INTERNATIONAL COURT OF JUSTICE

CASE

CONCERNING THE GABČÍKOVO-NAGYMAROS

PROJECT

(HUNGARY/SLOVAKIA)

REPLY

OF THE REPUBLIC OF HUNGARY

VOLUME 2

SCIENTIFIC REBUTTAL

APPENDICES

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A. SCIENTIFIC REBUTTAL

CHAPTER 1

INTRODUCTION

The *Scientific Evaluation* annexed to the Hungarian Counter-Memorial, clearly established the background to the dispute, identified the scientific issues involved, their interrelationships and complexity, and presented scientific studies and data to support its contentions. It demonstrated the complexity of the scientific questions and concerns. It showed as a necessary corollary, that awareness of the processes involved is not complete but is affected as new methods and data become available and as new standards become applicable. Although many of the original concerns expressed have now been confirmed by recent research, there nevertheless remain unresolved issues. Only the passage of time will reveal the full extent of the risk and damage to the area and its environment.

What is certain is that the area encompassed and threatened by the Original Project and now by Variant C *is* a region of high aesthetic value containing a landscape rich in historical and ecological significance. It *does* contain a rare and endangered wetland ecosystem rich in biological diversity. It *does* house the most extensive underground water reserves in Central Europe and, in the region below Nagymaros, it *is* a major source of water for Hungary's capital city.

This *Scientific Rebuttal* is intended to summarise the Hungarian position and develop previously stated contentions by marshalling new data and research. It will also analyse and examine Slovak studies and offer, where necessary, a detailed rebuttal of Slovak assertions and arguments.

The structure of this rebuttal reflects the range of scientific concerns.

Chapter 2 deals with the general evidential concerns raised by the Slovak Memorial and Counter-Memorial and clarifies certain points that were misunderstood or misrepresented by Slovakia.

Chapter 3 explores and develops issues of river hydraulics and morphology, flood protection and navigation.

Chapter 4 considers surface and groundwater hydrology, and, in particular, the impact of the Original Project and Variant C on surface water-flow, water quality and groundwater recharge. It states the agreed and actual discharges into the Old Danube and seepage canal. The subsequent groundwater levels have been simulated and where necessary erroneous Slovak data corrected. The complex surface water-groundwater interactions and the effects of colmatation are also discussed, especially with respect to groundwater quality.

Chapter 5 presents a synopsis of issues related to flora, fauna, biodiversity and the significance of the area for nature conservancy. The potential effects of peak operation modes as considered in the Original Project are presented, based on international research. The actual and future impact of Variant C on these values is reinforced and emphasised through new research and data.

Chapter 6 addresses the repercussions and effects on soils, agriculture, forestry and fishery. These effects are considered both in regard to short-term impact and over the longer term.

Chapter 7 evaluates the effectiveness of "remedial" or "mitigating" measures and their impact on groundwater, the wetland ecosystem, forestry, fishery and agriculture. It clarifies the debate and uses models to simulate the effects of proposed measures, that is, the regulation of the Old Danube and the supply of water in the side branches.

Chapter 8 reviews the seismological arguments, presenting new evidence which confirms earlier concerns.

Monitoring and research of the Project's wide range of consequences will continue to take place and the damage to the environment caused by Variant C assessed. It is however appropriate that here is repeated the final paragraph of the Introduction to the *Scientific Evaluation*:

> "The abundance of issues and data on the one hand and the lack of knowledge and information in certain fields on the other leaves a great deal of uncertainty over the extent to which the environment will be affected in the short and long term by the Project, and whether or not these changes can be considered acceptable."

There is now growing evidence that they cannot be considered acceptable.

CHAPTER 2

THE SCIENTIFIC CREDIBILITY OF THE SLOVAK CASE

2.1 INTRODUCTION

In the subsequent chapters of this *Scientific Rebuttal*, the Slovak submissions as to the main scientific components of the case are analysed on a subject by subject basis. However, a number of common themes run through these individual critiques, which, taken together, give serious cause for concern with respect to the scientific credibility of the Slovak material. The purpose of this Chapter is not to pre-empt the detailed analyses which follow, but to identify and illustrate these common themes and point out their overall implications.

2.2 LACK OF SCIENTIFIC EVIDENCE

Slovakia criticises the Hungarian position extensively on the grounds that no evidence has been produced to substantiate Hungarian environmental concerns. In fact, in addition to the large number of studies previously annexed, referenced and discussed,[1] the Hungarian Counter-Memorial (in particular Volume 2) presents the evidence in considerable detail. Computer simulation studies are used, for example to investigate potential surface water quality degradation and the effects on groundwater and hence ecology, forestry and agriculture, and these are extended, particularly with respect to remedial measures, in the following chapters. Relevant findings are quoted from Hungarian experience (for example, of groundwater quality degradation in bank-filtered wells) and from relevant international projects (for example, the Austrian and German dam experience). Recent observations from the Szigetköz are presented to quantify the short-term impacts of Variant C.

In contrast, the general style of the Slovak submissions is to make assertions concerning the technical aspects of the case without argument or supporting evidence. To take just two examples in the Slovak Counter-Memorial, it is asserted that eutrophication "has been extensively studied…in relation to this particular project".[2] There is no evidence from the Slovak side to support this statement, however. In the Slovak Counter-Memorial, it is stated that "it is equally undeniable

1 HC-M, paras 1.26-1.56 and 3.19-3.85. For a summary of the many studies undertaken before 1990, see HR, Annexes, vol 3, annex 10.

2 SC-M, para 7.34.

that this reservoir...will continue to be a good source of aquifer recharge".[3] The extensive scientific evidence presented in the *Scientific Evaluation*[4] shows this is not the case.

Where supporting documentation is referenced, there is an entirely inappropriate assessment of its scientific credibility. For example, extensive reference is made to reports by HQI, Bechtel and the EC. Each of these studies was carried out with severe constraints on time, manpower, resources and access to information. Further, the first two were commissioned by the proponents of the Original Project and information was primarily, if not exclusively, available to them from those organisations. Such brief overviews are in no sense a substitute for in-depth research, and none of those studies picked up relevant evidence of water quality problems available within Hungary, or relevant international experience. The EC reports fully relied on the data and information provided by the two partners. The EC experts made a valuable contribution despite Slovakia's rejection of their recommendations as a political "compromise...and unrelated to any scientific justification".[5] Nevertheless the reports submitted cannot be regarded as scientific studies based on independent field measurements, simulations or in-depth analysis of data.

Slovakia also criticises as unscientific the work of well-reputed organisations, including the WWF and Equipe Cousteau. In fact, any counter scientific opinion is attacked as unscientific. Thus the Ecologia reports (March and May, 1989) and the Hardi report (September, 1989), both highly reputable, are "not scientific reports prepared by experts".[6] This can be contrasted with Slovakia's extensive use of articles prepared by a popular journalist, based on material provided by Slovakia[7] to support their own case, or by the extensive use of newspaper cuttings.[8]

2.3 FAILURE TO PRODUCE RELEVANT STUDIES OR DATA

Slovakia has consistently maintained that an extensive programme of environmental studies has been undertaken under the title "Bioproject". It is most disturbing that these studies have not been made available for evaluation, despite

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3 SC-M, para 7.52.

4 *Scientific Evaluation*, HC-M, vol 2, chap 3.4-3.5.

5 SC-M, chap 1, fn 26.

6 SC-M, para 7.06.

7 SC-M, para 7.28.

8 SM, vol 2, annex 22; SM, vol 3, annex 34; SC-M, Annexes, vol 2, annexes 12, 13, 33, 34, 35, 42, 49.

repeated formal requests.[9] It should also be noted that where supporting studies were made available to the Court concerning soils (albeit in the original Slovak and without translations), these studies clearly demonstrate that the Slovak scientists share Hungarian concerns related to the complexity of the issues, the need for further evaluation and the lack of information on remedial measures.[10]

A major Slovak argument for building the barrage system was the alleged lowering of the riverbed.[11] Hungary presented evidence that the degradation of the riverbed was caused by overdredging.[12] Slovakia fails to present accurate data which would allow investigation of the cause of the substantial lowering of the riverbed around Bratislava.

2.4 LACK OF SCIENTIFIC UNDERSTANDING

Frequently, Slovakia makes comments which illustrate a failure to appreciate the basic scientific issues. A few illustrations can be presnted.

For example, the Slovak Counter-Memorial[13] attempts to relate the surface water quality issues of the Gabčikovo-Nagymaros Project to hydroelectric power plants on the Danube in Austria and Germany. This neglects the fact that important differences exist with respect to the river water quality (particularly nutrient load) and operating conditions which are dominant influences on eutrophication processes. Such a statement could not be supported by a competent water quality specialist.

With respect to groundwater quality issues, Slovakia frequently refers to short-term observations in an attempt to demonstrate that long-term effects will not occur. This shows a lack of awareness of the basic nature of groundwater quality responses. A fundamental characteristic of almost all groundwater quality problems is that they occur on a long-term time-scale. The movement of stable isotopes was discussed in the Hungarian Counter-Memorial[14] and clearly demonstrates that migration of non-reactive substances occurs on a time-scale of decades. The international experience of groundwater quality degradation[15] also

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9 HC-M, Annexes, vol 3, annexes 17, 24 and 30; see also HR, Annexes, vol 3, annexes 11 and 18.

10 Discussed in detail in Chapter 6.1 below; see also HR, Annexes, vol 3, annex 7.

11 SM, paras 2.85-2.86, 5.10 and 5.26; SC-M, paras, 7.81, 7.103 and 7.123.

12 *Scientific Evaluation*, HC-M, vol 2, chap 2; see also Chapter 3.1 of this Rebuttal.

13 SC-M, para 7.31.

14 *Scientific Evaluation*, HC-M, vol 2, chap 3.4.1.

15 *Scientific Evaluation*, HC-M, vol 2, chap 3.5.2.1.

confirms that adverse effects may take years to appear. Short-term observations have very limited relevance in this context.

The Slovak understanding of environmental issues in general is lacking scientific basis. It is stated that "environmental issues were carefully studied"[16] and a long list of studies is presented under the title "Water quality, Biology, Protection of Nature, Territorial Plan" comprising studies of surface and groundwater quality, agriculture, forestry and technical issues.[17] In addition, 99 studies are mentioned related to "water quality and environmental issues".[18] But in fact, almost all studies consider abiotic aspects of the environment or economic issues of forest productivity and agriculture. Biotic aspects of wetland ecology, including the functioning of the existing Danube wetland ecosystem, were not properly addressed.

Slovakia also frequently refers to monitoring as if this is sufficient in itself to resolve adverse effects. However, it is well known in the area of groundwater studies, to take just one example, that remediation is a technically extremely difficult, costly, long-term process which may not be realistically achievable. At the stage that adverse effects may be picked up by a monitoring programme, irreversible harm may have already occurred.

A final example concerns the very nature of risk assessment. The complex problems associated with the Project can only be assessed subject to high levels of uncertainty. It is essential that this is recognised in Environmental Impact Assessment and associated project evaluation. Yet the Slovak Counter-Memorial considers this essential uncertainty to be a possible weakness.[19] This displays a lack of basic understanding of the character of environmental impact assessment.

2.5 Distortion and Misrepresentation

Slovakia's Memorial and Counter-Memorial misrepresent the science presented by Hungary on numerous occasions. A few examples illustrate this:

In its pleadings, Hungary states that the impacts of Variant C may be less than they would have been under the 1977 Barrage System in a number of respects, and explains why this may be the case.[20] Then it states that in other respects the

16 SC-M, para 4.01.

17 SM, Annexes, vol 3, annex 23.

18 SC-M, para 4.05.

19 SC-M, para 7.66.

20 HM, para 5.108.

impact may be more severe and gives a number of precise reasons.[21] For Slovakia this text is "noticeably uncertain in tone" and produces "confusion".[22] No effort is visible to discuss the issues raised.

Misquotation is also used. For instance, where Hungary states that, for groundwater in the Middle Szigetköz, "the subsidence is 0-1 metre", this is described by Slovakia as "a decrease of just 0.5 m".[23]

Another approach is to attribute views to Hungary which cannot be justified on the evidence presented. For example, in the Slovak Counter-Memorial, it is suggested that Hungary is against dams in general: "In other words, it suggests, dams are generally not to be favoured."[24] This is most definitely not Hungary's position, which is specific in its concerns to the proposed Gabčikovo-Nagymaros Project and the relevant reaches of the Danube, with their associated specific environmental conditions.

With respect to the Bechtel, HQI, and EC reports, at least, selective use of quotations is made which distorts the overall sense of the documents in several important respects. For example, in the Slovak Memorial a quotation from the Bechtel report states that "the hydrologic regime of the project area has been thoroughly studied and potentially significant impacts have been identified by VIZITERV and associated experts".[25]

This gives a misleading impression of confidence. Bechtel in fact raises many important aspects of the project which have been inadequately treated. Some of the most far reaching criticisms refer to biological aspects,[26] but these in turn affect the entire conception of the Project and its operating modes.

Thus Bechtel states that "potential impacts to biological and archaeological resources may be significant, and planned mitigations may not be sufficient to reduce impacts to an insignificant level".[27] Lack of biological data means that appropriate management strategies for surface and groundwater cannot be defined, and "conflicts may be present with protecting biological resources". They state that "[t]he recommended studies for water quality and biology may result in identification of the need to modify the project's operational strategies", and that

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21 HM, para 5.109.

22 SC-M, para 8.01.

23 SC-M, para 8.23.

24 SC-M, para 7.29.

25 SM, para 2.31.

26 See HC-M, para 1.31 et seq.

27 HC-M, Annexes, vol 4 (part 1), annex 1 at p 15.

"[a]dditional flow releases to the old Danube River channel and side-arms may be necessary" as well as "[m]odified peaking schedules"[28] although "until more biological baseline conditions are established, this cannot be clearly determined".[29]

Specific comments by Bechtel relating to the need for more detailed study of surface and groundwater conditions include the following:

> "Potential problems that we believe require additional studies to quantify impacts...are the water quality and water level fluctuations downstream of the Gabcikovo barrage."[30]
>
> "Detailed studies of critical areas in Szigetkoz should be conducted....The hydrogeologic characteristics of a specific area will most likely differ from the homogeneous, isotopic conditions assigned in the analog modeling studies...."[31]
>
> "Exploration and installation of monitoring wells should be carried out in those areas where seepage is possible, and where previous studies have not been adequate."[32]

With respect to "the sensitive wildlife area near Asvanyraro", a detailed biological study is needed, to be followed by more detailed hydrological studies before an assessment can be made:

> "If adverse effects are anticipated, it is recommended that water levels and water quality be closely monitored for at least 1 year...."[33]
>
> "Modeling is needed to assess the possibility of reduced DO in the two reservoirs...."[34]

With respect to groundwater:

> "Another 10-15 sites should be selected for long-term measurements".[35]

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28 Ibid, p 15-16.

29 Ibid, p 15.

30 Ibid, p 17.

31 Ibid, p 18.

32 Ibid, p 19.

33 Ibid, p 20.

34 Ibid, p 27.

35 Ibid, p 29.

"Ground water quality sampling and quality analysis should be conducted monthly for 2 years to establish baseline conditions. Vertical sampling of a few deep wells should also be conducted."

"Ground water level data should be collected at all biological monitoring stations to monitor habitat changes. Stream gauging and water quality data should be collected at sensitive waterfowl locations...."[36]

These examples illustrate Bechtel's awareness that significant deficiencies existed in the knowledge of surface and groundwater conditions, and that several years of further detailed studies were required, integrating biological and hydrological aspects, for an appropriate project evaluation. "Due to the variable database, quantification of significant impacts to high, medium, and low is not possible."[37] But contrast this with Slovakia's statement that "the hydrologic regime of the project area had been thoroughly studied".

Few studies were ever presented by Slovakia, but some undermine their own credibility by plainly distorting their own findings in the conclusion. For instance a study on fish reported in detail the substantial changes expected in the composition of the fish fauna in the upper reservoir and states that this would eliminate the necessity of a fish pass at Gabčíkovo or Dunakiliti (because no migratory fish could live in or pass the reservoir). Nevertheless it concludes "[n]o great changes will occur in the species of ichthyofauna of the reservoir as compared to the main river flow".[38]

2.6 ERRONEOUS DATA

Possibly the most important aspect of scientific credibility is honesty in the reporting of data.

Slovakia presents erroneous data of the situation in Hungary, as, for example, in representing historical changes to groundwater levels.[39] The substantial inaccuracies in this diagram are analysed in *Chapter 4.4.1*, below.

A further example is the misrepresentation of groundwater changes in Hungary associated with side-arm recharge.[40] The current data are presented, and the differences discussed, in *Chapter 4.4.1*, below.

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36 Ibid, p 30.

37 Ibid, p 33.

38 SC-M, Annexes, vol 2, annex 25.

39 SC-M, illus CM-5.

40 SC-M, illus CM-13.

The "bottle-neck argument" in navigation was backed by the statement that "in June 1993, the Danube waterlevel around Nagymaros dropped to 68 cm, making navigation quite impossible".[41] It is true that the gauge reading was 68 cm on the 17 June 1993, but this reading corresponds to a water level still 78 cm above the navigational low-flow level agreed to by the Danube Commission.[42]

2.7 CONCLUSION

It can be concluded that Slovakia has undermined its credibility with respect to data presented and supporting arguments, demonstrating a lack of a basic understanding of the complex scientific issues which underlie the case.

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41 SC-M, para 8.43.

42 Moreover, the level only went below 98 cm in the period 16-18 June: on June 15 the gauge read 100 cm and on June 19 it read 126 cm. This strongly suggests that the water was retained in the Čunovo Reservoir for release on June 18 to aid the passage of a sea-going vessel. For details see Chapter 3, fn 79.

CHAPTER 3

RIVER MORPHOLOGY, FLOOD PROTECTION, NAVIGATION

3.1 RIVER MORPHOLOGY

3.1.1 BED DEGRADATION

Summary of the Scientific Position[1]

River regulation since the 19th century has confined the Danube to a single thread channel but has nevertheless retained a system of active side branches in the Szigetköz and Žitný Ostrov. These have a high value with respect to nature conservancy. Excessive industrial gravel mining since the 1960s together with ford dredging has led to a reduction in low-flow water levels and a subsequent lowering of groundwater levels in the vicinity of the channel. In the section from Rajka (rkm 1850) to Gönyű (rkm 1790) a total volume of more than 700,000 m^3 of sediment was dredged from the riverbed as an annual average in the 1970s and 1980s,[2] exceeding even the natural bedload arriving at Bratislava before the construction of dams in Germany and Austria.[3] As a result, low-flow water levels have dropped at Bratislava by nearly 2 m and at Gönyű by 1.5 m since 1966.[4] Riverbed surveys of the reach between Rajka and Gönyű between 1965 and 1991 indicate that the river morphology is governed by the accumulation of sediment and the excavation of gravel rather than by erosion. In certain sections aggradation prevailed despite dredging.

It can be assumed that the detrimental over-excavation[5] of gravel was carried out in anticipation of the construction of the Gabčíkovo-Nagymaros Barrage System

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1 For details see *Scientific Evaluation*, HC-M, vol 2, chap 2.2.2 and vol 4 (part 1), annex 6.

2 See *Scientific Evaluation*, HC-M, vol 2, *Table 2.1*.

3 The natural bedload transport at Bratislava was estimated to be 600,000 m^3; no measurements are available, but it can be assumed that the construction of Austrian dams resulted in a considerable reduction of sediment supply.

4 See *Scientific Evaluation*, HC-M, vol 2, *Fig 2 3*; no dredging data from the Slovak reach of the Danube were made available to Hungary.

5 The lowering of the riverbed has resulted not only in environmental damage in the Szigetköz and the Žitný Ostrov, but also in limited access to the port of Bratislava for ships.

because in the reservoirs the rise of water levels would compensate for the drop of the riverbed. In this respect riverbed degradation is closely related to the project plans.

Rebuttal of Slovak Assertions

The Slovak depiction of the Danube riverbed degradation ignores its main cause, i.e., gravel dredging from the river channel for industrial purposes. In place of this, the lowering of the riverbed, especially around Bratislava, is attributed to increased flow velocities through river training, reduced levels of sediment supply from upstream due to German and Austrian dams, and navigational dredging.[6] In most statements the degradation of the riverbed is merely attributed to erosion.[7]

As a matter of fact, the gravel volume extracted for industrial purposes by far exceeded the dredging of fords for the mitigation of navigation. In the 1970s and 1980s, average annual dredging volumes in the Danube reach between Rajka (rkm 1850) and the Ipoly mouth (rkm 1708) were 2.5 million m^3 for industrial purposes, compared to 0.4 million m^3 for river training and navigation.[8] The maximum annual dredging quotas for navigational dredging never exceeded 0.8 million m^3 in this reach[9] – far less than the Slovak assertion of 4 million m^3.[10] Unlike Hungary, Slovakia never presented full data on dredging activities.[11]

There is no doubt that most of the missing sediment in the riverbed was removed by dredging and not by erosion and that industrial gravel mining exceeded by far the dredging of ford sections for navigational requirements.

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6 SM, paras 1.18, 1.42 and 1.57.

7 SM, paras 2.85, 2.86, 5.10, 5.26 and 6.140; SC-M, paras 7.81, 7.103 and 7.123.

8 These average volumes are calculated from *Table 2.1, Scientific Evaluation*, HC-M, vol 2; they are covering different time spans for different river reaches, i.e., the years 1969-1991 (Rajka-Gönyü), 1965-1991 (Gönyü-Komárom) and 1970-1988 (Komárom-Ipoly mouth).

9 See *Scientific Evaluation*, HC-M, vol 2, *Fig 2.1*.

10 SM, para 1.42, fn 22; this volume might represent the total amount of dredging including industrial gravel mining on the 30 km Danube reach in Slovakia.

11 Hungary has presented exact dredging records to the Court in various documents, i.e., *Scientific Evaluation*, HC-M, vol 2, chap 2 and vol 4 (part 1), annex 6; these data are based on detailed annual dredging records for each river km, which are available in the protocols of the Boundary Waters Commission for the entire Hungarian/Slovak Danube reach, and should be available for the Slovak reach as well. Dredging data which were actually presented by Slovakia, e.g., in the Report *Gabčíkovo-WWF – the pros and cons* by Prof. Mucha (SC-M, vol 2, annex 24) do not allow conclusions on the dredging activities on the Slovak reach. It was only mentioned that gravel excavation was stopped in 1984 *except for navigational dredging*.

3.1.2 IMPACTS OF THE ORIGINAL PROJECT

Summary of the Scientific Position[12]

The area affected by the construction and operation of the Gabčíkovo-Nagymaros System would comprise the Dunakiliti-Hrušov Reservoir, the Danube reach between the Dunakiliti weir (rkm 1842) and the conjunction with the tailrace canal at rkm 1811, the Szigetköz floodplain with the side branch system, the impounded Danube reach from rkm 1811 to the Nagymaros barrage at rkm 1696 ("Nagymaros Reservoir") and the tailwater section downstream of Nagymaros with the two Danube branches around Szentendre Island and further downstream as far as the morphological impacts of the operation of Nagymaros could be anticipated.

The construction and especially the planned peak operation of the Gabčíkovo-Nagymaros System would have affected the different project parts as summarised in *Table 3.1*.

Presentation of New Data[13]

Austrian research projects concerning the impacts of peak operation on the aquatic fauna have demonstrated both the detrimental effect of the sudden pulse release when starting peak operation and the sudden flow reduction at the end of peaking. According to these investigations made on 6-7th order streams the changes in the composition of the bed sediments and high suspended loads during peaking result in a severe loss of biomass and biodiversity.

12 For details see *Scientific Evaluation*, HC-M, vol 2, chap 2.3 and vol 4 (part 1), annex 6.

13 *Table* 4 of H Nesemann and O Moog *Quantification of the environmental impacts of the planned Gabčíkovo-Nagymaros project. Forecast of the effects on benthic invertebrates based on an analysis of the Austrian Danube*, Vienna, 1995 (*hereinafter* Nesemann and Moog, 1995); HR, Annexes. vol 3, annex 4.

Table 3.1: Summary of morphological impacts of the Gabčíkovo-Nagymaros System[14]

Location	Impacts
Dunakiliti-Hrušov Reservoir	• Destruction of all side branch systems, islands and morphological features of the active floodplain on both sides of the Danube from Dunakiliti (rkm 1842) to Bratislava (rkm 1865) • deposition of approx. 90 % of the bedload and 77 % of the suspended load
Old Danube	• between rkm 1811 and rkm 1817 dredging would have been carried out to adapt the riverbed to the lower level of the downstream reach (which was to be dredged) • due to the total retention of the bedload in the reservoir, the degradation of the riverbed previously caused by excessive dredging would continue • the dominant residual discharge[15] of 50 m^3/s would lead to the characteristic habitat structures of a low-flow bed, but once or twice a year sudden flood releases would destroy most of the newly developed habitats, especially on the banks of the low-flow riverbed • vegetation would rapidly move into the former riverbed, and regular maintenance would be needed to ensure the flood discharge capacity of the channel • daily peak operation would reverse the direction of the flow up to rkm 1823 and associated water level fluctuations would endanger the stability of the banks
Szigetköz Floodplain	• colmatation of side branches is likely, especially considering the envisaged cascade system with 12 cross dykes on the Hungarian side
Nagymaros Reservoir	• the impoundment would drown two dozen islands covered with valuable wetland forests • dredging between the conjunction with the power canal at rkm 1811 and Gönyű (rkm 1791) was planned in order to increase the energy head at Gabčíkovo power station with subsequent destruction of fluvial habitats and lowering of adjacent groundwater levels • daily water level fluctuations by peak operation would amount to 4.5 m in the tailrace canal and still 2.5 m at the mouth of the Mosoni Danube (rkm 1793.3) leading to daily flow reversal for many kilometres in tributaries • flow velocities would vary accordingly each day, i.e., from 0.3 to 1.5 m/s in the middle of the reach • almost the entire Danube reach would suffer from erosion which it was hoped to stop by natural armouring; near Nagymaros and along the banks fine sediments would accumulate • rapid daily water level fluctuations would endanger the stability of the banks and prevent any growth of vegetation • fluvial habitats would suffer from daily fluctuations of flows resulting in unfavourable living conditions for the aquatic fauna (see annex 4, vol 3)
Downstream Nagymaros Reach	• according to the Joint Contractual Plan dredging of the tailwater was to increase the hydraulic head available for energy production[16] • the envisaged operation of Nagymaros included a remarkable peak operation towards the free-flowing Danube section downstream of the barrage; this could result in further degradation of the bed in the long term • the effects on the aquatic fauna would be similar to the ones in the Nagymaros Reservoir

14 For a more detailed analysis of the anticipated impacts, see *Scientific Evaluation*, HC-M, vol 2, chap 2.3.

15 The natural average flow of the Danube at Bratislava is 2,025 m^3/s; according to the Joint Contractual Plan 50 m^3/s were to be released in the Old Danube from March to November, and seepage water of only 18.9 m^3/s was regarded to be sufficient for the supply of the Old Danube from December to February; 200 m^3/s were to be released during the growing season in case of necessity (though no specifications for this were outlined).

16 SC-M, para 7.71; the detrimental effects of the lowering of the riverbed were obvious after industrial dredging in this reach had threatened bank-filtered well systems. For this reason gravel mining has been prohibited in this reach since 1980.

Rebuttal of Slovak Assertions

The Slovak Memorial and Counter-Memorial are silent about most of the environmental impacts addressed above. The consequences of peak operation in particular are hardly mentioned or even denied: as illustrated in the *Scientific Evaluation*,[17] the water levels in the Nagymaros headwater section would vary much more than the one metre claimed by Slovakia.[18] It is even denied that the Nagymaros power station would be operated at a peaking mode: "...its [Nagymaros step] discharge into the riverbed below would never vary...".[19] Or it is stated that "The planned operation of the project will not significantly alter the flow characteristics or hydrology of the river downstream of Nagymaros".[20] Actually the envisaged operation of Nagymaros at low-flow periods would result in daily discharge fluctuations from 1,000 m^3/s to more than 2,000 m^3/s with subsequent daily fluctuations of flow velocities and water levels far beyond Budapest.[21]

The envisaged peak operation of the Gabčíkovo-Nagymaros System not only endangers the stability of river banks, dykes and the bed itself, it also damages fluvial habitats by ever changing flow velocities and flow directions in tributaries and the lower reach of the Old Danube. The magnitude of the envisaged peak operation is unmatched in large European rivers.[22]

According to the Slovak Memorial and Counter-Memorial, potential erosion problems of the Old Danube riverbed should be handled with the construction of "underwater weirs".[23] It is not clear what kind of a construction is meant by this. Fortification of ford sections with rip-rap would stabilise particular sections, but not prevent the possible degradation of long river reaches between. Higher weirs, on the other hand, would create a sequence of impoundments in the Old Danube with well known detrimental impacts on the aquatic ecosystem.[24]

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17 *Scientific Evaluation*, HC-M, vol 2, *Fig 2.5*.

