);
*                  at 04-03-1999: for the filters at depth's of 100-120, 130-150 and 190-280 cm,
*                  values are for mixed samples obtained from the 8 plots in the Sectors 1 and 2
*         CONNS3 = Concentration of NO3-N (g m**[-3] water) for Sector 3;
*                  in general average of 4 observations (1 observation per plot);
*                  at 04-03-1999: for the filters at depth's of 100-120, 130-150 and 190-280 cm,
*                  values are for mixed samples obtained from the 8 plots in the Sectors 3 and 4
*         CONNS4 = Concentration of NO3-N (g m**[-3] water) for Sector 4;
*                  in general average of 4 observations (1 observation per plot);
*                  at 04-03-1999: for the filters at depth's of 100-120, 130-150 and 190-280 cm,
*                  values are for mixed samples obtained from the 8 plots in the Sectors 3 and 4
*         AVCONN = Average concentration of NO3-N (g m**[-3] water)
*         SECONN = Standard error (g m**[-3] water) of the average concentration of NO3-N
*         NUOB   = Number of observations for calculation of AVCONN and SECONN
*         -88.8  = Code for unknown values
*
* YR   MH   DA  DANU   NUFI  UPDP  LODP    CONNS1  CONNS2  CONNS3  CONNS4    AVCONN  SECONN  NUOB
**************************************************************************************************
1998    3    3     62      1   190   280      18.4    13.6    11.5     7.8      13.1     1.6    15
1998    3   10     69      2    70    90      60.3    45.5    43.9    47.8      49.4     2.2    16
1998    3   10     69      2   190   280      27.4    19.9    12.0    23.0      20.4     1.9    15
1998    4   29    119      1   100   120      42.3    29.5    21.4    29.2      30.6     2.7    16
1998    5   12    132      1   100   120      41.1    27.9    22.6    36.5      32.0     2.3    16
1998    5   29    149      1   190   280      21.2    17.5    17.3    11.4      17.2     1.4    19
1998    6    4    155      1   130   150      32.5    28.0    22.9    -8.8      26.2     2.0     6
1998    6    9    160      1   130   150      35.1    31.7    26.8    34.6      32.0     1.8    16
1998    6   23    174      1   130   150      33.9    23.8    20.4    28.4      26.6     2.0    16
1998    8   10    222      1   190   280      24.0    12.5     9.3    11.3      14.5     2.2    15
1998    9    7    250      2   100   120      23.7    21.5    21.9    24.4      22.3     0.6     8
1998    9    7    250      2   130   150      37.5    22.2    20.6    28.5      27.2     2.6    16
1998    9   21    264      1   100   120      31.0    20.5    19.7    24.8      24.0     1.5    16
1998   10    6    279      2   100   120      20.1    15.7    17.1   -88.8      17.2     0.8     7
1998   10    6    279      2   130   150      24.5    16.5    15.9    20.9      19.4     1.3    16
1998   10   20    293      2    70    90      19.2    14.4    15.8    19.5      16.4     0.9     9
1998   10   20    293      2   100   120      19.3    14.0    14.3    17.4      15.7     0.8    16
1998   12   18    352      2   100   120      22.4    13.7    13.6    16.2      16.7     1.2    15
1998   12   18    352      2   130   150      20.5    12.4    13.9    18.0      16.3     1.1    15
1999    1   28    393      1   100   120      15.0    12.0    12.5    14.7      13.6     0.6    16
1999    3    4    428      4    70    90       7.1     9.1     8.6     9.4       8.6     0.7    16
1999    3    4    428      4   100   120      11.4    11.4    11.5    11.5      11.5     0.1     2
1999    3    4    428      4   130   150      12.2    12.2    11.5    11.5      11.9     0.4     2
1999    3    4    428      4   190   280       7.8     7.8     3.5     3.5      5.70     2.2     2
1999    4   20    475      1   100   120      15.6    11.8    10.7    13.8      13.0     0.7    16
```

# Annex 27 Content of ASCII file NLA00.GPP

```
*File:    NLA00.GPP
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie; R.F.A. Hendriks
*Version: 1.0
*Date:    7 June 2001
*Source:  Measurements by ALTERRA
*           Concentration of Ortho-P & (PO4-P) in groundwater
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         NUFI   = Number of filters sampled
*         UPDP   = Upper boundary of the filter (cm below soil surface)
*         LODP   = Lower boundary of the filter (cm below soil surface)
*         COPPS1 = Concentration of PO4-P (g m**[-3] water) for Sector 1;
*                  in general average of 4 observations (1 observation per plot)
*         COPPS2 = Concentration of PO4-P (g m**[-3] water) for Sector 2;
*                  in general average of 4 observations (1 observation per plot)
*         COPPS3 = Concentration of PO4-P (g m**[-3] water) for Sector 3;
*                  in general average of 4 observations (1 observation per plot)
*         COPPS4 = Concentration of PO4-P (g m**[-3] water) for Sector 4;
*                  in general average of 4 observations (1 observation per plot)
*         AVCOPP = Average concentration of PO4-P (g m**[-3] water)
*         SECOPP = Standard error (g m**[-3] water) of the average concentration of PO4-P
*         NUOB   = Number of observations for calculation of AVCOPP and SECOPP
*         -8.88  = Code for unknown values
*         -9.99  = Values below the detection limit of 0.025 g PO4-P m**[-3] water.
*                  For calculation of the average contents (AVCOPP) this value is set at
*                  0.010 g PO4-P m**[-3] water.
*
* YR   MH   DA  DANU   NUFI  UPDP  LODP    COPPS1  COPPS2  COPPS3  COPPS4    AVCOPP  SECOPP  NUOB
**************************************************************************************************
1998    4   29   119      1   100   120    -9.990  -9.990  -9.990  -9.990    -9.990  -9.990    16
1998    9    7   250      2   100   120    -8.880  -8.880   0.142  -8.880     0.142   0.038     2
1998    9    7   250      2   130   150     0.119   0.131   0.128   0.098     0.122   0.011    13
1998    9   21   264      1   100   120     0.166   0.872   0.180   0.054     0.318   0.100    16
1998   10    6   279      1   130   150     0.045   0.035   0.035   0.036     0.038   0.003    16
1999    1   28   393      1   100   120    -9.990  -8.880   0.027   0.026     0.025   0.005     9
1999    2    3   399      1   100   120    -9.990  -9.990  -8.880  -8.880    -9.990  -9.990     8
1999    4   20   475      1   100   120    -9.990  -9.990  -9.990  -9.990    -9.990  -9.990    16
```

# Annex 28 Content of ASCII file NLA00.GTP

```
*File:    NLA00.GTP
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie; R.F.A. Hendriks
*Version: 1.0
*Date:    7 June 2001
*Source:  Measurements by ALTERRA
*           Concentration of Total-P (Tot-P) in groundwater
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         NUFI   = Number of filters sampled
*         UPDP   = Upper boundary of the filter (cm below soil surface)
*         LODP   = Lower boundary of the filter (cm below soil surface)
*         COTPS1 = Concentration of Tot-P (g m**[-3] water) for Sector 1;
*                  in general average of 4 observations (1 observation per plot)
*         COTPS2 = Concentration of Tot-P (g m**[-3] water) for Sector 2;
*                  in general average of 4 observations (1 observation per plot)
*         COTPS3 = Concentration of Tot-P (g m**[-3] water) for Sector 3;
*                  in general average of 4 observations (1 observation per plot)
*         COTPS4 = Concentration of Tot-P (g m**[-3] water) for Sector 4;
*                  in general average of 4 observations (1 observation per plot)
*         AVCOTP = Average concentration of Tot-P (g m**[-3] water)
*         SECOTP = Standard error (g m**[-3] water) of the average concentration of Tot-P
*         NUOB   = Number of observations for calculation of AVCOTP and SECOTP
*         -8.88  = Code for unknown values
*         -9.99  = Values below the detection limit of 0.025 g Tot-P m**[-3] water.
*                  For calculation of the average contents (AVCOTP) this value is set at
*                  0.010 g Tot-P m**[-3] water.
*
* YR   MH   DA  DANU   NUFI  UPDP  LODP    COTPS1  COTPS2  COTPS3  COTPS4    AVCOTP  SDCOTP  NUOB
************************************************************************************************
1998    9    7   250      2   100   120    -8.880  -8.880   0.153  -8.880     0.153   0.035     2
1998    9    7   250      2   130   150     0.203   0.687   0.097   0.147     0.310   0.174    13
1998    9   21   264      1   100   120     0.071   0.115   0.173   0.091     0.112   0.027    16
1998   10    6   279      1   130   150     0.205   0.140   0.166   0.157     0.167   0.013    16
1999    1   28   393      1   100   120     0.025  -8.880   0.041   0.030     0.034   0.007     9
1999    2    3   399      1   100   120    -9.990   0.027  -8.880  -8.880     0.022   0.003     8
1999    4   20   475      1   100   120     0.051   0.020   0.041   0.020     0.033   0.006    16
```

# Annex 29 Content of ASCII file NLA00.IMA

```
*File:          NLA00.IMA
*Code:          ASCII
*Access:        sequential
*Author:        L.J.T. van der Pas, J.H. Smelt
*Version:       1.0
*Date:          20 March 2001
*Source:        Measurements by Alterra
*                 Sorption of imidacloprid to soil of the 0-30 cm layer
*                 at three temperatures. Field at Andelst, The Netherlands
*
*       Description of the quantities and their units
*       TE     = Temperature (degree Celsius) during the sorption study
*       INCOIM = Initial concentration of imidacloprid (mg dm**[-3]) in the
*                liquid phase. INCOIM was calculated by dividing the mass
*                of imidacloprid added by the total volume of liquid in the
*                system.
*       EQCOIM = Concentration of imidacloprid (mg dm**[-3]) in the liquid
*                phase after 24 h equilibration
*       EQCTIM = Content of imidacloprid (mg kg**[-1])in the solid phase
*                after equilibration (content is defined as mass per
*                mass of dry soil), calculated from the added mass of
*               imidacloprid and the mass of imidacloprid
*                in the liquid phase after 24 h equilibration
*
*       System properties
*           Mass of dry soil         = 43.14 g (sd = 0.009 g, n = 27)
*                                          (sd = standard deviation)
*           Mass of total liquid phase       = 57.01 g (sd = 0.18 g, n = 27)
*
*          EQCOIM in blank soil was <0.005 mg dm**[-3]
*
* TE    INCOIM    EQCOIM    EQCTIM
****************************************************************************
   5     9.334     4.688     6.14
   5     9.334     4.771     6.03
   5     9.334     4.731     6.08
   5    0.9424    0.3566    0.774
   5    0.9424    0.3552    0.776
   5    0.9424    0.3598    0.770
   5    0.0932    0.0262    0.0886
   5    0.0932    0.0235    0.0921
   5    0.0932    0.0272    0.0872
*
  15     9.334     5.264     5.38
  15     9.334     5.189     5.48
  15     9.334     4.561     6.31
  15    0.9424    0.4067     0.708
  15    0.9424    0.4044     0.711
  15    0.9424    0.4059    0.709
  15    0.0932    0.0290    0.0849
  15    0.0932    0.0304    0.0830
  15    0.0932    0.0284    0.0856
*
  25     9.334     5.469     5.11
  25     9.334     6.011     4.39
  25     9.334     5.434     5.15
  25    0.9424    0.4617    0.635
  25    0.9424    0.4535    0.646
  25    0.9424    0.4492    0.652
  25    0.0932    0.0351    0.0768
  25    0.0932    0.0338    0.0786
  25    0.0932    0.0332    0.0793
```

# Annex 30  Content of ASCII file NLA00.IMD

```
*File:          NLA00.IMD
*Code:          ASCII
*Access:        sequential
*Author:        J.H. Smelt, L.J.T. van der Pas
*Version:       1.0
*Date:          20 March 2001
*Source:        Measurements by Alterra
*                 Desorption of aged imidacloprid residues in soil of the 0-30 cm layer
*                 at 25°C. Field Andelst, The Netherlands
*
*       Description of the quantities and their units
*      TI     = Time (days) after application of imidacloprid to the soil
*      MSSO   = Mass of dry soil(g)in desorption system
*      MSIM   = Mass of imidacloprid (micro gram) in desorption system
*      MSLI   = Mass of total liquid phase (g) in desorption system
*      EQCOIM = Concentration of imidacloprid (mg dm**[-3]) in the liquid
*                phase after 24 h equilibration.
*      EQCTIM = Content of imidacloprid (mg kg**[-1])in the solid phase
*               after 24 h equilibration (content is defined as mass per mass of dry soil),
*                calculated from columns 2 to 5.
*
*
*TI     MSSO    MSIM    MSLI  EQCOIM EQCTIM
********************************************************************************************
12     33.09   23.22   47.41  0.1991 0.4164
12     33.25   23.48   47.30  0.2103 0.4069
12     33.10   22.55   48.02  0.2088 0.3784
41     33.23   16.05   47.64  0.1459 0.2738
41     32.81   18.23   47.26  0.1307 0.3674
41     32.61   17.29   47.60  0.1320 0.3376
89     32.63   13.00   47.84  0.1083 0.2397
89     32.70   13.50   48.03  0.1062 0.2569
89     32.72   12.59   47.20  0.1094 0.2272
166    40.01   10.78   58.60  0.0663 0.1725
166    38.89   10.71   58.16  0.0632 0.1809
166    40.28   11.61   57.99  0.0616 0.1996
285    34.14   6.474   48.15  0.0414 0.1313
285    31.83   6.151   45.20  0.0399 0.1366
285    36.93   6.948   50.18  0.0445 0.1277
```

# Annex 31 Content of ASCII file NLA00.IMT (only the first part)

