

Report of the hydrological field trip to the Slovak Republic

September 4 - 11, 1993

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1 Introduction

The Agricultural University of Wageningen (WAU) and the Agricultural University of Nitra (AUN) in the Slovak Republic maintain official relations since the beginning of the seventies. Initially the organisation of excursions, one year in the Netherlands for Slovak students, the other year in Slovakia for Dutch students was the main topic of cooperation. Recently the exchange of students and staff as well as direct scientific cooperation are the main topics of activities between both universities.

In the framework of this cooperation AUN has invited the Department of Water Resources of WAU to hold the annual field trip 1993 to Slovakia. The program of the field trip was prepared by prof. dr. Pavel Kabina and prof. dr. Dusan Huska of the Department of Amelioration and was mainly focused on the water management of the river Danube, hydropower and drainage and irrigation practices in Slovakia. Obviously lessons can be learnt from the Slovak experience in these topics.

The field trip in Slovakia took place between september 5 and 10 and was mainly concentrated to the region of Nitra and Bratislava. Beside Dutch students also students of the Master of Sciences Course on Soil and Water Management participated.

Without exception all visits were very interesting and everywhere the group got a friendly reception and explanation.

This report is a summary of the visits that were attended during the trip. Each member of the group has contributed, based on the material that was presented during the visits.

Our thanks for a most successful trip must go to Lucia Trnovcová and Štefan Sklenár of the AUN who arranged a very interesting week and accompanied the group almost day and night. They did this in a very pleasant way.

We acknowledge the invitation of AUN and the kind hospitality all over the week very much. Our thanks also go to the participating students for their pleasant cooperation and friendly feeling during the tour.

Piet Warmerdam
Anton Dommerholt

2 List of participants

Agema, J.H.	(Jelle)	L50-C
Cardenas, M.G.	(Magali)	MSc-Soil and Water
Chacon, E.V.	(Eddie)	MSc-Soil and Water
Famba, S.I.	(Sebastiao)	MSc-Soil and Water
Grol, E.M. van	(Els)	L50-C
Jansen, J.	(Joca)	L50-C
Keulen, M.P. van	(Marja)	L50-C
Kongoli, C.	(Cezar)	MSc-Soil and Water
Leene, G.J.	(Gert)	L12
Rohaan, A.	(Arjanne)	L50-C
Veen, R. van de	(Roel)	L50-C
Verhallen, J.M.M.A.	(Annemiek)	L50-C
Vries, P. de	(Peter)	L50-C

3 Excursion-programme

Saturday - 4 september 1993

- 08.30 hr - departure from "De Nieuwlanden", Wageningen
- 17.30 hr - arrival at the hotel at Parsberg (Germany)
Gasthaus "Zum Schwan", Marktstrasse 6, Parsberg

Sunday - 5 september 1993

- 09.00 hr - departure from the hotel
- 17.00 hr - arrival at Nitra, welcome by Mr. Štefan Sklenár

Monday - 6 september 1993

- 08.30 hr - visit to the water works in the river Danube near Gabčíkovo
(during the whole day, including a very good lunch)

Tuesday - 7 september 1993

- 08.00 hr - departure to Šala
- 09.00 hr - visit to the irrigation plant in Šala
 - explanation in the office of the water authorities
 - visit to the outtake structure at Králová and a pumping station
- 11.30 hr - visit to the research station Žiharec
- 13.00 hr - lunch in Diakovce
- 15.00 hr - visit to the drop irrigation plant of vineyards in the state farm in Galanta

Before dinner a very interesting tour through the historic part of Nitra, that was guided in a professional way by Lucia Trnovcová.

Wednesday - 8 september 1993

- 08.00 hr - departure
- 09.00 hr - visit to the irrigation plant in Slňava
 - explanation by the water authorities
 - visit to the outtake structure and pumping station
- 14.00 hr - visit to the irrigation plant of an orchard
- 16.00 hr - sightseeing and shopping in the health resort Piešťany

Thursday - 9 september 1993

- 11.00 hr - visit to the Institute of Irrigation Research in Bratislava
- 13.00 hr - lunch, sightseeing and shopping in Bratislava
- 18.00 hr - farewell dinner

Friday - 10 september 1993

- 09.00 hr - departure from Nitra
- 17.00 hr - arrival at the hotel in Parsberg (Germany)

Saturday 11 september 1993

- 09.00 hr - departure from the hotel
- 18.00 hr - arrival at Wageningen

3.1 6 september

The Gabčíkovo project

(Explanation by Ms Valentova and Dipl.-ing. Ladislav Szerencsés)

The Danube is the second-biggest river in Europe and is flowing through eight countries. It takes water of about 9% of our continent by a 2857 km long track to the Black Sea. In Slovakia the Danube has a length of 172 km. It forms a border with Hungaria over a length of 142 km (Figure 1).



Figure 1

On the average twice a year, in May and November, there is a high water level at the Danube. These high waterlevels caused severe floods in 1954 and 1964 at the Slovak area. After these floods, which caused a lot of damage, it was clear that measures had to be taken; the Gabčíkovo project was started. This project contains the construction of a reservoir and an artificial canal supplied with water from the river Danube. At the end of the canal a large hydropower plant and ship lock is constructed. A project which would be a benefit for recreation, shipping and energy production. For a general layout of the project see Figure 2.

Realising the Gabčíkovo project, an area of 40 km² has been changed forever because every construction means an effect on the environment. In this case the waterreservoir caused a groundwaterlevel increase. In the past the groundwaterlevel was dropping as well as the bottom of the Danube, causing a very dry area around Bratislava.