18 SM, para 2.54.

19 SM, para 2.36.

20 SC-M, para 7.72.

21 HC-M, Annexes, vol 4 (part 1), annex 6, chap 5.5, at the Budapest gauge, daily water level fluctuations would be about 2 m.

22 Neither the barrage systems at the Upper Danube nor at the Rhine are operated at similar peak operation modes (see HC-M, para 4.211).

23 SM, para 2.86, SC-M, para 7.44; the issue of "underwater weirs" is addressed in more detail in Chapter 7, below.

24 See *Scientific Evaluation*, HC-M, vol 2, chaps 2.5 and 4.6.

In any case, there is no reason to assume that the "river banks would develop more naturally...and lateral erosion would start once more",[25] that "the correct implementation of the G/N Project was to lead...to a positive improvement",[26] or even that "... the original braided nature of the river can now be recreated...".[27]

3.1.3 Impacts of Variant C

Summary of the Scientific Position[28]

The impact area of Variant C with respect to river morphology comprises the Čunovo Reservoir, the Old Danube (including the side branches) and a certain river reach downstream of the conjunction with the power canal.

The morphological impacts of the construction and operation of Variant C are similar to the ones anticipated for the Original Project.[29] The upper reservoir is smaller, but big enough to retain the same amount of bedload as predicted above. The length of the abandoned riverbed is longer by 9 km, and the base discharge released in the Old Danube has varied between 200 and 350 m^3/s since the diversion of the river.[30] The medium flood immediately after the closure of the Danube in November 1992 eroded about 2-3 million m^3 of sediment below the floodplain weir at Čunovo;[31] this mass of sediments is expected to be transported down the channel intermittently with each release of larger floods.[32] Between rkm 1808 and 1800 new ford sections have developed since the commencement of operation of Variant C.

The "oversized" riverbed will eventually be covered with woody vegetation outside the wetted perimeter, and the beginning of this process can now be

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25 SC-M, para 7.104.

26 SC-M, para 7.22.

27 SC-M, para 7.28.

28 For details see HC-M, *Scientific Evaluation*, vol 2, chap 2 4 and Annexes, vol 4 (part 1), annex 6.

29 Hydrological implications are discussed in Chapter 4 of this Rebuttal.

30 See HR, Annexes, vol 3, annex 1.

31 EC-Hungary-Slovak Republic, Working Group of Monitoring and Water Management Experts for the Gabčíkovo Systems of Locks, *Data Report*, Budapest, Nov 2, 1993; HM, vol 5 (part 2), annex 18 at p 698.

32 The presently constructed weir at rkm 1843 will prevent any bedload from passing downstream.

observed (*Plate 3.1a*).[33] As anticipated in the Original Project, it is likely that fluvial and riparian habitats will eventually adapt to the prevailing low flows, but will be destroyed with each major flood release. Gradual degradation of the bed can be expected due to the retention of coarse sediments in the Čunovo Reservoir. On the other hand, the flow is backed up in the lower part of the Old Danube by the higher discharges entering the bed from the tailrace canal. This has already led to considerable siltation reaching 0.5-1.0 m thickness near the banks (*Plate 3.1b*).[34] The side branch system is not only affected by less frequent (and briefer) inundations compared to pre-dam conditions but also by lower concentrations of suspended load.

Rebuttal of Slovak Assertions

The Slovak documents submitted to the Court say little about the morphological impacts of Variant C. A third weir to be installed in the Čunovo complex in Phase II of the construction is supposed to enable the discharge of bedload.[35] This structure will not prevent the sedimentation of almost all bedload at the upstream end of the Čunovo Reservoir. Even in flood conditions it cannot be expected that a significant part of the bedload will pass through this structure.

It is stated by the Slovak Party that the Old Danube can now develop "more naturally".[36] An article written by Dr. Jäggi was quoted with selective statements apparently supporting this view.[37] In fact, the article of Dr. Jäggi contains a more detailed description of the necessary steps to be taken in order to achieve a semi-natural state of the old riverbed.[38] It is worthwhile to note that Dr. Jäggi not only proposes a more natural discharge regime for the Old Danube, but that he strongly opposes the construction of weirs in the main channel.[39] He writes:

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33 P Molnár, *The Danube after the diversion: an actual geological survey.* MÁFI, Budapest, 1995 (*hereinafter* Molnár, 1995); HR, Annexes, vol 3, annex 2.

34 Ibid.

35 SM, paras 5.29 and 5.35.

36 SC-M, paras 7.80 and 8.03; the EC Working Group Report contains such a statement referring to the dislocation of the navigation route from the Danube riverbed (HM, vol 5 (part 2), annex 14). This "unique chance" for the restoration of natural riverbed patterns would only exist if it were coupled with the natural discharge regime.

37 SC-M, para 8.03.

38 SC-M, Annexes, vol 2, annex 32.

39 See also Chapter 7.2 of this Rebuttal. The solution propagated by Dr Jäggi would have to be examined carefully with respect to ice release and the discharging of the 100-year flood without using the bypass canal; emergency navigation would no longer be possible. Dr Jäggi reiterates his critique of construction of weirs in a letter to Hungary, HR, Annexes, vol 3, annex 3.

"On a long term basis, however, a more dynamic approach may be necessary. The official proposal to build low weirs in the old Danube is in this respect also very static and only of some use on a short term basis. The flow conditions will be seriously altered.

The alternative is to recreate natural morphological elements. Taking off some of the existing training structures may induce lateral erosion and widening of the existing channel of the Old Danube. Of course, a dynamic development of such a channel is possible only if periodically bed forming flows of the order of about 3000 m^3/s are sent into this reach.

...the duration curve [of the discharge] has to reflect the original conditions with some short duration bed forming floods and higher base flow in summer, which can be compensated by lower flows in winter. On the whole, the new river will be some sort of a model of the original river and thus not be identical to it."[40]

The actual release of water in the Old Danube at Čunovo since the damming does not reflect Dr. Jäggi's suggestions. Flood flows were only shared above the discharge capacity of the turbines at Gabčíkovo, so that in 1994, just one flood flow with less than 2,000 m^3/s was discharged into the old riverbed.[41] It is interesting nevertheless to read that "Slovakia is in full agreement with the views expressed in Dr Jaeggi's paper".[42] That agreement is not reflected in the discharge regimes under Slovak control.

The assertion that colmatation of the side branches or main riverbed preventing groundwater recharge would not occur[43] is not supported by evidence. Actually there is no simulation method available to produce reliable forecasts of colmatation effects in natural river channels or even in side branch systems.[44]

40 SC-M, Annexes, vol 2, annex 32 at pp 434-435.

41 Compare flow charts in annex 1 (HR; Annexes, vol 3).

42 SC-M, para 8.03.

43 SC-M, paras 7.41-7.44, 8.26; in this respect the citation of the EC reports cannot be taken as evidence; although Hungary highly acknowledges the work done by the EC experts, it must be noted that these reports cannot be regarded as independent scientific studies since they fully relied on the database made available by the two Parties.

44 For further details on colmatation see Chapter 4.5, below.

Plate 3.1a The Degradation of the Abandoned Main Danube Bed
Willow and poplar bushes spread rapidly in the exposed parts of the abandoned riverbed after the diversion of the water (photograph taken in Oct 1994)

Plate 3.1b The Backwater Effect of the Tailrace Canal
The lower part of the main riverbed is backed up by the high water levels of the tailrace canal. The significant decrease in flow velocities resulted in the deposition of mud reaching 0.5 - 1.5 m (photograph taken in Jan 1994)

3.2 FLOOD PROTECTION

3.2.1 FLOOD PROTECTION IN THE ORIGINAL PROJECT

Summary of the Scientific Position[45]

As far as flood protection is concerned, there was – and is – no need for the G/N Project. The levees along the Szigetköz had been reinforced to meet the requirements of the 100-year design flood with sufficient freeboard to comply with international standards. Actually, larger floods occurred in 1970, 1974, 1975, 1981, 1985 and 1991[46] without causing major damage. Aside from the flood distribution between the Danube and the bypass canal, few benefits for the Hungarian side can be found.[47] Downstream of Gönyű some works have to be completed to reach the same level of security. In this reach the Slovak levees were raised to a higher level according to the Original Project plans *after* Hungary had suspended works at Nagymaros.

In the past many floods in this region were caused by so-called ice jams, i.e., a barrier of accumulated ice floes blocking the channel. Due to river regulation the danger of ice floods was considerably reduced. With the construction of a large reservoir – only necessary for peak energy production – a solid ice cover is likely to develop most winters, increasing the risk of ice jams at its upper end or at the weir gates. The safe release of broken ice is possibly the most difficult task in reservoir operation.[48]

Rebuttal of Slovak Assertions

Recalling the catastrophic floods of 1954 and 1965, Slovakia suggests that the region was left without adequate flood protection measures since that time.[49] In addition, it is claimed, that "...traditional methods of flood control were

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45 For more details see HC-M, *Scientific Evaluation*, vol 2, chaps 2.2.4, 2.3.3 and Annexes, vol 4 (part 1), annex 9.

46 SM, para 1.21.

47 It should also be noted that the additional discharge capacity of the bypass canal leads to higher discharges and flood stages below the conjunction with the Old Danube at extreme flood events, as stated below.

48 See *Scientific Evaluation*, HC-M, vol 2, chap 2.3.3 for operational procedures for the purpose of avoiding ice jams.

49 SM, paras 1.30-1.34 and SC-M, para 7.119.

insufficient in this region of the Danube".[50] It is also stated that "...the Project can substantially lower the costs for flood protection".[51]

It is not clear, what the new approach would be with regard to flood protection measures. The G/N System would allow "dissipation of flood waters in the Danube and its branches instead of the mere channelling of the flood downstream to the next problem area".[52] This is by no means, however, a new approach. The active floodplain inside the dykes has always served as a natural storage space, thus leading to significantly lower flood discharges at Nagymaros and Budapest than at Bratislava.[53] By contrast the power canal *would be able to transmit* up to 5,200 m^3/s without dissipating this flood volume in the floodplain.[54]

Downstream of the conjunction with the power canal, existing dykes had to be reinforced for the construction of the Nagymaros Reservoir – with methods which had been successfully applied in the Szigetköz region before 1977. So, part of these costs could be accounted for by the Project.

It is mentioned several times that floodplain forests were intended to be cleared along a 250 m wide strip of the upper Danube reach below Bratislava in order to lower flood stages in the city.[55] According to the discharge rating curves of the river gauge at Bratislava, flood levels, as well as low-flow levels, sank considerably over the last 30 years, augmenting the level of flood security.[56] In addition, such a measure would have increased flood stages downstream of the clearing which would have unfavourably affected both countries.

Flood protection was inevitably part of the Gabčíkovo-Nagymaros Project since several structures would have served both purposes – the production of energy and flood control. On top of this, the construction and operation of the Gabčíkovo-Nagymaros System created new flood hazards, e.g., potential rupture of high embankments, failure of gates at flood discharges and increased danger of ice

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50 SM, para 1.34.

51 SC-M, para 7.119, fn 159.

52 SM, para 2.80.

53 The 100-year flood was calculated to be 10,600 m^3/s at Bratislava and only 8,700 m^3/s at Nagymaros, despite an increase in drainage area (*Scientific Evaluation*, HC-M, vol 2, chap 3.2.1).

54 SC-M, para 8.07; Hungary acknowledges the benefits of the bypass canal in terms of flood protection for the Szigetköz, but the Gabčíkovo-Nagymaros Project was never the only solution to address future flooding problems; local accumulation of sediment in the main channel could have been managed by precise maintenance dredging, hydrological changes in flood conditions have always been accounted for by re-evaluating design flood levels.

55 SM, par 2.109, SC-M, paras 7.27 (fn 37) and 7.87 (fn 128).

56 See discharge rating curves in HC-M, vol 4 (part 1), annex 6.

development in the reservoirs with the potential blocking of flows. So, there were good reasons to include aspects of flood protection in the Treaty. Nevertheless, flood protection has never been the primary factor for the realisation of the Project.

Slovakia is silent about these additional risks and only talks about benefits in terms of flood security – benefits which could have been gained without the Gabčíkovo-Nagymaros System. A 100-year flood level was agreed to by both countries for normal risks of flooding; a higher flood protection level was necessary to cover additional risks caused by the envisaged structures of the Project.

3.2.2 FLOOD PROTECTION WITH VARIANT C

Summary of the Scientific Position[57]

The incomplete state of construction of Variant C called "Phase I" falls behind the mutually agreed safety standards of the Original Project. Neither the 100-year flood nor the 1,000-year flood can be discharged by the structures at the same level of safety previously adopted. Immediately after the closure of the Danube, the Čunovo weir could not even safely handle the flood discharge for which it was designed. The medium flood in November, 1992 (of which only 2,120 m^3/s had to be released at Čunovo, compared to the 100-year design flood of 10,600 m^3/s) caused considerable damage in the downstream channel, on the floodplain, in the side arms and at the structure itself, demonstrating that Variant C could not safely handle extreme floods like the ones in 1954, 1965 and 1991. The danger of uncontrolled flooding – possibly overtopping the reservoir dyke – imposes an additional flooding risk on Hungary.

The state of construction of Variant C, Phase I, does not allow the same procedures of ice release as agreed to in the Original Project; this was indicated by ice problems in January 1993. Therefore, Slovakia unilaterally accepted a significantly higher risk of uncontrolled flood discharge.

Rebuttal of Slovak Assertions

Obviously Slovakia has abandoned the mutually adopted safety standards for the flood discharge of the Original Project.[58] In the original design, a certain discharge capacity was kept as a reserve. With the commencement of operation with Variant C not yet complete, an additional risk of uncontrolled flooding was

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57 For details see *Scientific Evaluation*, HC-M, vol 2, chap 2.4.4. and vol 4 (part 1), annex 9.

58 *Scientific Evaluation*, HC-M, vol 2, *Table 2.5*.

unilaterally accepted by Slovakia (and imposed on Hungary). The total discharge capacity of "Phase I" was given as 12,715 m^3/s "once [the structure was] fully completed".[59] In other words, even this partial capacity was not available by the time of the closure of the Danube at Čunovo. Assuming the same safety standard as adopted for the Original Project, the (completed) structures of Variant C (Phase I) only had a 83% discharge capacity for the 100- and 1,000-year design floods,[60] not to mention the inability of discharging the 100-year flood without the bypass canal.

There was no reason at all to build Variant C for the purpose of flood protection. "Antiquated dykes" along the Danube on Slovak territory, which protect three villages between the Danube and the power canal, could have been reinforced by Slovakia without constructing Čunovo.[61] The Slovak dyke system along the Nagymaros Reservoir has actually been completed, and the failure of Hungary to fulfil the dredging between rkm 1816 and rkm 1791 (Gönyű) did not diminish the existing level of flood safety.[62] Increased sedimentation in this reach may well be induced by the implementation of Variant C itself.[63]

It is altogether misleading to state that the Szigetköz is for the first time "safeguarded from the threat of devastating floods ...".[64] The Szigetköz area had reached a 100-year flood protection level by 1977. The incomplete status of construction of Variant C in October 1992 actually endangered the area through uncontrolled flooding. In addition, the hazard of ice floods is increased by the construction and operation of the Čunovo Reservoir.[65]

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59 SM, para 5.48; SC-M, para 8.54.

60 This is calculated subjecting Variant C to the same safety levels as adopted for the Original Project: 100-year flood should leave a 1.5 m freeboard, use 50 % of the turbine and lock capacity at Gabčikovo and 75 % of the available discharge capacity at Čunovo. 1000-year flood should leave a 0.5 m freeboard, employ 50% of the turbine capacity and 100% of the lock capacity at Gabčikovo and 75-90% of the available capacity at Čunovo. Given these restraints Variant C, Phase I fails to satisfy the safety requirements for flood release. See *Scientific Evaluation*, HC-M, vol 2, chap 2.4.4 and *Table 2.8*.

61 SM, para 5.07.

62 SM, para 5.37.

63 SM, para 5.49; *Scientific Evaluation*, HC-M, vol 2, chap 2.4.3.

64 SC-M, para 8 07.

65 *Scientific Evaluation*, HC-M, vol 2, chap 2.4.4.

3.3 NAVIGATION

Summary of the Scientific Position[66]

Plans for river training to facilitate navigation were worked out in the 1960s but were only partially fulfilled due to the anticipated installation of the Gabčíkovo-Nagymaros System. In the Danube stretch along the envisaged power canal from rkm 1842 to rkm 1816 the regulation was completed, and only minor problems concerning a sharp bend at rkm 1814 remained, not presenting significant restrictions to navigation. Between Sap (rkm 1811) and Gönyü (rkm 1791) additional fords appeared after the opening of the power canal. Recent investigations by VITUKI and a Dutch-Hungarian consortium indicate that traditional regulation methods, including some maintenance dredging, would be sufficient to meet the requirements of class VI.B. vessels according to the UN EEC/CEMT classification system.[67]

Rebuttal of Slovak Assertions

Slovakia claims that the section between Bratislava and Budapest is "the Danube's only major remaining navigational bottleneck",[68] and points at the increased importance of the Danube as part of the network of navigable rivers after the opening of the Rhine-Main-Danube Canal in 1992.[69]

Actually there are a number of restrictions in navigability along the fairway Rhine-Main-Danube:[70]

- On the Rhine the navigational low-flow depth is 2.1 m in the free-flowing river reach downstream of the last barrage at Iffezheim (rkm 334) all the way to Cologne (rkm 686), though with one exception: downstream of the mouth of the Main near Bingen (from rkm 508-

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66 For more details see HC-M, *Scientific Evaluation*, vol 2. chap 2.2.3 and Annexes, vol 4 (part 1), annex 8.

67 Delft Hydraulics, Frederic R Harris, VITUKI, *Danube Environmental and Navigation Project. Feasibility Study Rajka-Budapest. Stretch B1: Szap-Ipoly Mouth*, Oct, 1994. Commissioned by the Ministry of Transport, Communication and Water Management (*hereinafter* Delft-Harris-VITUKI *Feasibility Study* Oct 1994); the updated final report is placed in the Library of the Court.

68 SM, para 1.20.

69 SM, para 1.11.

70 H Wösendorfer, 1992, *Nautical situation of the Austrian Danube in the framework of the fairway Rhine-Main-Danube*. [In German], 13. Seminar Landschaftswasserbau, Technische Universität Wien, pp 202-232.

557) there is a shallow rocky section with only a 1.9 m low-flow depth which cannot be improved beyond 2.1 m for technical reasons (the construction of a barrage system at this location is out of the question);

- some sections of the upper Main above Würzburg have a surface width of 45 m only, corresponding to a navigational width of 36 m; below Würzburg there are sections with navigational low-flow depths of 2.5 m allowing for a draught of 2.3 m;
- in the 72 km long German Danube section between Straubing and Vilshofen the water depth at navigational low-flow is presently 1.7 m;
- in the Austrian reach there are ford sections in the Wachau region which were improved by river training to 2.5 m navigational water depth;
- between Vienna and Bratislava the navigational low-flow depth is 2.25 m;
- in the Hungarian Danube below Budapest there are ford sections at rkm 1548 and 1522 with 2.4-2.5 m low-flow water depth;
- below the Iron Gate there are ford sections around rkm 858 with 2.2-2.4 m low-flow water depth;
- in the lower Danube reach between rkm 575-455 there are seven shallow sections with low-flow water depths of 1.8-2.5 m;
- four to five ford sections were recorded in the reach from rkm 345-317 with low-flow water depths of 1.6 m and 1.8-2.5 m, respectively.

This list of navigational restrictions in the fairway Rhine-Danube demonstrates that there will always be restrictions at certain times for certain ship classes to travel along the waterway. There is no common standard for the size of a vessel to travel from East to West; in fact, the Rhine as the most important fairway in Europe has a remarkable restriction in navigational low-flow depth.

It is not denied that the section between Bratislava and Budapest presents obstacles to navigation, but the Gabčíkovo-Nagymaros System is not and never was the only feasible long-term solution to resolve navigational problems.[71] There is a tendency in Western Europe in (navigational) river regulation to apply sophisticated river management methods which avoid the impoundment of free-flowing river sections.[72] Studies carried out, with international co-operation, of the Danube stretch from Sap (rkm 1811) to Budapest containing the majority of

71 Contrary to that implied in SM, paras 1.12, 1.39 and 1.45.

72 E.g., on the Austrian Danube reach below Vienna, on the upper Rhine below Iffezheim, on the river Elbe in Germany; for details see HR, vol 2, Appendix 5.

the ford sections in the Project area conclude that traditional methods of river training are feasible to meet the requirements of class VI.B. vessels.[73] For the Szigetköz reach only two problems remained unsolved in 1992 when international navigation was diverted to the bypass canal – a ford section near Dunakiliti (rkm 1842) which was caused by the Project itself, and a sharp bend at rkm 1814 which can be managed by ship traffic.[74]

In international fairways it is well accepted that ship traffic is restricted at certain times of the year to a certain draught or is even blocked during extreme low flow periods. In the Danube reach between Vienna and Bratislava, for example, navigation was restricted to maximum 2.0 m draught on 84 days per year on average from 1976 to 1985. In other words, on 280 days vessels with a draught of 2.0 m or more could navigate, depending on the hydrological situation.[75] Full navigation possibilities at Bratislava were possible on an average of 60% (220 days per year) from 1980 to 1991.[76] This means that on more than 140 days ships with draughts smaller than 2.5 m could still navigate, depending on the actual hydrological situation. On the other hand, all traffic was blocked on 36 consecutive days in 1994 when both ship locks at Gabčikovo were inoperable due to accidents.[77]

It is stated in the Slovak Counter-Memorial that "in June 1993, the Danube water level around Nagymaros dropped to 68 cm, making commercial navigation quite impossible".[78] This sounds dramatic. Actually, the gauge reading was 68 cm on 17 June 1993, but there was still plenty of water for even large ships, since this gauge reading corresponds to a water level of 78 cm *above* the navigational low-flow level agreed by the Danube Commission.[79]

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73 According to the UN EEC/CEMT classification system; Delft-Harris-VITUKI, *Feasibility Study*, Oct 1994.

74 See *Scientific Evaluation*, HC-M, vol 2, chap 2.2.3.

75 H Wösendorfer, 1992, *Nautical situation of the Austrian Danube in the framework of the fairway Rhine-Main-Danube*. [In German], 13. Seminar Landschaftswasserbau, Technische Universität Wien, pp 202-232.

76 SM, para 1.47.

77 HC-M, para 3.93.

78 SC-M, para 8.43.

79 The "Zero-level" of river gauge is arbitrarily fixed and does not correspond to the deepest point of the riverbed; at Nagymaros gauge the agreed navigational low-flow level corresponds to a gauge reading of minus 10 cm. Even so, the reasons for this drop are interesting (on June 15, the reading at Nagymaros was 100 cm). The period June 16-18 was the only time when the gauge reading went below 98 cm. The only explanation for this could be that the natural flow was retained in the Čunovo reservoir in order to accumulate water to be released on June 18.

Nobody ever intended to regulate the entire Danube below Komarno to allow all-year movement of large sea-going vessels. The decision to build large sea vessels at a Slovak shipyard includes a certain risk of suitable flow conditions for delivery, a risk quite independent of the dispute over the GN Project.[80]

The contention that navigation of larger vessels will be possible in the Old Danube in case of emergency[81] contradicts the persistent proposal of constructing "underwater weirs" with the aim of restoring original groundwater levels. Such weirs would have to reach a crest level of several metres above the riverbed, thus preventing the passage of even smaller vessels.[82]

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80 SC-M, paras 8.42 and 8.43; in June 1993 a large sea vessel was manoeuvred down the river by manipulating the discharge at Gabčikovo.

81 SC-M, para 8.40.

82 Cf Chapter 7, below.

CHAPTER 4

SURFACE AND GROUNDWATER HYDROLOGY

4.1 INTRODUCTION

Prior to the diversion, the elevated riverbed of the Danube used to recharge the aquifer. This process was reversed in October 1992 when the water level in the main riverbed dropped far below the average groundwater level. Since the diversion, groundwater recharge in the Szigetköz is mainly controlled by the infiltration processes in the upper reservoir. Reduced flow velocities led to deposition of fine sediments affecting the quantity and quality of the exfiltrating water. The envisaged groundwater recharge with a side-arm water supply system is not only governed by the bed resistance of the side branches and connecting canals to infiltration (i.e., colmatation), but also by the transmissivity of subsurface layers of sediments and the water level differences between the side canals and the main riverbed. Given the expected and already observed processes, the potential use of the Szigetköz aquifer is threatened by the effects on both the quantity and quality of the extractable water.

The major source of Budapest's water supply are bank-filtered wells located in the Danube reach alongside the Szentendre Island. These would have been impacted by the Original Project. Substantial dredging was intended in this reach in order to increase the useful head for energy production at the Nagymaros hydroelectic plant. This would certainly be at the expense of the exploitable bank-filtered water. In fact, industrial dredging was stopped in this reach in 1980 for this very reason. Additional risks are associated with the changing patterns of erosion and deposition in this reach caused by the envisaged peak operation of Nagymaros. It is known from certain well fields that this can lead to a deterioration of the quality of the extracted water..

4.2 SURFACE WATER HYDROLOGY

4.2.1 ORIGINAL PROJECT

According to the agreed water balance in the Joint Contractual Plan, which fixed all water withdrawals from the reservoir and the seepage canals, 50 m^3/s should be released in the old riverbed at Dunakiliti from March to November, only increasing to 200 m^3/s in case of need during the growing season, and 18.9 m^3/s seepage water from under the weir was regarded as sufficient during the winter months. The Hungarian side branches were to receive between 17 and 34 m^3/s, depending on the season and state of colmatation. Larger amounts of water could have been extracted but only with a reduction of the share of energy received from the power plants.

This water balance was never changed. The alleged increase in discharge to a permanent 350 m^3/s for the Old Danube or a weekly flushing of 1,300 m^3/s was never agreed between the two parties and there is no indication that this "decision" was ever communicated to Hungary.[1] The same is true for the supply of the Hungarian side-arm system; the discharge capacities installed, e.g., 250 m^3/s in the ship lock at Dunakiliti could only be used by Hungary at the cost of its energy share.

The impacts of the Original Project on surface water levels and flow velocities would have been manifold.[2] Flow velocities would have been substantially reduced in backwater reaches entailing the sedimentation of fines, i.e., in the Dunakiliti-Hrušov Reservoir, in the lower part of the Old Danube (up to rkm 1823), and in large parts of the Nagymaros Reservoir, especially towards the barrage and along the banks. In the Danube between rkm 1842 and rkm 1811, water levels would drop far below the lowest water level ever recorded, thus disconnecting those side-arms that were still permanently joined with the main channel in pre-dam conditions.

It is misleading to state that "...prior to the diversion a full connection between the side-arms and the main channel was achieved only at times of flooding, that is for no more than around 20 days per year",[3] or that "...regular water fluctuations simply did not occur due to the region's isolation from the main river".[4]

Despite the degradation of the riverbed by excessive dredging some side-arms were still permanently connected to the main channel with their lower reaches on about 140 days per year;[5] only the upper ends of these side-arms had been closed previously to facilitate navigation. In addition, in pre-dam conditions the wetlands along the Danube still experienced the full range of surface and groundwater level

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1 SM, para 2.69; SC-M, para 4.33: it cannot be found in any of the protocols of the Government Plenipotentiaries, not even as a matter of discussion.

2 For details, see *Scientific Evaluation*, HC-M, vol 2, chap 2.3.

3 SC-M, para 8.22.

4 SC-M, para 7.99.

5 HC-M, vol 1, *Table 3*.

fluctuations which are essential for the survival of the biota in the wetland habitats.[6]

The envisaged peak operation would have led to large fluctuations of both water levels and flow velocities. The largest range would occur in the tailrace canal, the lower part of the Old Danube and the upper part of the Nagymaros Reservoir. Daily water level fluctuations would reach up to 4.5 m at rkm 1811, and flow would be stagnant in the tailrace canal and even reversed in the lower part of the Old Danube and Mosoni Danube at some point in the day. In large parts of the Nagymaros Reservoir, daily fluctuations of flow and water levels would lead to a permanent disturbance of aquatic and riparian habitats. Similar effects could be observed downstream of Nagymaros where peak operation on a smaller scale towards the free-flowing river section was envisaged in the Original Project plans.[7]

The Slovak Memorial and Counter-Memorial are silent about these detrimental impacts on the natural environment. Notably, the effects of peak operation are entirely ignored, and the operation of Nagymaros on peaking modes is even denied.[8] The "unique chance" for the development of a "more natural" riverbed does not exist for the upper part of the Old Danube, as was pointed out above.[9]

4.2.2 Variant C

The actual release of flows in the old riverbed was different from the stipulated discharges for the Original Project. In 1993, an average discharge of 353 m^3/s, including floods, was released at Čunovo.[10] In 1994, an average discharge of only 217 m^3/s was released, including an 8-day flood release in the middle of April. Only between March and June was the monthly average above 200 m^3/s. Compared to 1993, the monthly averages were about 100 m^3/s lower. No increase was registered in 1995.