```
*File:          NLA00.IMT
*Code:          ASCII
*Access:        sequential
*Author:        L.J.T. van der Pas & J.H. Smelt
*Version:       1.0
*Date:          28 March 2001
*Source:        Measurements by Alterra
*                 Transformation of imidacloprid in soil from three
*                 layers. field Andelst, The Netherlands
*
*       Description of the quantities and their units
*       YR    = Year
*       MH    = Month
*       DA    = Day within month
*       TI    = Time (days) elapsed since application of imidacloprid
*       UPDP  = Upper boundary (cm) of the layer
*       LODP  = Lower boundary (cm) of the layer
*       TE    = Temperature (degree Celsius) during the incubation
*       MSIM  = Mass of imidacloprid (micro g) remaining
*                     Mass was not corrected for extraction efficiency
*                     (being about 100%, see report) with all incubation series
*
*       System properties: layer 0-30 cm
*           Mass of dry soil          = 66.0 g
*           Mass of water             = 14.4 g
*           Mass of imidacloprid added = 54.6 micro g
*           Imidacloprid was applied on 10 february 1999.
*
*       System properties: layer 40-70 cm
*           Mass of dry soil          = 72.2 g
*           Mass of water             = 17.4 g
*           Mass of imidacloprid added =  2.18 micro g
*           Imidacloprid was applied on 9 february 1999.
*
*       System properties: layer 80-120 cm (not water saturated)
*           Mass of dry soil          = 69.7 g
*           Mass of water             = 19.8 g
*           Mass of imidacloprid added =  2.18 micro g
*           Imidacloprid was applied on 9 february 1999.
*
*  YR    MH    DA   TI  UPDP  LODP   TE   MSIM
*******************************************************************************
 1999     2    11    1     0    30    5   56.9
 1999     2    11    1     0    30    5   53.1
 1999     2    22   12     0    30    5   52.8
 1999     2    22   12     0    30    5   55.4
 1999     3     8   26     0    30    5   54.2
 1999     3     8   26     0    30    5   53.3
 1999     3    23   41     0    30    5   52.7
 1999     3    23   41     0    30    5   49.3
 1999     4     6   55     0    30    5   49.5
 1999     4     6   55     0    30    5   49.2
 1999     5    10   89     0    30    5   45.8
 1999     5    10   89     0    30    5   42.0
 1999     6    28  138     0    30    5   46.6
 1999     6    28  138     0    30    5   47.8
 1999     7    26  166     0    30    5   45.8
 1999     7    26  166     0    30    5   44.3
 1999     9     8  210     0    30    5   40.4
 1999     9     8  210     0    30    5   40.5
 1999    11    22  285     0    30    5   37.7
 1999    11    22  285     0    30    5   38.7
*
 1999     2    11    1     0    30   15   50.3
 1999     2    11    1     0    30   15   56.0
 1999     2    22   12     0    30   15   52.2
 1999     2    22   12     0    30   15   52.3
 1999     3     8   26     0    30   15   48.8
 1999     3     8   26     0    30   15   49.8
```

# Annex 32  Content of ASCII file NLA00.MBE

```
*File:           NLA00.MBE
*Code:           ASCII
*Access:        sequential
*Author:        J.H. Smelt; L.J.T van der Pas
*Version:        1.1
*Date:           7 Febr 2002
*Scource:        Measurements by Alterra
*                  Areic mass of Bentazone(BE)
*                  Andelst, The Netherlands
*
*                Description of the quantities and their units
*                YR      = Year
*                MH      = Month
*                DA      = Day within month
*                DANU    = Day number (value is 1 at 1 Jan 1998)
*                UPDP    = Upper boundary (cm) of the layer sampled
*                LODP    = Lower boundary (cm) of the layer sampled
*                AEMSBES1= calculated areic mass of BE (kg ha**[-1])of sector 1;
*                        at 08-04-1998: average of 8 observations (columns);
*                        at all other sampling times: 1 observation (1 analysis per layer of the 4 columns)
*                AEMSBES2= calculated areic mass of BE (kg ha**[-1])of sector 2;
*                        at 08-04-1998: average of 8 observations;(1 analysis per layer of the 4 columns)
*                        at all other sampling times: 1 observation
*                AEMSBES3= calculated areic mass of BE (kg ha**[-1])of sector 3;
*                        at 08-04-1998: average of 8 observations; (1 analysis per layer of the 4 columns)
*                        at all other sampling times: 1 observation
*                AEMSBES4= calculated areic mass of BE (kg ha**[-1])of sector 4;
*                        at 08-04-1998: average of 7 observations; (1 analysis per layer of the 4 columns)
*                        at all other sampling times: 1 observation
*                AVAEMSBE= Average areic mass of bentazone (kg ha**([-1]) in soil (sum of all sampled layers)
*               SEAEMSBE= Standard error (kg ha**[-1]) of the average areic mass
*               NUOB    = Number of observations for calculation of AVAEMSBE
*
*                -9.9999  = Value below limit of quantification of 0.005 kg ha**[-1]; means that almost
*                    all layers had contents below set limit of quantification in soil(0.0008 mg dm**[-3]
*
*
*                Dose of bentazone: 1.330 kg ha**[-1], based on nominal concentrations in spray liquid
*
*  YR    MH    DA   DANU   UPDP   LPDP   AEMSBES1   AEMSBES2   AEMSBES3  AEMSBES4  AVAEMSBE  SEAEMSBE   NUOB
**************************************************************************************************************
 1998     4     8     98      0     15      1.398      1.309      1.491     1.445     1.408    0.0511     31
 1998     4    29    119      0    120     0.5673     0.5564     0.9030    0.6073    0.6585    0.0822      4
 1998     6    15    166      0    120     0.2198     0.2314     0.1716    0.2186    0.2104    0.0132      4
 1998     8    10    222      0    120     0.0914      0.021     0.0453    0.1084    0.0665    0.0202      4
 1998    12     2    336      0    120    -9.9999    -9.9999    -9.9999   -9.9999   -9.9999   -9.9999      4
```

# Annex 33 Content of ASCII file NLA00.MBR

```
*File:           NLA00.MBR
*Code:           ASCII
*Access:         sequential
*Author:         R.F.A. Hendriks; J.H. Smelt
*Version:        1.0
*Date:           14 Febr 2002
*Scource:        Measurements by Alterra
*                  Areic mass of bromide (BR)
*                  Andelst, The Netherlands
*
*                Description of the quantities and their units
*                YR       = Year
*                MH      = Month
*                DA       = Day within month
*                DANU    = Day number (value is 1 at 1 Jan 1998)
*                UPDP    = Upper boundary (cm) of the layer sampled
*                LODP    = Lower boundary (cm) of the layer sampled
*                AEMSBRS1= calculated areic mass of BR (kg ha**[-1])of sector 1(sum of all sampled layers);
*                        at 08-04-1998: average of 8 observations;
*                        at all other sampling times: 1 observation (1 analysis per layer of the 4 columns)
*                AEMSBRS2= calculated areic mass of BR (kg ha**[-1])of sector 2;
*                        at 08-04-1998: average of 8 observations;
*                        at all other sampling times: 1 observation
*                AEMSBRS3= calculated areic mass of BR (kg ha**[-1])of sector 3;
*                        at 08-04-1998: average of 7 observations;
*                        at all other sampling times: 1 observation
*                AEMSBRS4= calculated areic mass of BR (kg ha**[-1])of sector 4;
*                        at 08-04-1998: average of 8 observations;
*                        at all other sampling times: 1 observation
*                AVAEMSBR= Average areic mass of bentazone (kg ha**([-1])in soil
*               SEAEMSBR= Standard error (kg ha**[-1]) of the average areic mass
*               NUOB    = Number of observations for calculation of AVAEMSBR
*
*                Limits of quantification and calculating areic masses:
*                If contents in analysed layers were below limits of quantification (<0.5 g m**[-3]) in one
*                or two sectors,this content was set at 0.25 g m**[-3](= 0.25 kg ha**[-1]for a layer of 10 cm)
*                to make the best estimate for the areic mass for that layer in the sector.
*               If the content in a particular layer in 3 or all 4 sectors were below the limit of
*               quantification, this content was set at zero.
*
*                Dose of bromide: 59.6 kg ha**[-1], (based on the nominal concentration in spray liquid)
*
*  YR    MH   DA   DANU   UPDP   LODP  AEMSBRS1  AEMSBRS2   AEMSBRS3   AEMSBRS4  AVAEMSBR  SEAVAEMBR  NUOB
*************************************************************************************************************
 1998     4    8     98      0     15     58.87     48.66      53.74      52.73     53.49       2.11    31
 1998     4   29    119      0    120     14.43     13.60       6.32       8.01     10.59       2.01     4
 1998     6   15    166      0    120     13.15     17.64      14.66      10.92     14.09       1.41     4
 1998     8   10    222      0    120     36.61     24.54      20.70      24.70     26.64       3.45     4
 1998     9   21    264      0    120     36.50     40.23      43.23      34.71     38.67       1.91     4
 1998    12    2    336      0    110     21.11     21.59      12.35      14.67     17.43       2.32     4
 1999     4   20    475      0    120     10.99     12.90      16.90      13.59     13.59       1.23     4
```

# Annex 34 Content of ASCII file NLA00.MIM

```
*File:           NLA00.MIM
*Code:           ASCII
*Access:         sequential
*Author:        J.H. Smelt; L.J.T van der Pas
*Version:        1.1
*Date:           8 Febr 2002
*Scource:        Measurements by Alterra
*                  Areic mass of Imidacloprid (IM)
*                  Andelst, The Netherlands
*
*                Description of the quantities and their units
*                YR       = Year
*                MH      = Month
*                DA       = Day within month
*                DANU    = Day number (value is 1 at 1 Jan 1998)
*                UPDP    = Upper boundary (cm) of the layer sampled
*                LODP    = Lower boundary (cm) of the layer sampled
*                AEMSIMS1= calculated areic mass of IM (kg ha**[-1])of sector 1;
*                        at 29-05-1998: average of 8 observations;
*                        at all other sampling times: 1 observation (1 analysis per layer of the 4columns)
*                AEMSIMS2= calculated areic mass of IM (kg ha**[-1])of sector 2;
*                        at 29-05-1998: average of 8 observations;
*                        at all other sampling times: 1 observation (1 analysis per layer of the 4columns)
*
*                AEMSIMS3= calculated areic mass of IM (kg ha**[-1])of sector 3;
*                        at 29-05-1998: average of 8 observations;
*                        at all other sampling times: 1 observation (1 analysis per layer of the 4columns)
*                AEMSIMS4= calculated areic mass of IM (kg ha**[-1])of sector 4;
*                        at 29-05-1998: average of 7 observations;
*                        at all other sampling times: 1 observation (1 analysis per layer of the 4columns)
*                AVAEMSIM= Average areic mass of imidacloprid (kg ha**([-1]); (sum of all sampled layers)
*               SEAEMSIM= Standard error(kg ha**[-1]) of the average areic mass
*               NUOB    = Number of observations for calculation of AVAEMSIM
*
*                Dose of imidacloprid: 0.700 kg ha**[-1], based on nominal concentration in spray liquid
*
*
*  YR    MH    DA   DANU   UPDP   LPDP   AEMSIMS1  AEMSIMS2  AEMSIMS3  AEMSIMS4  AVAEMSIM  SEAEMSIM NUOB
***********************************************************************************************************
 1998     5    29    149      0     15     0.4251    0.5313    0.5866    0.6810    0.5520    0.0312   31
 1998     9    21    264      0    120     0.2483    0.2701    0.2487    0.2067    0.2434    0.0132    4
 1998    12     2    336      0    110     0.2326    0.2879    0.2303    0.2873    0.2595    0.0162    4
 1999     4    20    475      0    120     0.2477    0.2409    0.2212    0.3293    0.2598    0.0238    4
```

# **Annex 35 Content of ASCII file NLA00.PDY** (only the first part)

```
*File:      NLA00.PDY
*Code:      ASCII
*Access:    sequential
*Author:    L.J.T. van der Pas & J.H. Smelt
*Version:   1.0
*Date:      14 March 2001
*Source:    Measurements by ALTERRA at field Andelst, The Netherlands
*           Daily precipitation at soil surface level
*
*
*      Registration started on 17 November 1997 at 12.00 h
*      Registration ended on 3 May 1999 at 12.00 h
*      Day start at 00.00 h, end at 24.00 h
*
*      Description of the quantities and their units
*      YR    = year
*      MH    = month
*      DA    = day within month
*      DANU  = day number (value is 1 at 1 January 1998)
*      PR    = precipitation (mm/d), rounded off on 0.1 mm
*
*YR   MH  DA  DANU   PR
*********************************************************************
1997  11  17  -44    .0
1997  11  18  -43    .0
1997  11  19  -42    .0
1997  11  20  -41   1.4
1997  11  21  -40    .3
1997  11  22  -39    .0
1997  11  23  -38    .0
1997  11  24  -37    .0
1997  11  25  -36    .0
1997  11  26  -35    .0
1997  11  27  -34   3.8
1997  11  28  -33   4.9
1997  11  29  -32   1.9
1997  11  30  -31    .3
1997  12   1  -30    .3
1997  12   2  -29   1.1
1997  12   3  -28    .0
1997  12   4  -27    .0
1997  12   5  -26    .5
1997  12   6  -25   3.0
1997  12   7  -24    .0
1997  12   8  -23    .3
1997  12   9  -22   3.0
1997  12  10  -21  22.5
1997  12  11  -20   2.5
1997  12  12  -19   8.5
1997  12  13  -18    .3
1997  12  14  -17    .3
1997  12  15  -16    .0
1997  12  16  -15    .0
1997  12  17  -14    .0
1997  12  18  -13    .0
1997  12  19  -12    .3
1997  12  20  -11    .0
1997  12  21  -10   6.3
1997  12  22   -9    .0
```

# **Annex 36 Content of ASCII file NLA00.PIT** (only the first part)