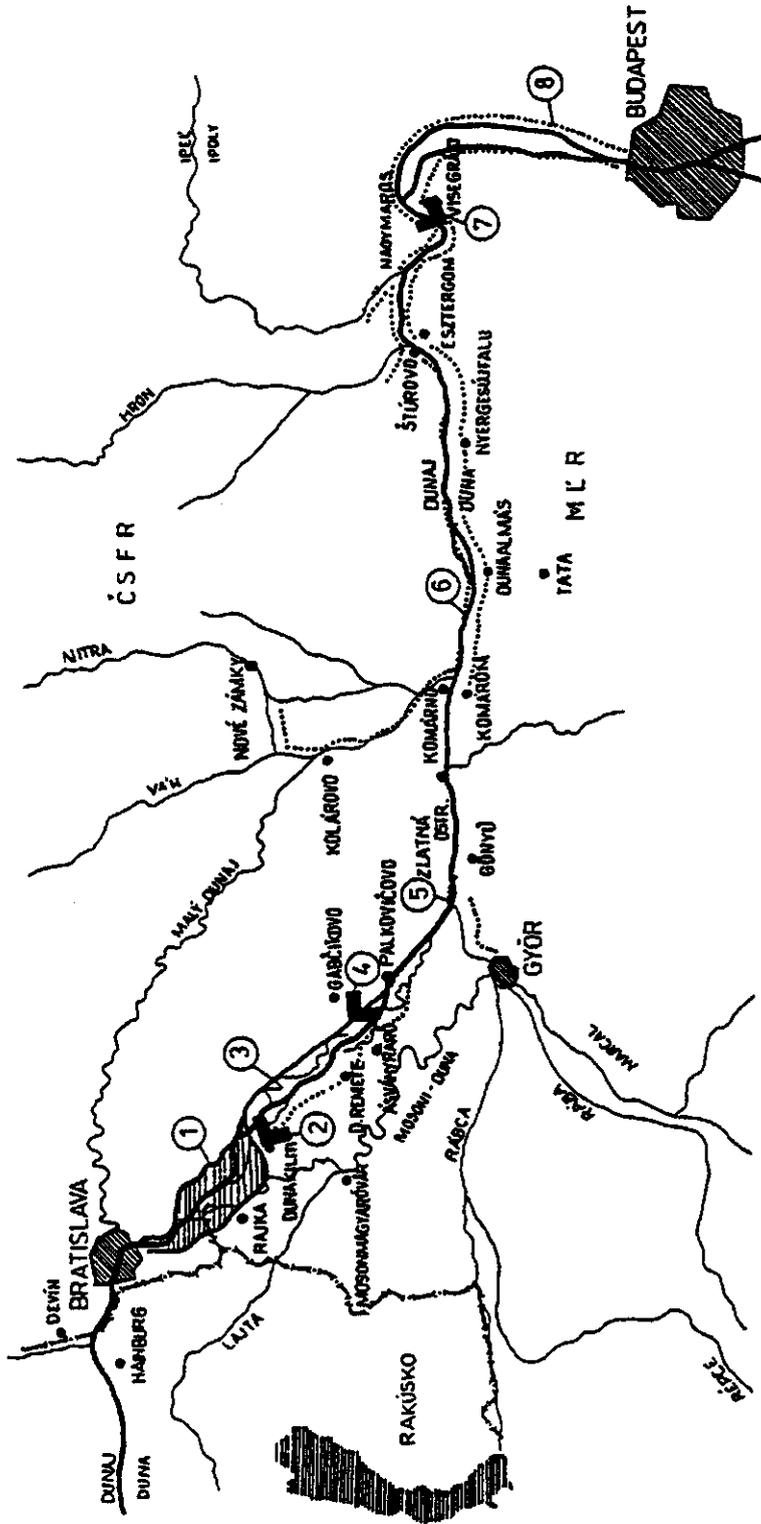


Figure 2

General Layout of the Gabčíkovo-Nagyymaros Project

- (1) Reservoir Hrušov–Dunakiliti, length 16 km, surface (incl. canal) at el. 131,1 m (above the Baltic sea) – 60 sq. km, total/utilisable volumes 200/60 mill. cubic meters.
- (2) Weir Dunakiliti, river kilometer 1842 – 7 sections 24 meters wide, with segment gates with a flap, height 8,0 + 3,3 meters.
- (3) Power canal 17,0 + 8,0 km long, capacity 5300 cu. mecs.
- (4) Gabčíkovo power station with vertical Kaplan turbines – capacity 8 x 90 = 720 MW – and two ship-locks 34 x 275 m.
- (5) Deepening of river bed on a length of 20 km.
- (6) Flood-protection measures – heightening of levees, seepage canals and pumping stations.
- (7) Nagyymaros dam, river kilometer 1696,25, max. el. 107,83 m (above the Baltic), reservoir volume, weir-dimensions and ship-locks same as at Gabčíkovo, power station with horizontal bulb turbines 6 x 26,3 = 158 MW.
- (8) Deepening of the river-bed on a length of 40 km.