6 *Scientific Evaluation*, HC-M, vol 2, chap 4.3. This also shows in the vegetation potential survey, with water-dependent vegetation communities in the Szigetköz (*Plate 5.2*, below).

7 Detrimental impacts of peak operation on the aquatic fauna are discussed in Chapter 5, below.

8 SM, para 2.36; the Nagymaros Reservoir would continually release a minimum base discharge of about 1,000 m^3/s. On top of this, a sudden release of more than 2,000 m^3/s during a few hours was envisaged in order to provide storage room for the large water volumes entering the Nagymaros Reservoir during energy production at Gabčikovo (HC-M, Annexes, vol 4 (part 1), annex 6, chap 5.5).

9 Chapter 3.1, above.

10 HR, Annexes, vol 3, annex 1; the prevailing discharges were about 300-350 m^3/s in the growing season and about 250-300 m^3/s from August to December 1993.

The diversion of the Danube in 1992 resulted in an immediate drop of surface water levels and a subsequent drop of groundwater levels associated with bank failures all along the channel.

Flow velocities were cut in half in the old riverbed or even more in the lower part which is influenced by the backwater of the conjunction with the power canal.

Flood flows lasted just a few days – only as long as the natural flood discharge exceeded the turbine capacity at Gabčíkovo.

4.3 SURFACE WATER QUALITY

Summary of the Scientific Position

The issues of surface water quality are discussed in detail in the Hungarian Counter-Memorial.[11] A primary concern is that issues of surface water quality had been neglected in the supporting studies for the Original Project[12] and, despite further recent studies in Hungary and Slovakia, have not been fully explored. In addition, these issues are highly complex, and require sophisticated mathematical models to represent the interaction of processes, but even the best model predictions are subject to high levels of uncertainty. This must be recognised in assessments of the risks of environmental damage.

Historical trends of Danube water quality show dramatic increases in nutrients.[13] Hence increases in algal biomass have occurred, and changes in the phytoplankton populations. Simulation results presented in the Hungarian Counter-Memorial show that both the Original Project and Variant C would be expected to lead to further increases in algal biomass, with increased risk of severe water quality degradation (the effect of the project on biochemical oxygen demand in the river can exceed the impacts of wastewater discharges). However, occurrence of algal blooms is likely to be associated with particular weather characteristics, and hence is highly unpredictable.

Bacteriological quality in the Danube remains poor, while heavy metals are detected in water and sediments in concentrations which exceed limit values. It can be noted that the highest pollutant concentrations in sediments are associated with the fine sediment fractions, which will be strongly affected by changing patterns of sedimentation as a result of the Original Project and Variant C.

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11 *Scientific Evaluation*, HC-M, vol 2, chap 3.3.

12 As noted by Somlyódy *et al.*, 1989; HC-M, Annexes, vol 4 (part 2), annex 13.

13 *Scientific Evaluation*, HC-M, vol 2, chap 3.3.

The peak power generation of the Original Project would have led to flow reversal in tributaries, and hence, for example, to potentially severe water quality problems in the Mosoni Danube due to wastewater discharges or stormwater overflows.

Adverse water quality changes in the Mosoni Danube as a result of the Danube diversion led to fish mortalities in 1993.

Rebuttal of Slovak Assertions

With regard to surface water quality, the Slovak Counter-Memorial attempts to relate simply the Gabčíkovo-Nagymaros Project to hydroelectric schemes in Austria and Germany.[14] This is a major misconception, which to say the least is unprofessional. Generalisation from one set of systems to another cannot be made without detailed analysis. It should be realised that German and Austrian dams/reservoirs are operating under different conditions. For example, Biochemical Oxygen Demand, Phosphorus and Nitrogen loads are lower, residence times are shorter (the systems are primarily throughflow), the temperature conditions are generally lower (and far from optimal for algae growth), flow depths and velocities are different, etc.

In this context of a discussion of water quality classification, the Slovak Counter-Memorial acknowledges that the content of nutrients in Danube water remains high, but states that "[t]his does not mean that the water quality is bad overall".[15] Again this is an over-simplification. Overall classifications of water quality are of limited value. Detailed analysis is required for appropriate impact assessment, as indicated in the Hungarian Counter-Memorial.[16] It should be noted that the old Hungarian classification system quoted by Slovakia was quite lax in comparison with current standards, excluding the extremes of observations and leaving out the worst components from the integrated classification.[17] Results according to the more recent classification of the joint Hungarian-Slovak monitoring system are given in the Hungarian Counter-Memorial.[18] The EC quotation that the Danube water is "well-suited for river bank infiltration"[19] should not detract from the potential adverse effects of the Project on bank-filtered water supplies, documented in the Hungarian Counter-Memorial.[20]

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14 SC-M, para 7.31.

15 SC-M, para 7.32.

16 *Scientific Evaluation*, HC-M, vol 2, chap 3.3.

17 *Scientific Evaluation*, HC-M, vol 2, chap 3.3, *Tables 3.2a-c*.

18 *Scientific Evaluation*, HC-M, vol 2, chap 3.3.1.1.

19 SC-M, para 7.32, citing the EC Working Group, *Data Report*, Nov 23, 1993.

20 *Scientific Evaluation*, HC-M, vol 2, chap 3.5.

The designers of the Original Project may have been aware of the "potential for eutrophication",[21] but no substantive, well-documented analysis of the impact of the Original Project appears to have been undertaken by them in this context. The potential impact is fully documented in the Hungarian Counter-Memorial.[22] It can be noted that according to the OECD eutrophication classification scheme for lakes and rivers, the river at present falls in the worst category, that observed changes over the past 30 years are striking, including the appearance of blue-green algae, and that simulations clearly indicate that the situation is made worse by the upstream reservoir. Any additional degradation has the potential to affect the river and its users for a long distance downstream.

The Slovak Counter-Memorial attempts to draw simplistic comparisons between the G/N Project and other dams.[23] It was noted above that risks of eutrophication are much lower on the upstream dams. No evidence has been presented by Slovakia to show that "eutrophication...has been extensively studied...in relation to this particular Project".[24]

In the Slovak Counter-Memorial, some counter-acting effects of the reservoir for eutrophication are mentioned, based on a 1985 Hungarian EIS.[25] However, these are hypothesised without any detailed supporting analysis.

In the Hungarian Memorial,[26] the EC Working Group Report of 23 November 1992[27] is quoted to indicate that the danger of harmful impacts on groundwater quality was recognised. Slovakia accuses Hungary of taking words out of context.[28] This is incorrect with respect to both a strict interpretation of Hungary's text and the general implications of the EC Report. The Hungarian text was making the simple point that the EC acknowledged the danger of harmful impacts of the reservoir. Its quotation of the EC Report is preceded by "Its report of 23 November 1992 stated that under certain conditions..."[29] and thus there is no incorrect use of the quotation. More importantly, it is correct that the specific EC quotation referred to the situation where 95% of the Danube flow was returned to the Old Danube, the first of 5 scenarios considered (but one of considerable

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21 SC-M, para 7.33.

22 *Scientific Evaluation*, HC-M, vol 2, chap 3.3.

23 SC-M, paras 7.31 and 7.34.

24 SC-M, para 7.34.

25 SC-M, para 7.35.

26 HM, para 5.44.

27 HM, Annexes, vol 5 (part 2), annex 14.

28 SC-M, para 7.36.

29 HM, para 5.44.

significance, indicating irreversibility of the project while the present dam remains). However, similar points are made by the EC for other scenarios. For example, for scenario B (the main part of the water to Gabčíkovo) –

> "The net impact of the reservoir on the surface water quality in the downstream Danube is expected to be negative for the first couple of years and uncertain in the long term."[30]
>
> "...the smaller velocities and much smaller depths in the Danube downstream the dam will result in significantly different (generally negatively) water quality conditions with regard to self-purification, oxygen conditions, eutrophication, etc."[31]
>
> "With regard to the conditions in the floodplain and associated areas on both sides this operation will result in a continuation of the immediate negative impacts experienced during the past weeks. In the longer term, the change in dynamics with much smaller fluctuations may in addition influence the groundwater quality in a negative direction."[32]

In paragraph 7.37 of the Slovak Counter-Memorial, three errors of understanding must be pointed out. Once again, Slovakia refers to monitoring as if that, in itself, guarantees a solution to any problem (however complex). Secondly, Slovakia uses short-term observations to argue that long-term effects will not occur (the variability of eutrophication effects is fully discussed in the Hungarian Counter-Memorial[33]). Thirdly, Slovakia appears to argue that taking the main part of the flow through the bypass canal would prevent eutrophication. While this may indeed minimise effects in the canal and part of the reservoir, it entirely ignores other areas of stagnant water in the reservoir and the entire remainder of the system, including the Old Danube channel and side-arms.[34]

Both the Bechtel and HQI Reports were regrettably superficial with respect to water quality,[35] and this was a general characteristic of the previous attempts at an EIS.

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30 HM, Annexes, vol 5 (part 2), annex 14 at p 460.

31 Ibid.

32 HM, Annexes, vol 5 (part 2), annex 14 at p 460.

33 *Scientific Evaluation*, HC-M, vol 2, chap 3.3.

34 *Plate 6.5*, taken near Dunakiliti, shows a stagnant reach of the Old Danube.

35 SC-M, para 7.36; see also the Bechtel and HQI reports (HC-M, Annexes, vol 4 (part 1), annex 1 and HM, Annexes, vol 5 (part 1), annex 9, respectively).

Slovakia mentions existing problems of eutrophication in the side-arm systems prior to the project.[36] It is correct that such water quality problems occurred, although it must be pointed out that the reduction in flows to the side-arm systems prior to project construction occurred as a result of gravel extraction and associated bed lowering, and that the situation has further deteriorated as a result of the construction. Slovakia also argues that this produced a deterioration in groundwater quality. As is fully explained in the Hungarian Counter-Memorial, the primary recharge source for the Szigetköz aquifer was good quality water from the main Danube channel, only replaced by poor quality water following the Danube diversion.[37]

4.4 GROUNDWATER

4.4.1 GROUNDWATER IN THE SZIGETKÖZ AND ADJACENT AREAS

Summary of Scientific Position

Groundwater flow

Prior to the diversion of the Danube, groundwater levels throughout the extensive (5 km^3) aquifer of the Szigetköz and adjacent areas were determined by Danube water levels. High water-table conditions occurred in the summer as a result of the seasonal pattern of Danube flows, and thus coincided with the period of maximum vegetation demand for water. This provided the environmental conditions to support the wetland vegetation of the Szigetköz and, where groundwater levels rose into the fine soil over the alluvial aquifer, natural sub-irrigation was provided to support agricultural crops.

The aquifer is a major potential water resource of naturally high quality water, although at present this is under-exploited.

Simulation results of the impact of the Original Project were reported in the Hungarian Counter-Memorial.[38] A radical change in the regional flow patterns was demonstrated. Instead of from the Danube channel, recharge mainly occurred from the reservoir and from the floodplain side-arm system. Average groundwater levels were predicted to increase near the reservoir, but to decrease in the riparian

36 SC-M, para 7.39.

37 *Scientific Evaluation*. HC-M, vol 2, chap 3.4.

38 *Scientific Evaluation*. HC-M, vol 2, chaps 3.3.2 and 3.4.2 and HC-M, vol 5, *Plates 3.10-3.12, 3.15* and *3.16* .

Plate 4.1 Siltation of the Čunovo Reservoir

Between July 1994 and January 1995 the water level of the Čunovo reservoir was decreased by some 2 metres. Significant areas dried out in the upper part of the reservoir, and vascular plants took root. Siltation after one and half years of operation has reached 40 cm in the lower part of the impoundment (photograph taken in Oct 1994) wetlands by in excess of 3 m. However, groundwater variability would also be reduced, leading to larger decreases in peak groundwater levels. An area of 300 km^2 was shown to suffer groundwater decrease on the Hungarian territory: sub-irrigation would reduce or be totally lost over an area of 167 km^2.

Predicted results for Variant C were qualitatively similar, and were supported by observed response following the Danube diversion.

Groundwater quality

Recharge from the Danube main channel is of high chemical quality. However, the change in recharge sources carries an important risk of water quality degradation. Fine sediments will be deposited in the reservoir (whether under the Original Project or Variant C). Recent low-water levels in the Čunovo reservoir have revealed that the fine sediments layer is already up to 40 cm deep *(Plate 4.1)*. This layer is expected to decay – organic decomposition consumes oxygen and can lead to chemically reducing conditions, and hence the mobilisation of iron, manganese and ammonium. Such effects are predicted for the reservoir and have already been observed to occur in the side-arm system.[39] They are well-known in the international literature, and have been observed for other Danube dams.[40] These processes are likely to develop over a period of years, and the contaminated water will propagate through the aquifer over a time-scale of decades. Propagation times have been estimated for the aquifer using isotopic tracers.[41]

Rebuttal of Slovak Assertions

The Resource

In their discussion of the importance of the Szigetköz aquifer,[42] Slovakia apparently misreads the Hungarian Memorial and confuses the water resources of the Szigetköz with the bank-filtered groundwater supply to Budapest. Estimates of the resource potential of the Szigetköz are of the order of 1 million m^3/day, which is comparable to the requirements of a city such as Budapest. Hungary thus demonstrated the relative magnitude of this valuable resource, but did not suggest that it would, in the foreseeable future, be used to supply that city. Hungary did however point out that the area affected by the Gabčikovo-Nagymaros Project included the bank-filtered groundwater supply to Budapest. On the basis of their

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39 *Scientific Evaluation*, HC-M, vol 2, chap 3.5.2.3.

40 See *Scientific Evaluation*, HC-M, vol 2, chap 3.5.2.1.

41 *Scientific Evaluation*, HC-M, vol 2, chap 3.4.1.1.

42 SC-M, paras 7.45-7.50.

misreading, Slovakia accuses Hungary of taking a position which is "scientifically untenable and deliberately misleading".[43]

Slovakia also claims an overstatement of the potential of the Szigetköz aquifer. But, the figure of 300,000 m^3/day quoted[44] is simplistic and represents potential abstraction based on the natural recharge from the Danube under pre-dam conditions. Significantly higher yields are available from the aquifer through the development of bank-filtered resources. Recent estimates indicate potential yields of 1.3 million m^3/day.[45]

It can be noted that the Szigetköz can be developed for bank-filtered supply and that in its natural state the aquifer is predominantly recharged by Danube surface water. There is thus no contradiction or confusion in referring to "the largest bank filtered water resource in Europe" as Slovakia suggests.[46] In fact, confusion in this respect is introduced by the Slovak Counter-Memorial Illustration CM-4, which attempts to differentiate between well types, although both wells presented derive their recharge from the Danube.

The Nature of the Risks

Slovakia claims that Hungary alleges "immediate deterioration of water quality as a result of Project operation".[47] In fact, Hungary takes pains to emphasise the long-term nature of the environmental damage in the references cited.[48]

It is a characteristic of groundwater systems that response times for geochemical processes and the transport of contaminants are long. It is also generally recognised that, once groundwater is contaminated, remediation may be impossible. The fact that degradation is expected to be a long-term process is presented by Slovakia as an indication that the threat is not serious.[49] International opinion does not concur with this line of reasoning.

In the same paragraph, Slovakia criticises Hungary for a lack of certainty in its risk assessment. This demonstrates lack of understanding of the underlying science.

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43 SC-M, para 7.46.

44 SC-M, para 7.46.

45 VITUKI, A szigetközi távlati felszín alatti vízbázis védelme (*Protection of the future groundwater resources of Szigetköz area*) Report for the Ministry of Transport, Telecommunication and Water Management of the Republic of Hungary, 1994.

46 SC-M, para 7.24.

47 SC-M, para 7.22.

48 SC-M, para 7.22, fn 30.

49 SC-M, para 7.51.

Given a complex environmental problem there are few certainties. It remains to demonstrate that a serious level of risk exists to resources of great value. This has been done, with full supporting evidence.

Slovakia states that "the simple fact is that there is no evidence that the Project will have adverse impacts on ground water quality, either immediately or in the future".[50] This statement has been clearly demonstrated to be false in the Hungarian Counter-Memorial.[51] As discussed, below, evidence is available from the Hungarian reach of the Danube and international dam experience, including the Austrian Danube, and adverse impacts were clearly anticipated by the leading Slovak scientists and international co-workers.[52]

Slovakia implies that lack of short-term evidence is a reassuring indication of no adverse effects.[53] This is an attempt to promote a naïve view of environmental impact. In addition to the observational evidence and simulation results presented by Hungary,[54] the international experience clearly shows that problems of groundwater quality are likely to be detectable only after several years.[55] Similarly surface water quality effects are known to be highly variable, depending on biological response to nutrient supply under particular climatic and flow conditions.

In paragraph 7.47 of the Slovak Counter-Memorial, Slovakia discusses the importance of the Žitný Ostrov/Szigetköz aquifer and states that "[i]t is scarcely likely that Slovakia would ignore any possible threat to the purity of this water resource". It does indeed seem remarkable that Slovakia should have proceeded with the reservoir given the international experience of groundwater degradation[56] and the widely publicised concerns of their senior scientists.[57] The conclusion can

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50 SC-M, para 7.29.

51 *Scientific Evaluation*, HC-M, vol 2, chap 3 5.

52 I Mucha, *Danubian Lowland – Ground Water Model (Annex 2 from PHARE)*, Bratislava, August 1990; J C Refsgaard *et al.*, *An Integrated Eco and Hydrodynamic Model for the Prediciton of Wetland Regime in the Danubian Lowland Under Alternative Operation Strategies for the Gabčikovo Hydropower Plant*. London, June 1994; HC-M, Annexes, vol 4 (part 2), annexes 11 and 12, respectively.

53 SC-M, paras 7.62 and 7.64.

54 *Scientific Evaluation*, HC-M, vol 2.

55 *Scientific Evaluation*, HC-M, vol 2, chap 3.5.2.1.

56 Described in the *Scientific Evaluation*, HC-M, vol 2, chap 3.5.2.1.

57 I Mucha, 1990, (HC-M, vol 4 (Part 2), annex 11); Mucha and Paulikova, *Ground Water Quality in the Danubian Lowlands downwards from Bratislava*, 1991, 1(5) European Water Pollution Control 13 (HM, vol 5 (Part 1), annex 11).

be reached that Slovakia, in proceeding with the Project, has ignored warnings of the threat to this resource. [58]

The Role of Monitoring

There is a continuing theme throughout the Slovak Counter-Memorial that monitoring programmes are in themselves a solution to complex, partly understood environmental problems. This is nonsense, especially where long-term effects are anticipated.

Certainly extensive monitoring of groundwater levels took place, although even this could not be described as comprehensive. For example, Slovakia refers to a Hungarian network of 213 shallow (10 m) boreholes and 45 (40 m) survey boreholes,[59] but it must be remembered that the aquifer is several hundred meters deep and that the "typical" well in the Slovak Counter-Memorial Illustration CM-4 is at greater than 80 m depth. Similarly, recent observations of side-arm response have provided new insights into the complexity of surface water-groundwater interactions, as described in *Chapter 7*, below.

However groundwater quality issues remain to be resolved, as evidenced by the Slovak PHARE programme.[60]

The Nature of the Evidence

Where Hungary has provided scientific evidence, Slovakia relies on unsubstantiated assertion, for example it declares that "it is equally undeniable that this reservoir...will continue to be a good source of aquifer recharge".[61]

Slovakia consistently quotes the HQI and Bechtel studies to dismiss problems of groundwater contamination. Both of these studies were brief and necessarily superficial, not including field work or simulation runs, and cannot be presented as an alternative to detailed scientific studies.

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58 Cf SC-M, para 7.48.

59 SC-M, para 7.48, fn 74.

60 Mucha, 1990; HC-M, vol 4 (part 2), annex 11.

61 SC-M, para 7.52.

Misrepresentation of Data

With respect to groundwater data, the Slovak Counter-Memorial is apparently deliberately misleading. Slovakia claims exaggeration of groundwater decreases,[62] but confirms the Hungarian statistics in its own illustration.[63]

Slovakia also claims contradiction in the Hungarian position on observed groundwater level decreases, but achieves this by misreporting a Hungarian statement[64] that, for the middle areas of the Szigetköz, "the subsidence is 0-1 meter" as "a decrease of just 0.5 m".[65]

Further, the Slovak diagram[66] appears to show impacts of groundwater recharge which are simply incorrect. *Plate 4.2* presents the Hungarian data for comparison. It can be seen that the beneficial effects of the recharge system have been wholly misrepresented.

Once again, in representing historical changes to groundwater levels (between 1960 and 1990),[67] Hungarian conditions (at least) are erroneously presented. *Plate 4.3* shows the true change in average groundwater levels in comparison with the Slovak claims. The latter is shown to be a significant exaggeration of water level decreases.

Slovakia states that "...toxic hydrocarbons are not found in the Danube's sediments save for near the Slovnaft refinery".[68] This is incorrect. For example, benzo(a)pyrene, a toxic (carcinogenic) polyaromatic hydrocarbon, has been recorded at Bratislava (rkm 1869), Komárom (rkm 1768) and Szob (rkm 1707) as part of the joint Hungarian-Slovak monitoring programme.[69]

Misrepresentation of Processes

Paragraph 7.60 of the Slovak Counter-Memorial quotes the EC to confirm the high quality of groundwater as well as of Danube recharge and makes a clear assertion of the high quality natural state. However, Slovakia also states that there

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62 SC-M, para 8.23.

63 SC-M, illus CM-13

64 SC-M, para 8.23, fn 39.

65 SC-M, para 8.23.

66 SC-M, illus CM-13.

67 SC-M, illus CM-5.

68 SC-M, para 7.59.

69 Hungarian-Slovak Boundary Water Commission, Water Quality Subcommission, Protocol, March 21-25, 1994.

is no evidence of deterioration in recharge water. Clear evidence to the contrary was reported in the Hungarian Counter-Memorial.[70]

The Slovak Counter-Memorial confirms a lack of awareness of the basic water quality concerns.[71] It is the generation of reducing conditions that is precisely the concern with respect to mobilisation of metals, and this can readily occur due to sediment decomposition.[72] Problems of contaminants in sediments cannot simply be dismissed.[73] As noted in the Hungarian Counter-Memorial,[74] maximum observed heavy metal concentrations are consistently higher than limit values.

Slovakia argues that eutrophication in Hungarian side-arms is solely due to a failure to implement side-arm recharge.[75] This is an over-simplification of a complex system response. In the Hungarian Counter-Memorial[76] the effect of the reservoir (for both the Original Project and Variant C) on increasing algal productivity and hence the quality of side-arm flows is demonstrated. The construction of a weir, as proposed in the Slovak Counter-Memorial, to allow increased flows to the Hungarian side-arm system would create an additional impounded section in which further increases are expected. Increased flows to the side-arm system would reduce eutrophication in the side-arms only at the expense of further algal increases in the Old Danube channel below the weir.

Slovakia argues[77] that the system can be managed through remedial measures. This is countered in detail in *Chapter 7* of this Rebuttal, below.

Additional flows to the Mosoni Danube would, in general, be beneficial,[78] but it must be recalled that under the Original Project, flow reversal would have occurred, with serious adverse water quality effects[79] and that as a result of the Danube diversion, fish mortalities occurred. In its associated footnote[80] it is suggested that groundwater recharge from the Mosoni Danube would reduce sulphate concentrations in the vicinity of Rábca and Hanság. In fact, high sulphate

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70 *Scientific Evaluation*, HC-M, vol 2, chap 3.5.

71 SC-M, para 7.54, fn 83.

72 *Scientific Evaluation*, HC-M, vol 2, chap 3.5.

73 SC-M, para 7.55.

74 *Scientific Evaluation*, HC-M, vol 2, chap 3.3.1 5.

75 SC-M, para 7.58.

76 *Scientific Evaluation*, HC-M, vol 2, chap 3.3.

77 SC-M, paras 7.56-7.58.

78 SC-M, para 7.63 .

79 *Scientific Evaluation*, HC-M, vol 2, chap 3.3.

80 SC-M, para 7.63, fn 97.

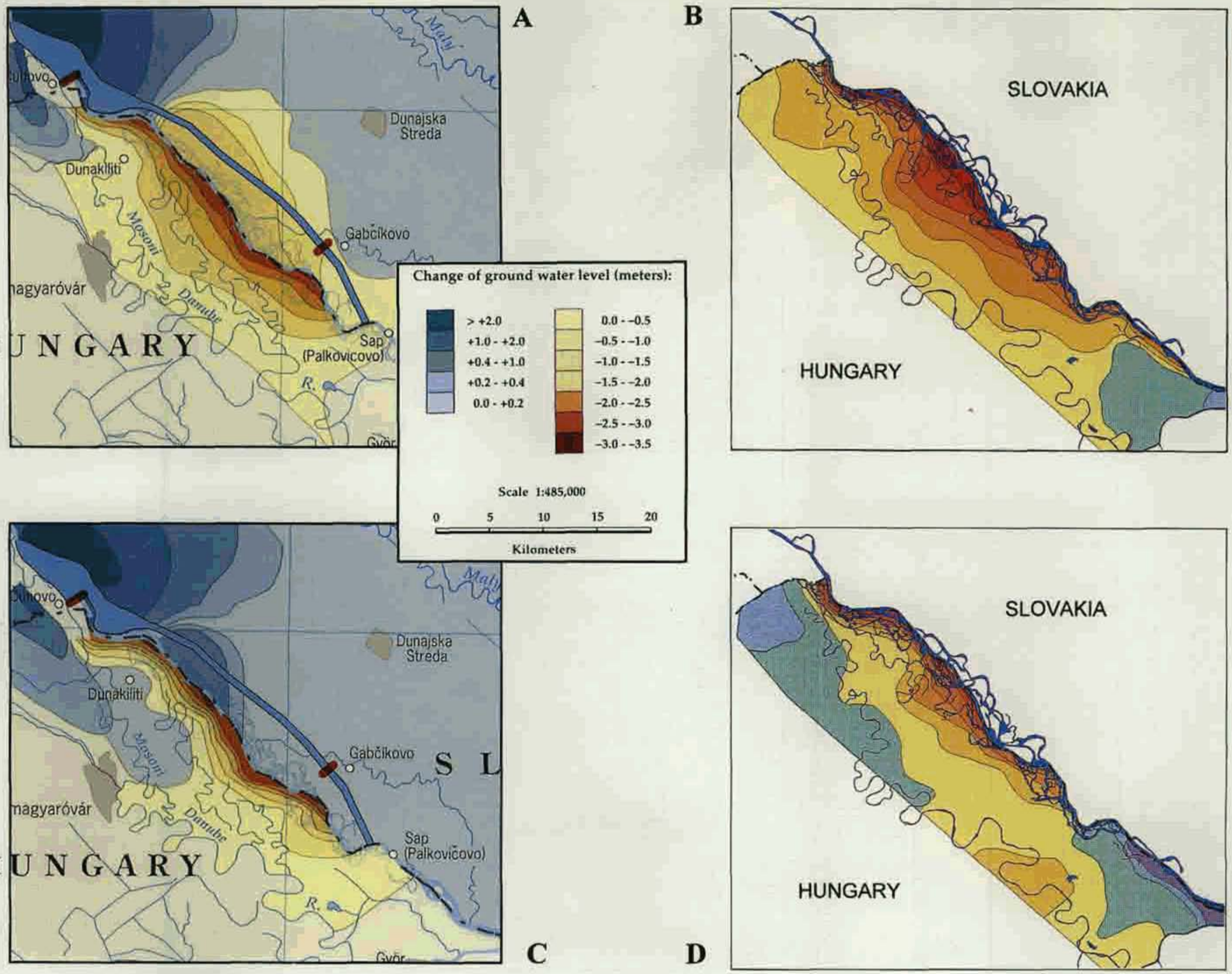

Plate 4.2 Changes in Groundwater Level in 1993

A. Spring 1993 (as presented in SC-M, illus CM-13)
B. Observed water level differences in Hungary (March 15, 1993 level compared with the 1981-1990 average)
C. July-September 1993 (as presented in SC-M, illus CM-13)
D. Observed water level differences in Hungary (Sept. 1, 1993 level compared with the 1981-1990 average)