```
*File:      NLA00.PIT
*Code:      ASCII
*Access:    sequential
*Author:    L.J.T. van der Pas & J.H. Smelt
*Version:   1.0
*Date:      13 March 2001
*Source:    Measurements by ALTERRA at field Andelst, The Netherlands
*           Precipitation Intensity
*
*      Precipition at soil surface level, presented as mm precipitation per event(pulse)of the tipping bucket.
*      So this is the precipitation collected between the clock time of two consecutive pulses.
*
*      For the period from 15-06-98 to 4-07-98 and from 29-01-99 to 26-02-99, only values of daily
*      precipitation were available, due to lack of detailed registration by the equipment (see report for details).
*      Total rainfall is presented as one "pulse" at 12.00 h on days with precipitation in those periods.
*
*      Registration started on 17 November 1997 at 12.00 h and no precipitation was registrated until 20 November.
*      Registration ended on 3 May 1999 at 12.00 h, last day with precipitation was on 22 April
*
*      Description of the quantities and their units
*      YR    = year
*      MH    = month
*      DA    = day within month
*      HO    = hour within day
*      MN    = minute
*      SC    = second
*      CUTI  = cumulative time (value is 0.000 at 1 January 1998 0.0 h)
*      PREV  = precipitation(mm per event)
*      CUPR  = cumulative precipitation
*
* YR   MH   DA   HO   MN   SC      CUTI      PREV     CUPR
********************************************************************************************************************
1997   11   20    8   17   60   -41.654     0.274      0.3
1997   11   20   13   58   49   -41.417     0.274      0.5
1997   11   20   15    2   51   -41.373     0.274      0.8
1997   11   20   15   10   58   -41.367     0.274      1.1
1997   11   20   15   17   15   -41.363     0.274      1.4
1997   11   21   15    1   23   -40.374     0.274      1.6
1997   11   27   13   11   47   -34.450     0.274      1.9
1997   11   27   13   45   51   -34.426     0.274      2.2
1997   11   27   14    3   55   -34.414     0.274      2.5
1997   11   27   14   23    6   -34.401     0.274      2.7
1997   11   27   14   43   53   -34.386     0.274      3.0
1997   11   27   15    5    6   -34.371     0.274      3.3
1997   11   27   15   37   37   -34.349     0.274      3.6
```

# Annex 37 Content of ASCII file NLA00.PLI

```
*File:    NLA00.PLI
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie, R.F.A. Hendriks
*Version: 1.0
*Date:    3 December 2000
*Source:  Measurements by ALTERRA
*           Piezometric Levels in the aquifer: Instantaneous measurements
*           Andelst, The Netherlands
*
*         Description of the quantities and their units:
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         PZLVPA = Piezometric level (m below soil surface), Plot A,
*                     Tube at A destroyed at harvesting crop in Aug. 1999 !!!
*         PZLVPI = Piezometric level (m below soil surface), Plot I
*         PZLVPO = Piezometric level (m below soil surface), Plot O
*         -99.99 = Code for unknown values
*
*         Soil surface at Plot A was 0.12 m lower than at plot O
*         Soil surface at Plot I was 0.18 m lower than at plot O
*
*        Measurements somewhere between 8.00 and 18.00 h daytime
*
* YR   MH   DA  DANU    PZLVPA  PZLVPI  PZLVPO
**********************************************************************
1997   11   17   -44      1.82    1.78    2.08
1997   12   19   -12      1.25    1.19    1.40
1998    1    2     2      0.82    0.75    0.86
1998    1    8     8      0.63    0.57    0.73
1998    1   22    22      0.85  -99.99    0.97
1998    2    5    36      1.10    1.05    1.29
1998    2   18    49      1.39    1.35    1.64
1998    3    3    62      1.44  -99.99    1.67
1998    3    7    66      0.50  -99.99  -99.99
1998    3   10    69      0.77  -99.99    0.83
1998    3   17    76      0.83    0.78    0.96
1998    3   24    83      0.96  -99.99    1.14
1998    3   30    89      1.08    1.03    1.29
1998    4   17   107      0.88    0.83    0.99
1998    4   29   119      0.82    0.77    0.97
1998    5   12   132      1.01    0.95    1.17
1998    5   19   139      1.21  -99.99    1.42
1998    5   29   149      1.34    1.30  -99.99
1998    6   23   174      1.11    1.07    1.32
1998    7    3   184      1.32    1.27    1.54
1998    7   16   197      1.38    1.33    1.59
1998    8   10   222      1.61  -99.99    1.86
1998    8   14   226      1.70    1.65    1.97
1998    9    7   250    -99.99    1.30    1.62
1998    9   21   264    -99.99    0.68    0.84
1998   10    6   279    -99.99    0.99    1.32
1998   11    2   306    -99.99    0.25    0.45
1998   11    3   307    -99.99    0.26    0.46
1998   11   17   321    -99.99    0.55    0.74
1998   12    2   336    -99.99    0.72    1.05
1998   12   18   352    -99.99    0.60    0.73
1999    1    5   370    -99.99    0.61    0.81
1999    1   28   393    -99.99    0.73    0.92
1999    2    3   399    -99.99    0.71    0.83
1999    2   25   421    -99.99    0.54    0.74
1999    4    6   461    -99.99    0.78    0.91
1999    4   20   475    -99.99    0.63    0.76
1999    5    3   488    -99.99    0.75    0.91
1999    5    7   492    -99.99    0.72    0.87
```

# Annex 38  Content of ASCII file NLA00.SAN

```
*File:    NLA00.SAN
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie; R.F.A. Hendriks
*Version: 1.0
*Date:    28 December 2000
*Source:  Measurements by ALTERRA
*            Concentration of Ammonium-N (NH4-N) in soil
*            Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         NULA   = Number of layers sampled
*         UPDP   = Upper boundary (cm) of the layer
*         LODP   = Lower boundary (cm) of the layer
*         COANS1 = Concentration of NH4-N (g m**[-3] soil) for Section 1;
*                  at 08-04-1998: average of 7 (6 at 0-5 cm depth) observations;
*                  at 21-09-1998: average of 4 observations;
*         COANS2 = Concentration of NH4-N (g m**[-3] soil) for Section 2;
*                  at 08-04-1998: average of 7 (8 at 5-10 cm depth) observations;
*                  at 21-09-1998: average of 4 observations;
*         COANS3 = Concentration of NH4-N (g m**[-3] soil) for Section 3;
*                  at 08-04-1998: average of 7 (5 at 10-15 cm depth) observations;
*         COANS4 = Concentration of NH4-N (g m**[-3] soil) for Section 4;
*                  at 08-04-1998: average of 8 (6 at 5-10 cm depth; 7 at 10-15 cm depth) observ.
*         AVCOAN = Average concentration of NH4-N (g m**[-3] soil)
*         SECOAN = Standard error (g m**[-3] soil) of the average concentration
*         NUOB   = Number of observations (analyses) for calculation of AVCOAN and SECOAN
*         -9.99  = Values below the limit of quantification of 0.05 g NH4-N (0.06 g NH4) m**[-3] soil.
*                For calculation of the average concentrations (AVCOAN) this value is set at
*                0.025 NH4-N g m**[-3] soil, to get realistic averages.
*
* YR   MH   DA  DANU   NULA  UPDP  LODP    COANS1  COANS2  COANS3  COANS4    AVCOAN  SECOAN  NUOB
*************************************************************************************************
1998    4    8    98      3     0     5      1.37    1.71    1.17   19.49      6.58    3.77    28
1998    4    8    98      3     5    10      0.92    0.57    0.52   14.18      3.56    2.90    28
1998    4    8    98      3    10    15      0.81    0.43    0.21   42.23     11.74    6.84    26
1998    4   29   119      7     0    10      0.21    0.79    0.35    0.79      0.53    0.15     4
1998    4   29   119      7    10    20      0.60   -9.99    1.44    0.83      0.72    0.29     4
1998    4   29   119      7    20    30      1.58    0.24    0.61   -9.99      0.62    0.35     4
1998    4   29   119      7    30    50      0.07    0.06    0.06    0.09      0.07    0.01     4
1998    4   29   119      7    50    70      0.10    0.08    0.06    0.05      0.07    0.01     4
1998    4   29   119      7    70    90     -9.99    0.47   -9.99   -9.99      0.14    0.11     4
1998    4   29   119      7    90   120      0.06   -9.99    0.11    0.17      0.09    0.02     4
1998    6   15   166      7     0    10      0.31    1.25   -9.99    0.40      0.50    0.27     4
1998    6   15   166      7    10    20      0.05    0.18    0.11   -9.99      0.09    0.02     4
1998    6   15   166      7    20    30      0.31   -9.99   -9.99   -9.99      0.10    0.07     4
1998    6   15   166      7    30    50     -9.99   -9.99   -9.99    0.39      0.12    0.09     4
1998    6   15   166      7    50    70     -9.99   -9.99    0.05    0.11      0.06    0.02     4
1998    6   15   166      7    70    90     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1998    6   15   166      7    90   120     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1998    8   10   222      7     0    10     -9.99   -9.99    0.06   -9.99     -9.99    0.01     4
1998    8   10   222      7    10    20      0.07   -9.99    0.13    0.16      0.10    0.03     4
1998    8   10   222      7    20    30      0.09   -9.99    0.29    0.09      0.13    0.06     4
1998    8   10   222      7    30    50      0.07    0.11   -9.99    0.26      0.12    0.05     4
1998    8   10   222      7    50    70      0.20    0.12    0.11    0.17      0.15    0.02     4
1998    8   10   222      7    70    90      0.15    0.09    0.09   -9.99      0.09    0.02     4
1998    8   10   222      7    90   120     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1998    9   21   264      7     0    10      1.01    5.55    1.54    1.65      2.95    0.93    10
1998    9   21   264      7    10    20      0.42    0.63    0.19    0.29      0.47    0.07    10
1998    9   21   264      7    20    30      0.48    0.64    0.29    0.39      0.51    0.12    10
1998    9   21   264      7    30    50      0.80    0.85    0.07    0.65      0.73    0.09    10
1998    9   21   264      7    50    70      0.28    0.49   -9.99   -9.99      0.32    0.07    10
1998    9   21   264      7    70    90      0.42    0.38    0.08   -9.99      0.33    0.09    10
1998    9   21   264      7    90   120      0.04    0.10   -9.99   -9.99      0.07    0.02    10
1998   12    2   336      7     0    10     -9.99    0.27    1.12   -9.99      0.36    0.26     4
1998   12    2   336      7    10    20     -9.99    0.07    0.15    0.14      0.10    0.03     4
1998   12    2   336      7    20    30     -9.99    0.15   -9.99    0.19      0.10    0.04     4
1998   12    2   336      7    30    50      1.21    0.52    0.32    0.77      0.70    0.19     4
1998   12    2   336      7    50    70      0.86    0.92    0.74    0.86      0.84    0.04     4
1998   12    2   336      7    70    90      0.29    0.17    0.43   -9.99      0.23    0.09     4
1998   12    2   336      7    90   120      0.06    0.21    0.14   -9.99      0.11    0.04     4
1999    4   20   475      7     0    10      0.31    0.21    0.35    0.18      0.26    0.04     4
1999    4   20   475      7    10    20      0.29    0.15    0.33   -9.99      0.20    0.07     4
1999    4   20   475      7    20    30      0.58    0.33    1.09    0.27      0.57    0.19     4
1999    4   20   475      7    30    50      0.50    0.34    0.61    0.44      0.47    0.06     4
1999    4   20   475      7    50    70      0.53    0.25    0.05    0.59      0.35    0.13     4
1999    4   20   475      7    70    90      0.28    0.13    0.13    0.13      0.16    0.04     4
1999    4   20   475      7    90   120      0.09   -9.99   -9.99    0.07      0.06    0.02     4
```

# **Annex 39 Content of ASCII file NLA00.SBD** (only the first part)