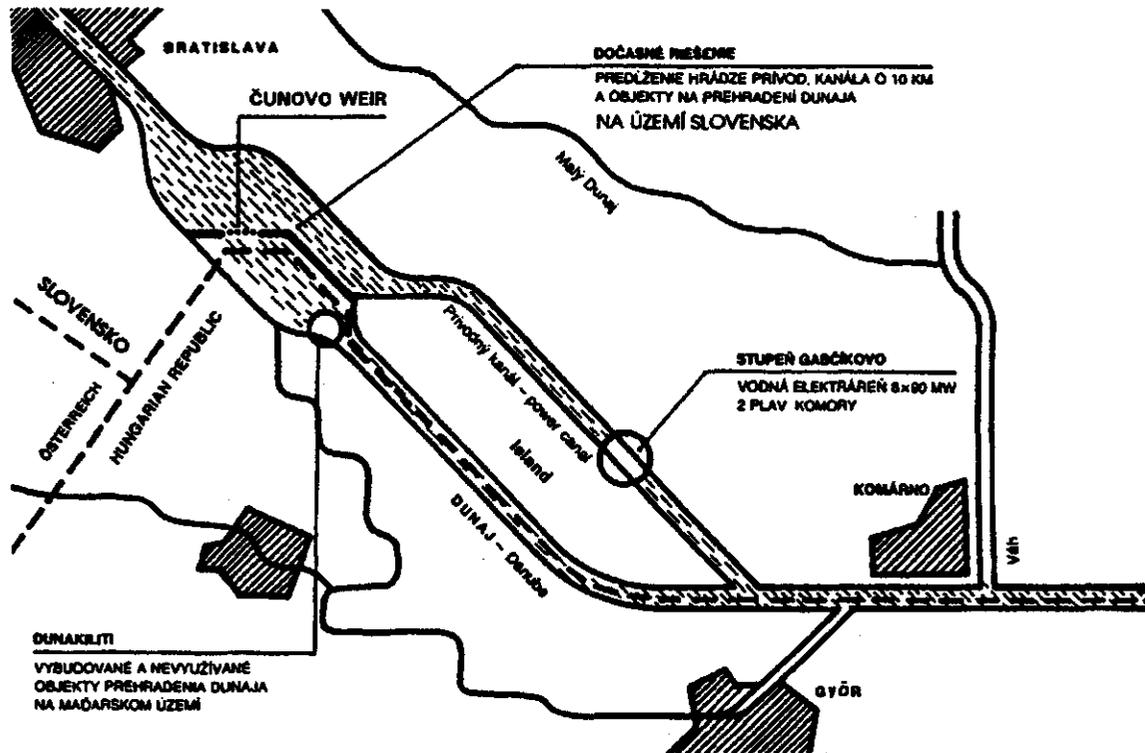


Figure 3 The Gabčíkovo project

Figure 3 shows the location of the Dunakiliti weir constructed in the old river bed of the Danube. This weir diverts the water to the new canal. It was built on Hungarian territory under Hungarian supervision.

The Nagymaros dam (powerstation) is located a long way downstream of Gabčíkovo also on Hungarian territory. The dam is needed to realize a higher waterlevel at the river section between the Dunakiliti and the Nagymaros dam. This higher waterlevel is very important for the flora and fauna of the "new island" between the power canal and the old riverbed (Figure 3). If there is a higher waterlevel more water can be diverted to the canal and pass through the powerplant Gabčíkovo, which will produce more energy. The Nagymaros dam itself should produce 158 MW.

The island inbetween the power canal and the river Danube has a very rich fauna (waterbirds and a lot of fish species) and flora. Watercourses on the island are supplied with water by seepage from the power canal and by inflow canals (Figures 4 and 5).

After a long period of preparations a treaty for this project was signed in 1977 by both countries: Hungaria and Slovakia. In that year the construction works were started. However after ten years of constructing activities and with a few years to go, the Hungarians required the Slovaks in 1988 to slow down the construction because of lack of money



Figure 4 Watercourses with cascades on the island



Figure 5 One of the inlet structures from the power canal to the watercourses on the island

on their side. In 1989 the Hungarians wanted the Slovaks to bring back everything to the original state. This was on behalf of the environment. But the project was already in such a state that the original state was impossible to regain. The Slovaks went on with the project. At that moment the Hungarians have shut down their part of the project. This means that the Nagymaros dam has not been finished and the Dunakiliti dam has not been taken in operation by the Hungarians.

As a result, the Slovaks had to make another diversion structure to replace the essential Dunakiliti dam. This was only possible on their own territory. A 10 km long dyke (Dočasné Riešenie) (Figure 6) upstream the Dunakiliti weir was build and also the Čunovo weir was constructed.

The Čunovo weir is a temporary solution to the lack of implementation of the Dunakiliti weir on the Hungarian part. It consists of two parts: an adjustable part for low flows and a spillway in case of high flows (once every 100 years). The latter consists of 20 segments, width 20 m, height 24 m, so ice-breakers can pass in wintertime.

The construction was started the 15th october 1992 and it took 40 days to complete the most important parts of the construction.