Scale 1:485,000

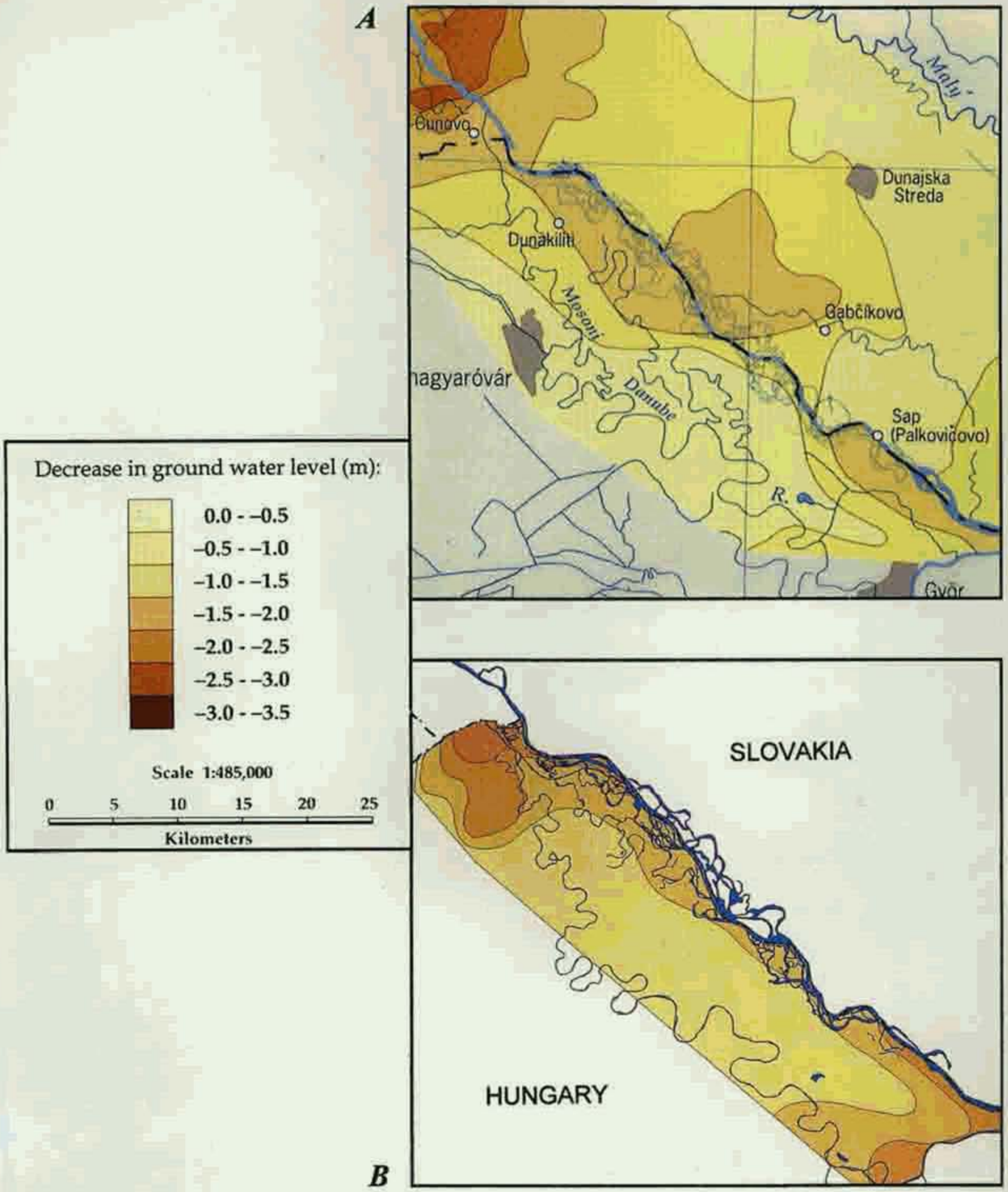

Plate 4.3 Decrease in Groundwater Levels between 1960 and 1990

A. As presented in SC-M, Illus. CM-5.

B. Observed decrease on Hungarian territory between 1960 and 1990 (annual averages)

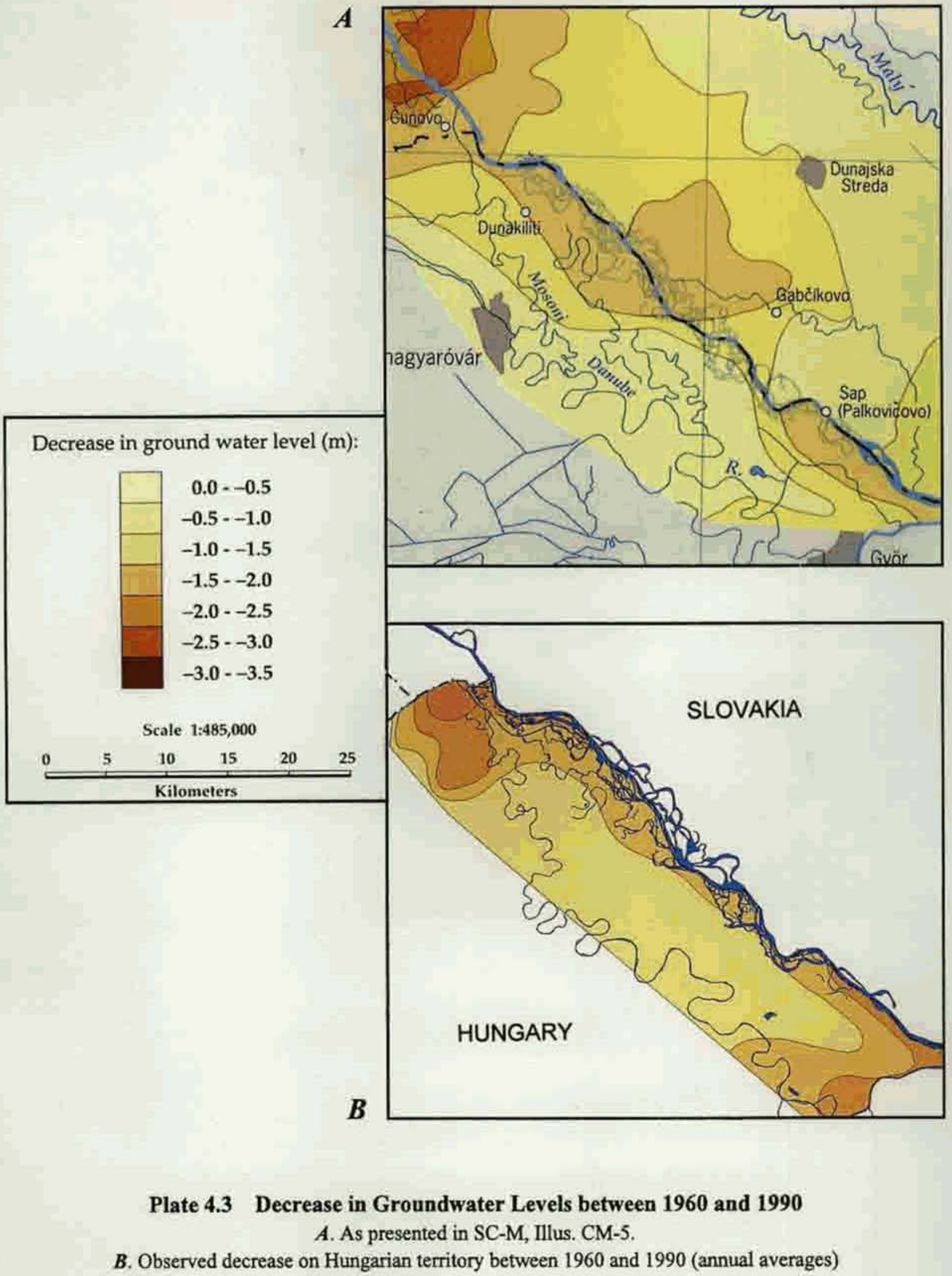

Plate 4.3 Decrease in Groundwater Levels between 1960 and 1990

A. As presented in SC-M, Illus. CM-5.

B. Observed decrease on Hungarian territory between 1960 and 1990 (annual averages) concentrations do occur in this region (concentrations exceeding 1000 mg/l), but the effect of a slightly increased Mosoni Danube recharge would be negligible; the groundwater has a different origin in this region.

4.4.2 GROUNDWATER DOWNSTREAM OF THE SZIGETKÖZ – BANK-FILTERED WATER SUPPLIES

Summary of the Scientific Position

Downstream of Gönyü, the large alluvial cone which underlies the Szigetköz gives way to thinner and discontinuous alluvial aquifers of limited areal extent. However the hydraulic connection with the Danube remains a dominant influence, and many of these aquifers have been developed for bank-filtered groundwater supplies, most notably in the vicinity of Budapest. In the reach between Gönyü and Nagymaros subject to backwater influence from the Nagymaros reservoir, existing well-fields have a capacity of 30,000 m^3/day. Below Nagymaros, 64% of the Budapest water supply comes from well-fields to the north of the city. This is obviously of major strategic importance to Hungary.

Concern for the impact of the Gabčíkovo-Nagymaros Project relates to the yield and quality of these supplies, primarily due to the Nagymaros power station and its operation. Hungarian experience has been that where gravel layers in the riverbed have been reduced in thickness, well yield has been reduced and there is an associated increased risk of pollutant ingress. Changes to river sediment distribution have led to the deposition of fine sediments adjacent to wells, and the degradation of these sediments has followed the processes described above, leading to long-term deterioration of well water quality.[81]

It is calculated that in the backwater reach of the Nagymaros dam, sediment deposition will affect the quality of bank-filtered supplies. Just downstream, recent sediment changes, believed to be due to the Nagymaros coffer dam, have resulted in serious quality degradation at two wells.[82]

Downstream of Nagymaros, further dredging was planned in conjunction with the Original Project in order to increase the head for energy production.[83] According to the Joint Contractual plan, bed-levels were to be lowered in the reach below Nagymaros leading to a reduction in low-flow water levels of 0.6-1.2 m, thus reducing the available filter-zone of wells extracting bank-filtered water for the

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81 *Scientific Evaluation*, HC-M, vol 2, chap 3.6.

82 *Scientific Evaluation*, HC-M, vol 2, chap 3.6.3.2.

83 HC-M, Annexes, vol 4 (part 1), annex 6 at p 401.

supply of Budapest. Industrial gravel exploitation in this reach was stopped in 1980 for this very reason. This is particularly important because in this reach, the thickness of the saturated gravel layers is just 2-7 m.[84] Further bed degradation could be expected due to erosion. Taken in conjunction with changing patterns of sediment deposition, it is concluded that there is a serious risk to Budapest water supplies, in terms of yield and quality.

Rebuttal of Slovak Assertions

The Slovak Counter-Memorial refers to Hungarian concerns as "simple speculation",[85] states that "assertions without scientific basis have been made"[86] and accuses Hungary of a breach of treaty obligations in not carrying out sufficient research.[87] The detailed studies reported in the Hungarian Counter-Memorial[88] supplement earlier studies and provide more than adequate refutation of these points.

4.5 COLMATATION

Summary of the Scientific Position

The inter-relationships between surface water and groundwater are fundamental to the determination of the impacts of the Project with respect to groundwater recharge, groundwater quality, and the effectiveness of remedial measures. These depend on the near-surface hydrogeological conditions, which reflect the history of alluvial deposition of the Szigetkoz and Žitný Ostrov, but will also be strongly affected by changing patterns of sediment deposition, both in the reservoir and side-arm system. These issues have been discussed in detail in the *Scientific Evaluation*,[89] but it is worthwhile to reiterate here that the processes are complex and poorly understood.

It was expected that significant sediment deposition would occur in the Dunikiliti-Hrušov Reservoir, and that has now been observed for Variant C (*Plate 4.1*).[90] The long-term implications for groundwater recharge from the reservoir are

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84 P Molnár, A Szentendrei-sziget földtani és vízföldtani viszonyai. (*Geological and hydrogeological assessments of the Szentendre Island*), MÁFI Report, 1994, MÁFI Archives.

85 SC-M, para 7.66.

86 SC-M, para 7.67.

87 SC-M, para 7.68.

88 *Scientific Evaluation*, HC-M, vol 2, chap 3.6.

89 HC-M, vol 2, chap 3.4.

90 Molnár, 1995; HR, Annexes, vol 3, annex 2.

uncertain, but it is clear from the groundwater simulation studies that, following the diversion of the main Danube flows, reservoir infiltration is a most important source of recharge to the regional aquifer, and that this will be restricted by the colmatation processes. It will be recalled from the *Scientific Evaluation*,[91] that simulations have predicted that degradation of fine sediments will lead to a major change in the chemistry of groundwater recharge, leading to degradation of the groundwater resource.

For the Danube channel below the reservoir, changing patterns of sedimentation are expected, and observed changes are discussed in *Chapter 3*, above and annex 2.[92]

For the side-arm system, there are a number of complex, and unresolved scientific concerns. It is evident that the present side-arm system has a complex geomorphology (discussed in *Chapter 7*, below), and includes a wide range of conditions, varying from old, silted branches to recently excavated, gravel bed sections (*Plate 7.1*). Prediction of the effects of different flow regimes on the distribution of fine sediments is uncertain, but sediment deposition will lead to reduced channel bed infiltration (colmatation) and hence reduced groundwater recharge. In addition, chemical degradation of the sediments will lead to degradation of groundwater quality, as is already observed.[93] However, other processes must also be considered as important controls on groundwater recharge from the side-arm system. Continuous infiltration is expected to lead to a reduction in the hydraulic conductivity of the bed, even under gravel bed conditions, due to progressive blocking of the gravel pores with fine sediment materials. In the natural situation of varying water-table conditions, reverse flows (exfiltration) will occur to flush the bed. This will not occur in the managed state. An additional factor is the subsurface hydrogeology, which includes a complex, heterogeneous stratigraphy, due to the pattern of alluvial deposition. The combined effect of these last two factors is that even under conditions of free-flowing, newly excavated, gravel bed side-arm sections, simple hydraulic connection between surface water and groundwater is not observed.[94] This is discussed further in *Chapter 7*, below.

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91 HC-M, vol 2, chap 3.5.2.2.

92 Molnár, 1995; HR, Annexes, vol 3.

93 *Scinetific Evaluation*, HC-M, vol 2, chap 3.5.

94 Molnár, 1995; HR, Annexes, vol 3, annex 2.

Rebuttal of Slovak Assertions

Slovakia states that colmatation "had been given careful study by the Treaty parties and by independent experts."[95] However, no study addressing colmatation has been submitted by Slovakia, and the independent experts were, to our knowledge, limited by time, data and resources to preliminary, rough calculations.

Slovakia implies, that flushing of fine sediments is sufficient to guarantee good infiltration conditions.[96] This is not the experience of current Hungarian field investigations.[97] With respect to the performance of the Slovak side-arm recharge systems, it should be noted that the data presented[98] are extremely limited with respect to the distribution of wells in the recharge areas and the associated time-series data.

Slovakia claims that the construction of weirs in the old riverbed would not lead to colmatation.[99] Again, prediction of colmatation based on sedimentation-erosion processes on channels is highly uncertain, especially when it is considered that even thin layers of fine sediments could substantially decrease infiltration rates. Observed sedimentation of fines on the backwater reach of the old bed above the conjunction with the power canal, (*Plate 3.1b*) as well as in areas of stagnant water along the banks in free-flowing sections *(Plate 6.5)* indicate that siltation is actually occurring in the main channel to a greater extent than expected. The construction of the weir at rkm 1843 with a crest level of 121.8 m a.s.l. above the bed will inevitably lead to a considerable deposition of fines with subsequent increase of riverbed resistance to infiltration. As is well known from Austrian reservoirs, flood flows will erode only a certain part of the deposits and in the long run, an equilibrium between deposition and erosion will evolve.

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95 SC-M, para 7.41.

96 SC-M, paras 7.42 and 7.43.

97 Chapter 7, below.

98 SC-M, para 7.42, fn 61; quoting the EC Working Group, *Data Report*, Nov 1993 (HM, Annexes, vol 5 (part 2), annex 18 at p 707).

99 SC-M, para 7.44.

CHAPTER 5

WETLAND ECOLOGY AND VEGETATION

5.1 THE IMPACT OF THE ORIGINAL PROJECT

Summary of the Scientific Position

The Szigetköz has an exceptionally high ecological and protectional value on a European scale.[1] Together with the Slovak Žitný Ostrov, it has been a functioning, active floodplain containing a large area of islands, side-arms, natural and planted forests and fringe forests, meadows and swamps, reedbeds and arable land prior to the diversion of the river.[2] In spite of previous human activities, all these habitats were still governed by the dominating dynamics arising from periodic and episodic floods with associated fluctuating levels of surface and groundwater.[3] In particular, the active floodplain had kept its dynamic character despite slight changes in the hydrological regime resulting from dropping low-flow water levels.

The hydrological changes following implementation of the Original Project would have seriously affected the habitats and biota of the active and protected floodplain in the Szigetköz. This includes a halt to the morphological processes, a drastic decline of the ecological functions, a change and reduction of species composition, the disappearance of sensitive indigenous species and the invasion of species of lower sensitivity – predominantly common weeds. The highly fluctuating water levels induced by peak power would have had a devastating effect on the terrestrial and aquatic fauna and vegetation downstream of Gabčíkovo including the lower part of the old riverbed up to rkm 1823. The damming at Nagymaros would have submerged some 20 islands and most of the shoreline, whereas downstream of the barrage, sites would have been lost due to the envisaged lowering of the riverbed. Summarising these main effects, the construction and operation of the Gabčíkovo-

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1 HM, vol 1, appendix 1; HC-M, Annexes, vol 4 (part 2), annex 18, According to the flora-fauna-habitat directive of the European Union (directive 92/43/EEC from May 21, 1992), the major part of its area would have to be protected; its natural softwood riparian forests covering about 800 ha would have to be protected *with priority*!

2 HM, paras 1.06-1.14 and 5.10; HM, Annexes, vol 5 (part II), annex 20; H-CM, paras 1.54 and 1.147.

3 *Scientific Evaluation*, HC-M, vol 2, chap 4.3.1 and Annexes, vol 4 (part 2), annex 16 at p 676.

Nagymaros Project would change the character of the riverine wetland entirely by destroying most of its natural values and ecological functions.

Presentation of New Data

a) Wetland vegetation[4]

Systematic monitoring of wetland vegetation, which only started in 1986, showed that the habitats in the Szigetköz were remarkably diverse and preserved in an almost natural state. This unique area had preserved its original biocoenoses possessing 1,008 species of vascular plants 10% of which are protected including Red Listed and endemic species. 80 plant communities are identified, clearly exceeding the number for similar floodplains at Wallsee or in the Vienna Basin in Austria and in the vicinity of Baja in Hungary. During the study of willow woods and riparian softwood forests, it also became apparent that the degree of degradation of forests and meadows was much lower on the wet floodplain of the Szigetköz than elsewhere in the Danube valley.[5]

Eleven characteristic forest communities (including forest-steppe) still exist in the relatively small area of 5,800 ha of forested land including original and almost natural associations, three of a relict character and another four which cover higher elevations. Aside from plantations, the main features of species composition had been preserved from the 1960s until the present day. Thirteen wetland plant communities thrived undisturbed in aquatic habitats and represented much of the landscape's beauty with their flowering mats. Another four very sensitive associations with a pioneer character occupied the silt banks of the active floodplain. Wet and ancient swamp meadows, hayfields and dry grassland communities as well as natural and man-made weed communities added to the biological diversity and variety of the Szigetköz.

In-depth monitoring concluded that the Szigetköz had managed to preserve its ecological potential throughout the period prior to the diversion of the Danube in 1992.

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4 See T Simon and M Szabó, *Impact of the G/N Project on Vegetation in the Szigetköz*, Budapest, 1995 (*hereinafter* Simon and Szabó, 1995); HR, Annexes, vol 3, annex 5.

5 HC-M, Annexes, vol 4 (part 2), annex 19.

b) Forestry[6]

A recent study from the Forest Research Institute referring to proposed water recharge programmes confirms these statements on the conditions prior to the diversion:

> "The majority of the stands grew under optimal conditions, which is demonstrated by the fact that the production capacity was high in 90, 74 and 71% of all stands for the hybrid poplars, willow and native poplar stands, respectively."

c) Aquatic fauna[7]

Anticipated impacts of the Gabčikovo-Nagymaros Project on the aquatic fauna can best be studied by looking at river reaches, which underwent similar alterations in flow regime. Numerous Austrian studies of benthic invertebrates demonstrate clearly the impacts of channelisation, impoundments and peak operation on the ecological quality of river sections with respect to faunal composition.

In general, the biodiversity of channelled and impounded stretches of the Danube is lower than free-flowing river reaches: the number of species inhabiting the main stream is reduced to some 50% of the original fauna. Biodiversity in the stretches embanked with rip-rap is especially low. Furthermore, these impoverished stretches are currently colonised by non-native, pollution-tolerant taxa that outcompete autochthonous species. Floodplains actively connected to the main channel shelter an extraordinary high number of aquatic species, as is shown by the existence of some 500 taxa downstream of Greifenstein and Vienna.

The impacts of peak operation on aquatic habitats and fauna was investigated in several 6th-7th order streams in Austria. It was found that the changes to habitats due to altered sedimentation-erosion processes in the affected river reaches, diminished the areas for spawning. In addition, the altered flow regime increased drift rates. Thus a reduction of invertebrate abundance and biomass was observed of 75-95% compared to undisturbed river reaches. The reduction of fish biomass was in the same order of magnitude and correlated to the amplitude of flow fluctuations.

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6 Z Somogyi, L Halupa and Gy Juhász, *Assessment of Long-term Changes in the Productivity of Forest Stands in the Szigetköz that can be Expected under Different Water Regimes*, Budapest, 1995 (*hereinafter* Somogyi et al., 1995); HR, Annexes, vol 3, annex 6.

7 Nesemann and Moog, 1995; HR, Annexes, vol 3, annex 4.

Detailed rebuttal of Slovak Assertions

The Slovak allegation, that as a "historical fact"[8] "regular water level fluctuations [in the Hungarian branch system] simply did not occur due to the region's isolation from the main river,"[9] is incorrect. The Szigetköz river branch system was not completely cut off from the Danube and its floods since the lower ends of the branches were still connected to the main channel. In addition, the high lateral transmissivity of floodplain sediments maintained groundwater dynamics despite a certain reduction in inundation frequency.[10] In this way, regular water level fluctuations were still able to control ecological processes in the active floodplain. Their influence had been gradually declining in the years before the diversion, but without causing significant damage to the ecosystem, as pointed out above. The dramatic change did not take place until the implementation of Variant C.

Slovakia claims in its pleadings that neither the Original Project nor Variant C imply an adverse effect on the environment.[11] For example, Slovakia declares that, with peak operation "the flora on the Danube river banks themselves would be affected but, that aside, no serious environmental risks ensued".[12] The destruction of riparian vegetation on a 120 km long river reach is in itself unacceptable. Adverse effects on the aquatic fauna are ignored.[13]

Slovakia frankly admits that a substantial part of valuable wetland forests will be lost when it states that a "species change would be inevitable"[14] in a 300 m band alongside the Danube. In fact, some of the most valuable near-natural forests stands are riparian forests along the banks of the Danube.[15]

The overall conclusion that "no significant [harm] done to the biological state of the water and no changes inducing ecological 'catastrophes' will occur"[16] is not

8 SC-M, para 7.100.

9 SC-M, para 7.99.

10 See Chapter 7.3 of this Rebuttal.

11 SC-M, chaps IV, VII and VIII.

12 SC-M, para 4.26, citing the Hungarian 1985 Impact Assessment.

13 See *Scientific Evaluation*, HC-M, vol 2, chap 4.4.1.3 and 4.4.2.4 for a summary of the main impacts on the aquatic fauna.

14 SC-M, para 4.26.

15 Simon and Szabó, 1995; HR, Annexes, vol 3, annex 5.

16 SC-M, para 4.26, citing the Hungarian 1985 Environmental Impact Assessment.

shared by independent experts.[17] The WWF, after re-examining its position, concludes that there is a "severe impact of the Gabčíkovo scheme on the biodiversity of the Danube floodplain".[18]

The paragraphs devoted to aquatic fauna in the Slovak Counter-Memorial are very short and limited, dealing only with fish and based on a "brief exposition of the Project's expected impact on the region's fish set out in Annex 25".[19] This paper describes the well known degradation of the ichthyofauna from the 1960s up to the damming of the Danube, and it correctly predicts substantial changes in the species composition of fish fauna in the upper reservoir.[20] Nevertheless, the author of the study concludes, in plain contradiction to his own results, that "no great changes will occur in the species' of the ichthyofauna of the reservoir as compared to the main flow".

It is surprising that Slovakia did not request this report from Prof. J Holčik, a world renowned Slovak ichthyologist and ecologist, member of the Slovak Academy of Sciences in Bratislava, and "the only scientist recommended by all sides: Greens, Slovaks and Hungarians",[21] who states:

> "With...vanishing all the arms on either side of the present floodplain stretching between Hrušov and Palkovičovo, the losses will be the highest. The total ichthyomass will decrease in the entire section between Bratislava and the Nagymaros Reservoir by 75 %, available production by 75 %, and the possible yield by 91-82 %. The section which will be the most affected is that adjacent to the old Danube bed where total losses in all parameters of this alternative exceed 95 %, and on a unit area basis 80 %. Highest losses will be in production and yield, since after completing of the construction programmed, the present production of the floodplain and accompanying yield increases in the high water years will cease to exist. In the optimal alternative, i.e. if the arms are partly preserved, the

17 See HC-M, Annexes, vol 4, annexes 3 and 4; see also J Lösing, 1989, Ecological problems of the Danubian barrage system Gabčíkovo-Nagymaros (CSSR-Hungary) (in German), *Natur und Landschaft* 64 (2): 64-67; incidentally, an analysis of the neighbouring, upstream stretch of the Austrian Danube arrived at similar results: E. Dister, 1984. To the problematical nature of the intended Danubian barrage near Hainburg/Lower Austria (in German), *Natur und Landschaft* 59 (5): 190-194.

18 SC-M, Annexes, vol 2, Annex 37.

19 SC-M, para 7.104.

20 It is even mentioned that the idea of constructing fish passes at Gabčíkovo or Dunakiliti "was abandoned because given the anticipated hydrological regime and the particular composition of the ichthyofauna, the effectiveness of fish passes is eliminated" (SC-M, Annexes, vol 2, annex 25); i.e., the reservoir eliminates all typical rheophile migrating fish species.

21 F Pearce, *New Scientist*, 17 September 1995; SC-M, Annexes, vol 2, annex 19 at p 176.

losses expected will be from one half to one third of those in the least favourable alternative."[22]

5.2 THE IMPACT OF VARIANT C

Summary of the Scientific Position

Variant C has produced the same fall in the water level that would have occurred after the implementation of the Original Project, but affects a longer reach of the Danube. Therefore, as anticipated, all alluvial biotopes of the Szigetköz lost the specific character of floodplain territories.[23] As a result, floral and faunistic communities will present a drastic decline in biodiversity in the near future, the first signs of which are now visible as demonstrated below. The loss of water connections between the main channel and the diverse waterbodies of the floodplain adversely impacts the functioning and productivity of this alluvial wetland ecosystem in both its aquatic and terrestrial (riverine) components.

At the moment, the affected stretch of the Danube is suffering from various kinds of damage and will continue to do so in the future. Sediment load is reduced significantly by its retention in the Čunovo reservoir (*Plate 4.1*). Prior to the closure of the Danube, sediments played an important role in the ecosystem by silting up the floodplain, providing nutrients and physical stress to the biota. The diversion severely impacted the Szigetköz due to the sudden lowering of the water level in the main channel and the accompanying complete dessication of several paleopotamic[24] habitats such as the Lipót area. Most of the paleopotamic water bodies disappeared. The order and balance among the faunal and floral communities were upset by radical changes, most obvious in the significant short-term change in the fish fauna. Typical wetland vegetation habitats with water-weed and marsh communities were seriously damaged. With regards to forest vegetation, 5% of the trees were classified as dead at the end of 1993.

Variant C's exceptionally low water level in the Old Danube reduces the active floodplain habitat to a rather small area only incorporating low and extremely low elevations. Since these levels covered just 7% of the forest stands in the Szigetköz

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22 J Holčik, I Bastl and M Vranovsky 1981, Hydrology and Ichthyology of the Czechoslovak Danube in relation to predicted changes after the construction of the Gabčikovo-Nagymaros River Barrage System, *Práce Lab. Rybár. Hydrobiol.* 3: 19-158. (*hereinafter* Holčik *et al*, 1981).

23 HC-M, paras 3.57 and 3.58; *Scientific Evaluation*, HC-M, vol 2, chap 4.

24 paleopotamic habitat ~ former river habitat

Plate 5.1a New Vegetation Cover on the Abandoned Riverbed

Two years after the diversion, young willow shoots densely cover the exposed riverbed, probably to be overshadowed and eliminated in the next ten years by the more competitive and faster-growing poplars. This could jeopodise operation modes for closing Gabčíkovo and directing ice floes through the Čunovo structures. The young poplar in the foreground indicates the mean Danube water level before the diversion

Plate 5.1b Bank of a Slovak Side Arm Indicate the Lack of Floods

Canadian golden-rod (*Solidago canadensis*) standing in the foreground indicates the lack of floods – the weed only tolerates floods for a few days.
On the left, is part of a cross-dyke, which has neither been reinforced nor raised

before the implementation of Variant C,[25] the floodplain's actual area will decrease to an amount which does not exceed this range.

The long-term effects will be felt over a much greater area. The entire active floodplain needs frequent inundations and large fluctuations of the groundwater table in order to maintain its essential functions as a riverine ecosystem. High floods of a week or more during the summer half-year used to select adaptive species and provide nutrients, and ensure a good oxygen supply to the root zone.