```
*File:    NLA00.SBD
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie; R.F.A. Hendriks
*Version: 1.0
*Date:    27 December 2000
*Source:  Measurements by ALTERRA
*           Dry bulk density
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR   = Year
*         MH   = Month
*         DA   = Day within month
*         DANU = Day number (value is 1 at 1 January 1998)
*         NULA = Number of layers sampled
*         UPDP = Upper boundary (cm) of the layer
*         LODP = Lower boundary (cm) of the layer
*         BDS1 = Dry bulk density (g cm**[-3]), average for Sector 1
*         BDS2 = Dry bulk density (g cm**[-3]), average for Sector 2
*         BDS3 = Dry bulk density (g cm**[-3]), average for Sector 3
*         BDS4 = Dry bulk density (g cm**[-3]), average for Sector 4
*         AVBD = Average dry bulk density (g cm**[-3])
*         SEBD = Standard error (g cm**[-3]) of the average dry bulk density
*         NUOB = Number of observations
*         -99. = Code for unknown values
*
* YR   MH   DA  DANU   NULA  UPDP  LODP      BDS1    BDS2    BDS3    BDS4      AVBD    SEBD  NUOB
*************************************************************************************************
1997   10   27   -65     12     0    10     1.144   1.231   1.243   1.155     1.193   0.026    16
1997   10   27   -65     12    10    20     1.499   1.433   1.411   1.501     1.461   0.018    16
1997   10   27   -65     12    20    30     1.455   1.427   1.501   1.496     1.470   0.019    16
1997   10   27   -65     12    30    40     1.561   1.476   1.528   1.548     1.528   0.014    16
1997   10   27   -65     12    40    50     1.529   1.469   1.513   1.521     1.508   0.011    16
1997   10   27   -65     12    50    60     1.485   1.503   1.522   1.535     1.511   0.012    16
1997   10   27   -65     12    60    70     1.510   1.429   1.504   1.528     1.493   0.020    16
1997   10   27   -65     12    70    80     1.494   1.432   1.517   1.494     1.484   0.015    16
1997   10   27   -65     12    80    90     1.522   1.492   1.496   1.498     1.502   0.009    16
1997   10   27   -65     12    90   100     1.488   1.473   1.479   1.506     1.487   0.014    16
1997   10   27   -65     12   100   110     1.477   1.423   1.452   1.478     1.458   0.019    16
1997   10   27   -65     12   110   120     1.457   1.504   1.482   1.467     1.477   0.014    16
1998    1   21    21      9     0    10     1.491   1.472   1.389   1.284     1.409   0.047    16
1998    1   21    21      9    10    20     1.716   1.618   1.727   1.650     1.680   0.028    15
1998    1   21    21      9    20    30     1.651   1.582   1.656   1.553     1.610   0.044    16
1998    1   21    21      9    30    40     1.710   1.664   1.657   1.660     1.674   0.014    15
1998    1   21    21      9    40    50     1.616   1.620   1.561   1.683     1.620   0.020    16
1998    1   21    21      9    50    60     1.579   1.594   1.563   1.598     1.584   0.017    16
1998    1   21    21      9    60    70     1.558   1.567   1.546   1.620     1.573   0.019    16
1998    1   21    21      9    70    80     1.611   1.584   1.598   1.708     1.625   0.021    16
1998    1   21    21      9    80    90     1.609   1.531   1.634   1.594     1.596   0.016    15
```

# Annex 40 Content of ASCII file NLA00.SBE

```
*File:           NLA00.SBE
*Code:           ASCII
*Access:         sequential
*Author:         J.H.Smelt; L.J.T. van der Pas;
*Version:        1.1
*Date            8 Febr. 2002
*Source:         Measurements by Alterra
*                Concentrations of Bentazone (BE) in soil;
*                Andelst, The Netherlands
*
*                Description of the quantities and their units
*                YR      = Year
*                MH      = Month
*                DA      = Day within month
*                DANU    = Day number (value is 1 at 1 Jan 1998)
*                NULA    = Number of layers sampled
*                UPDP    = Upper boundary (cm) of the layer
*                LODP    = Lower boundary (cm) of the layer
*                COBES1   = Concentration (mg dm**[-3]) of BE for sector 1;
*                           at 8-04-1998: average of 8 observations;
*                           at all other sampling times: 1 observation (1 analysis for 4 columns, mixed)
*                COBES2   = Concentration (mg dm**[-3]) of BE for sector 2;
*                           at 8-04-1998: average of 8 observations;
*                           at all other sampling times: 1 observation (1 analysis for 4 columns, mixed)
*                COIBE3   = Concentration (mg dm**[-3]) of BE for sector 3;
*                           at 8-04-1998: average of 7 observations; (a few less at 5-10 cm and 10-15 cm)
*                           at all other sampling times: 1 observation (1 analysis for 4 columns, mixed)
*                COIBE4   = Concentration (mg dm**[-3]) of BE for sector 4;
*                           at 8-04-1998: average of 8 observations; (a few less at 5-10 cm and 10-15 cm)
*                           at all other sampling times: 1 observation (1 analysis for 4 columns, mixed)
*                AVCOBE = Average concentration of bentazone (mg dm**[-3] for the 4 sectors
*               SECOBE = Standard error (mg dm**[-3]) of the average concentration of bentazone
*               NUOB   = Number of observations (analyses) used for calculation of AVCOBE and SECOBE
*                -9.9999= Values below the set limit of quantification of 0.0008 mg dm**[-3]soil.
*                        For calculation  of the average concentration(AVCOBE), this value was set at 0.0004
*                        to get realistic averages
*
*                Concentrations "blank" soil samples, collected 30-03-98, were below limit of quantification
*
*                Concentrations were not corrected for extraction efficiency, which ranged
*                on average between 82% for the lowest concentrations to 100.6% for the higher contents.
*
*   YR    MH    DA   DANU   NULA    UPDP   LODP    COBES1    COBES2    COBES3     COBES4   AVCOBE   SECOBE NUOB
***************************************************************************************************************
  1998     4     8     98      3       0      5    2.6711    2.5089    2.9104     2.5134   2.5600   0.1444   31
  1998     4     8     98      3       5     10    0.1112    0.1050    0.0779     0.1691   0.1165   0.0282   29
  1998     4     8     98      3      10     15    0.0135    0.0119    0.0098     0.0227   0.0149   0.0028   27
*
  1998     4    29    119      7       0     10    0.1340    0.3385    0.2224     0.1499   0.2112   0.0466    4
  1998     4    29    119      7      10     20    0.2140    0.1314    0.4744     0.2472   0.2668   0.0734    4
  1998     4    29    119      7      20     30    0.0936    0.0506    0.1161     0.0743   0.0836   0.0140    4
  1998     4    29    119      7      30     50    0.0561    0.0168    0.0397     0.0479   0.0401   0.0085    4
  1998     4    29    119      7      50     70    0.0040    0.0012    0.0053     0.0147   0.0063   0.0029    4
  1998     4    29    119      7      70     90    0.0027   -9.9999   -9.9999     0.0053   0.0022   0.0012    4
  1998     4    29    119      7      90    120   -9.9999   -9.9999   -9.9999    -9.9999  -9.9999  -9.9999    4
*
  1998     6    15    166      7       0     10    0.0158    0.0058    0.0046     0.0031   0.0073   0.0029    4
  1998     6    15    166      7      10     20    0.0503    0.0259    0.0379     0.0411   0.0388   0.0050    4
  1998     6    15    166      7      20     30    0.0362    0.0454    0.0229     0.0329   0.0343   0.0047    4
  1998     6    15    166      7      30     50    0.0512    0.0478    0.0297     0.0401   0.0422   0.0048    4
  1998     6    15    166      7      50     70    0.0068    0.0235    0.0101     0.0223   0.0157   0.0042    4
  1998     6    15    166      7      70     90    0.0008    0.0058    0.0028     0.0051   0.0036   0.0012    4
  1998     6    15    166      7      90    110   -9.9999   -9.9999    0.0070     0.0022   0.0025   0.0016    4
*
  1998     8    10    222      7       0     10    0.0019    0.0026    0.0017     0.0021   0.0021   0.0002    4
  1998     8    10    222      7      10     20    0.0077    0.0011    0.0040     0.0014   0.0035   0.0015    4
  1998     8    10    222      7      20     30    0.0043    0.0023    0.0012     0.0051   0.0032   0.0009    4
  1998     8    10    222      7      30     50    0.0076    0.0021    0.0033     0.0113   0.0061   0.0021    4
  1998     8    10    222      7      50     70    0.0105    0.0026    0.0011     0.0170   0.0078   0.0037    4
  1998     8    10    222      7      70     90    0.0135    0.0015    0.0100     0.0122   0.0093   0.0027    4
  1998     8    10    222      7      90    120    0.0047    0.0009    0.0032     0.0063   0.0038   0.0011    4
*
  1998    12     2    336      7       0     10   -9.9999   -9.9999   -9.9999    -9.9999  -9.9999  -9.9999    4
  1998    12     2    336      7      10     20    0.0008    0.0008    0.0007    -9.9999   0.0007   0.0001    4
  1998    12     2    336      7      20     30   -9.9999   -9.9999   -9.9999    -9.9999  -9.9999  -9.9999    4
  1998    12     2    336      7      30     50   -9.9999   -9.9999   -9.9999    -9.9999  -9.9999  -9.9999    4
  1998    12     2    336      7      50     70   -9.9999   -9.9999   -9.9999    -9.9999  -9.9999  -9.9999    4
  1998    12     2    336      7      70     90   -9.9999   -9.9999   -9.9999    -9.9999  -9.9999  -9.9999    4
  1998    12     2    336      7      90    120   -9.9999   -9.9999   -9.9999    -9.9999  -9.9999  -9.9999    4
```

# **Annex 41 Content of ASCII file NLA00.SBR** (only the first part)

```
*File:    NLA00.SBR
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie; R.F.A. Hendriks
*Version: 1.1
*Date:    15 February 2002
*Source:  Measurements by ALTERRA
*           concentration of Bromide (Br) in soil
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         NULA   = Number of layers sampled
*         UPDP   = Upper boundary (cm) of the layer
*         LODP   = Lower boundary (cm) of the layer
*         COBRS1 = concentration of Br (g m**[-3] soil) for Section 1;
*                  at 08-04-1998: average of 8 observations;
*                  at 21-09-1998: average of 4 observations;
*         COBRS2 = concentration of Br (g m**[-3] soil) for Section 2;
*                  at 08-04-1998: average of 8 observations (a few less at 5-10 cm and 10-15 cm depth);
*                  at 21-09-1998: average of 4 observations;
*         COBRS3 = concentration of Br (g m**[-3] soil) for Section 3;
*                  at 08-04-1998: average of 7 observations (a few less at 5-10 cm and 10-15 cm depth);
*         COBRS4 = concentration of Br (g m**[-3] soil) for Section 4;
*                  at 08-04-1998: average of 8 observations (a few less at 5-10 cm and 10-15 cm depth);
*         AVCOBR = Average concentration of Br (g m**[-3] in soil)
*         SECOBR = Standard error (g m**[-3] soil) of the average concentration
*         NUOB   = Number of observations (analyses) for calculation of AVCOBR and SECOBR
*         -9.99  = Values below the limit of quantification of 0.5 g m**[-3] soil. For calculation of
*                  the average concentrations (AVCOBR) this value is set at 0.25 g m**[-3] soil, to get
*                   realistic averages.
*
*                Concentrations in "blank" soil samples, collected 30-03-98, were below set limit
*                of quantification of 0.5 g m**[-3] soil.
*
*  YR    MH    DA   DANU    NULA   UPDP   LODP     COBRS1   COBRS2   COBRS3   COBRS4     AVCOBR   SECOBR   NUOB
*****************************************************************************************************************
 1998     4     8     98       3      0      5     104.47    85.88    96.62    85.09      92.90     4.17     31
 1998     4     8     98       3      5     10      11.24     9.88     8.19     9.49       9.81     1.35     29
 1998     4     8     98       3     10     15       2.03     2.30     6.32     4.34       5.19     0.56     27
 1998     4    29    119       7      0     10       9.36    11.99     2.59     6.28       7.55     2.03      4
 1998     4    29    119       7     10     20       1.25     0.86     2.06    -9.99       1.10     0.38      4
 1998     4    29    119       7     20     30       0.55    -9.99     0.61    -9.99      -9.99    -9.99      4
 1998     4    29    119       7     30     50      -9.99    -9.99    -9.99     0.52      -9.99    -9.99      4
 1998     4    29    119       7     50     70      -9.99    -9.99    -9.99    -9.99      -9.99    -9.99      4
 1998     4    29    119       7     70     90       1.63    -9.99     0.53     0.62       0.80     0.28      4
 1998     4    29    119       7     90    120      -9.99    -9.99    -9.99    -9.99      -9.99    -9.99      4
 1998     6    15    166       7      0     10       2.94     4.70     3.43    -9.99       2.83     0.94      4
 1998     6    15    166       7     10     20       3.03     4.00     5.57     3.54       4.04     0.55      4
 1998     6    15    166       7     20     30       2.72     4.05     3.49     3.12       3.34     0.28      4
 1998     6    15    166       7     30     50       2.23     2.45     1.08     2.00       1.94     0.30      4
 1998     6    15    166       7     50     70      -9.99    -9.99    -9.99    -9.99      -9.99    -9.99      4
 1998     6    15    166       7     70     90      -9.99    -9.99    -9.99    -9.99      -9.99    -9.99      4
 1998     6    15    166       7     90    120      -9.99    -9.99    -9.99    -9.99      -9.99    -9.99      4
 1998     8    10    222       7      0     10      10.69    13.36     9.06     9.88      10.75     0.93      4
 1998     8    10    222       7     10     20       8.64     7.74     3.82     3.73       5.98     1.29      4
 1998     8    10    222       7     20     30       4.84     2.44     2.50     3.29       3.27     0.56      4
 1998     8    10    222       7     30     50       4.26    -9.99     2.41     2.90       2.45     0.83      4
 1998     8    10    222       7     50     70       1.96    -9.99    -9.99     1.00       0.87     0.41      4
 1998     8    10    222       7     70     90      -9.99    -9.99    -9.99    -9.99      -9.99    -9.99      4
 1998     8    10    222       7     90    120      -9.99    -9.99    -9.99    -9.99      -9.99    -9.99      4
 1998     9    21    264       7      0     10       7.62     6.06     3.17     1.31       5.92     1.67     10
 1998     9    21    264       7     10     20       5.65    10.67     6.05     1.80       7.31     1.59     10
 1998     9    21    264       7     20     30       4.66     7.56     9.08     2.06       6.00     1.05     10
 1998     9    21    264       7     30     50       3.69     3.94     5.63     4.13       4.03     0.42     10
 1998     9    21    264       7     50     70       2.94     2.06     3.49     5.00       2.85     0.46     10
 1998     9    21    264       7     70     90       1.33     0.95     1.76     2.64       1.35     0.22     10
 1998     9    21    264       7     90    120       0.88     0.68     1.06     2.01       0.93     0.15     10
 1998    12     2    336       7      0     10       0.61     1.12    -9.99    -9.99      -9.99    -9.99      4
 1998    12     2    336       7     10     20       2.07     3.26    -9.99    -9.99       1.46     0.74      4
 1998    12     2    336       7     20     30       2.82     4.59     0.66     0.62       2.17     0.96      4
 1998    12     2    336       7     30     50       2.13     2.60     0.85     0.83       1.60     0.45      4
 1998    12     2    336       7     50     70       1.96     1.25     1.92     1.44       1.64     0.18      4
 1998    12     2    336       7     70     90       2.06     1.28     1.61     2.13       1.77     0.20      4
 1998    12     2    336       7     90    110       1.66     1.19     1.22     2.38       1.61     0.28      4
```

# Annex 42  Content of ASCII file NLA00.SCP