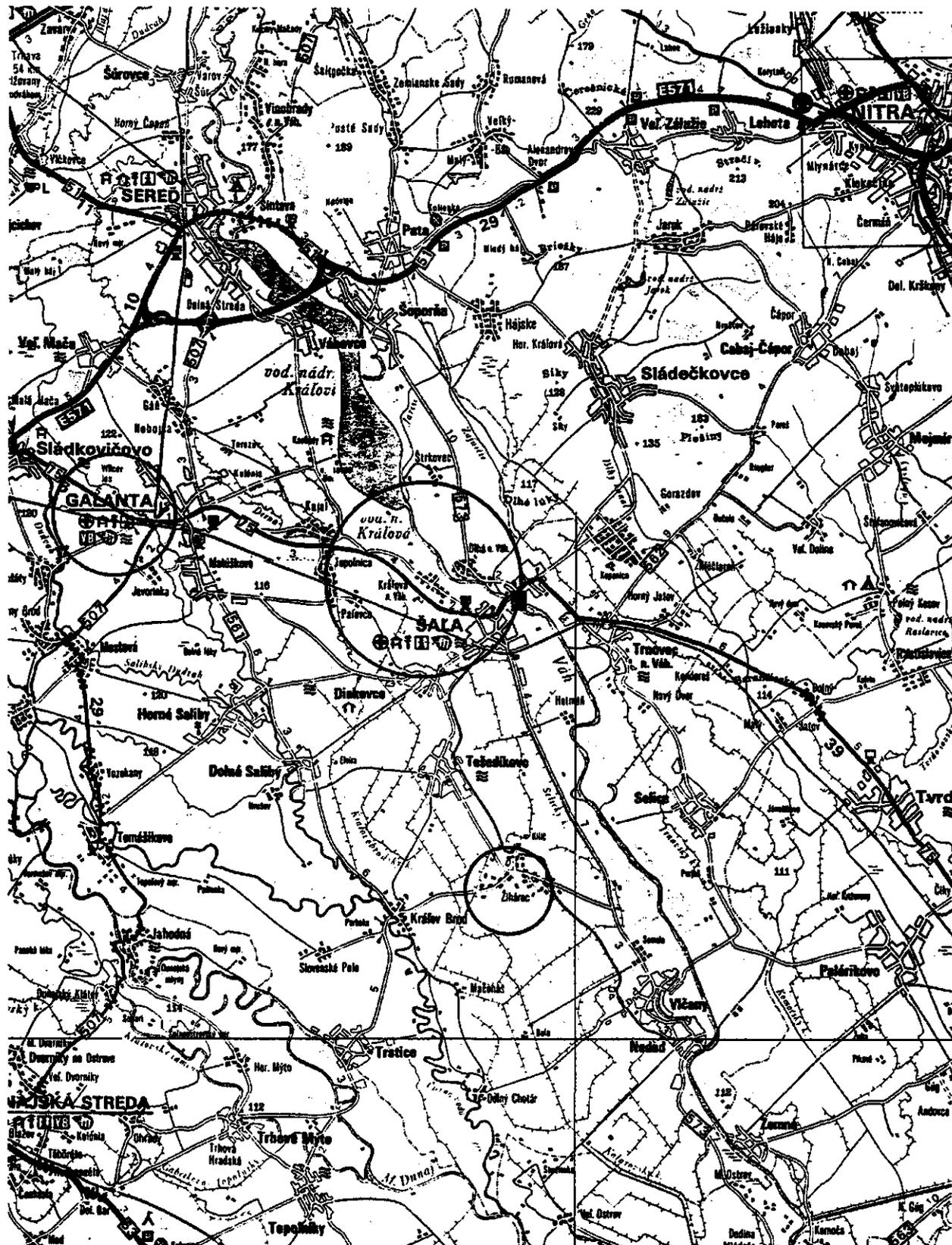
Arjanne, Els and Peter



Figure 6 The Dočasné Riešenie dyke. At the left side the power canal, at the right side the old riverbed of the river Danube.

3.2 7 september 1993

Sala/Kráľová, Žiharec, Galanta



The irrigation system in Sala/Králová

During our visit to Sala and Králová, the people from the local water authorities introduced us to the irrigation system in the area. The need for irrigation in the area is due to the water deficit in the dry season amounting to about 200 mm (average annual rainfall about 550 mm). The source of irrigation water is the river Váh. Initially, water was taken directly from the river.

In 1964, a dam was build in the river Váh so that water could be stored and taken from the reservoir by inlet stations into the irrigation canals. By means of a number of pumping stations the water can be distributed from these canals into a pipe system to the consumers. The potential area to irrigate is 50.000 ha and the actual system total discharge is 6 m³/sec. The main irrigation method is sprinkler irrigation, using strip irrigators and wide range center pivot irrigators. The maintenance of the system is subsidized by the state and the farmers pay only for electricity. We visited a pumping station and the intake structure at Králová (Figure 7).