The morphology of the old riverbed had preserved its natural character despite a gradual decline. Since 1992, it has altered its flow regime significantly with subsequent changes in habitat conditions, i.e., the creation of stagnant waters with eutrophication and siltation (*Plate 6.5*).

Presentation of New Data

a) Wetland Vegetation[26]

A comprehensive study from the Department of Plant Taxonomy and Ecology, Eötvös University, determined changes in flora, indicator populations, plant communities and observation areas. Although obvious changes in forest communities will only manifest in the long-term, the size of the assimilatory leaf area is an excellent indicator of changes in water supply at a given habitat. *Figure 5.1* shows the results of a survey of four tree species.

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25 See Somogyi *et al.*, 1995; HR, Annexes, vol 3, annex 6.

26 Simon and Szabó, 1995; HR, Annexes, vol 3, annex 5.

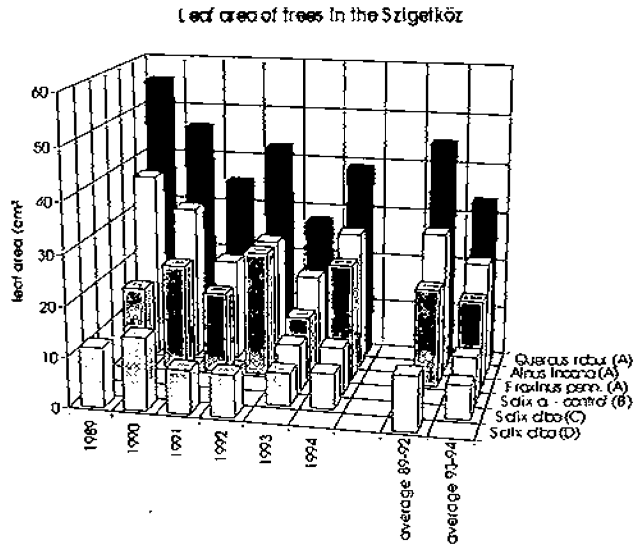

Figure 5.1. Leaf area of trees in the Szigetköz before and after the implementation of Variant C.[27] *Localities of the samples:*

site A - Dunasziget, hardwood riparian forest within the Szigetköz;
B - Vének, softwood riparian forest, control plot;
C - Dunaremete, softwood riparian forest, impacted by diversion;
D - Kisoroszi, softwood riparian forest, outside of the Szigetköz.

The influence of Variant C is clearly reflected in the reduction in leaf area values, amounting to 20-28%. All tree species now experience a sub-optimal water supply, which can lead to extinction within a few years, especially in the case of willows.

Investigations of other morphological features support these conclusions. The shoot height of the Common Reed (*Phragmites australis*) was 10-25% lower on sites in the Szigetköz after the diversion, than on unaffected control plots, indicating the beginning of a rather rapid habitat transformation in the protected marsh-reed communities.[28] The average leaf area and shoot height of Tall Plantain

27 See HR, Annexes, vol 3, annex 5, *Table 1*. In the Middle Szigetköz (site A) for the Grey Alder (*Alnus incana*) and the Common Oak (*Quercus robur*) the average leaf area in the two years after the diversion (1993-1994) was 20% and 26% lower than that for the years prior to it (1989-1992), respectively. The high precipitation in 1994 proved to be beneficial for the trees especially for the disturbance tolerant North-American Pennsylvanian Ash (*Fraxinus pennsylvanica*) but even they did not reach their previous values.

28 HR, Annexes, vol 3, annex 5, *Fig. 2*.

Vegetation Potential of the Szigetköz (Pre-dam Conditions)

Original near-natural state, based on surveys between 1980-1992

Scale: M = 1:100,000

0 — 5 km

Legend

- *I. Flooded forests and aquatic-marsh vegetation*
- *II. Wet forests and meadows*
- *III. Damp forests and meadows*

(exact definitions of vegetation groups: see text)

Plate 5.2

(*Plantago altissima*) growing in impacted meadows in the Middle Szigetköz, decreased to half or even one third of control samples indicating ultimately the current destruction of the highly diverse flood meadows.[29] The mean leaf size of the Yellow Water-lily (*Nuphar lutea*) was 50% and 75% lower than that of the controls in 1993 and 1994, respectively so that the species' complete extinction is anticipated within three years in the terrestrialised wetlands of the Szigetköz.[30]

Changes in plant communities also prove the detrimental effects of Variant C and confirm the generalisation of the indicators' results. The measurements and field surveys carried out in the monitoring programme unambiguously showed habitat degradation, first of all drying and invasion of weeds, and the first steps of vegetation pattern transformation. *Plate 5.1a* shows an example of the rapid colonisation of the newly created terrestrial habitats and *Plate 5.1b* illustrates the invasion of weeds.

The original state of the potential natural vegetation pattern surveyed in the Szigetköz between 1980 and 1992, is shown in *Plate 5.2.*

The Original Project would have destroyed completely about 4,500 ha and partially 3,500 ha of the floodplain vegetation potential (*Plate 5.3*). Most importantly, the complete willow-poplar forest (zone I), with an average width of 3 km in the Szigetköz active floodplain, would practically disappear on an area of approximately 6,500 ha, together with its associated pondweed-marsh habitats. Wet forests and meadows (zone II) are only expected to survive with reduced vitality in a patch close to the Dunakiliti-Hrušov Reservoir. The potential willow-poplar zone would be replaced by dry forests and grasslands (zone IV) on approx. 1,000 ha and by a mosaic of dry and damp (mesophilic) forests and meadows (zones IV and III) on approx. 2,000 ha. Two major patches of this mosaic would develop in the protected floodplain outside the dykes on an area of almost 5,000 ha. The character of the entire vegetation inside the dykes will change due to the lack of regular floods, i.e., they will nevermore be alluvial vegetation but become a mixture of common floodplain species and additional lowland species.

Similar impacts were predicted for the long-term effects of Variant C. The changes in spatial cover with wetland vegetation (4,500 ha of complete and 3,500 ha of partial loss) will be very similar, too, as shown in *Plate 5.4*. A major difference between the two variants is that the dry riparian grasslands (zone IV) are anticipated to occur between rkm 1851 and 1837 on an area of about 1,000 ha. Between rkm 1832 and 1818 a mosaic of dry (zone IV) and damp forests (zone III) is predicted along the Old Danube. Wet forests (zone II) are anticipated to occur in

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29 Ibid, *Fig. 3.*

30 Ibid. *Fig. 1.*

an adjacent narrow belt. Another narrow strip is foreseen to be sustained along the Mosoni Danube.

b) Forestry[31]

A recent study from the Forest Research Institute predicts the long-term spatial decrease of the economically valuable hybrid poplars in the active floodplain of the Middle Szigetköz by 21% and a dramatic drop of willows by 95%. The expected long-term productivity will decrease accordingly.[32]

Rebuttal of Slovak Assertions

The Slovak Counter-Memorial devotes just two pages to the impacts of Variant C on the natural environment (flora, fauna, ecology), and furthermore, these pages only consider fish.

In its section on Variant C headed "Flora and Fauna",[33] Slovakia gives no new data or monitoring results to support its affirmations of a "successful implementation" of Variant C. Here again, Slovakia reiterates the benefits of "underwater weirs" which as indicated below[34] and in the Hungarian Counter-Memorial,[35] cannot be an ecological solution even if it were a hydraulic one.

No scientific evidence is given in the Slovak Counter-Memorial, no scientific arguments, only the assertion that "the [Slovak] floodplain and branch system of the river is preserved and restored".[36] The only "evidence" presented to support this statement are a number of photographs showing impounded Slovak side-arms artificially filled with water and surrounded by green forest.[37] From what is said above, it is clear that after two years diversion, a green forest is not evidence of a healthy wetland vegetation community. Even if groundwater levels were increased effectively, which is doubtful,[38] natural functioning is not restored and severe losses in biodiversity is inevitable.

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31 Somogyi *et al.* HR, Annexes, vol 3, annex 6.

32 See Chapter 6.2 of this Rebuttal.

33 SC-M, paras 8.35-8.39.

34 See below, Chapters 7.

35 HC-M, chaps 1 and 3; *Scientific Evaluation*, HC-M, vol 2, chap 4.

36 SC-M, para 7.27.

37 SM, illus 36A-D; SC-M, illus CM-6c and CM-18.

38 For a more detailed rebuttal of remedial measures, see Chapter 7 of this Rebuttal.

Expected Vegetation Potential of the Szigetköz (Original Project)

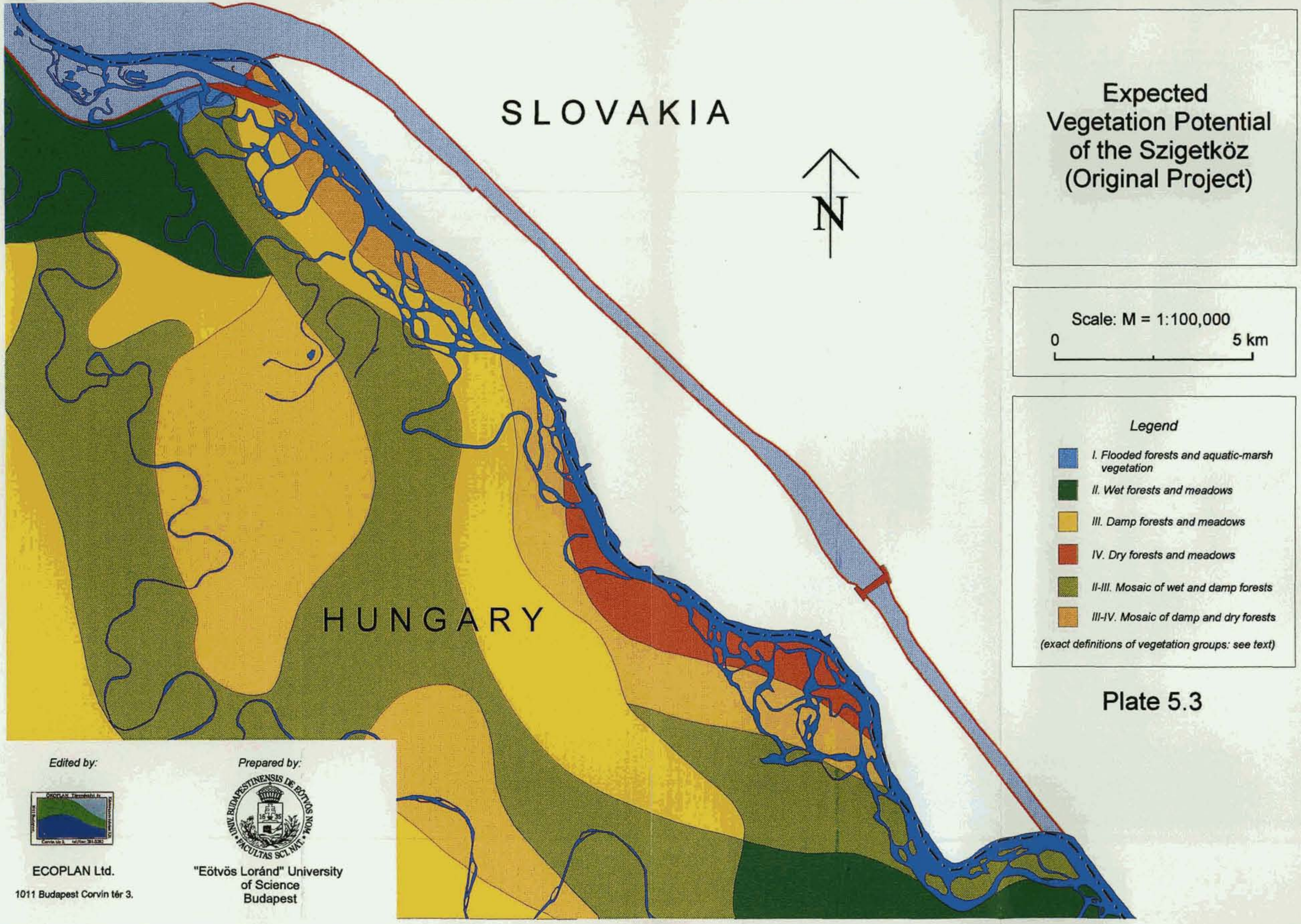

Plate 5.3

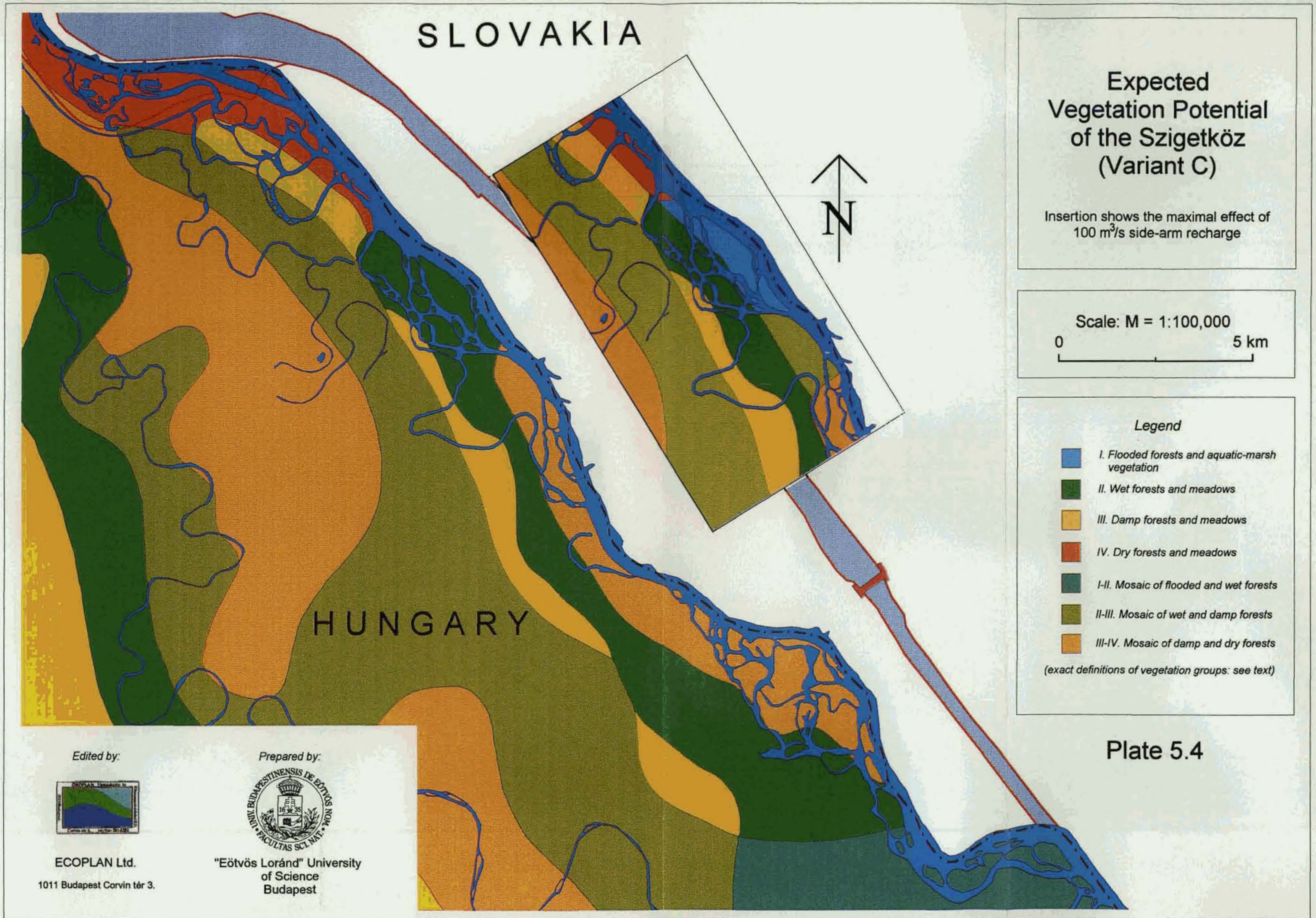
SLOVAKIA
HUNGARY
N
Expected Vegetation Potential of the Szigetköz (Variant C)
Insertion shows the maximal effect of 100 m³/s side-arm recharge
Scale: M = 1:100,000
0
5 km
Legend
I. Flooded forests and aquatic-marsh vegetation
II. Wet forests and meadows
III. Damp forests and meadows
IV. Dry forests and meadows
I-II. Mosaic of flooded and wet forests
II-III. Mosaic of wet and damp forests
III-IV. Mosaic of damp and dry forests
(exact definitions of vegetation groups: see text)
Edited by:
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Plate 5.4

CHAPTER 6

SOILS, AGRICULTURE, FORESTRY AND FISHERY

6.1 SOILS AND AGRICULTURE

6.1.1 SUMMARY OF THE SCIENTIFIC POSITION

In Hungary, the Szigetköz region is one of the most valuable territories from the point of view of agriculture as well as nature conservation. Soils are important determining factors of plant production and have a unique role in preserving the natural and semi-natural state of the landscape. In the Szigetköz, the particular groundwater conditions and associated soil moisture regimes have been a determining influence on soil (and hence landscape) development.[1] In addition, the natural water regime, which provided a natural sub-irrigation for much of the area, was an essential factor in enhancing agricultural productivity and reducing susceptibility to drought, as well as maintaining the natural ecosystems.

Short-term impacts of the Original Project would have involved a loss of this natural moisture supply over large areas of the Szigetköz.[2] Impacts with respect to forestry and natural ecosystems are discussed elsewhere.[3] For agriculture a loss of productivity and susceptibility to drought would have had severe consequences for the local economy. In the long term, soil structural change and modification of the soil nutrient status were expected. In particular, the soils have a high carbonate content, due to their alluvial origins, and the soil structure is sensitive to the development of carbonate accumulation layers which can lead to development of impervious horizons.[4] Changes to mineralisation were expected due to a change in aerobic/anaerobic conditions and the temperature regime, leading to loss of soil fertility.

In the vicinity of the Dunakiliti-Hrušov reservoir, water-table rises were expected, with associated problems including loss of aeration (affecting soil biota,

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1 The soil formation processes are described in the *Scientific Evaluation*, HC-M, vol 2, chap 5.1.2.

2 Quantified in *Scientific Evaluation*, HC-M, vol 2, chap 3.4.

3 Chapters 5 and 6.2 of this Rebuttal.

4 *Scientific Evaluation*, HC-M, vol 2, chap 5.1.6.

microbiological processes and nutrient regime), problems of tillage and machinery access, and occurrence of secondary salinisation/alkalisation processes.

Impacts of groundwater quality have already been discussed,[5] but obviously degradation of groundwater quality has implications for soils and soil water.

The observed impacts of Variant C have borne out the concerns for short-term adverse impacts, although the time-scales of change are in general, too slow for long-term effects to be readily discernable. The *Scientific Evaluation*[6] discussed observed groundwater changes. The impacts on agricultural production were difficult to quantify due to the complexity of interdependent factors such as climate and agricultural practices, but nevertheless these were estimated for 1993 based on a multi-factor analysis and shown to be significant.[7]

A more recent analysis of detailed agricultural and soils data[8] allows further definition of the soil water effects. In *Plate 6.2*, the average depth of groundwater in the growing season, based on an agricultural monitoring programme between 1980 and 1992, is used in conjunction with soils information to identify the conditions of natural sub-irrigation before dam construction. The corresponding conditions after completion of Variant C are shown in *Plate 6.4*. The dramatic reduction is evident (a 78.3% loss in agricultural areas in the Middle Szigetköz receiving natural sub-irrigation supply). This is further illustrated in *Figure 6.1*, which shows observed soil moisture profiles and associated groundwater levels at a representative location in the Szigetköz prior to, and following the completion of, Variant C. It can clearly be seen that the reduction in groundwater level is accompanied by a considerable loss in soil moisture.

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5 *Scientific Evaluation*, HC-M, vol 2, chap 3.5.

6 *Scientific Evaluation*, HC-M, vol 2, chap 3.4.3; see also Chapter 4.4 of this Rebuttal.

7 *Scientific Evaluation*, HC-M, vol 2, chap 5.2.3.

8 E Molnár, G Palkovits and K Rajkai, *Evaluation of the effect of the Danube Hydroelectric Barrage System on Soil properties and Agricultural Production in the Szigetköz Region*, Budapest, 1995.

SLOVAKIA
HUNGARY
N
Species of the Szigetköz Floodplain Forests (Pre-dam Conditions)
Scale: M = 1:100,000
0
5 km
Legend
hybrid poplars
native poplars
willows
hardwoods
inundation dyke
Edited by:
ECOPLAN Ltd.
1011 Budapest Corvin tér 3.
Prepared by:
Forest Research Institute Budapest

Plate 6.1

Forest Production and Agricultural Moisture Supply in the Szigetköz (Pre-dam Situation)
In the floodplain:
Long-term yield capacity of the forests
In the protected floodplain:
Observed natural sub-irrigation conditions in arable and grassland areas between 1980 and 1992
Scale: M = 1:100,000
0
5 km
Legend
forest production capacity
high
medium
low
sub-irrigation conditions
average depth of groundwater in the growing season (in centimetres)
direct moistening
indirect moistening
periodical moistening
inundation dyke
Plate 6.2
SLOVAKIA
HUNGARY
N
300
250
200
150
300
250
200
150
Edited by:
Prepared by:
ECOPLAN Ltd.
1011 Budapest Corvin tér 3.
Pannonian University of Agriculture
Forest Research Institute Budapest

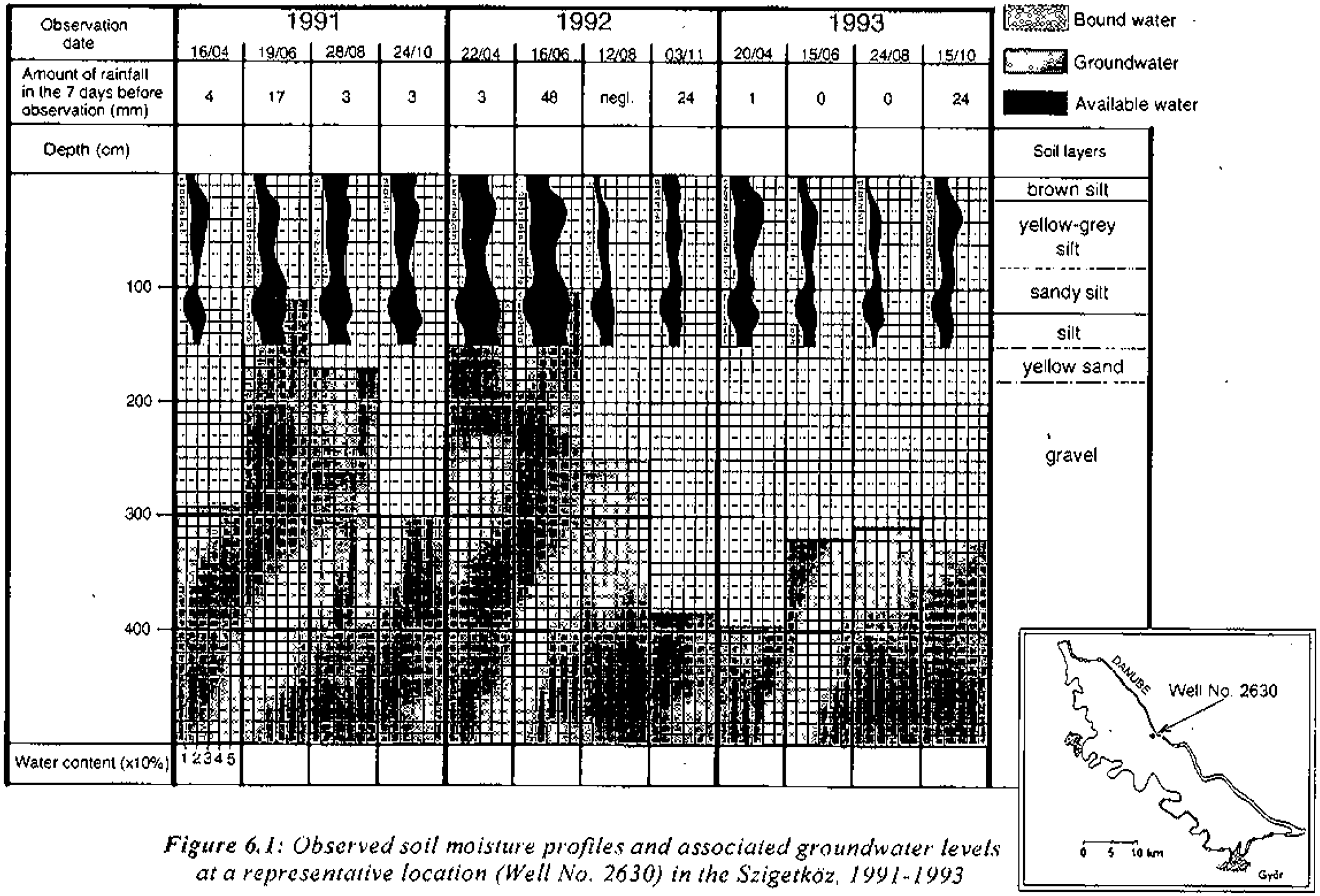

Figure 6.1: Observed soil moisture profiles and associated groundwater levels at a representative location (Well No. 2630) in the Szigetköz, 1991-1993

6.1.2 Critique of Slovak Studies

Introduction

Four reports, in Slovak from the Irrigation Farming Research Institute (VUZH), Bratislava, were deposited with the International Court.[9] They are 1993 progress reports from a 1990-1994 Slovak programme of work on soils in Žitný Ostrov. The reports provide important support for Hungarian concerns, and also demonstrate that, as late as 1993, research into the issues of concern was far from complete and amelioration measures have yet to be defined.

Slovak Concerns for Long-Term Effects

The following translated excerpts clearly demonstrate that Slovak scientists were aware of the potential for serious long-term adverse effects due to the implementation of the GNBS project:

> "The ecological effects of the operation of the Danube hydroelectic plant will probably affect extensive agricultural areas in the Žitný Ostrov region, which are the farmlands producing the highest yield per hectare in our country, due to the advantageous groundwater regime.
>
> The construction and operation of the Danube Barrage System will bring about a lasting change in the depth of groundwater levels in the areas affected, which will be reflected in the modification of farmland soil characteristics and systems (especially with regard to the water regime and the temperature system), and will be accompanied by modifications in the most important conditions of agricultural production."[10]
>
> "The construction of the Danube Barrage System constitutes a significant intervention into the natural environment of the region which will bring about lasting changes in the groundwater levels in the southern part of the Danubian plains. In a large part of this area, changes in the groundwater level entail the modification of the regimes of farmland, modifying the characteristics of agricultural soils, and changes in the levels of high mineral content groundwater may accelerate the accumulation of salts in the soil or farmland profiles. Individual changes to the soil in the various areas will depend on the level of groundwater in those areas, the composition of the soil grains and the duration of the effects of the

9 Š Rehák *et al.*, 1993; HR, Annexes, vol 3, annex 7, parts 1-4.

10 Š Rehák *et al.*, 1993; HR, Annexes, vol 3, annex 7, part 2, chap 1.

modified conditions. Given the manifold nature of the particle composition of farmlands and the soil, and the differences in the depth and salt content of groundwaters, we have to expect a wide range of changes in the properties and transport characteristics of farmland soil."[11]

The Reported Research

The reports describe a programme of soil sampling, and soil physical and chemical analysis for the Žitný Ostrov, and classification for a database using Geographical Information System. In addition, work has defined the distribution depth of soil to underlying gravel layers. The results have been used to calculate optimum groundwater levels for a range of soil and crop types to maximise crop production, as an aid to groundwater management.

The work is incomplete (as at November 1993) and simulations presented take no account of chemical processes or structural change, although these are recognised as important effects. A substantial set of proposals for further work is included, which indicate the incomplete nature of the work. The research has focussed on issues of classification and short-term water management, while the more complex, difficult and wide-ranging issues of long-term degradation remain unquantified.

Slovak Concerns Regarding the Incomplete Nature of the Research

This is clearly demonstrated by the following quotations:

> "The chemical properties of farmland soils and their variability and dynamics have to be assessed according to the farmland hydrological categories, taking into account the system of production (fertilisation)."
>
> "The maximum and minimum groundwater levels have to be identified from the aspect of capillary supply; the conditions of saturation and the influx of undesirable materials in groundwater have to be determined."
>
> "Remedial measures must be proposed for the operating conditions of the hydroelectric plant with the assessment of their effects on the potential productivity of crops." [12]

---

11 Š Rehák *et al.*, 1993; HR, Annexes, vol 3, annex 7, part 3, chap 2.1.

12 HR, Annexes, vol 3, annex 7, part 1.

"It is necessary to update already existing results...and to implement long-term soil research methods."[13]

Conclusions

In summary, these documents mirror our concern for soil degradation and agricultural productivity. Work in 1993 was incomplete and narrowly focussed. Important issues such as changing chemical status and long-term effects had been recognised but have not yet been addressed. Even in 1993, amelioration measures were still to be proposed.