```
*File:        NLA00.SCP
*Code:        ASCII
*Access:      sequential
*Author:      J.H. Smelt
*Version      1.1
*Date:        1 May 2001
*Source:             Soil samples taken by Alterra,
*             measurements by the Laboratory for Soil and Crop testing at Oosterbeek,The Netherlands.
*             Soil Chemical properties and texture, field Andelst, The Netherlands
*
*      Description of the quantities and their units
*      NULA   = Number of layers sampled
*      OR     = Origin of soil sample:
*              1 = sector 1, 2 = sector 2, 3 = sector 3, 4 = sector 4,
*                                  (soils collected from 16 soil cores (4 per sector) taken at 27-10-97
*              5 = average value of each soil property for the sectors 1 to 4
*              6 = standard deviation of the average values (n=4)
*              7 = soil batch used for incubation and sorption experiments of bentazone, collected 30-03-98
*              8 = soil batch used for incubation and sorption experiments of imidacloprid,collected 3-02-99
*      UPDP   = Upper boundery (cm ) of the layer
*      LODP   = Lower boundery (cm ) of the layer
*      PHKC   = pH-KCL
*      PHWA   = pH-water
*      FROM   = Fraction of organic matter (% of dry soil mass)
*      FROC   = Fraction of organic carbon (% of dry soil mass)
*      FRCC   = Fraction of calcium carbonate (% of dry soil mass)
*      FRCL   = fraction of clay (% of mineral parts)
*      FRSI   = Fraction of silt (% of mineral parts)
*      FRSA   = Fraction of sand (% of mineral parts)
*      CTTP   = Content of total phosphate (mg P2O5 100 g**-1 dry soil)
*      CTTN   = Content of total nitrogen (mg 100 g**-1 dry soil)
*      CRNM   = Content of N-mineral (mg 100 g**-1 dry soil)
*      EC     = actual cationic exchange capacity (cmol+ kg**-1)
*      -99.0  = code for unknown values
*
*NULA   OR   UPDP   lODP   PHKC   PHWA   FROM   FROC   FRCC   FRCL   FRSI   FRSA  CTTP    CTTN   CTNM     EC
**********************************************************************************************************
    5    1    0.0   30.0    7.0    7.5    2.3  -99.0    0.2   27.4   53.5   19.1  192.0  148.0   15.5  -99.0
    5    1   30.0   50.0    6.6    7.4    1.2  -99.0    0.3   30.6   52.4   17.0  123.0   91.0    7.6  -99.0
    5    1   50.0   70.0    7.3    7.9    1.1  -99.0    2.9   34.2   52.2   13.6  125.0   87.0    4.9  -99.0
    5    1   70.0   90.0    7.5    7.9    1.1  -99.0    4.7   34.6   47.8   17.6  122.0   81.0    8.5  -99.0
    5    1   90.0  120.0    7.4    7.9    1.1  -99.0    4.0   37.2   47.3   15.4  133.0   76.0    9.7  -99.0
*
    5    2    0.0   30.0    7.1    7.7    2.2  -99.0    0.2   27.3   51.7   21.0  194.0  154.0   16.9  -99.0
    5    2   30.0   50.0    7.3    7.8    1.1  -99.0    2.5   28.7   52.4   18.9  127.0   90.0    8.2  -99.0
    5    2   50.0   70.0    7.4    8.0    0.9  -99.0    7.2   34.3   52.2   13.5  123.0   81.0    4.4  -99.0
    5    2   70.0   90.0    7.4    8.2    0.9  -99.0    6.6   39.5   50.2   10.3  124.0   76.0    6.0  -99.0
    5    2   90.0  120.0    7.4    8.2    0.9  -99.0    5.6   37.5   45.8   16.7  141.0   64.0    7.6  -99.0  (continued next page)
```

```
*
    5    3    0.0   30.0    7.1    7.8    2.0  -99.0    0.2   29.2   52.9   17.9  211.0  133.0   11.8  -99.0
    5    3   30.0   50.0    7.1    7.8    1.1  -99.0    0.8   31.3   51.6   17.1  126.0   88.0    5.8  -99.0
    5    3   50.0   70.0    7.4    8.1    1.0  -99.0    4.1   36.5   51.7   11.8  125.0   83.0    2.8  -99.0
    5    3   70.0   90.0    7.4    8.1    0.9  -99.0    6.7   35.5   51.0   13.5  126.0   73.0    4.0  -99.0
    5    3   90.0  120.0    7.5    8.2    1.1  -99.0    7.8   36.0   48.0   16.0  142.0   77.0    4.3  -99.0
*
    5    4    0.0   30.0    7.2    7.7    2.0  -99.0    0.3   27.0   53.5   19.5  216.0  135.0   11.8  -99.0
    5    4   30.0   50.0    7.2    7.8    1.1  -99.0    1.2   29.2   48.3   22.5  133.0   89.0    6.7  -99.0
    5    4   50.0   70.0    7.4    8.0    0.9  -99.0    4.8   34.1   47.5   18.4  114.0   78.0    4.4  -99.0
    5    4   70.0   90.0    7.4    8.1    1.0  -99.0    4.1   40.3   48.4   11.3  123.0   76.0    6.0  -99.0
    5    4   90.0  120.0    7.5    8.2    1.0  -99.0    5.0   38.0   47.1   14.9  133.0   73.0    6.3  -99.0
*
    5    5    0.0   30.0    7.1    7.7    2.1  -99.0    0.2   27.7   52.9   19.4  203.3  142.5   14.0  -99.0
    5    5   30.0   50.0    7.1    7.7    1.1  -99.0    1.2   30.0   51.2   18.9  127.3   89.5    7.1  -99.0
    5    5   50.0   70.0    7.4    8.0    1.0  -99.0    4.8   34.8   50.9   14.3  121.8   82.3    4.1  -99.0
    5    5   70.0   90.0    7.4    8.1    1.0  -99.0    5.5   37.5   49.4   13.2  123.8   76.5    6.1  -99.0
    5    5   90.0  120.0    7.5    8.1    1.0  -99.0    5.6   37.2   47.1   15.8  137.3   72.5    7.0  -99.0
*
    5    6    0.0   30.0   0.08   0.13   0.15  -99.0   0.05   1.00   0.85   1.28  12.04  10.15   2.60  -99.0
    5    6   30.0   50.0   0.31   0.20   0.05  -99.0   0.94   1.21   1.95   2.57   4.19   1.29   1.05  -99.0
    5    6   50.0   70.0   0.05   0.08   0.10  -99.0   1.81   1.15   2.28   2.84   5.25   3.77   0.91  -99.0
    5    6   70.0   90.0   0.05   0.13   0.10  -99.0   1.32   2.84   1.50   3.24   1.71   3.32   1.84  -99.0
    5    6   90.0  120.0   0.06   0.15   0.10  -99.0   1.61   0.85   0.92   0.78   4.92   5.92   2.27  -99.0
*
    1    7      0     30    7.2    7.9    2.3   1.28   1.29   27.2   53.2   19.2  -99.0  -99.0  -99.0   22.4
*
    3    8      0     30    7.1    7.2    2.5    1.5    1.5   28.6   54.3   17.1  -99.0  -99.0  -99.0   24.2
    3    8     40     70    7.5    8.1    1.2  -99.0    2.9   31.9   54.1   13.0  -99.0  -99.0  -99.0  -99.0
    3    8     80    120    7.6    8.2    1.0  -99.0    6.6   36.2   48.0   15.8  -99.0  -99.0  -99.0  -99.0
```

# Annex 43 Content of ASCII file NLA00.SHC (only the first part)

```
*File:    NLA00.SHC
*Code:    ASCII
*Access:  Sequential
*Author:  R.F.A. Hendriks
*Version: 1.0
*Date:    15 April 2001
*Source:  Measurements by ALTERRA
*           Soil hydraulic conductivity
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         NULA = Number of layers sampled
*         UPDP = Upper boundary (cm) of the layer
*         LODP = Lower boundary (cm) of the layer
*         NURE = Number of replicates
*         SMNU = Sample number (1 and 11; 2 and 12; etc. are pairs of duplicates;
*                note that SMNU in file NLA00.SHP refers to the same samples)
*         NUMP = Number of measuring points per replicate
*         PSHD = Pressure head (cm); negative values indicate suction
*         HYCD = Hydraulic conductivity (cm day[-1])
*
*NULA  UPDP LODP  NURE  SMNU NUMP     PSHD      HYCD
**********************************************************************************
    6    11   19     2     1  357     -8.0  1.15E+00
    6    11   19     2     1  357     -8.6  3.86E-01
    6    11   19     2     1  357     -9.1  6.91E-01
    6    11   19     2     1  357     -9.5  5.05E-01
    6    11   19     2     1  357    -10.3  5.15E-01
    6    11   19     2     1  357    -10.6  1.47E-01
    6    11   19     2     1  357    -10.9  3.74E-01
    6    11   19     2     1  357    -11.2  5.56E-01
    6    11   19     2     1  357    -11.4  7.09E-01
    6    11   19     2     1  357    -11.6  8.95E-01
    6    11   19     2     1  357    -11.8  1.06E+00
    6    11   19     2     1  357    -12.0  7.34E-01
    6    11   19     2     1  357    -12.2  3.54E+00
    6    11   19     2     1  357    -12.2  1.21E+00
    6    11   19     2     1  357    -12.4  1.24E+00
    6    11   19     2     1  357    -12.6  1.34E+00
    6    11   19     2     1  357    -12.7  9.59E-01
    6    11   19     2     1  357    -12.8  1.82E+00
    6    11   19     2     1  357    -12.9  9.99E-01
    6    11   19     2     1  357    -13.1  1.37E+00
    6    11   19     2     1  357    -13.1  1.32E+00
    6    11   19     2     1  357    -13.3  1.03E+00
    6    11   19     2     1  357    -13.4  4.19E-01
    6    11   19     2     1  357    -13.5  1.05E+00
    6    11   19     2     1  357    -13.6  1.31E+00
    6    11   19     2     1  357    -13.8  1.02E+00
    6    11   19     2     1  357    -13.9  1.14E+00
    6    11   19     2     1  357    -14.0  1.30E+00
    6    11   19     2     1  357    -14.3  1.02E+00
    6    11   19     2     1  357    -14.4  5.80E-01
    6    11   19     2     1  357    -14.5  1.02E+00
    6    11   19     2     1  357    -14.7  9.88E-01
    6    11   19     2     1  357    -14.8  7.38E-01
    6    11   19     2     1  357    -15.0  9.91E-01
    6    11   19     2     1  357    -15.3  8.70E-01
    6    11   19     2     1  357    -15.3  1.00E+00
    6    11   19     2     1  357    -15.6  9.78E-01
    6    11   19     2     1  357    -15.6  1.00E+00
```

# Annex 44 Content of ASCII file NLA00.SHP

```
*File:    NLA00.SHP
*Code:    ASCII
*Access:  Sequential
*Author:  R.F.A. Hendriks
*Version: 1.0
*Date:    15 April 2001
*Source:  Measurements by ALTERRA
*           Soil hydraulic parameters
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*
*         NULA   = Number of layers sampled
*         UPDP   = Upper boundary (cm) of the layer
*         LODP   = Lower boundary (cm) of the layer
*         NURE   = Number of replicates
*         SMNU = Sample number (1 and 11; 2 and 12; etc. are pairs of duplicates;
*                note that SMNU in file NLA00.SHC refers to the same samples)
*
*         Van Genuchten parameters optimized on basis of results of the evaporation method,
*         as given in file NLA00.SHC:
*         MOFRRS = Residual volume fraction of liquid (cm**[3] cm**[-3])
*         MOFRSR = Volume fraction of liquid (cm**[3] cm**[-3]) at saturation
*         ALPHA  = Shape factor (cm**[-1])
*         N      = Shape factor (-)
*         L      = Shape factor (-)
*         HYCDSR = Hydraulic conductivity (cm day[-1]) at saturation
*
*         Direct measurements:
*         HYCDSRME = Measured hydraulic conductivity (cm day[-1]) at saturation
*
*         Samples for measuring the hydraulic conductivity at saturation were not the same
*         as the ones used for the evaporation method
*
*NULA  UPDP LODP NURE   SMNU  MOFRRS  MOFRSR   ALPHA      N        L   HYCDSR  HYCDSRME
*******************************************************************************************
    6    11   19    2      1   0.010   0.400  0.0200  1.110   -5.500    42.26       3.7
    6    11   19    2     11   0.010   0.400  0.0180  1.080  -16.203    44.47       5.5
    6    22   30    2      2   0.010   0.390  0.0018  1.240    0.000     0.30       0.0
    6    22   30    2     12   0.010   0.389  0.0080  1.090  -18.012     5.81       0.0
    6    36   44    2      3   0.010   0.390  0.0095  1.130   -2.500    14.62      43.2
    6    36   44    2     13   0.010   0.390  0.0100  1.118   -3.334    15.65       5.7
    6    61   69    2      4   0.010   0.480  0.0150  1.088    0.000    61.44     696.4
    6    61   69    2     14   0.010   0.445  0.0120  1.060    0.000    78.87     135.5
    6    96  104    2      5   0.010   0.443  0.0180  1.080  -11.000    71.29     142.7
    6    96  104    2     15   0.010   0.437  0.0018  1.240   -4.284     0.96     728.7
    6   131  139    2      6   0.010   0.525  0.0088  1.048  -38.024    13.99      90.4
    6   131  139    2     16   0.010   0.525  0.0014  1.240    0.000     0.43       0.0
```

# Annex 45 Content of ASCII file NLA00.SIM