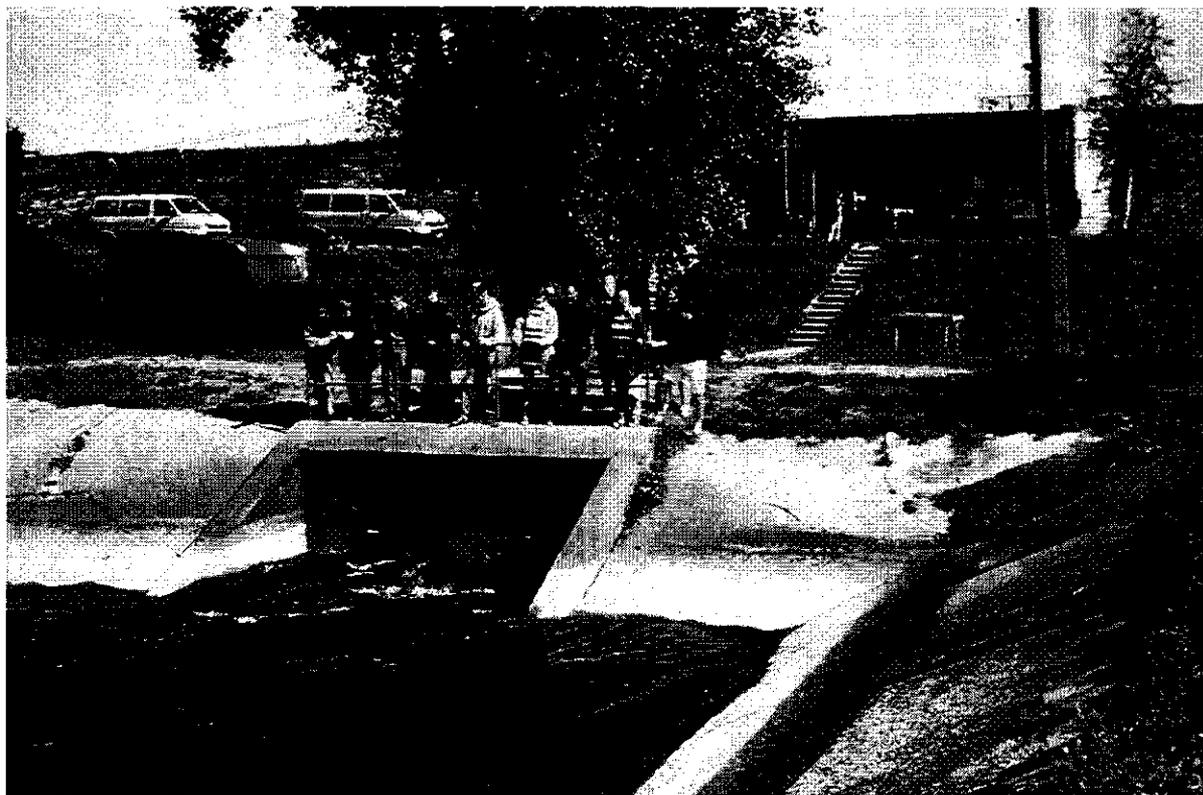


Figure 7 The intake structure. Behind the dyke is the reservoir.

*The research station of the Water Research Institute,
Bratislava in Žiharec*

The research station of the Water Research Institute (VÚVH) in Žiharec was founded in 1954 to study the vertical hydrological elements of the water balance. In the successive years the research programme was extended to include more complex research. Recently, the programme has been focused on free water evaporation measured by different evaporation tanks (Class-A, GGI-20 m², GGI-3 m², GGI-3000 cm²) (Figure 8), and determined by 36 weighing lysimeters, 47 compensating lysimeters in which 4 types of the most common Slovak soils, different groundwater levels and different crops are used (Figure 11), basic meteorological observations, soil moisture estimation at the research plot and in an adjacent area, and groundwater level observations.

Based on the information and data of the research station, the research group has developed and tested the one-dimensional mathematical model DAIR (DAILY IRrigation) for vertical hydrological balance simulation. The comparison of the model on an international level was performed in cooperation with the Agricultural University of Wageningen (Koopmans, Stricker, 1990).

During our visit to the research station, Mr. Pavel Petrovič introduced us to the staff and the range of activities executed at the station (Figure 9). After his introduction, we could visit the research station and see some of the experiments going on at the moment. For example: the weighable lysimeters with maize for measuring evapotranspiration (Figure 10) and the compensating lysimeters with trees for different groundwater levels and four different Slovak soil types. The objective of the latter experiment is to select the species of forest trees which best suit the different groundwater regimes. This assumes special importance because the water projects greatly affect the ground water regime and consequently the natural environment. We could also see the meteorological station set up in the research plot.