6.1.3 REBUTTAL OF SLOVAK ASSERTIONS

In its Counter-Memorial, Slovakia argues that declining groundwater levels had occurred prior to the damming of the Danube and that this had lead to loss of capillary supply in large parts of the Žitný Ostrov and the Szigetköz.[14] In *Chapter 4.4.1*, above, it is shown that Slovak claims of historical groundwater decreases are inaccurate, exaggerated and misleading (see, for example, *Plate 4.3*). It is certainly not the case that capillary supply had been lost in large parts of the Szigetköz; this is clearly demonstrated in the Hungarian Counter-Memorial[15] and in the recent agricultural analysis presented above (see also *Plate 6.2*). It is also stated that the Gabčíkovo-Nagymaros Project was intended to raise water levels in the vicinity of the reservoir and the side-arm system. While a local rise in the vicinity of the reservoir was indeed expected,[16] the impact of side-arm recharge management, as proposed by Slovakia, is discussed in detail in *Chapter* 7, below and demonstrated to be minimal.

The Slovak Counter-Memorial also accuses Hungary of a failure to produce evidence of loss of capillary effect.[17] This loss was demonstrated by simulation in the *Scientific Evaluation*[18] and above (*Plate 6.4* and *Figure 6.1*) from recent observations.

Slovakia once again demonstrates a failure to comprehend the long-term nature of many of the associated impacts when it claims that carbonate accumulation has not

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13 HR, Annexes, vol 3, annex 7, part 2.

14 SC-M, paras 7.92 and 7.93.

15 See e.g., *Scientific Evaluation*, HC-M, vol 2, chap 3.4.2.

16 HC-M, vol 5, *Plate 3.11*.

17 SC-M, paras 7.93 and 7.97.

18 *Scientific Evaluation*, HC-M, vol 2, chap 3.4.2.

Expected Forest Production in the Szigetköz (Original Project)

Long-term yield capacity after species changes

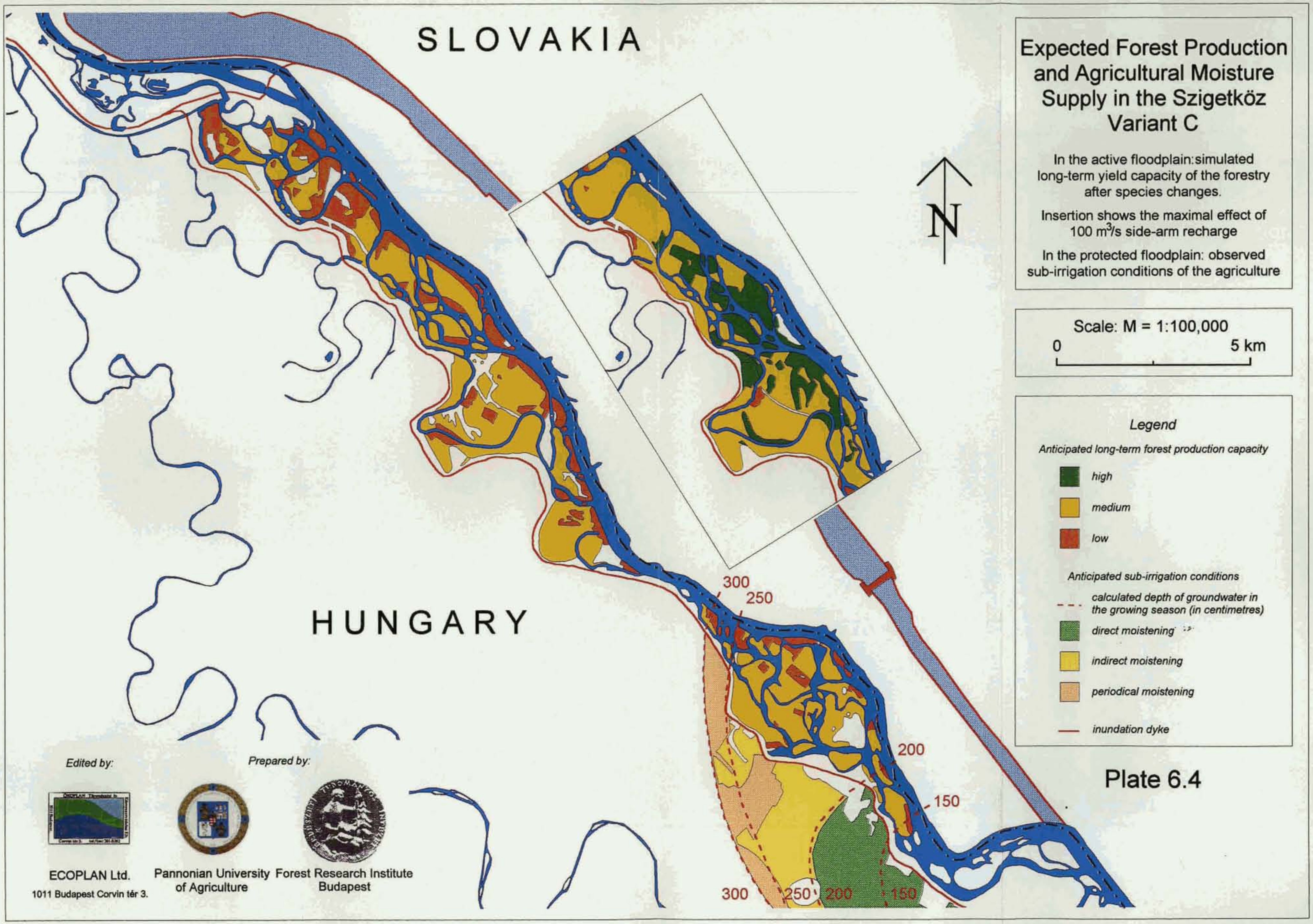
Scale: M = 1:100,000
0 — 5 km

Legend

Anticipated long-term forest production capacity

- *high*
- *medium*
- *low*
- *inundation dyke*

Plate 6.3


Expected Forest Production and Agricultural Moisture Supply in the Szigetköz Variant C
In the active floodplain:simulated long-term yield capacity of the forestry after species changes.
Insertion shows the maximal effect of 100 m³/s side-arm recharge
In the protected floodplain: observed sub-irrigation conditions of the agriculture
Scale: M = 1:100,000
0
5 km
Legend
Anticipated long-term forest production capacity
high
medium
low
Anticipated sub-irrigation conditions
calculated depth of groundwater in the growing season (in centimetres)
direct moistening
indirect moistening
periodical moistening
inundation dyke
SLOVAKIA
HUNGARY
N
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Pannonian University of Agriculture
Forest Research Institute Budapest

Plate 6.4

occurred[19] and implies that this (even if it is true, and no evidence is produced to support the comment) is evidence of unrealistic concerns. Such effects are extremely unlikely to be observable within a year or two even given intensive soil chemical research. In paragraphs 7.94 and 7.95 of its Counter-Memorial, Slovakia also indicates a failure to appreciate the complexity of soil chemical change. Subtle changes to the biogeochemical soil regime can cause carbonate accumulation, as is already observed elsewhere in the region.[20]

Slovakia also turns to the Bechtel report to support its arguments.[21] This report, carried out in a limited time, with limited resources, and on behalf of the GNBS proponents, did not provide an in-depth analysis of many important environmental aspects of the project. Such a review is in no sense a substitute for detailed research.

6.2. FORESTRY

6.2.1 SUMMARY OF THE SCIENTIFIC POSITION[22]

The impact of the Barrage System on forestry in Hungary covers areas which include stands of 8,600 ha in the Szigetköz of which 1,000 ha have been cleared for the construction of the Gabčikovo-Nagymaros Barrage System. Only small forest areas are impacted downstream of Gönyü.

In addition to weather conditions, type of tree species *(see Plate 6.1)* and soil conditions, the stand productivity in the Szigetköz mainly depends on groundwater levels and the dynamics of the discharge regime. Under pre-dam conditions the annual wood increment in the part of the active floodplain most affected was 65,000 m^3. The clearance of forests accounts for an annual loss of 17,000 m^3 in production. The drop in groundwater levels[23] and the reduced dynamics of water levels would, in the long-term, result in substantial changes to the species composition and structure of the optimum forest stands. The anticipated loss in yield was calculated in detail for areas in the active floodplain (see below). Short-term damage can be detected by actual measurements of the annual increment of stand volume. *Figure 6.2* shows a distinct drop in growth of hybrid poplar observation plots in the active floodplain after the diversion of the Danube.

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19. SC-M, para 7.94.

20. *Scientific Evaluation*, HC-M, vol 2, chap 5.1.6.

21. SC-M, para 7.97.

22. For details see *Scientific Evaluation*, HC-M, vol 2, chap 5.3.

23. HC-M, vol 5, *Plates 3.11* and *3.13* (Original Project and Variant C, respectively).

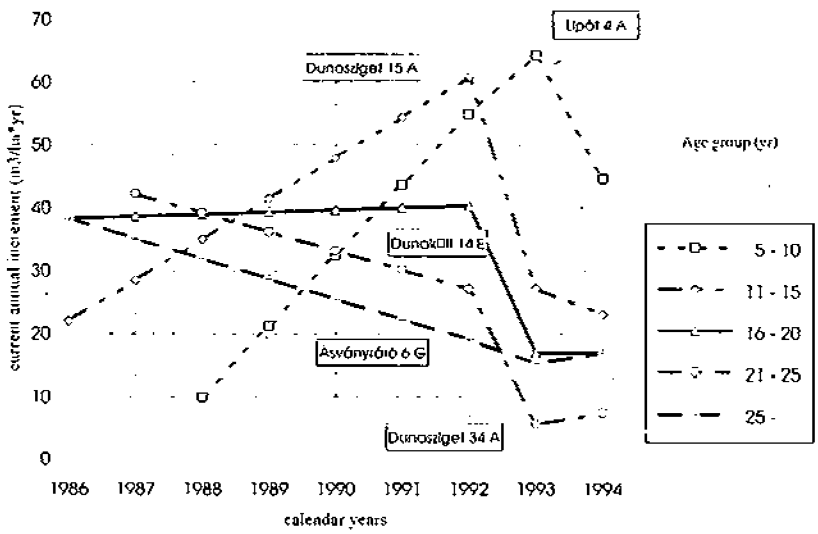
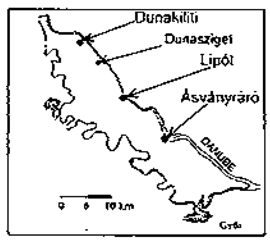


Figure 6.2: Annual volumetric growth of hybrid poplar stands by age group.



6.2.2 PRESENTATION OF NEW DATA[24]

A study evaluated the potential long-term changes in the productivity of forest stands in the active floodplain which suffered from a drop of groundwater levels after the implementation of Variant C or which would have resulted after implementing the Original Project.[25] For optimum timber production the selection of species would need to be changed to suit altered site conditions. Long-term damage based on average yields would result in an annual loss of about 140

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24 Z Somogyi *et al.*, *Assessment of long-term changes in the productivity of stands in the Szigetköz that can be expected under different water regimes.* Budapest, 1995; HR, Annexes, vol 3, annex 6.

25 Only those areas which experienced a drop of average groundwater levels were included in the study. In addition, probable degradation of forests by missing and reduced groundwater level fluctuations was not considered in the study.

million HUF (Original Project) or of about 110 million HUF (Variant C).[26] The anticipated long-term difference in yield between pre-dam conditions and the Original Project or Variant C can be seen by comparing *Plates 6.2-6.4.*

6.2.3 REBUTTAL OF SLOVAK ASSERTIONS

Slovakia's main assertion concerning forestry is that sinking groundwater levels caused by the degradation of the riverbed *before the diversion of the Danube* had adversely affected forestry, and that the Project was aiming at reversing this process.[27] Actually no decrease in timber productivity was experienced in the decades before the implementation of Variant C. Natural forests were partially replaced by cultivated forests with more productive species, mainly hybrid poplars. In fact, forestry statistics do not indicate a decline in forest production in the Szigetköz before the diversion of the Danube. Despite a certain drop in groundwater levels between 1960 and 1990,[28] the major part of the Szigetköz still experienced sub-irrigation by capillary rise and regular inundations;[29] thus a dramatic loss of sub-irrigation occurred only after the implementation of Variant C and not prior to the damming.[30]

6.3. FISHERY

6.3.1 ORIGINAL PROJECT

Summary of the Scientific Position[31]

With the implementation of the Original Project, the faunistic structure of the natural fish communities would have changed, the total fish biomass and production would decrease significantly in the entire section of the Slovak-Hungarian Danube.[32] The peak operation of the Original Project, that is the high

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26 Calculated from *Table 5* in Somogyi *et al.*; HR, Annexes, vol 3, annex 6.

27 SC-M, paras 7.92, 7.94, 7.98 and 8.33.

28 See *Plate 4.3.*

29 See *Plate 6.2.*

30 SC-M, para 7.93. see *Plate 6.4.*

31 For details see *Scientific Evaluation,* HC-M, vol 2, chap 5.4.

32 J Holčik, I Bastl and M Vranovsky, 1981, Hydrobiology and ichthyology of the Czechoslovak Danube in relation to predicted changes after the construction of the Gabčikovo-Nagymaros

daily water level fluctuations, would destroy fish communities in the riparian ecotones and diminish the productivity of the whole system.

Water engineering works connected with the construction of the Original Project caused detrimental changes in the fishery resources, which was indicated by a decreasing trend of catch in the late 1980s. The implementation of the Original Project would have resulted in similar damage observed in the Gabčikovo sector of the Danube since the operation of Variant C.[33]

Critique of Additional Slovak Studies

In the Slovak Counter-Memorial there is an annexed study: "Fish, Fisheries and the G/N Project" by Anton Kirka.[34] The author does not distinguish the Original Project from Variant C in the paper: the Gabčikovo-Nagymaros Project is mentioned, but some statements refer to Variant C, while a few statements relate to the pre-dam situation, commented on below.

Some suppositions in the Slovak study concerning the fish communities of the reservoir are contradictory. The study says, e.g., "[n]o great changes will occur in the species of ichthyofauna of the reservoir as compared to the main river flow." And then evidence for significant changes is presented: "...the reservoir will become practically an isolated ecosystem, with ichthyocenoses depending on their own reproduction", "typical rheofile species...will decrease", "increases in populations of phytolitophyle species...may be expected", which show that the first sentence of the Slovak study is unsupported.

The study states, that the continuous decrease in the total fishery catch commenced in the second half of the 1960s. The commercial and recreational catch in the Czechoslovak Danube between 1961 and 1979 show that the reduction was not too progressive.[35] The statistical data of fishery in the upper stretch of the Hungarian Danube[36] demonstrates that there was not a significant decline in the total catch between 1968 and 1987.

River Barrage System, *Práce Lab Rybár. Hydrobiol.* 3: 19-158 (*hereinafter* Holčik *et al.*, 1981).

33 HM, paras 5.78-5.81.

34 SC-M, Annexes, vol 2, annex 25.

35 Holčik *et al.*, 1981; see *Figure 6.3.*

36 O Bertalan, *Report on the 1993 observation of the changing Danubian fish fauna and its habitats in the Szigetköz monitoring*. Agricultural and Food Industrial Promoters Ltd (manuscript) 1994, (*hereinafter* Bertalan, 1994); see also *Figure 6.4.*

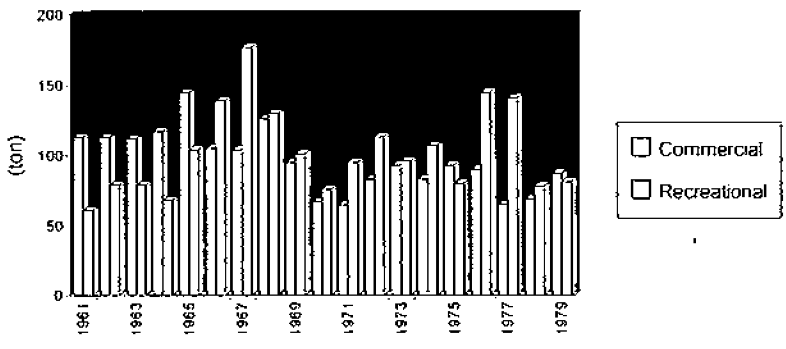

Figure 6.3: Catch of commercial and recreational fishery in the Czechoslovak Danube between 1961 and 1979[37]

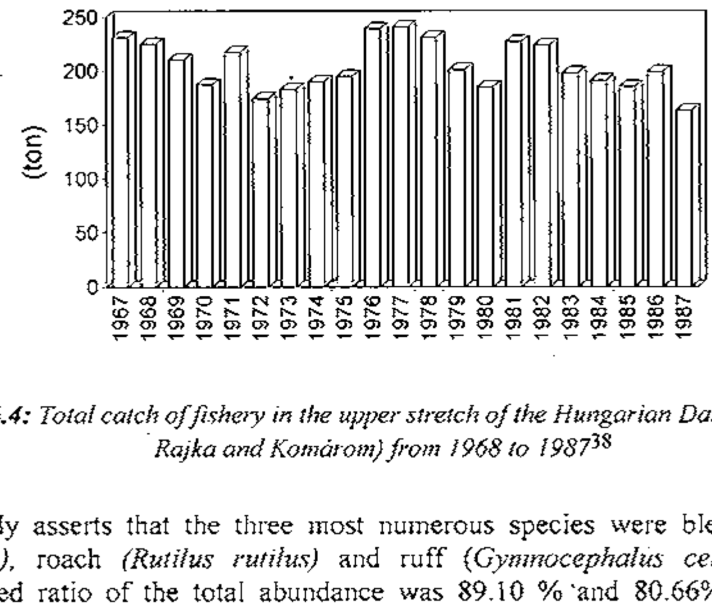

Figure 6.4: Total catch of fishery in the upper stretch of the Hungarian Danube (between Rajka and Komárom) from 1968 to 1987[38]

The study asserts that the three most numerous species were bleak (*Alburnus alburnus*), roach (*Rutilus rutilus*) and ruff (*Gymnocephalus cernuus*). Their aggregated ratio of the total abundance was 89.10 % and 80.66% in the total ichthyomass. When and where were these data observed? There are no references in the paper. A cross-border ichthyological investigation[39] did not find significant

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37 Holčik *et al.*, 1981.

38 Bertalan, 1994.

39 G Copp, G Guti, B Rovny and J Cerny, 1993. Hierarchical analysis of habitat use by 0+ juvenile fish in the Hungarian/Slovak floodplain of the River Danube. *Env. Biol. Fish* 40: 329-348, (*hereinafter* Copp *et al.* 1994).

differences between the Hungarian and Slovak side in the relative densities of juvenile fish based on 1170 point samples taken in 1992 – before the implementation of Variant C. Roach *(Rutilus rutilus)* and bleak *(Alburnus alburnus)* were the most abundant, but Ruff *(Gymnocephalus cernuus)* was a rare species.

"The ichthyocenoses were in an unbalanced state with a predominance of non-ravenous species over ravenous one in a very unfavourable ratio".[40] This quotation not a particularly scientific statement. Which species are "ravenous" and "non-ravenous" and what is the balanced state between them?

The study does not deal with the impacts of the daily peak operation of the Original Project on the fish communities. The reduction of fish biomass correlates well with the amplitude of flow fluctuation. In the first few kilometres below all peak operated hydropower stations investigated on Austrian rivers, a reduction in the benthic invertebrate biomass of between 75 and 95% compared with undisturbed areas could be detected. In the following 20 to 40 km the reduction was still between 40 and 60%. The reduction of fish fauna biomass was of the same order of magnitude.[41]

Detailed Rebuttal of Slovak Assertions

In the Slovak pleadings, there are no comments properly addressing the negative impacts of the Original Project on fish. The operation of the Original Project would have resulted in many disadvantageous faunistic changes, a general degradation of natural fish reproduction and a detrimental reduction of fishery resources.[42]

The Slovak Counter-Memorial declares in this respect that "it is pointless to make a comparison between the G/N Project's impact and the impact of other dam projects on the Danube, the Rhine, or the Rhone".[43] The comparison is meaningful for two reasons: first, the Slovak recharge system is a chain of small impoundments with significantly reduced flow, and second, the examples of the interconnected branch system on the Upper Rhine or the channalised and impounded stretch of the Austrian Danube compare well in their general impacts,

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40 SC-M, Annexes, vol 2, annex 25 at p 374.

41 Nesemann and Moog, 1995; HR, Annexes, vol 3, annex 4.

42 Holčik *et al.*, 1981; *Scientific Evaluation*, HC-M, vol 2, chap 5.4.

43 SC-M, para 7.102.

but showed the opposite effect to that claimed by Slovakia.[44] The diversity of habitats and aquatic species has been very substantially reduced.[45]

It is well known that the water quality of the Danube and the fishery catch were adversely affected by pollution in the 1970s and the situation has improved in a part due to waste water treatment,[46] but this treatment was not necessarily associated with the Project, therefore water quality improvement was not a benefit of the Project. The population dynamics of some fish species spawning in the main channel barbel (*Barbus barbus*), sterlet (*Acipenser ruthenus*), bullhead (*Cottus gobio*) indicate the improvement of the water quality of the Slovak-Hungarian Danube since the beginning of the 1980s, which may be a consequence of the operation of the waste water treatment plant in Vienna, too.

The statement in the Slovak Counter-Memorial, "the total fish catch in the Slovak-Hungarian sector of the Danube shows a steady decline since the 1960s"[47] is true, but it must be noted that a more significant reduction started in the second half of the 1980s.[48]

6.3.2 Variant C

Summary of the Scientific Position

The diversion of the Danube into the power canal terminated the contact between the Old Danube and the side-arm systems in the Gabčíkovo sector of the river, and caused severe damage to the fishery resources. The observed damage, as reduction of fish production, fish mortalities, etc., are detailed in the Hungarian Memorial and Counter-Memorial.[49] The unfavourable modification of fish fauna is discussed in Appendix 2 of the Hungarian Memorial.

The negative ecological impacts of the implementation of Variant C, that is the loss of floodplain habitats, changes in the Alpine character flood regime, reduction of flow rate, decrease in suspended silt load, etc., and the expected negative

44 HC-M. Annexes, vol 4 (part 2), annex 15

45 *Scientific Evaluation*, HC-M, vol 2, chap 4.6; Nesemann and Moog, 1995

46 SC-M, para 7.103.

47 SC-M, para 7.104.

48 For details see *Scientific Evaluation*, HC-M, vol 2, chap 5.4.3-5.4.4.

49 HM, para 5.128; HC-M para 3.78-3.80; *Scientific Evaluation*, HC-M, vol 2, chap 5.4.4.

consequences, that is the changes in fish communities, decline of fishery potential, etc., are evaluated in the Hungarian Memorial and Counter-Memorial.[50]

Critique of Additional Slovak Studies

Kirka's study annexed in the Slovak Counter-Memorial mainly deals with the impacts of Variant C on fish.[51]

The predicted increase of economically preferred species such as zander (*Stizostedion lucioperca*), wels (*Silurus glanis*), pike (*Esox lucius*), carp (*Cyprinus carpio*), tench (*Tinca tinca*), etc., is improbable. The increased sedimentation in the reservoir will rapidly cover the spawning grounds which at the same time affects the survival of fish eggs. It should also be noted that a negative influence will be exercised by the rather low temperature in the reservoir. This might well prevent natural reproduction of carp, tench and wels, even if the influence of sedimentation and lack of suitable substrate were not negative factors.[52]

The statement that the total catch of the commercial and recreational fishery in the reservoir can be higher than it was in the branches before inundation is not convincing. The biomass density of fish in the former branches in the territory of the reservoir was 118 kg/ha. Due to the inhibited reproduction mentioned above, the fish biomass density in the reservoir is likely to be equivalent to the previous biomass density in the main river channel, i.e., about 35 kg/ha.[53]

Under the circumstances mentioned above, the reservoir will most likely be populated with just a few species and the expected presence of 43 species is questionable.

The assertion that the conditions in the tailrace canal are similar to those in the main channel is implausible. The Gabčíkovo Barrage is an insurmountable barrier for fish migrating instinctively against the current in the spawning season and the tailrace canal is an unsuitable habitat for the reproduction of numerous migratory species.

The permanent presence of burbot (*Lota lota)* and gudgeon (*Gobio gobio)* in the Old Danube does not offer evidence of an improvement in water quality. These species occurred in the main channel in the pre-dam situation too, and their permanent presence does not indicate any positive change.

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50 HM, para 5.126-5.129; HC-M para 3.81; *Scientific Evaluation*. HC-M, vol 2, chap 5.4.4.

51 SC-M, Annexes, vol 2, annex 25.

52 Holčik *et al.*, 1981.

53 Holčik *et al.*, 1981.

The statement that the most effective way to maintain fishing areas would be to dam the river and fill it through the intake structure from the bypass canal in order to reach optimum fish production is also unacceptable. The system does not function as an ideal spawning area without the seasonal fluctuation of the discharge. In slow-flowing or standing side-arms, the macrophytes spread to the medial parts of the branches, water bodies start to eutrophicate and become shallower. The fish community will be dominated by some phytophilic cyprinid species and pike will be the only predatory species.[54]

Detailed Rebuttal of Slovak Assertions

It is quite clear that a large amount of spawning grounds and both adult and juvenile fish disappeared with the implementation of Variant C.[55] Since the diversion of the Danube, the migratory access for fish has been interrupted between the Old Danube and the side-arms, and many fish species are consequently prevented from moving to their ideal spawning, nursery, feeding and wintering habitats. Lack of large-scale fish recruitment will have detrimental effects on the fish populations of the Middle Danube for a few hundred kilometres downstream.[56]

Slovakia does not accept the statement of the Hungarian Memorial that the silting of the old riverbed with the implementation of Variant C has rendered it an unsuitable habitat for certain fish species. Rather it claims that the same habitat for fish species, as existed prior to the diversion of the Danube, may be maintained and even improved.[57] In fact, alterations of fish populations may be expected due to changes in the hydrological conditions in the main channel. At the end of July 1994, considerable fish mortalities (15 tons) were documented in the Old Danube between rkm 1842-1802, which indicated unfavourable ecological conditions in the old riverbed.[58] Eurytrophic and neozoan fish species can colonise the altered and often homogenised habitats at such densities that they inhibit the native fauna.[59]

The Slovak argument that the conditions for fish in the Old Danube prior to the damming were not good due to the high velocity of flow and high turbidity[60] is

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54 Holčík *et al.*, 1981.

55 HC-M, paras 3.78-3.80; HC-M, vol 1, *Plate 13*; *Scientific Evaluation*, HC-M, vol 2, chap 5.4.

56 HC-M, para 3.81; *Scientific Evaluation*, HC-M, vol 2, chap 5.4.

57 SC-M, paras 8.35-8.36.

58 For details see HC-M, paras 3.79 and 3.81; *Scientific Evaluation*, HC-M, vol 2, chap 5.4.

59 Nesemann and Moog, 1995; HR, Annexes, vol 3, annex 4.

60 SC-M, para 8.36.

also *unacceptable*. It is true that the conditions in the Old Danube prior to the damming did not favour the limnophilic fish species, which prefer stagnant waters, but those conditions were good for the native rheophilic fish of the river, which do not avoid high flow velocity and high turbidity.[61]

Slovakia states that the river banks would develop more naturally and lateral erosion would start once more in the bypassed section of the Danube with the implementation of the Project, as well as asserting that no reduction in the number of species is to be expected.[62] In fact, the natural character of this Danube section has deteriorated considerably, (see *Plate 6.5*). Since the operation of Variant C, the current velocity has become slower, the Alpine-character flood regime has changed and the area of lentic habitats has increased significantly, with a corresponding increased density of submerged aquatic vegetation. All these influences can be expected to lead to an alteration of fish communities in the bypassed section of the Danube. The fish mortalities observed at the end of July 1994 showed the detrimental conditions.[63]

It is true that "the main Danube channel, as opposed to the side-arms, was characterised by a low ichthyomass (fish density)".[64] However, its value for fishing was not the primary importance of the main Danube. The old riverbed was not only a particular habitat, but it also supplied and connected the side-arm systems, as well as being an important migratory way for fish.[65]

It is doubtful that "no great changes would be expected in the fish types in the reservoir...and some better spawning grounds would be created".[66] The increased sedimentation, the movement of sediment and the low temperature regime will prevent the reproduction of many fish species in the reservoir. Another unfavourable impact on the fish population is the partial surface freezing, particularly in places with increased sedimentation, which prevents the usual hibernation of fish.[67]

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61 G Guti, Fisheries ecology of Danube in the Szigetköz floodplain *Opuscula Zoologica*, Budapest, 1993, 26: 67-75 (*hereinafter* Guti, 1993); *Scientific Evaluation*, HC-M, vol 2, chap 5.4.