```
*File:           NLA00.SIM
*Code:           ASCII
*Access:         sequential
*Author:         J.H.Smelt , L.J.T. van der Pas;
*Version:        1.2
*Date:           10 March 2003
*Source:         Measurements by Alterra
*                  concentrations of imidacloprid (IM) in the soil;
*                  Andelst, The Netherlands
*
*                Description of the quantities and their units
*                YR     = Year
*                MH     = Month
*                DA     = Day within month
*                DANU   = Day number (value is 1 at 1 Jan 1998)
*                NULA   = Number of layers sampled
*                UPDP   = Upper boundary (cm) of the layer
*                LODP   = Lower boundary (cm) of the layer
*                COIMS1  = concentration (mg dm**[-3]) of IM for sector 1;
*                         at 29-05-1998: average of 8 observations;
*                         at all other sampling times: 1 observation (1 analysis for 4 columns, mixed)
*                COIMS2  = concentration (mg dm**[-3]) of IM for sector 2;
*                         at 29-05-1998: average of 8 observations;
*                         at all other sampling times: 1 observation (1 analysis for 4 columns, mixed)
*                COIMS3  = concentration (mg dm**[-3]) of IM for sector 3;
*                         at 29-05-1998: average of 8 observations;
*                         at all other sampling times: 1 observation( 1 analysis for 4 columns, mixed)
*                COIMS4  = concentration (mg dm**[-3]) of IM for sector 4;
*                         at 29-05-1998: average of 7 observations;
*                         at all other sampling times: 1 observation (1 analysis for 4 columns, mixed)
*                AVCOIM = Average concentration of imidacloprid (mg dm**[-3],in soil
*               SECOIM = Standard error (mg dm**[-3]) of the average concentrations of imidacloprid
*               NUOB   = Number of observations for calculation of AVCOIM
*                -9.9999= Values below set limit of quantification (0.0009 mg dm**[-3].
*                        For calculation of the average concentration (AVCOIM) this value was
*                        set at 0.00045 to get realistic averages
*
*                concentrations in "blank" soil samples, collected 30-03-98, were below limit of quantification
*
*                concentrations were not corrected for extraction efficiency, which was on average 104.2%
*                (sd =10.5, n=32); sd = standard deviation
*
*   YR   MH    DA    DANU  NULA   UPDP   LODP     COIMS1    COIMS2   COIMS3   COIMS4   AVCOIM   SECOIM   NUOB
*****************************************************************************************************************
  1998    5    29     149     2      0      5     0.6747    0.9286   1.0408   1.2529   0.9871   0.0577     31
  1998    5    29     149     2      5     15     0.0405    0.0670   0.0662   0.0545   0.0585   0.0103     31
*
  1998    9    21     264     7      0     10     0.1802    0.2156   0.1905   0.1436   0.1825   0.0149      4
  1998    9    21     264     7     10     20     0.0432    0.0394   0.0314   0.0410   0.0387   0.0026      4
  1998    9    21     264     7     20     30     0.0085    0.0026   0.0148   0.0154   0.0103   0.0030      4
  1998    9    21     264     7     30     50     0.0034    0.0027   0.0032   0.0012   0.0026   0.0005      4
  1998    9    21     264     7     50     70     0.0009    0.0016   0.0010  -9.9999   0.0010   0.0002      4
  1998    9    21     264     7     70     90     0.0034    0.0014   0.0011  -9.9999   0.0016   0.0006      4
  1998    9    21     264     7     90    120    -9.9999   -9.9999  -9.9999  -9.9999  -9.9999  -9.9999      4
*
  1998   12     2     336     7      0     10     0.1609    0.2257   0.1180   0.1634   0.1670   0.0222      4
  1998   12     2     336     7     10     20     0.0467    0.0384   0.0774   0.0838   0.0616   0.0112      4
  1998   12     2     336     7     20     30     0.0073    0.0145   0.0168   0.0276   0.0166   0.0042      4
  1998   12     2     336     7     30     50     0.0031    0.0021   0.0054   0.0039   0.0036   0.0007      4
  1998   12     2     336     7     50     70     0.0023    0.0009   0.0012   0.0018   0.0016   0.0003      4
  1998   12     2     336     7     70     90     0.0018    0.0009   0.0015  -9.9999   0.0012   0.0003      4
  1998   12     2     336     7     90    110     0.0016   -9.9999  -9.9999  -9.9999  -9.9999  -9.9999      4
*
  1999    4    20     475     7      0     10     0.0341    0.0303   0.0804   0.0638   0.0522   0.0120      4
  1999    4    20     475     7     10     20     0.1073    0.0978   0.0820   0.1474   0.1086   0.0139      4
  1999    4    20     475     7     20     30     0.0900    0.0850   0.0066   0.0886   0.0676   0.0203      4
  1999    4    20     475     7     30     50     0.0063    0.0021   0.0126   0.0102   0.0078   0.0023      4
  1999    4    20     475     7     50     70    -9.9999   -9.9999   0.0068   0.0024   0.0026   0.0015      4
  1999    4    20     475     7     70     90    -9.9999    0.0105   0.0033   0.0015   0.0040   0.0023      4
  1999    4    20     475     7     90    120    -9.9999   -9.9999   0.0022  -9.9999   0.0009   0.0004      4
```

# **Annex 46 Content of ASCII file NLA00.SMM** (only the first part)

```
*File:    NLA00.SMM
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie; R.F.A. Hendriks
*Version: 1.1
*Date:    11 May 2001
*Source:  Measurements by ALTERRA
*           Soil moisture content as mass fraction
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         NULA   = Number of layers sampled
*         UPDP   = Upper boundary (cm) of the layer
*         LODP   = Lower boundary (cm) of the layer
*         MOFRS1 = Mass fraction of liquid (g g**[-1]), average for Sector 1
*         MOFRS2 = Mass fraction of liquid (g g**[-1]), average for Sector 2
*         MOFRS3 = Mass fraction of liquid (g g**[-1]), average for Sector 3
*         MOFRS4 = Mass fraction of liquid (g g**[-1]), average for Sector 4
*         AVMOFR = Average mass fraction of liquid (g g**[-1])
*         SEMOFR = Standard error (g g**[-1]) of the average mass fraction of liquid
*         NUOB   = Number of observations
*         -99.0  = Code for unknown values
*
* YR   MH   DA  DANU   NULA  UPDP  LODP    MOFRS1  MOFRS2  MOFRS3  MOFRS4    AVMOFR  SEMOFR  NUOB
*************************************************************************************************
1997   10   27   -65     12     0    10     0.229   0.221   0.222   0.203     0.219   0.004    16
1997   10   27   -65     12    10    20     0.229   0.228   0.228   0.213     0.225   0.002    16
1997   10   27   -65     12    20    30     0.234   0.232   0.222   0.213     0.225   0.003    16
1997   10   27   -65     12    30    40     0.221   0.234   0.230   0.216     0.225   0.004    16
1997   10   27   -65     12    40    50     0.233   0.236   0.243   0.233     0.237   0.004    16
1997   10   27   -65     12    50    60     0.244   0.239   0.251   0.232     0.241   0.005    16
1997   10   27   -65     12    60    70     0.246   0.261   0.262   0.257     0.256   0.004    16
1997   10   27   -65     12    70    80     0.242   0.280   0.260   0.275     0.264   0.005    16
1997   10   27   -65     12    80    90     0.248   0.278   0.269   0.279     0.268   0.005    16
1997   10   27   -65     12    90   100     0.270   0.272   0.279   0.267     0.272   0.007    16
1997   10   27   -65     12   100   110     0.277   0.308   0.291   0.282     0.289   0.008    16
1997   10   27   -65     12   110   120     0.303   0.282   0.301   0.291     0.294   0.008    16
1998    1   21    21      9     0    10     0.270   0.264   0.269   0.255     0.264   0.003    16
1998    1   21    21      9    10    20     0.232   0.244   0.240   0.239     0.239   0.004    15
1998    1   21    21      9    20    30     0.219   0.235   0.226   0.222     0.225   0.003    16
1998    1   21    21      9    30    40     0.224   0.227   0.233   0.229     0.228   0.004    15
1998    1   21    21      9    40    50     0.236   0.223   0.245   0.233     0.234   0.004    16
1998    1   21    21      9    50    60     0.257   0.233   0.257   0.245     0.248   0.004    16
1998    1   21    21      9    60    70     0.252   0.251   0.263   0.252     0.254   0.004    16
1998    1   21    21      9    70    80     0.255   0.278   0.261   0.261     0.264   0.005    16
1998    1   21    21      9    80    90     0.270   0.285   0.265   0.272     0.272   0.005    15
```

# **Annex 47 Content of ASCII file NLA00.SMV** (only the first part)

```
*File:    NLA00.SMV
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie; R.F.A. Hendriks
*Version: 1.1
*Date:    11 May 2001
*Source:  Measurements by ALTERRA
*           Soil moisture content as volume fraction
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         NULA   = Number of layers sampled
*         UPDP   = Upper boundary (cm) of the layer
*         LODP   = Lower boundary (cm) of the layer
*         MOFRS1 = Volume fraction of liquid (cm**[3] cm**[-3]), average for Sector 1
*         MOFRS2 = Volume fraction of liquid (cm**[3] cm**[-3]), average for Sector 2
*         MOFRS3 = Volume fraction of liquid (cm**[3] cm**[-3]), average for Sector 3
*         MOFRS4 = Volume fraction of liquid (cm**[3] cm**[-3]), average for Sector 4
*         AVMOFR = Average volume fraction of liquid (cm**[3] cm**[-3])
*         SEMOFR = Standard error (cm**[3] cm**[-3]) of the average volume fraction of liquid
*         NUOB   = Number of observations
*         -99.0  = Code for unknown values
*
* YR   MH   DA  DANU   NULA  UPDP  LODP    MOFRS1  MOFRS2  MOFRS3  MOFRS4    AVMOFR  SEMOFR  NUOB
*************************************************************************************************
1997   10   27   -65     12     0    10     0.262   0.272   0.276   0.234     0.261   0.007    16
1997   10   27   -65     12    10    20     0.344   0.327   0.323   0.320     0.328   0.006    16
1997   10   27   -65     12    20    30     0.339   0.331   0.333   0.319     0.331   0.006    16
1997   10   27   -65     12    30    40     0.344   0.346   0.351   0.334     0.344   0.005    16
1997   10   27   -65     12    40    50     0.356   0.347   0.368   0.354     0.356   0.005    16
1997   10   27   -65     12    50    60     0.362   0.359   0.381   0.355     0.364   0.006    16
1997   10   27   -65     12    60    70     0.371   0.374   0.393   0.392     0.382   0.008    16
1997   10   27   -65     12    70    80     0.362   0.401   0.394   0.411     0.392   0.008    16
1997   10   27   -65     12    80    90     0.377   0.414   0.401   0.418     0.403   0.006    16
1997   10   27   -65     12    90   100     0.400   0.401   0.409   0.402     0.403   0.007    16
1997   10   27   -65     12   100   110     0.408   0.438   0.418   0.415     0.420   0.008    16
1997   10   27   -65     12   110   120     0.441   0.421   0.444   0.427     0.433   0.008    16
1998    1   21    21      9     0    10     0.404   0.388   0.373   0.327     0.373   0.014    16
1998    1   21    21      9    10    20     0.398   0.393   0.414   0.295     0.375   0.027    15
1998    1   21    21      9    20    30     0.362   0.371   0.373   0.342     0.362   0.010    16
1998    1   21    21      9    30    40     0.382   0.378   0.387   0.284     0.358   0.025    15
1998    1   21    21      9    40    50     0.381   0.361   0.380   0.392     0.379   0.005    16
1998    1   21    21      9    50    60     0.406   0.370   0.402   0.392     0.393   0.007    16
1998    1   21    21      9    60    70     0.393   0.392   0.407   0.407     0.400   0.006    16
1998    1   21    21      9    70    80     0.410   0.440   0.416   0.447     0.428   0.007    16
1998    1   21    21      9    80    90     0.433   0.327   0.433   0.433     0.406   0.028    15
1998    3   30    89     12     0    10     0.286   0.272   0.259   0.257     0.268   0.006    16
1998    3   30    89     12    10    20     0.339   0.335   0.350   0.347     0.343   0.005    16
1998    3   30    89     12    20    30     0.343   0.333   0.331   0.321     0.332   0.005    16
1998    3   30    89     12    30    40     0.324   0.323   0.341   0.340     0.332   0.005    16
1998    3   30    89     12    40    50     0.338   0.346   0.357   0.352     0.348   0.007    16
1998    3   30    89     12    50    60     0.357   0.346   0.380   0.354     0.359   0.007    16
1998    3   30    89     12    60    70     0.372   0.391   0.398   0.374     0.384   0.006    16
1998    3   30    89     12    70    80     0.359   0.410   0.393   0.403     0.391   0.008    16
1998    3   30    89     12    80    90     0.400   0.416   0.405   0.414     0.409   0.005    16
1998    3   30    89     12    90   100     0.448   0.408   0.421   0.384     0.415   0.009    16
1998    3   30    89     12   100   110     0.446   0.434   0.443   0.403     0.431   0.008    16
1998    3   30    89     12   110   120     0.435   0.467   0.453   0.447     0.450   0.009    16
```

# Annex 48  Content of ASCII file NLA00.SKN