Figure 8 The different evaporation tanks



Figure 9 Explanation by Pavel Petrovič on the meteorological station

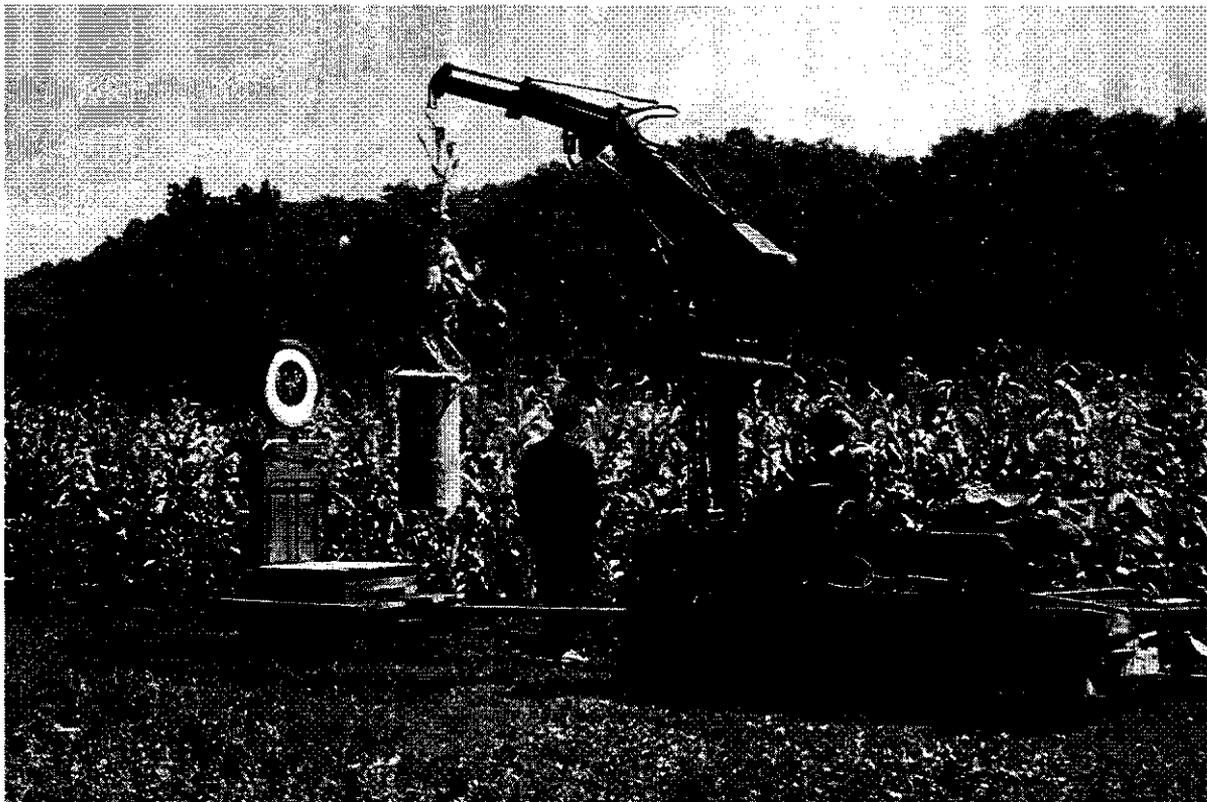


Figure 10 One of the lysimeters with maize is placed on the weighing device.

**FIG. 7. SUGAR BEET ACTUAL ET
ON MEDIUM-HEAVY SOIL IN 1986**

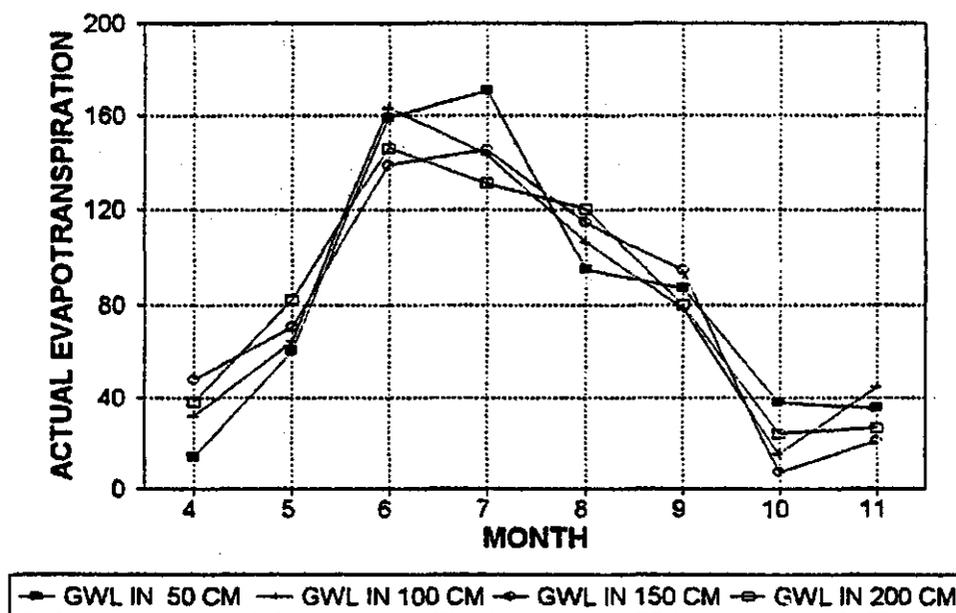


Figure 11 Some results presented on the Symposium on Precipitation and Evaporation in Bratislava, September 20-24, 1993.

The drop irrigation system at the state farm in Galanta

We visited the vineyards at the state farm in Galanta, where the unique underground drop irrigation system for Slovakia has been developed and implemented.

The source of the water is groundwater which is pumped to the root zone in plastic tubes on a depth of 0.60 meter below soil surface. These tubes are equipped with droppers at a distance of 1.5 meter, discharging the water at a rate of 4 l/hour and at a pressure of 0.3 atm.