62 SC-M, para 7.104.

63 HC-M, paras 3.79 and 3.81; *Scientific Evaluation*, HC-M, vol 2, chap 5.4.4.

64 SC-M, para 7.104.

65 Guti, 1993; *Scientific Evaluation*, HC-M, vol 2, chap 5.4.

66 SC-M, para 7.104.

67 Holčík *et al.*, 1981.

Plate 6.5 Benthic Eutrophication in the Danube, 1994

Decrease in flow velocity caused benthic eutrophication even in the main river. The photograph (taken in summer 1994, at 1845 riverkm near Dunakiliti) presents Canadian pond weed (*Elodea canadensis*, dark green in the water foreground) and mats of green algae (*Cladophora sp*., light green on the surface)

In contrast with the Slovak opinion, the seepage canals and the tailrace canal do not provide good living conditions for fish.[68] The thermal conditions in the seepage canal are satisfactory for mostly exotic species. The flow in the tailrace canal is higher than the flow in the Old Danube bed and in the spawning season, it directs the shoals of fluvial fish, migrating instinctively against the current, to the tailwater of the Gabčíkovo Barrage which is an insurmountable barrier for them.[69]

68 SC-M, para 7.104.

69 Guti, 1993; *Scientific Evaluation*, HC-M, vol 2, chap 5.4.

CHAPTER 7

ECOLOGICAL EVALUATION OF REMEDIAL MEASURES

A central assertion of Slovakia is that all detrimental impacts of the Gabčíkovo-Nagymaros System can be remedied by appropriate counter measures. One of the most important disbenefits of either project is the drastic change in the surface water and groundwater regime in the Szigetköz, affecting not only potential drinking water resources but also wetland flora and fauna, forestry production, agriculture and fishery. Various remedial measures for the Original Project and for Variant C were considered by both parties, including the construction of weirs in the Old Danube, the implementation of a recharge system in the active floodplain and in the protected side of the floodplain. Some have been implemented.

In this section of the *Scientific Rebuttal* the impacts of various remedial measures on groundwater recharge, aquatic habitats and the aquatic fauna, wetland vegetation, forestry and agriculture will be discussed. A first section clarifies the hydraulic implications of the repeated Slovak proposal to build "underwater weirs" (a term which does not exist in river engineering).

7.1 TECHNICAL CLARIFICATION OF "UNDERWATER WEIRS"

7.1.1 TECHNICAL TERMS

A *weir* is a lateral structure in a riverbed, controlling (i.e., raising) upstream water levels at prevailing discharges. In this case prevailing discharges were stipulated as 18.9/50/200 m^3/s for the Original Project[1] and were released in the old riverbed in the range of about 200-400 m^3/s for Variant C.[2] Depending on the crest height of the weir and the gradient of the river, the construction of a weir results in an impoundment of a certain river reach with reduced flow velocities.

Although elevated above downstream water levels, weirs can be called submerged in the sense that water runs over the crest. Weirs may increase groundwater levels *and* prevent the erosion of the riverbed. River bottom sills or ground sills may locally prevent erosion, but *not* increase groundwater levels.

1 Joint Contractual Plan, Summary Documentation, vol 0-1-A, 1977

2 HR, Annexes, vol 3, annex 1.

None of the considered lateral structures in the old riverbed which are explained below are sills; they are either low weirs or high weirs, but should not be termed "underwater weirs".[3]

7.1.2 HISTORY OF THE PROPOSALS FOR THE REGULATION OF THE OLD DANUBE

The Summary Documentation of the Joint Contractual Plan (1978) contains a provision to construct "bottom sills" in the Old Danube in the "event of need", and it continues: "...such water levels can be produced equal to the low waters prior to the construction".[4]

Obviously the reason for constructing weirs in the old riverbed was to re-establish groundwater levels. In fact, two alternatives were studied by the Hungarian party with six weirs from rkm 1837.5 to rkm 1820 at low flow (560 m^3/s) and at mean flow.[5] Even the crests of the smaller weirs were 3-4 m above the bottom of the riverbed. Since the constructions would have been unfavourable for ice release and emergency navigation, they were not included in the Joint Contractual Plan.

In June 1989, the Government Plenipotentiaries decided that 7-8 rip-rap weirs with about 1.0 m height above the bed level should be designed. At Hungary's request facilities for sporting navigation were to be included in the construction.[6]

During the EC-negotiations on a Temporary Water Management Regime in 1993, a scenario for the regulation of the Old Danube for Variant C with eight weirs was introduced.[7] The crest height of these weirs was 4.2 m on average above the bed level. These structures were aimed at sustaining groundwater levels, regardless of emergency navigation or ice release. They would divide the old riverbed into a

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3 The expression "underwater weir" implies to laymen a structure that is not visible and does not interrupt the continuity of the flow, and this is in fact the Slovak description of "underwater weirs" which are allegedly "similar...to a natural ford or sandbank" (SC-M, para 7.44).

4 Joint Contractual Plan, Summary Documentation, vol 0-1, chap 7.7; the Hungarian word for "bottom sills" reads "fenékküszöbök".

5 VIZITERV Dept 5/2, *Regulation of the inundation of the Old Danube*, GNBS, Joint Contractual Plan, Studies. 19,222 E-V-4.18, 1976.

6 Protocol of the negotiations of the Government Plenipotentiaries on the co-operation in implementing the GNBS, Bratislava, June 8-9, 1989, Appendix 3; SM, Annexes, vol 4, annex 58.

7 EC Working Group of monitoring and Water Management Experts for the Gabčikovo System of Locks, *Report on Temporary Management Regime* (Bratislava, Dec 1, 1993): Scenario 3; HC-M, Annexes, vol 5 (part 2), annex 19.

sequence of eight impoundments and control upstream water levels. The environmental impacts were discussed in the Hungarian Counter-Memorial.[8]

7.1.3 SLOVAK UNDERSTANDING OF "UNDERWATER WEIRS"

According to repeated Slovak assertions the construction of "underwater weirs" in the Old Danube was supposed to raise water levels in order to sustain the depleted aquifer adjacent to the main channel, to allow flow into the side branch systems and to "slow down erosion of the riverbed".[9] The envisaged crest height of such structures was never defined in the Slovak submissions to the Court, but it was said that "a level corresponding to low water level in the Danube in pre-dam conditions" should be maintained[10] or that with a "flow of 350 m^3/s...such weirs would have maintained the main channel at its pre-Project level corresponding to the natural flow of 1,300 m^3/s".[11]

As pointed out above and as investigated by Hungary in 1976,[12] the increase of surface water levels to pre-dam conditions with an associated discharge of 50 m^3/s or even 350 m^3/s would necessitate the construction of a series of weirs in the main channel of several metres elevation above the bed.[13]

During the EC-negotiations on a Temporary Water Management Regime Slovakia proposed the construction of 9 weirs in the Old Danube to sustain water levels.[14] The crest levels of these weirs were 25 cm higher than the ones investigated in scenario #3 of the EC-negotiations, thus their crest level was about 4.5 m above the riverbed on average. There is no doubt that Slovakia is well aware of the required crest height when urging the construction of "underwater weirs" in order to restore pre-dam water levels with small discharges.

The 6 weirs discussed at the early stage of the Project and the 8 or 9 weirs presented during the EC-negotiations were similar to the weirs implemented at the

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8 *Scientific Evaluation*, HC-M, vol 2, chaps 2.5 and 4.6.1.

9 SM, paras 2.49, 2.70, 2.86, 2.101, 2.113, 5.10, 5.41, 5.52 and 5.55; SC-M, paras 4.33, 7.44, 7.56, 8.06, 8.29, 9.65 and 10.132.

10 SM, para 2.49.

11 SM, para 5.41; an agreement on a discharge of 350 m^3/s cannot be found in any of the protocols of the Government Plenipotentiaries.

12 VIZITERV Dept 5/2 *Regulation of the inundation of the Old Danube*, GNBS, Joint Contractual Plan, Studies, 19,222 E-V-4.18, 1976.

13 See *Table 2.9* and *Fig. 2.7* in the *Scientific Evaluation*, HC-M, vol 2, p 37; the effect of low weirs is demonstrated in *Fig. 7.1*.

14 I Mucha, *Report on Temporary Water Management Regime - Independent Scenario* (Bratislava, Nov 28, 1993).

abandoned channels of the Upper Rhine.[15] It is worthwhile noting that in public relation brochures as well as in its submissions during the EC-negotiations, Slovakia demands the construction of high weirs pointing to the Upper Rhine experience.[16] In its Memorial Slovakia is silent concerning any technical details of the envisaged structures. In its Counter-Memorial, a different description of "underwater weirs" is given. There it reads "...the underwater weir is very similar both in substance and in effect to a natural ford or sandbank ...The weirs are built up from stone and river gravel - the only difference is that they are not subject to erosion".[17] Schematic drawings without numbers are given which should explain "their dissimilarity with the transverse barrages used on the Rhine river".[18] Actually the only difference seems to be the material used to build the weirs which is rather insignificant from an ecological point of view.[19]

The 7-8 weirs having about one metre elevation above the bed considered in 1989 by the Government Plenipotentiaries, would be different from the Upper Rhine structures, both in substance and in effect. They would not re-establish original water levels, but locally protect cross-sections. *Figure 7.1* shows that the weirs proposed in 1989 would be far too low to re-establish previous low-flow water levels (930 m^3/s) at a discharge of 200 m^3/s. The previous 1,300 m^3/s water level would be attained by about 1.5 m even with an increased discharge of 350 m^3/s in the old riverbed.[20]

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15 HC-M, Annexes, vol 4 (part 2), annex 14.

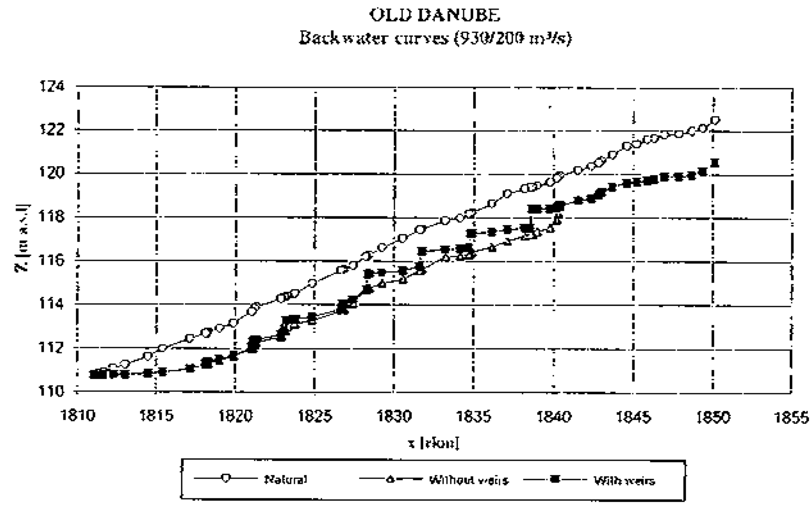
16 *The Gabčíkovo Project - Saving the Danube's Inland Delta*, Water Management Construction, State Enterprise, Bratislava, brochure, 1993.

17 SC-M, para 7.44.

18 SC-M, para 8.27, fn 47; I Mucha, *Gabčíkovo - WWF, the Pros and Cons*, Bratislava, April 1994 (SC-M, Annexes, vol 2, annex 24).

19 Fish passage can be ensured for concrete structures as well as for rock-filled weirs.

20 SC-M, para 5.41; the crest height for the weirs investigated is 1.3 m above the bed.



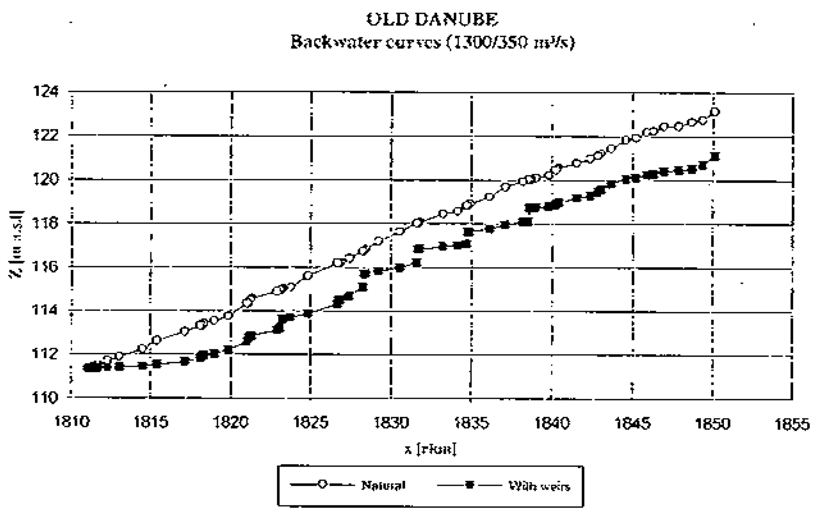


Figure 7.1: *Waterlevels along the Danube with different weir and recharge scenarios*

It is therefore not clear at all, what the persistent Slovak proposal of constructing "underwater weirs" in the Old Danube seeks to achieve. The detrimental ecological effects of a sequence of impoundments in the old riverbed at prevailing flows are outlined in the Hungarian Counter-Memorial[21] and are summarised in *Chapters* 7.4 and 7.5 below.

21 *Scientific Evaluation*, HC-M, vol 2, chaps 2.5 and 4.6.1.

7.2 RIVER MORPHOLOGY AND FLUVIAL HABITATS

7.2.1 ORIGINAL PROJECT

As pointed out above, the construction of even low weirs in the Old Danube would turn the running river into a series of impoundments, especially if coupled with small discharges of 50 to 400 m^3/s. In this case not a single free-flowing river section would remain in the Project reach between Bratislava (rkm 1965) and Nagymaros (rkm 1697). Hence all fluvial habitats in this Danube reach, dependent on running water, would either be changed to stagnant or nearly stagnant aquatic habitats or would be thoroughly disturbed by the detrimental impacts of peak operation.

Despite numerous river training measures and continuous dredging, the main channel of the Danube had preserved (and still has downstream of Čunovo) its natural character in terms of diversity of fluvial habitats as typical for large rivers, i.e.,

- areas with coarse gravel exposed to high flow velocities even at low flows, others with sand and fine gravel at inner bends, and areas with fine sand and silt under almost stagnant flows;
- river training works, such as groynes create local scouring and deposition of sediments, thus replacing to a certain extent natural habitats which were lost by fixing the riverbed;
- variations in cross-sections combined with riffle-pool systems create different flow dynamics along the river with a variety of depths and widths resulting in diverse habitats;
- numerous islands at different altitudes in the section between Győr and Nagymaros often shelter undisturbed softwood vegetation and carry valuable riparian habitats; willow vegetation growing on river banks represent valuable habitats for the aquatic fauna of running water;
- moving bars of gravel and sand lead to ever changing conditions of local flow velocities and riverbed patterns.

The artificial discharge and sediment regime imposed on the old riverbed by the Original Project would significantly damage the ecosystem of the previously large river, but the section would still have preserved its fluvial character with corresponding habitats. Thus most of the aquatic fauna could survive.

The construction of even low weirs would certainly lead to a thorough change of habitat conditions in the Old Danube. Further reduced flow velocities[22] with little variation in cross-sections and along the river would result in drastic loss in habitat diversity.[23] Sedimentation of fine sand and silt could be expected covering all gravel sediments with a homogenous layer which would be partially removed a few times per year during short flood releases. After flood events the covering layer of fines would immediately be re-established and grow until the next flood release. No artificial discharge regime could create habitat conditions that are typical for the free-flowing river. This view is backed by Dr Jäggi who states:

> "A full realisation of this system [a series of submerged weirs] would result in a series of lakes, through which the water would flow only very slowly. The Danube would completely lose its character of a running water, a character for which an intensive fight is on between Vienna and Hainburg."[24]

7.2.2 Variant C

The impacts of a weir at rkm 1843 as proposed by Slovakia[25] on fluvial habitats would be similar to the ones outlined above. In the impoundment created, a drastic loss in habitat diversity would occur, and deposited sand and silt would cover all gravel sediments with a homogeneous layer. In addition, the river section downstream of the weir would be endangered by erosion since no bedload could pass the weir at all, not even the large amount of sediment which was eroded from the floodplain in November 1992, and which represents a certain storage reserve for the Old Danube after the closure of the river.

7.3 SURFACE AND GROUNDWATER HYDROLOGY

7.3.1 Introduction

As explained in *Chapter 7.1* above, various remedial measures were discussed in the context of the Original Plan, including sequences of weirs in the Old Danube

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22 A comparison between flow velocity profiles for the Old Danube with and without weirs at low discharges is given in the *Scientific Evaluation*, HC-M, vol 2, *Fig 2.7*.

23 Similar effects on aquatic fauna were demonstrated for Austrian river reaches by Nesemann and Moog, 1995; HR, Annexes, vol 3, annex 4.

24 HR, Annexes, vol 3, annex 3; details of the Hainburg conflict are contained in HR, vol 2, Appendix 5.

25 SC-M, illus CM-12.

bed. Weirs present problems with respect to navigation, flood management, and ice transmission as well as sedimentation, erosion and water quality, and in addition represent a dramatic change in aquatic regime with corresponding biological implications, discussed in *Chapters 7.4* and *7.5*, below.

It was noted that the Slovak position appeared to promote high weirs in its public relations material and in its approach to EC negotiations, but that in the Slovak Counter-Memorial the description of weirs presented[26] apparently refers to a low sill-like structure. The Slovak Counter-Memorial also heavily promotes the concept of a single (high) weir[27] to enhance side-arm flows and quotes[28] the EC Working Group as stating that "[t]his underwater weir is sufficient without other measures to ensure the water supply to the Hungarian floodplain".[29]

It is evident that there is confusion in the Slovak position concerning recommendations for remedial measures, despite frequent assertions in the Slovak Counter-Memorial that all adverse consequences of the Original Project and Variant C can be resolved by such measures. There is also a failure to understand the complex physical characteristics of the side-arm system, and a misinterpretation of the EC position. Certainly (setting aside long-term adverse effects), current Hungarian results indicate that provision of a single weir will not provide effective remediation in the short-term unless accompanied by the associated much higher Danube discharges required by the EC (an average discharge of 800 m^3/s and a minimum of 400 m^3/s).[30] To illustrate these points, recent research into the detailed response of the Szigetköz side-arm system is first described, followed by simulation results of groundwater response to various remedial measures given the dam and reservoir of the Original Project and consider the effects of remedial measures on Variant C.

7.3.2 PRESENTATION OF NEW DATA

An extensive programme of field investigation was initiated in 1991 to obtain further insights into surface water-groundwater interactions in the side-arm

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26 SC-M, para 7.44.

27 SC-M, para 8.13; The preparation for this document pre-dates the Agreement Concerning Certain Temporary Measures and Discharges in the Danube and Mosoni Branch of the Danube, which stipulated the construction of a weir at rkm 1843 and an increased discharge in the old riverbed to an annual average of 400 m^3/s. The impacts of these measures will be observed in future monitoring.

28 SC-M, para 8.11.

29 EC Working Group, *Report on Temporary Water Management* (Dec 1, 1993); HM, Annexes, vol 5 (part 2), annex 19.

30 HC-M, Annexes, vol 5 (part 2), annex 19 at p 816.

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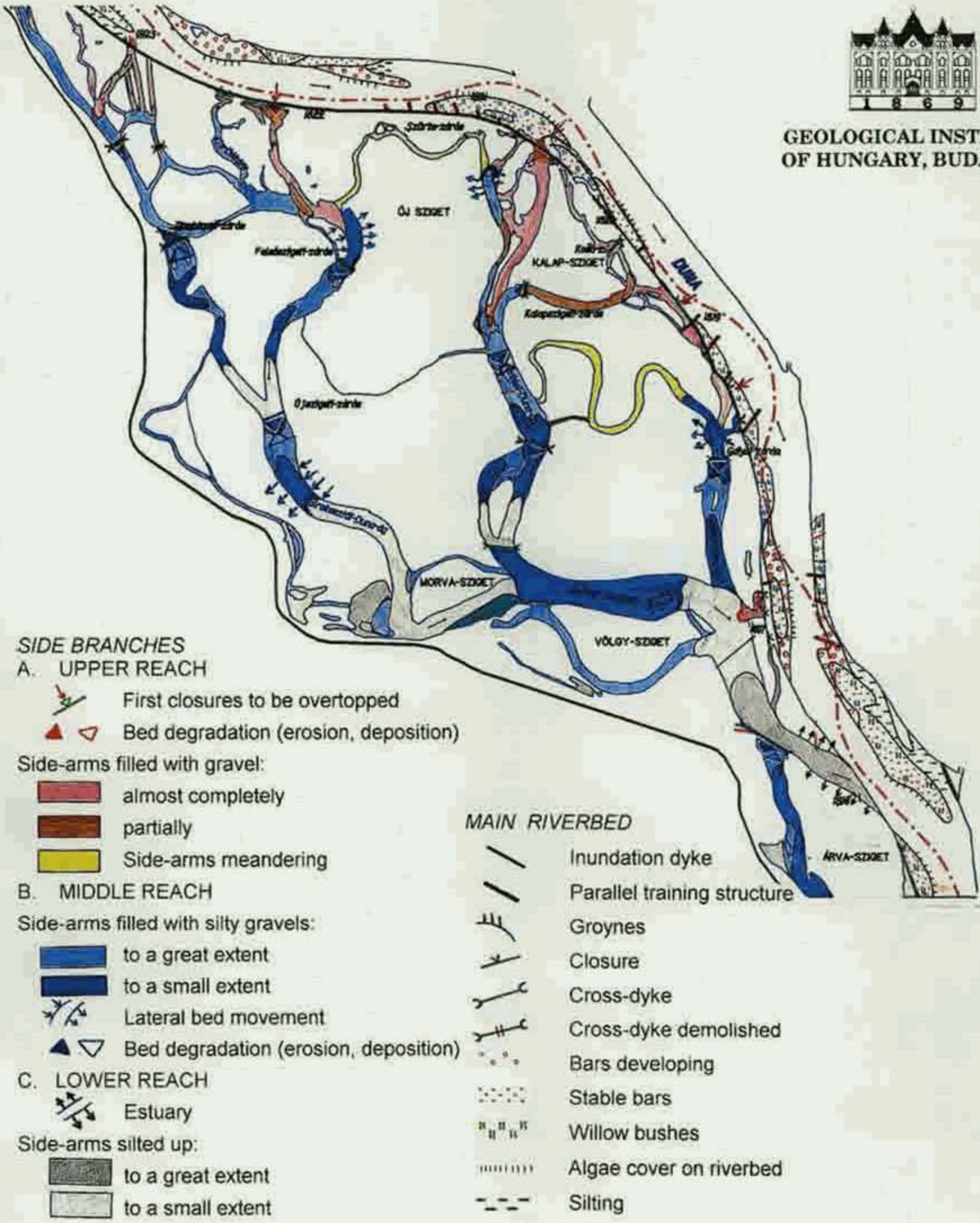

Plate 7.1 Survey of Riverbed Morphology

as mapped by MÁFI, Hungarian Geological Institute (after P Molnár, 1994a, slightly revised) system. Spot measurements of surface water and adjacent groundwater levels have been made at 25 locations (*Figure 7.3*).[31] These have been complemented by detailed geophysical investigations of subsurface properties using multiple transects at 5 locations.[32] The spatial distribution and organisation of sediment deposition has also been investigated through geomorphological mapping.[33] More recently, in 1994, a representative set of nine cross-sections (five in the active floodplain, four in the protected areas) has been instrumented with dense networks of wells at various depths and distances from the channels (70 wells in total), and conjunctive measurements made of surface and groundwater levels.[34]

The picture that emerges is one of complexity and unexplained variability. Differences between surface water levels and adjacent groundwater levels of up to 1.2 m have been observed, but these are not simply related to surface flow conditions or depths of sediment deposition in the surface water system. In fact, some of the largest differences occurred in a recently excavated side-arm channel (1993) with flow velocities in the range 1.0-1.5 m/s and a gravel bed. It is evident that bed resistance to groundwater recharge is not merely a function of channel flow regime and sedimentation. It must be remembered that the geomorphological development of the region is of a complex network of shifting channels, and this has led to highly heterogeneous subsurface conditions, illustrated in the geophysical profile of a floodplain transect shown in *Figure 7.2*. The spatial organisation of the contemporary pattern of side-arm channel sediments is shown in *Plate 7.1*, which illustrates again the process complexity.

It should also be noted that groundwater quality monitoring has observed indicators of anaerobic conditions (for example high iron concentrations) even below riverbed sections with rapid surface flow and a clean gravel bed.

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31 I Horváth, Gy Tóth, A Szigetköz felszínalatti vízminőségének alakulása a vízpótlás hatására (*Shaping of groundwater quality of Szigetköz effected by the recharge*), MÁFI, Budapest, 1994.

32 P Ocsenás, Tanulmány a Cikola-sziget és Ásványráró környezetében végzett geofizikai mérésekről (*Report on the geophysical survey at Cikola Island and Ásványráró*), ELGI, Budapest, 1994 (*hereinafter* Ocsenás, 1994).

33 P Molnár, 1994a, A Szigetköz Duna-szakasz aktuálgeológiai felmérése (*Actual geological survey of the Szigetköz Danube Reach*) *In:* Scharek *et al.*, 1994, *Data aquisition and evaluation*, (MÁFI, 1994) (*hereinafter* Molnár, 1994a).

34 VITUKI, A szigetközi távlati felszínalatti vízbázis védelme (*Protection of the future groundwater resources of Szigetköz area*) Report for the Ministry of Transport, Telecommunication and Water Management, 1994

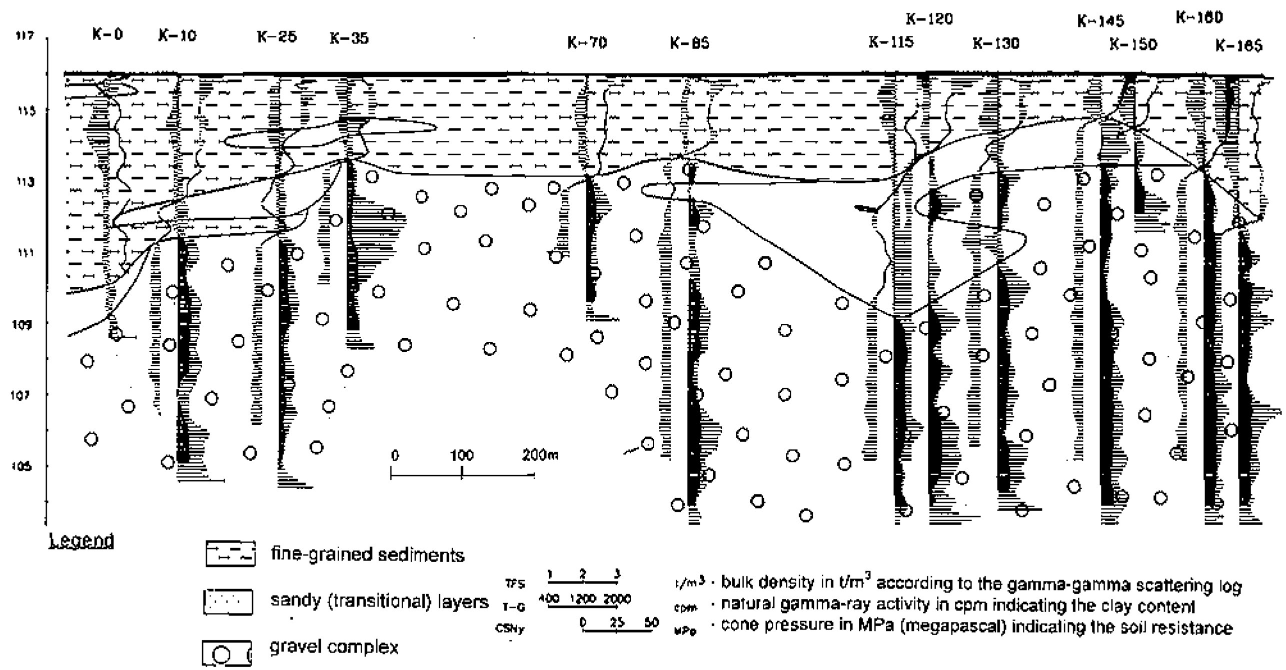

Figure 7.2: *Results of engineering geophysical soundings (penetration tests) along profile 'k', North of Ásványráró, after Ocsenás et al., 1994 (see Fig. 7.3 for location of profile 'k')*

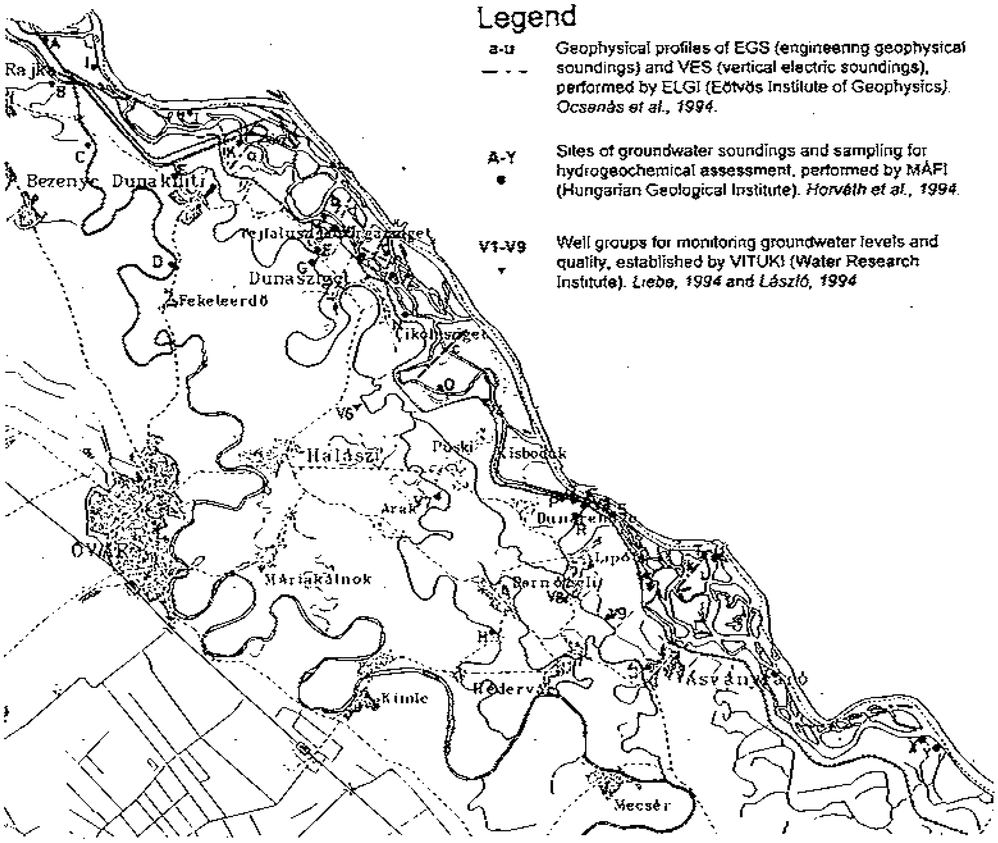

Figure 7.3: *Additional field surveys in the Szigetköz to investigated the near-surface groundwater levels and quality*

Detailed analysis of the results is in progress, but preliminary results of modelling using saturated/unsaturated simulation methods point to strong effects of spatial heterogeneity within the overall structure of strongly vertically-stratified cross-sections. Overall, the subsurface system is strongly anisotropic as well as heterogeneous. Small-scale monitoring and modelling must be interpreted within the larger-scale groundwater context, but the process insights clearly suggest that a simplistic approach to design of remediation measures is inadequate, and that the elimination of surface water sediment deposition by enhanced surface water discharges, if that can be achieved, is not likely in itself to solve problems of recharge management.[35]

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35 See Chapter 4.5, above on colmatation.