```
*File:    NLA00.SKN
*Code:    ASCII
*Access:  Sequential
*Author:  R.F.A. Hendriks
*Version: 1.0
*Date:    28 December 2000
*Source:  Measurements by ALTERRA
*           Concentration of Kjeldahl-N in soil
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR      = Year
*         MH      = Month
*         DA      = Day within month
*         DANU    = Day number (value is 1 at 1 January 1998)
*         NULA    = Number of layers sampled
*         UPDP    = Upper boundary (cm) of the layer
*         LODP    = Lower boundary (cm) of the layer
*         COKNS12 = Concentration of Kjeldahl-N (g m**[-3] soil) for Sections 1 and 2
*                    (representative for catchment area of drain set 1)
*         COKNS34 = Concentration of Kjeldahl-N (g m**[-3] soil) for Sections 3 and 4
*                    (representative for catchment area of drain set 2)
*         AVCOKN  = Average concentration of Kjeldahl-N (g m**[-3] soil)
*         SECOKN  = Standard error (g m**[-3] soil) of the average concentration
*         NUOB    = Number of observations (analyses) for calculation of AVCOKN and SECOKN
*         -99.0   = Code for unknown values
*
* YR   MH   DA  DANU   NULA  UPDP  LODP   COKNS12 COKNS34    AVCOKN  SECOKN  NUOB
****************************************************************************************
1998    9   21   264      7     0    10      0.94    1.59      1.27    0.33     2
1998    9   21   264      7    10    20      3.71    0.81      2.26    1.45     2
1998    9   21   264      7    20    30      2.13    0.47      1.30    0.83     2
1998    9   21   264      7    30    50      1.42    0.45      0.93    0.48     2
1998    9   21   264      7    50    70      0.82    0.22      0.52    0.30     2
1998    9   21   264      7    70    90      0.79    0.29      0.54    0.25     2
1998    9   21   264      7    90   120      0.72    0.10      0.41    0.31     2
1998   12    2   336      7     0    10     17.53    3.93     10.73    6.80     2
1998   12    2   336      7    10    20      5.02    4.69      4.85    0.17     2
1998   12    2   336      7    20    30      8.00    5.55      6.77    1.22     2
1998   12    2   336      7    30    50      4.27    2.89      3.58    0.69     2
1998   12    2   336      7    50    70      4.66    9.50      7.08    2.42     2
1998   12    2   336      7    70    90      4.83    3.39      4.11    0.72     2
1998   12    2   336      7    90   120      5.12    7.99      6.56    1.43     2
1999    4   20   475      7     0    10      0.11    2.15      1.13    1.02     2
1999    4   20   475      7    10    20      1.36    2.27      1.81    0.46     2
1999    4   20   475      7    20    30      2.94  -99.00      2.94  -99.00     1
1999    4   20   475      7    30    50      0.15    1.95      1.05    0.90     2
1999    4   20   475      7    50    70      0.86    0.26      0.56    0.30     2
1999    4   20   475      7    70    90      2.94    2.08      2.51    0.43     2
1999    4   20   475      7    90   120      2.96    0.56      1.76    1.20     2
```

# **Annex 49 Content of ASCII file NLA00.SNN** (only the first part)

```
*File:    NLA00.SNN
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie; R.F.A. Hendriks
*Version: 1.0
*Date:    28 December 2000
*Source:  Measurements by ALTERRA
*           concentration of Nitrate-N (NO3-N) in soil
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         NULA   = Number of layers sampled
*         UPDP   = Upper boundary (cm) of the layer
*         LODP   = Lower boundary (cm) of the layer
*         CONNS1 = Concentration of NO3-N (g m**[-3] soil) for Section 1;
*                  at 08-04-1998: average of 8 (7 at 10-15 cm depth) observations;
*                  at 21-09-1998: average of 4 observations;
*         CONNS2 = Concentration of NO3-N (g m**[-3] soil) for Section 2;
*                  at 08-04-1998: average of 8 (7 at 10-15 cm depth) observations;
*                  at 21-09-1998: average of 4 observations;
*         CONNS3 = Concentration of NO3-N (g m**[-3] soil) for Section 3;
*                  at 08-04-1998: average of 7 (5 at 10-15 cm depth) observations;
*         CONNS4 = Concentration of NO3-N (g m**[-3] soil) for Section 4;
*                  at 08-04-1998: average of 8 (7 at 10-15 cm depth) observations;
*         AVCONN = Average concentration of NO3-N (g m**[-3] soil)
*         SECONN = Standard error (g m**[-3] soil) of the average concentration
*         NUOB   = Number of observations (analyses) for calculation of AVCONN and SECONN
*
* YR   MH   DA  DANU   NULA  UPDP  LODP    CONNS1  CONNS2  CONNS3  CONNS4    AVCONN  SECONN  NUOB
*************************************************************************************************
1998    4    8    98      3     0     5      6.01    4.83    4.13    3.09      4.53    0.91    31
1998    4    8    98      3     5    10      3.12    3.74    2.03    2.54      2.88    0.57    31
1998    4    8    98      3    10    15      1.89    1.59    1.55    0.78      1.45    0.16    26
1998    4   29   119      7     0    10     30.43   10.03    7.58    6.93     13.74    5.60     4
1998    4   29   119      7    10    20      8.31   26.04    8.85    9.26     13.12    4.31     4
1998    4   29   119      7    20    30      9.02   10.11   10.19   25.50     13.71    3.94     4
1998    4   29   119      7    30    50     13.54   15.16    9.02   15.89     13.40    1.54     4
1998    4   29   119      7    50    70      9.24   11.88    8.04   11.32     10.12    0.90     4
1998    4   29   119      7    70    90      6.25   10.17    6.48    5.23      7.03    1.08     4
1998    4   29   119      7    90   120      8.38   10.71    9.48   10.90      9.87    0.59     4
1998    6   15   166      7     0    10      6.24    4.40    5.16    4.72      5.13    0.40     4
1998    6   15   166      7    10    20      4.29    2.89    3.68    2.95      3.45    0.33     4
1998    6   15   166      7    20    30      4.36    2.16    3.47    1.51      2.87    0.64     4
1998    6   15   166      7    30    50      1.80    1.33    0.79    1.66      1.40    0.23     4
1998    6   15   166      7    50    70      0.76    0.50    0.29    0.62      0.54    0.10     4
1998    6   15   166      7    70    90      0.50    0.45    0.29    0.34      0.39    0.05     4
1998    6   15   166      7    90   120      2.55    0.91    0.95    1.40      1.45    0.38     4
1998    8   10   222      7     0    10      8.89   10.15    7.90    6.24      8.29    0.83     4
1998    8   10   222      7    10    20     11.76   14.58   12.83   11.33     12.63    0.72     4
1998    8   10   222      7    20    30     13.64   16.02   13.34   12.67     13.92    0.73     4
1998    8   10   222      7    30    50      5.64    6.73    5.25    4.23      5.46    0.52     4
1998    8   10   222      7    50    70      3.20    3.58    2.62    1.99      2.85    0.35     4
1998    8   10   222      7    70    90      1.95    3.08    2.46    1.46      2.24    0.35     4
1998    8   10   222      7    90   120      3.98    4.33    4.59    3.03      3.99    0.34     4
1998    9   21   264      7     0    10      8.46   13.68    6.62    8.02     10.32    1.50    10
1998    9   21   264      7    10    20      6.62   11.14    8.32    3.76      8.31    1.03    10
1998    9   21   264      7    20    30      9.98   13.95   12.18    7.20     11.51    1.13    10
1998    9   21   264      7    30    50      8.07    8.76    7.21    6.16      8.07    0.74    10
1998    9   21   264      7    50    70      5.35    4.74    3.53    6.11      5.00    0.68    10
1998    9   21   264      7    70    90      3.81    3.16    2.18    3.47      3.35    0.51    10
1998    9   21   264      7    90   120      4.67    4.20    2.64    2.68      4.08    0.53    10
1998   12    2   336      7     0    10     21.06   14.38    3.78    7.70     11.73    3.80     4
1998   12    2   336      7    10    20     20.46    8.38    6.44    5.97     10.31    3.42     4
1998   12    2   336      7    20    30     10.86    9.79    5.91    4.78      7.84    1.47     4
1998   12    2   336      7    30    50      6.37    6.67    5.27    3.81      5.53    0.65     4
1998   12    2   336      7    50    70      4.83    4.49    5.60    4.39      4.83    0.28     4
1998   12    2   336      7    70    90      3.72    4.07    4.92    5.04      4.44    0.32     4
1998   12    2   336      7    90   120      2.71    3.12    3.62    4.77      3.55    0.45     4
```

# **Annex 50 Content of ASCII file NLA00.SPP** (only the first part)

```
*File:    NLA00.SPP
*Code:    ASCII
*Access:  Sequential
*Author:  K. Oostindie; R.F.A. Hendriks
*Version: 1.0
*Date:    28 December 2000
*Source:  Measurements by ALTERRA
*           Concentration of Phosphate-P &(PO4-P) in soil;
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         NULA   = Number of layers sampled
*         UPDP   = Upper boundary (cm) of the layer
*         LODP   = Lower boundary (cm) of the layer
*         COPPS1 = Concentration of PO4-P (g m**[-3] soil) for Section 1;
*                  at 21-09-1998: average of 4 observations;
*         COPPS2 = Concentration of PO4-P (g m**[-3] soil) for Section 2;
*                  at 21-09-1998: average of 4 observations;
*         COPPS3 = Concentration of PO4-P (g m**[-3] soil) for Section 3;
*         COPPS4 = Concentration of PO4-P (g m**[-3] soil) for Section 4;
*         AVCOPP = Average concentration of PO4-P (g m**[-3] soil)
*         SECOPP = Standard error (g m**[-3] soil) of the average concentration
*         NUOB   = Number of observations (analyses) for calculation of AVCOPP and SECOPP
*         -9.99  = Values below the limit of quantification of 0.02 g m**[-3] soil. For calculation of
*                  the average concentrations (AVCOPP) this value is set at 0.01 g m**[-3] soil,
*                   to get realistic averages.
*
* YR   MH   DA  DANU   NULA  UPDP  LODP    COPPS1  COPPS2  COPPS3  COPPS4    AVCOPP  SECOPP  NUOB
*************************************************************************************************
1998    4   29   119      7     0    10      0.21    0.17    0.92    0.13      0.36    0.19     4
1998    4   29   119      7    10    20      0.07    0.21    0.15    0.15      0.15    0.03     4
1998    4   29   119      7    20    30      0.09    0.10    0.27    0.34      0.20    0.06     4
1998    4   29   119      7    30    50      0.04    0.16    0.03    0.05      0.07    0.03     4
1998    4   29   119      7    50    70     -9.99    0.02    0.06    0.05      0.03    0.01     4
1998    4   29   119      7    70    90      0.03    0.03    0.04   -9.99      0.02    0.01     4
1998    4   29   119      7    90   120     -9.99    0.04    0.07   -9.99      0.03    0.02     4
1998    6   15   166      7     0    10      0.09    0.13   -9.99    0.11      0.08    0.03     4
1998    6   15   166      7    10    20      0.10    0.09    0.11    0.11      0.10    0.01     4
1998    6   15   166      7    20    30      0.10   -9.99    0.10    0.03      0.06    0.03     4
1998    6   15   166      7    30    50     -9.99   -9.99   -9.99    0.02     -9.99    0.00     4
1998    6   15   166      7    50    70     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1998    6   15   166      7    70    90     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1998    6   15   166      7    90   120     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1998    8   10   222      7     0    10      0.11    0.12    0.13    0.15      0.13    0.01     4
1998    8   10   222      7    10    20      0.11    0.15    0.16    0.16      0.14    0.01     4
1998    8   10   222      7    20    30      0.02    0.17    0.18    0.19      0.14    0.04     4
1998    8   10   222      7    30    50     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1998    8   10   222      7    50    70     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1998    8   10   222      7    70    90     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1998    8   10   222      7    90   120     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1998    9   21   264      7     0    10      0.12    0.16    0.15    0.25      0.16    0.02    10
1998    9   21   264      7    10    20      0.08    0.12    0.15    0.19      0.11    0.02    10
1998    9   21   264      7    20    30      0.19    0.13    0.18    0.23      0.17    0.03    10
1998    9   21   264      7    30    50     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99    10
1998    9   21   264      7    50    70     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99    10
1998    9   21   264      7    70    90     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99    10
1998    9   21   264      7    90   120     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99    10
1998   12    2   336      7     0    10      0.14    0.12    0.16    0.19      0.15    0.02     4
1998   12    2   336      7    10    20      0.14    0.14    0.17    0.20      0.16    0.01     4
1998   12    2   336      7    20    30      0.17    0.16    0.19    0.18      0.18    0.01     4
1998   12    2   336      7    30    50     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1998   12    2   336      7    50    70     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1998   12    2   336      7    70    90     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1998   12    2   336      7    90   120     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
```

# Annex 51 Content of ASCII file NLA00.SOX