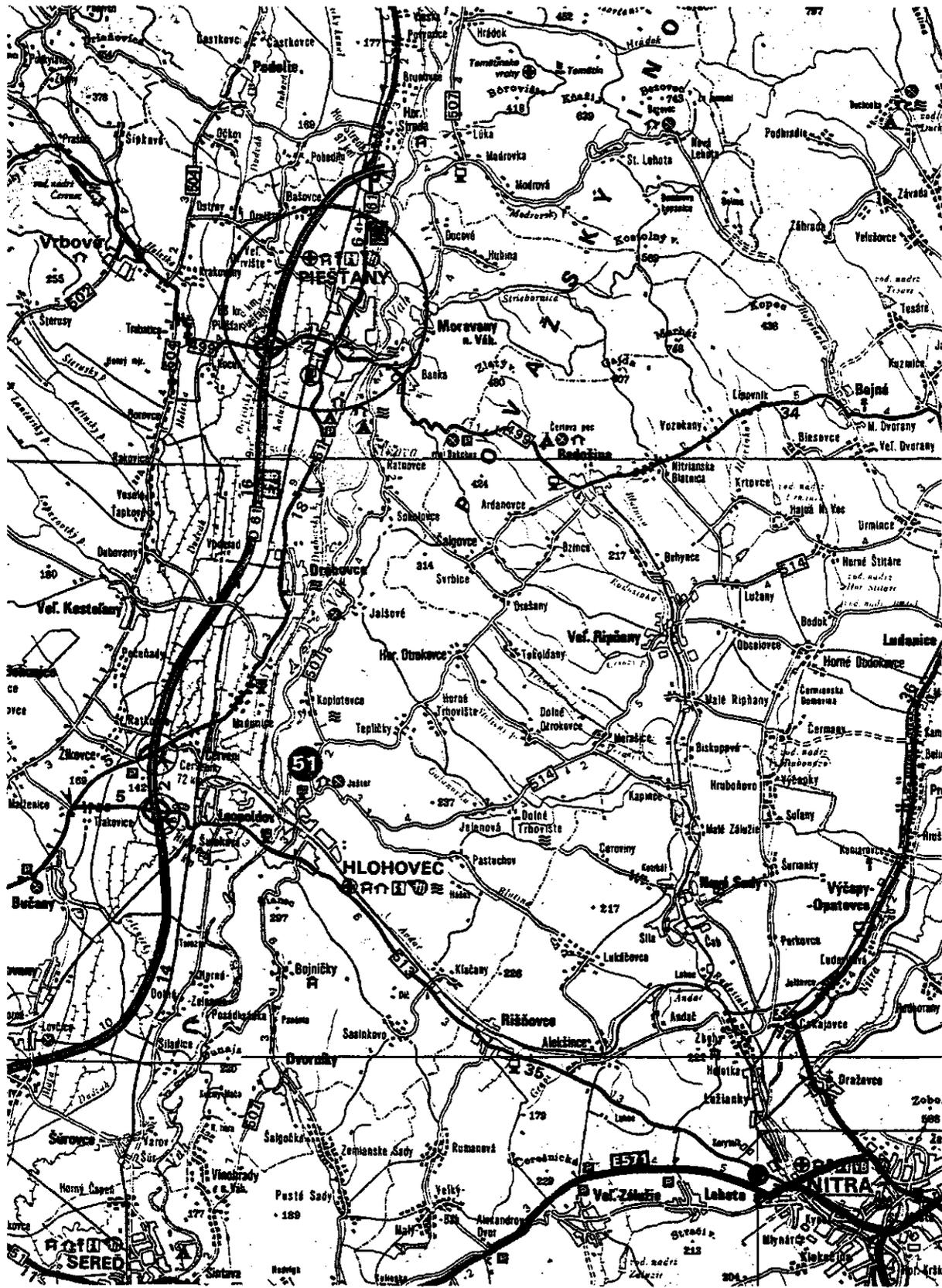
This irrigation system extends over an area of 173 ha of the vineyard. The system provides good possibilities to control and regulate the water supply but on the other hand the equipment which is produced by the state farm itself is expensive.

At the moment the state farm is facing economic problems with the feasibility of the system and the finding of suitable markets for the system. Due to the political changes it is also difficult to make the growing of vineyards profitable.

Magali, Cezar, Eddie and Sebastiao

3.3 8 september 1993

Slňava, Piešťany



The irrigation plant in Sĺňava

We were welcomed by ing. Michelcık, mr. P. Konovsky and ing. Hlubina (Figure 13). The Trnava region has 30.000 ha to be irrigated. Therefore three pumping stations are used. The north eastern part has a fertile soil of sedimentary deposit. The landscape can be described as a table landscape (8.000 ha). The main river is the river Váh. In this area the irrigation water is taken out of a canal with a length of 4 km that is connected to the river Váh by means of syphons (Figure 12). The total capacity of the syphons is 5 m³/s. At the end of the canal is a dam with a power station, that forces the operator of the irrigation system to taking water at times not coinciding with the peaktime of the power station.

From the syphons the water flows into an open canal. The canal leads to a pumping station where the water is pumped into a pipe network system. Other smaller pumping stations distribute the water to the field.

Near the main pumping station is a small reservoir for storage. The pumping station has a number of pumps with different capacities. In a dry year like 1993 all the pumps are needed and about 6 million m³ of

water in four months of the growing season is used for the whole area (30.000 ha). A pressure system is used to balance the pressure in the pipes. The pressure in the main pipe is kept at a level of 0.8 MPa, in the distribution pipe 0.6 MPa and in the sprinklers 0.4 MPa. To solve the problem of waterhammer, when farmers suddenly close pipes, special valves and pressure levelling tanks are installed.

20% of the north eastern part is irrigated by wing irrigators and 80% by strip irrigators. Wing irrigation is only suitable for flat areas.

The system of irrigation comes from Austria and is a relative simple system. The water is distributed on request of the farmers. The main system is subsidized by the government and the irrigation details had to be bought by the farmers. The farmers must pay 1.9 Slovakian Kroons (SKr) for 1 m³ of water. The prize for water is the main input for the farmers and the cooperatives.

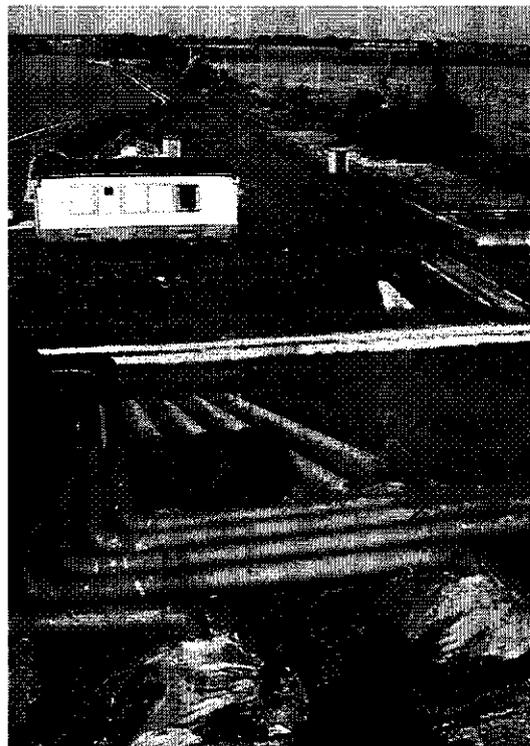


Figure 12 Inlet of water from the canal by means of syphons



Figure 13 Explanation of the irrigation system by the water authorities

Pumping station near Piešťany

This large pumping station also takes water from the river Váh by means of a number of syphons. These syphons are directly connected to a number of pumps and a pipe network. It is therefore a totally closed system.

The pumping station services 40 cooperatives and 50 small farmers. During four months this summer 500.000 m³ of water was used. Although the water is subsidized the real costs are 3 SKr/m³. The farmers pay 1.9 SKr and the cooperatives only 0.7 SKr. The government has reserved 9-10 million SKr for irrigation subsidy till now. The pumping capacity costs 0.450 kWh/m³. Normally the electricity is only available after 12 a.m. The organisation, responsible of the maintenance of the system, doubt whether the whole system of irrigation can survive without subsidy.

The irrigation plant of an orchard

We were welcomed by Mr. Sedlacko. The orchard is part of a State school for Agricultural Food Production, Department of Horticulture. The other parts of the school are the Economic-Business Department, the Flower- and the Vegetables Department (Figure 14).



Figure 14 The entrance of the school

The whole orchard and the greenhouses are served by an own pumping station. The water is provided by a reservoir and by two groundwater wells. The irrigation water for the greenhouses is pumped from the wells.

A new part of the orchard is irrigated by a drip system developed in Hungary. There are problems with the supply of spare parts, like filters for the equipment.

Mr. Minarik shows us around the orchard. He tells that due to a yearly rainfall of 200 mm less than in Holland, all of the orchard trees and especially the apple trees have to be irrigated. In the old part of the orchard a sprinkler irrigation system caused a lot of diseases of the leaves. Now 20 ha is irrigated with a strip irrigation system. In the new part of the orchard the drip irrigation system exists of a main pipeline and three lateral pipelines which divides the area of the orchard in 36 parts. The amount of water through every dripper can be regulated and lies between two and four liters an hour (Figure 15). The sandy soils makes irrigation necessary almost throughout the growing season. If the rainfall amounts to approximately 700 mm/year the water use will be roughly spoken 2500 m³/ha (=250 mm). At a rainfall amount of 500 mm/year the water use is about 5000 m³/year. The needed amount of irrigation supply is calculated

from water demand minus rainfall. The water demand depends on the growing stage of the tree and is known by data from practice.

The old part of the orchard with strip irrigation will be cleared. The quality of the apple-production of this trees is not good enough for the changing wishes of the public after the revolution. They seem to want a better quality (larger apples).

Annemiek, Joca and Jelle



Figure 15 Detail of a dripper

3.4 9 september 1993

The Institute of Irrigation Research in Bratislava

Thursday 9 September 1993 we visited the Institute of Irrigation research in Bratislava. We were welcomed by Mr Novotný, head of the section Realization and Marketing (Figure 16). The institute has 130 employees. The institute was introduced to us by means of a videofilm. The problem was stated by telling that in former Czechoslovakia 20% of the land area was dry. It could be ameliorated with respect to agricultural use by irrigation. In 1958 ministrators and scientists realized that a special institute for irrigation research was required. In january 1959 the institute was founded in Bratislava. Besides scientific research the institute also transfers results from the research and other important information to agricultural practice.



Figure 16 Welcome by Mr. Novotný and two other employees.

The Institute consists of five sections:

- 1 Section of crop growing systems under irrigation conditions
- 2 Section of hydropedology
- 3 Section of chemistry
- 4 Section of realization and marketing
- 5 Section of scientific and technical information

- ad1 The section obtains and analyses data for the control of the irrigation regime of field crops, vegetable crops and fruit crops with the aim of increasing the irrigation water effectiveness and production efficiency.
The section obtains data to optimize the input of technology and input of chemicals into the production scheme. The production economization and effects on quality are considered.
- ad2 The activities of the hydrogeology section consist of the solution of problems of the regime of water in the soil-plant-atmosphere system.
- ad3 The main activities of the section of chemistry consist of the evaluation of water, soil and plant quality and their reciprocal contingency.
- ad4 The activities of the section of realization and marketing consist of application of research results and related training of users. The marketing and propagation activities are dealt with consultancy in economic-organizational and technological problems.
- ad5 This section provides data and information for decision-makers and managers in the sphere of science, technics and economy.

Nowadays 360.000 ha of Slovakia is under irrigation. The situation of the institute has changed now by splitting the former Republic Czechoslovakia into a Czech and a Slovakian Republic. The institute lost several departments that were situated in the Czech Republic, e.g. in Praha.

A special research area and a department of the institute are situated in the eastern part of Slovakia, where heavy clay soils are present. These clay soils were drained only in the past while nowadays drainage and irrigation is applied. Research is done concerning the effects of drainage and irrigation on the heavy clay soils.

A guided tour through the chemical laboratories was given by Mrs. Blaskova. Several measuring tools were shown (Figure 17). The material was modern in most cases. A UV-spectrometer was used for detection of magnesium and iron. The Kjeldahl-method was used for N-analysis. Contents of Zn and Cu were determined with a colorograph, which can detect concentrations of 10^{-9} mol/l. The newest instrument of the institute, an Atomic Absorption Spectrophotometer, is used to detect heavy metals. Organic compounds were analysed using gas chromatography. Pesticides and herbicides are mostly detected with this method.

The visit was ended with some questions and thanking the people of the institute for their hospitality.

Marja, Gert and Roel



Figure 17 Roel as reporter in the chemical laboratory