```
*File:         NLA00.SOX
*Code:         ASCII
*Access:       sequential
*Author:       R.F.A. Hendriks
*Version       1.0
*Date:         17 March 2003
*Source:       Measurements by Alterra.
*                Oxalic extractable Phosohate (P), Aluminium (Al) and Iron (Fe)
*                Andelst, The Netherlands
*
*      Description of the quantities and their units
*      NULA    = Number of layers sampled
*      OR      = Origin of soil sample:
*                1 = sector 1, 2 = sector 2, 3 = sector 3, 4 = sector 4,
*                5 = average value of each soil property for the sectors 1 to 4
*                6 = standard deviation of the average values (n=4)
*      UPDP    = Upper boundery (cm ) of the layer
*      LODP    = Lower boundery (cm ) of the layer
*      CTTPOX  = Content of oxalic extractable total Phosphate (mmol P kg**-1 dry soil)
*      CTALOX  = Content of oxalic extractable Aluminium (mmol Al kg**-1 dry soil)
*      CTFEOX  = Content of oxalic extractable Iron (mmol Fe kg**-1 dry soil)
*
*
*NULA   OR   UPDP   LODP   CTTPOX   CTALOX   CTFEOX
******************************************************************************************
    6    1    0.0   25.0     15.7     32.8     43.0
    6    1    0.0   30.0     17.0     34.2     34.9
    6    1   30.0   50.0      4.3     18.7     12.9
    6    1   50.0   70.0      7.2     38.9     20.6
    6    1   70.0   90.0      6.4     41.8     20.1
    6    1   90.0  120.0      6.0     47.2     20.2
*
    6    2    0.0   25.0     18.7     36.9     44.5
    6    2    0.0   30.0     15.6     31.8     37.6
    6    2   30.0   50.0      6.8     40.0     27.1
    6    2   50.0   70.0      8.6     46.4     17.8
    6    2   70.0   90.0      6.2     38.3     18.0
    6    2   90.0  120.0      7.0     37.7     17.9
*
    6    3    0.0   25.0     20.3     42.5     46.7
    6    3    0.0   30.0     18.3     34.9     39.2
    6    3   30.0   50.0      8.4     40.5     24.3
    6    3   50.0   70.0      7.8     43.0     24.2
    6    3   70.0   90.0      7.6     38.4     21.9
    6    3   90.0  120.0      7.6     42.7     23.3
*
    6    4    0.0   25.0     18.7     33.4     32.0
    6    4    0.0   30.0     22.8     37.6     37.4
    6    4   30.0   50.0      8.4     38.8     24.8
    6    4   50.0   70.0      8.4     50.2     30.5
    6    4   70.0   90.0      6.0     41.3     13.7
    6    4   90.0  120.0      6.2     44.8     15.1
*
    6    5    0.0   25.0     18.4     36.4     41.5
    6    5    0.0   30.0     18.4     34.7     37.3
    6    5   30.0   50.0      7.0     34.5     22.3
    6    5   50.0   70.0      8.0     44.6     23.3
    6    5   70.0   90.0      6.5     39.9     18.4
    6    5   90.0  120.0      6.7     43.1     19.1
*
    6    6    0.0   25.0      1.9      4.5      6.5
    6    6    0.0   30.0      3.1      2.4      1.8
    6    6   30.0   50.0      1.9     10.6      6.4
    6    6   50.0   70.0      0.6      4.8      5.5
    6    6   70.0   90.0      0.7      1.9      3.6
    6    6   90.0  120.0      0.8      4.0      3.5
```

# Annex 52  Content of ASCII file NLA00.STP

```
*File:    NLA00.STP
*Code:    ASCII
*Access:  Sequential
*Author:  R.F.A. Hendriks
*Version: 1.0
*Date:    28 December 2000
*Source:  Measurements by ALTERRA
*           Concentration of Total-P in soil;
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         YR     = Year
*         MH     = Month
*         DA     = Day within month
*         DANU   = Day number (value is 1 at 1 January 1998)
*         NULA   = Number of layers sampled
*         UPDP   = Upper boundary (cm) of the layer
*         LODP   = Lower boundary (cm) of the layer
*         COTPS1 = Concentration of Total-P (g m**[-3] soil) for Section 1;
*                  at 21-09-1998: average of 4 observations;
*         COTPS2 = Concentration of Total-P (g m**[-3] soil) for Section 2;
*                  at 21-09-1998: average of 4 observations;
*         COTPS3 = Concentration of Total-P (g m**[-3] soil) for Section 3;
*         COTPS4 = Concentration of Total-P (g m**[-3] soil) for Section 4;
*         AVCOTP = Average Content of Total-P (g m**[-3] soil)
*         SECOTP = Standard error (g m**[-3] soil) of the average concentration
*         NUOB   = Number of observations (analyses) for calculation of AVCOTP and SECOTP
*         -9.99  = Values below the limit of quantification of 0.02 g m**[-3] soil. For calculation of
*                  the average concentrations (AVCOTP) this value is set at 0.01 g m**[-3] soil,
*                   to get realistic averages.
*
*
* YR   MH   DA  DANU   NULA  UPDP  LODP    COTPS1  COTPS2  COTPS3  COTPS4    AVCOTP  SECOTP  NUOB
*************************************************************************************************
1998    9   21   264      7     0    10      0.39    0.20    0.18    0.56      0.32    0.08    10
1998    9   21   264      7    10    20      0.93    0.97    0.89    1.43      0.99    0.09    10
1998    9   21   264      7    20    30      1.51    1.07    1.01    1.03      1.24    0.22    10
1998    9   21   264      7    30    50      0.13    0.11    0.10    0.09      0.12    0.01    10
1998    9   21   264      7    50    70      0.07    0.07    0.05    0.13      0.07    0.01    10
1998    9   21   264      7    70    90      0.03    0.05    0.07    0.07      0.05    0.01    10
1998    9   21   264      7    90   120      0.04    0.04   -9.99    0.07      0.04    0.01    10
1998   12    2   336      7     0    10      0.03   -9.99    0.03    0.08      0.04    0.02     4
1998   12    2   336      7    10    20      0.19    0.11    0.15    0.19      0.16    0.02     4
1998   12    2   336      7    20    30      0.14    0.11    0.05    0.26      0.14    0.04     4
1998   12    2   336      7    30    50      0.05   -9.99   -9.99   -9.99     -9.99    0.01     4
1998   12    2   336      7    50    70     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1998   12    2   336      7    70    90     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1998   12    2   336      7    90   120     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1999    4   20   475      7     0    10      0.12    0.08    0.06    0.11      0.09    0.01     4
1999    4   20   475      7    10    20      0.09    0.08    0.18    0.17      0.13    0.03     4
1999    4   20   475      7    20    30      0.11    0.13   -9.99    0.18      0.14    0.02     3
1999    4   20   475      7    30    50      0.08    0.07    0.09    0.09      0.08    0.01     4
1999    4   20   475      7    50    70     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1999    4   20   475      7    70    90     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
1999    4   20   475      7    90   120     -9.99   -9.99   -9.99   -9.99     -9.99   -9.99     4
```

# **Annex 53 Content of ASCII file NLA00.STE** (only the first part)

```
*File:      NLA00.STE
*Code:      ASCII
*Access:    sequential
*Author:    L.J.T. van der Pas & J.H. Smelt
*Version:   1.0
*Date:      15 March 2001
*Source:    Measurements by ALTERRA
*             Daily soil temperatures at three depths & daily air temperatures
*             at field Andelst, The Netherlands
*
*      Registration started on 9 January 1998 at 00.00 h and ended on 2 May 1999 at 24.00 h.
*      Minimum and Maximum air temperatures for the periods 13 to 29 April 1998 and
*      16 to 21 September were taken from the weather station 'Haarweg' at Wageningen
*      at 10 km distance.
*
*      Description of the quantities and their units
*      YR     = year
*      MH     = month
*      DA     = day within month
*      DANU   = day number (value is 1 at 1 January 1998)
*      AITEAV = average air temperature (deg. Celcius at 1.5 m height)
*      AITEMI = minimum air temperature (            ,,              )
*      AITEMA = maximum air temperature (            ,,              )
*      SOTE1    = daily average soil temperature (deg. Celcius) at 0.05 m depth
*      SOTE2    = daily average soil temperature (deg. Celcius) at 0.50 m depth
*      SOTE3    = daily average soil temperature (deg. Celcius) at 1.0  m depth
*
*
*   YR    MH     DA  DANU AITEAV AITEMI  AITEMA  SOTE1   SOTE2  SOTE3
******************************************************************************
  1998     1      9     9   10.2    7.3    11.7    8.3     6.7    7.0
  1998     1     10    10    7.0    4.9    10.5    6.2     7.0    7.1
  1998     1     11    11    5.5    0.1    10.0    4.5     6.8    7.2
  1998     1     12    12    7.2    5.1    10.4    5.6     6.4    7.2
  1998     1     13    13    6.9    2.6     9.6    5.4     6.4    7.2
  1998     1     14    14    8.2    5.1    10.0    6.6     6.4    7.1
  1998     1     15    15    6.5    3.9     8.6    5.5     6.5    7.1
  1998     1     16    16    7.0    5.4     8.7    6.4     6.5    7.1
  1998     1     17    17    5.0    2.5     6.6    4.8     6.5    7.2
  1998     1     18    18    4.8    3.5     6.0    4.5     6.3    7.2
  1998     1     19    19    5.2    1.8     6.8    5.1     6.1    7.1
  1998     1     20    20    3.0    1.6     4.3    3.7     5.9    7.0
  1998     1     21    21    0.3   -1.5     1.4    2.5     5.6    7.0
  1998     1     22    22   -0.5   -1.4     0.5    1.5     5.2    6.8
  1998     1     23    23    0.2   -1.6     1.2    1.1     4.7    6.7
  1998     1     24    24    1.9    0.3     3.5    1.8     4.2    6.5
  1998     1     25    25    0.6   -1.2     2.0    1.7     4.1    6.2
  1998     1     26    26   -1.8   -4.5     1.2    0.8     3.9    6.0
  1998     1     27    27   -3.4   -7.2     1.1    0.2     3.6    5.8
  1998     1     28    28    0.8   -0.9     2.0    0.4     3.4    5.7
  1998     1     29    29    1.2    0.6     2.2    0.9     3.2    5.5
  1998     1     30    30    2.3    0.8     3.4    2.4     3.2    5.2
  1998     1     31    31    0.0   -4.4     3.3    2.1     3.4    5.2
  1998     2      1    32   -5.1   -8.0    -2.3    0.5     3.4    5.2
  1998     2      2    33   -3.7  -10.5     1.6   -0.4     3.2    5.1
  1998     2      3    34    1.0   -1.0     3.7    0.3     2.9    5.0
  1998     2      4    35    0.8   -2.6     4.8    0.3     2.7    4.9
  1998     2      5    36    2.7    0.0     6.2    0.3     2.6    4.7
  1998     2      6    37    4.5    2.8     6.9    2.2     2.5    4.6
  1998     2      7    38    2.4    0.6     5.5    1.8     2.9    4.4
```

# Annex 54 Content of ASCII file NLA00.SWR (only the first part)

```
*File:    NLA00.SWR
*Code:    ASCII
*Access:  Sequential
*Author:  R.F.A. Hendriks
*Version: 1.0
*Date:    15 April 2001
*Source:  Measurements by ALTERRA
*           Soil water retention characteristic
*           Andelst, The Netherlands
*
*         Description of the quantities and their units
*         NULA = Number of layers sampled
*         UPDP = Upper boundary (cm) of the layer
*         LODP = Lower boundary (cm) of the layer
*         NURE = Number of replicates
*         SMNU = Sample number (1 and 11; 2 and 12; etc. are pairs of duplicates;
*                note that SMNU in file NLA00.SHP refers to the same samples)
*         NUMP = Number of measuring points per replicate
*         PSHD = Pressure head (cm); negative values indicate suction
*         MOFR = Volume fraction of liquid (cm**[3] cm**[-3])
*
*NULA  UPDP LODP  NURE  SMNU NUMP     PSHD    MOFR
**********************************************************************************
    6    11   19     2     1  492     -6.2   0.401
    6    11   19     2     1  492     -6.8   0.401
    6    11   19     2     1  492     -7.3   0.401
    6    11   19     2     1  492     -7.8   0.401
    6    11   19     2     1  492     -8.6   0.401
    6    11   19     2     1  492     -8.2   0.401
    6    11   19     2     1  492     -8.9   0.400
    6    11   19     2     1  492     -9.2   0.400
    6    11   19     2     1  492     -9.4   0.400
    6    11   19     2     1  492     -9.7   0.400
    6    11   19     2     1  492     -9.9   0.400
    6    11   19     2     1  492    -10.1   0.400
    6    11   19     2     1  492    -10.2   0.399
    6    11   19     2     1  492    -10.4   0.399
    6    11   19     2     1  492    -10.5   0.398
    6    11   19     2     1  492     -9.6   0.398
    6    11   19     2     1  492     -9.7   0.398
    6    11   19     2     1  492    -10.7   0.398
    6    11   19     2     1  492    -10.2   0.397
    6    11   19     2     1  492    -10.8   0.397
    6    11   19     2     1  492    -10.6   0.397
    6    11   19     2     1  492    -10.9   0.397
    6    11   19     2     1  492    -11.1   0.397
    6    11   19     2     1  492    -11.5   0.396
    6    11   19     2     1  492    -11.1   0.396
    6    11   19     2     1  492    -11.0   0.396
    6    11   19     2     1  492    -11.9   0.396
    6    11   19     2     1  492    -11.1   0.396
    6    11   19     2     1  492    -11.1   0.396
    6    11   19     2     1  492    -12.2   0.396
    6    11   19     2     1  492    -12.6   0.396
    6    11   19     2     1  492    -11.2   0.396
    6    11   19     2     1  492    -12.9   0.395
    6    11   19     2     1  492    -13.2   0.395
    6    11   19     2     1  492    -11.4   0.395
    6    11   19     2     1  492    -12.2   0.395
    6    11   19     2     1  492    -13.4   0.395
    6    11   19     2     1  492    -11.5   0.394
    6    11   19     2     1  492    -12.5   0.394
    6    11   19     2     1  492    -13.7   0.394
    6    11   19     2     1  492    -11.7   0.394
```