7.3.3 GROUNDWATER RESPONSE TO REMEDIAL MEASURES - ORIGINAL PROJECT

In the Hungarian Counter-Memorial,[36] simulations were presented to show the effect of the Original Project on *average* groundwater levels in the Szigetköz, for discharges of 50 and 200 m^3/s respectively. It was shown[37] that for 50 m^3/s in the Old Danube, groundwater levels would have decreased over an area of 311 km^2 and decreases would have exceeded 3 m over 20 km^2 . The corresponding area affected for a 200 m^3/s discharge was 282 km^2. However, this significantly under-estimates the effect on peak groundwater levels which occur as a result of the high summer flows and coincide with the period of maximum vegetation demand for water.

The net effect on average groundwater levels of a discharge of 100 m^3/s in the side-arm system for a 200 m^3/s discharge in the Old Danube channel is shown in *Plate 7.2*. This includes the effect of seven cross-dykes to control flows and water levels in the side-arm system and represents existing conditions of bed conductivity. It is evident that rises are small in magnitude and spatially highly localised. The area affected by a rise in groundwater level of more than 0.5 m is only 4.6 km^2. The largest rise_is less than 0.6 m. The Old Danube channel is effectively acting as a drain, as a result of the high horizontal transmissivity of the near-surface alluvial aquifer and the steep hydraulic gradients. This is illustrated in the cross-section in the Inset on *Plate 7.2*.

If a set of eight low (1.3 m high) weirs is introduced in the Old Danube channel, the river water levels increase as shown in *Figure 7.1*, but the resulting increase in groundwater levels is by no means sufficient to alleviate groundwater level decreases. If a 200 m^3/s flow is considered, together with 100 m^3/s side-arm flows and the eight low weirs, these measures fail to recreate the average summer groundwater levels (as experienced over the period 1981-1990) as illustrated in *Plate 7.3*. An area of 9,000 ha is affected by groundwater level reductions of 1-2 m and 1,100 ha are affected by more than 2 m. 8,000 ha still suffer from a fall of between 0.2 and 1.0 m.

There is uncertainty in these simulations due to the effects of clogging (which were discussed in *Chapter 4.5* above), but these represent best estimates, calibrated on 1993 observed data.

The conclusion from these results is that to mitigate groundwater level reductions it is necessary to reproduce high water levels in the Old Danube. However low weirs are inadequate for the flow regime of the Original Project, and high weirs

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36 HC-M, vol 5, *Plate 3.11*.

37 *Scientific Evaluation*, HC-M, vol 2, *Table 3.4*.

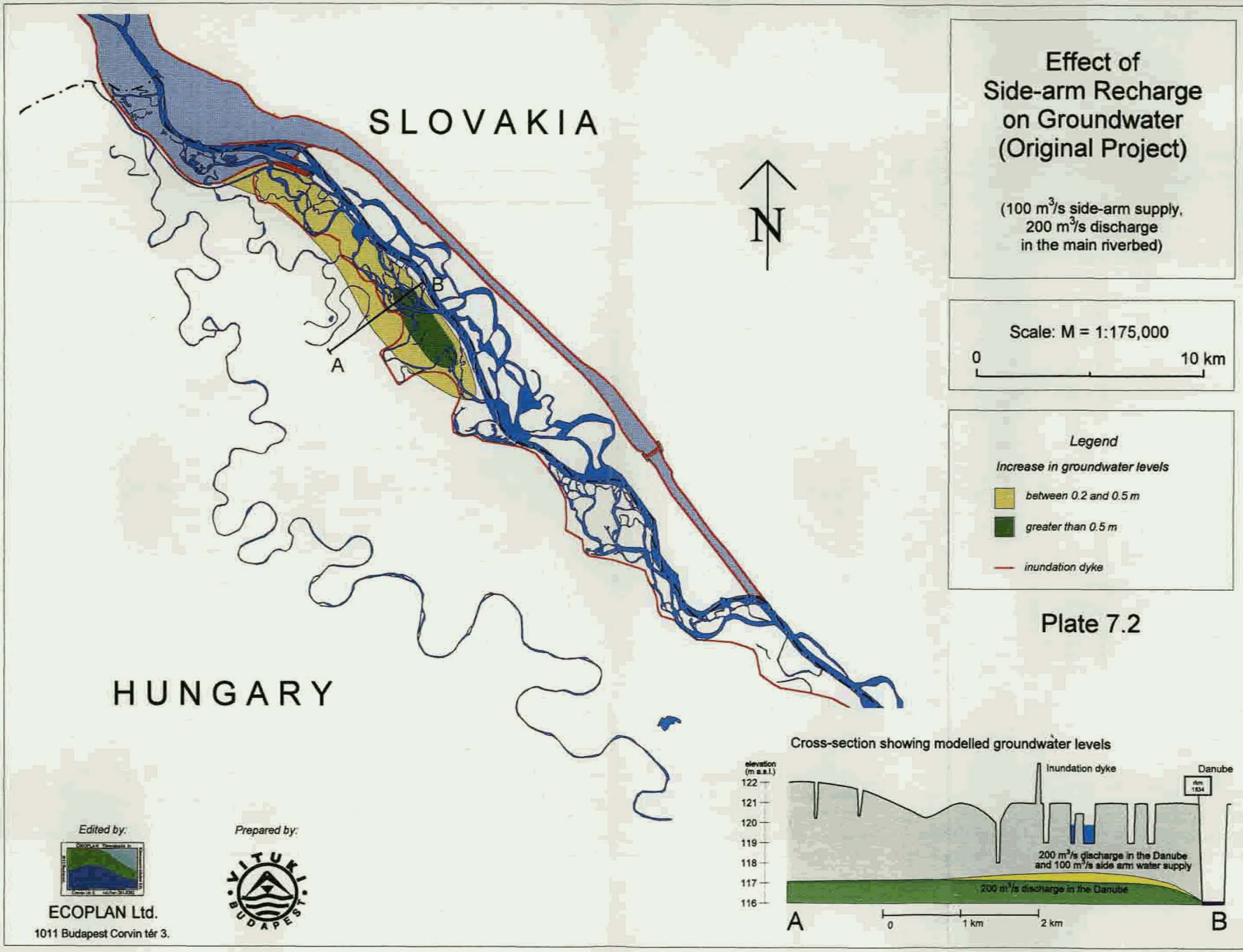
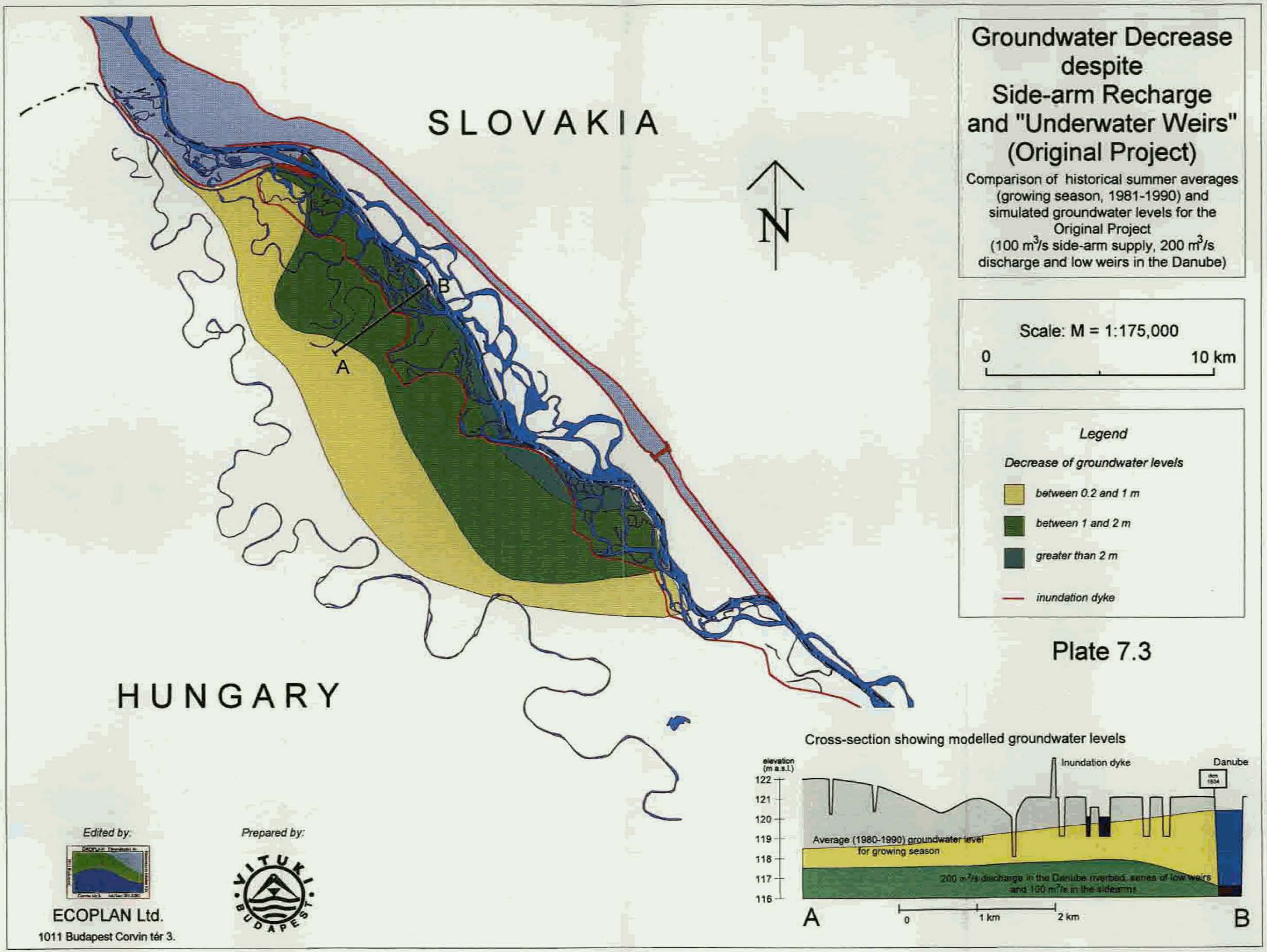

Effect of
Side-arm Recharge
on Groundwater
(Original Project)
(100 m3/s side-arm supply,
200 m3/s discharge
in the main riverbed)
Scale: M = 1:175,000
0
10 km
Legend
Increase in groundwater levels
between 0.2 and 0.5 m
greater than 0.5 m
inundation dyke
SLOVAKIA
HUNGARY
N
A
B
Cross-section showing modelled groundwater levels
elevation (m a.s.l.)
122
121
120
119
118
117
116
Inundation dyke
Danube
200 m3/s discharge in the Danube and 100 m3/s side arm water supply
200 m3/s discharge in the Danube
0
1 km
2 km
A
B
Edited by:
ECOPLAN Ltd.
1011 Budapest Corvin tér 3.
Prepared by:
VITUKI BUDAPEST

Plate 7.2


Groundwater Decrease despite Side-arm Recharge and "Underwater Weirs" (Original Project)
Comparison of historical summer averages (growing season, 1981-1990) and simulated groundwater levels for the Original Project (100 m³/s side-arm supply, 200 m³/s discharge and low weirs in the Danube)
SLOVAKIA
HUNGARY
N
A
B
Scale: M = 1:175,000
0
10 km
Legend
Decrease of groundwater levels
between 0.2 and 1 m
between 1 and 2 m
greater than 2 m
inundation dyke
Cross-section showing modelled groundwater levels
elevation (m a.s.l.)
122
121
120
119
118
117
116
Inundation dyke
Danube
Average (1980-1990) groundwater level for growing season
200 m³/s discharge in the Danube riverbed, series of low weirs and 100 m³/s in the sidearms
A
0
1 km
2 km
B
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VITUKI BUDAPEST

Plate 7.3

present additional serious operational problems for ice and flood release and emergency navigation. Their long term adverse environmental consequences are described in *Chapters 7.4, 7.5* and *7.6*.

7.3.4 GROUNDWATER RESPONSE TO REMEDIAL MEASURES - VARIANT C

The effect of a single weir, as specifically proposed in the Slovak Counter-Memorial, is shown in *Plate 7.4* for a discharge of 300 m^3/s in the Old Danube, with an additional flow of 100 m^3/s to the side-arm system, in comparison with no side-arm recharge and 400 m^3/s in the Old Danube. The resulting increase in groundwater levels is insignificant. A maximum increase of less than 0.6 m occurs, and the area influenced by rises of 0.5 m or more is less than 400 ha. Sensitivity to the effects of clogging due to deposited sediments has been investigated. Using the most favourable (lowest) observed bed resistance throughout the entire side-arm system results in an additional rise of less than 30 cm.

This strongly suggests that the Slovak recommendation is ineffective and that the EC recommendations are only valid if taken in their entirety, i.e., allowing for greatly increased discharges in the Old Danube.

7.4 WETLAND ECOLOGY AND VEGETATION

Slovakia alleges that remedial measures such as the artificial water recharge with cross-dykes in the side-arm system and the weirs in the riverbed of the Old Danube would have beneficial effects for the environment and hence for the river-floodplain ecosystem. It goes even beyond, purporting to restore the original floodplain balance:

> "Further, the original braided nature of the river can now be recreated by interconnection between the side arms and the old Danube channel. This was proposed as part of the G/N Project and is currently projected as part of the implementation of Variant 'C', as is the addition of riverbed material."[38]

The Slovak argument culminates in the assertion "that the Project could, with Hungary's participation, lead to a restoration of river conditions approximating those that existed before the introduction of major river regulation schemes in the middle of the last century".[39]

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[38] SC-M, para 7.28.

[39] SC-M, para 9.86, repeated in para 9.104.

All Slovak assertions with regard to fauna, flora and fishery, demonstrate either ignorance or a lack of concern for the basic ecology of floodplains. Proposed or implemented remedial measures are inadequate and some could be detrimental, not only in the present but in the future. The claim that "the floodplain and branch system of the river is preserved and restored"[40] is diametrically opposed to the facts both from an ecological and a hydrodynamic point of view. It is obvious that the Slovak floodplain is not restored but destroyed. An artificial cascade of several communicating reservoirs is not a floodplain system.[41] The floodplain (as the terrestrial element of the river-floodplain ecosystem) and the aquatic habitats need floods[42] (or the flood-pulse[43]). This is necessary to preserve the specific species composition and habitat diversity,[44] that is to provide oxygen, nutrients and to select adapted species. An artificial recharge system cannot ensure this basic condition on either the left bank of the Danube or in the Szigetköz.

An interconnection of all surface waters in the Szigetköz associated with a large permanent discharge would minimise the former natural differences between them as occured in the previous floodplain along the Upper Rhine. The latter was the product of a large-scale mitigation measure in the side-arms, which is very similar and hence comparable to the Slovak side-arm system.[45] The result was a disaster: almost all of the rare species and habitats became extinct within two decades.[46] Biodiversity was destroyed by the new homogeneous condition. There is no doubt that the envisaged or implemented supply system will have the same destructive effect in the Szigetköz as well as in the Žitný Ostrov.

The cross-dykes in the side-arm system, as implemented in the Žitný Ostrov since May 1993, transform the previous continuum of the floodplain and its water bodies into a sequence of biologically almost isolated ponds. *Plate 7.5* demonstrates the ecological disconnection of the recently established water steps by the in-effective passage in an existing cross-dyke.

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40 SC-M, para 7.27.

41 See e.g., *Plate 7.5*, which demonstrates the disconnecting effect of Slovak cross-dykes.

42 See HC-M, Annexes, vol 4 (part 2), annex 16, chap 1.3.

43 See *Scientific Evaluation*, HC-M, vol 2, chap 4.6 at p 153.

44 See HC-M, Annexes, vol 4 (part 2), annex 16, chap 1.4.

45 Adverse impacts are primarily the 'levelling' of differences in the temperature and nutrient regimes of side-arms, which depend on the surface and groundwater flow. These differences in habitat conditions existed even in permanently connected branch systems, which also allowed for species migration at the same time.

46 See HC-M, Annexes, vol 4 (part 2), annex 15.

Effect of Side-arm Recharge on Groundwater (Variant C)

Simulated groundwater level differences between
a) 300 m^3/s discharge into the Danube, 100 m^3/s side-arm recharge and
b) 400 m^3/s discharge into the Danube, no side-arm recharge

Scale: M = 1:175,000

0 10 km

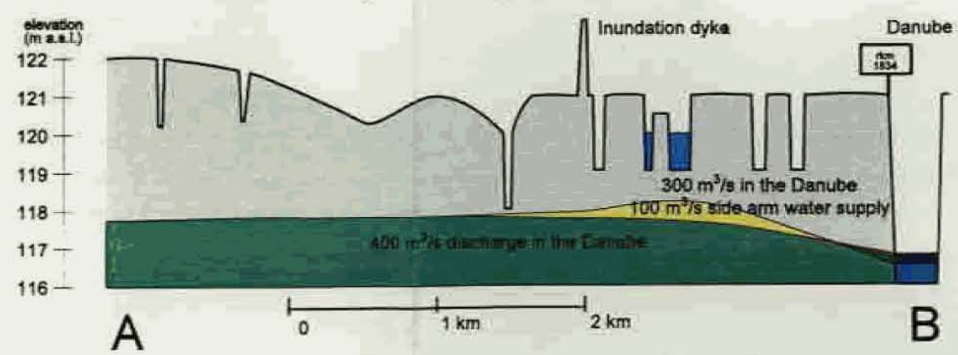
Legend

Increase of groundwater levels

- *between 0.2 and 0.5 m*
- *greater than 0.5 m*
- *inundation dyke*

Plate 7.4

Cross-section showing modelled groundwater levels



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Slovakia claims that in its part of the Danubian inland delta "...not a single species from the presently known plant communities of the floodplain ecosystem has been threatened or, much less, has disappeared due to the implementation of Variant 'C'. The impact of the G/N Project on Szigetköz would have followed this example if the specific mitigation measures had not been abandoned by Hungary."[47] No evidence is presented to support this statement.[48]

Concerning the threat or disappearance of species it cannot be suggested that "the actual success of this modification [the artificial water recharge] can now be judged from the Slovak side arm system".[49] Comprehensive biological monitoring in the Szigetköz since 1986 has shown that most of the native plant species occur in several fragmented habitats or in small populations, frequently approaching the limits of their tolerance.[50] Even before the diversion, the vegetation and fauna of the floodplain could not tolerate further drying or lack of floods. In any event, it is impossible to evaluate changes on the Slovak side as long as no monitoring data are presented by the Slovak party to support the argument.

The Slovak Counter-Memorial proposed the construction of a single weir at rkm 1843 in order to "restore" the side branches of the Szigetköz.[51] The proposed system brings water back, but not to the floodplain, only to the desiccated side-arms. Regular inundations of the floodplain and fluctuations of water levels (as well as all other dynamics[52]), which had led to the characteristic formation of aquatic and floodplain habitats[53] and are essential for the survival of the wetland ecosystem, would not be restored by the recharge system.

Ecological conclusion of remedial measures

The vaunted 'remedial measures' may alleviate the short-term damages to a certain extent but not compensate for long-term losses. They cannot replace the functioning of the river-floodplain ecosystem. Long-term damage would be reduced to a much greater degree by raising and reshaping the Old Danube in a

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47 SC-M, para 7.101.

48 See Chapter 2 of this Rebuttal.

49 SC-M, para 7.101

50 HR, Annexes, vol 3, annex 5.

51 SC-M, illus. CM-12, after p 210 and paras 8.06-8.13.

52 See HC-M, vol 2, *Fig. 4.1*, p 129.

53 Such *processes* can never be depicted in *photographs*, which only show the conditions at that very moment. Cf. SC-M, illus CM-6A-C, after p 186.

near-natural manner in conjunction with a much greater flow, as proposed by the WWF.[54] The only long-term remediation is the restoration of the original conditions in the former active floodplain.

7.5 AQUATIC HABITATS/FISHERY

In the Slovak-Hungarian section of the Danube, fishery resources have been modified in diversity and productivity since the end of the last century. The equilibrium of the ecological conditions achieved in the 1950s and 1960s, was again disturbed by the construction work of the Gabčíkovo-Nagymaros Project. But the real impact was made with the implementation of Variant C,[55] which caused detrimental changes in the fish communities, as well as resulting in severe damage to the commercial and recreational fishery.[56]

Hungary's position is related to the recommendation of the EC Working Group report of December 1, 1993, that the primary objectives are to enable as good environmental conditions as possible within the given discharge constraints, while the secondary objective is electricity production.[57]

The ichthyological study annexed in the Slovak Counter-Memorial contains some statements regarding the management of fishery problems.[58] In this respect, the Slovak and Hungarian positions are very different. The study declares that the construction of the Gabčíkovo-Nagymaros Project was a possible way to stop the decreases in fish production, in economic value of the ichthyocenose and total catch. Hungary has not experienced these benefits. In the relatively short time that has passed since the diversion of the Danube, the living conditions for the fish communities have deteriorated considerably.[59] Strategies for effective implementation of remedial measures for the fishery resources have to be conceived at different levels. At the level of the water management of the Danube, priorities must be set among a number of competing uses of which fisheries is but one. At the level of fish ecology, certain measures can be employed to improve the diversity of the natural habitats and the living conditions of fish communities. At

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54 See HM, Annexes, vol 5 (part 2), annex 20.

55 *Scientific Evaluation*, HC-M, vol 2, chap 4.5-4.6.

56 HM, paras 5.78-5.81 and paras 5.127-5.129; HC-M, paras 3.78-3.81; *Scientific Evaluation*, HC-M, vol 2, chap 5.4.

57 EC Working Group, *Report on Temporary Water Management Regime* (Bratislava, Dec 1, 1993); HM, Annexes, vol 5 (part 2), annex 19.

58 A Kirka, *Fish, Fisheries and the G/N Project*, 1994 (*hereinafter* Kirka, 1994); SC-M, Annexes, vol 2, annex 25.

59 HM, para 5.81 and paras 5.128-5.129; HC-M, paras 3.78-3.81; *Scientific Evaluation*, HC-M, vol 2, chap 5.4.

Plate 7.5 Passage in a Slovak Cross-dyke: no Pass for Fish

The concrete ramp has a constant cross-section and slope. It is unsurmountable for all aquatic fauna in the upstream direction and only allows the passage of drifting plankton in the downstream direction. The pass is in fact a *barrier,* which disconnects populations upstream and downstream of the dyke the level of fishery, the resource may have to be allocated among several interested groups and management techniques applied in order to control the type and amount of fish being caught.

The Slovak ichthyofauna monitoring[60] reports that the greatest part of the fish species have settled in the tailrace canal, although the study goes on to refer to improvements in water quality in the Old Danube. Why would the fish have settled in the tailrace canal when the water quality had ameliorated in the Old Danube? The occurrence of burbot *(Lota lota)* and gudgeon *(Gobio gobio)* in the old riverbed does not offer evidence of such an improvement.[61] The results of ichthyofauna monitoring in Slovakia indicated some changes in species variety and quantity, but these data do not provide evidence of a successful implementation of remedial measures.

The Slovak study states that "the most effective way to maintain fishing areas would be to dam the river and fill it through the intake structure from the bypass canal in order to reach optimum fish production".[62] In this sense, the highly manipulated side-arm system[63] may be a kind of fish farm. This is hardly acceptable if the primary objectives are to preserve the native fish communities and to reach the ideal natural recruitment of fish populations. If these are the aims, the main requirements would be to maintain the original habitat diversity and to assure migratory access between aquatic habitats, instead of dissecting the natural branch system.

Slovakia argues that the changes in water regime prior to 1989 had led to a decrease in fish numbers in the side-arms, and that this situation was to be reversed by means of the Project's artificial recharge programme.[64] According to publicly available knowledge, the recharge system in the Slovak floodplain is not functioning well from the aspect of fishery. The side-arms are dissected by weirs into a sequence of small reservoirs that lead to quasi-lacustrine flow conditions and consequently, rather uniform habitats. The current velocity is too high (>2 m^3/s) in the fish passes at the weirs, which is insurmountable for smaller fish species migrating between the segregated branches.[65] In habitats thus created, the

60 Kirka, 1994; SC-M, Annexes, vol 2, annex 25.

61 See comments in Chapter 6.

62 Kirka, 1994; SC-M, Annexes, vol 2, annex 25 at p 374.

63 E.g., Pearce's article (Dam truths on the Danube) describes this system as "highly artificial" in the *New Scientist*, Sept 17, 1994; SC-M, Annexes, vol 2, annex 19.

64 SC-M, para 7.104.

65 See *Plate 7.5.*

fish community will in due course be reduced to species adapted to almost stagnant waterbodies and able to resist rapid rises of discharge.[66]

The assumption that "full water capacity"[67] is the most important condition for the functioning of alluvial floodplains is another manifestation of Slovakia's ignorance of fluvial ecology. Water level fluctuations are essential for the existence and survival of the diverse aquatic, semi-aquatic and terrestrial habitats.[68] The impacts of the Original Project, Variant C and the evaluation of remedial measures have been explained in earlier reports.[69] By contrast, Slovakia states that "the G/N Project...aims to turn the old Danube from a partially canalised river into an approximation of the original braided river: the attempt is to recreate a more natural side arm system"[70] and that, "[t]his situation [pre-dam] *has to be reversed* by means of the Project's artificial program".[71] These assertions are scientifically unfounded for reasons which have already been explained.[72]

7.6 FORESTRY

7.6.1 SUMMARY OF HUNGARIAN POSITION

Wetland forests largely depend on the natural discharge regime of free-flowing rivers including periods of inundation, drought and fluctuating groundwater levels. The envisaged and actually implemented recharge system in Slovakia is calculated to provide a nearly constant groundwater and surface water level excluding large fluctuations. In addition, it was demonstrated above that the recharge system envisaged would not even be able to maintain a constant groundwater level at a higher altitude nor could pre-dam groundwater levels be re-established.[73]

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66 *Scientific Evaluation*, HC-M, vol 2, chap 4.6, chap 5.4.

67 SC-M, para 7.99.

68 *Scientific Evaluation*, HC-M, vol 2, chap 4

69 Ibid. chaps 4.4, 4.5 and 4.6, respectively.

70 SC-M, para 7 102.

71 SC-M, para 7.104, emphasis added.

72 See Chapter 3.1.3 of this Rebuttal.

73 See *Plates 7.2, 7.3* and *7.4*.

7.6.2 PRESENTATION OF NEW DATA[74]

A study evaluated the potential long-term changes in the productivity of forest stands in the active floodplain allowing for a recharge of 100 m^3/s in the Hungarian side branches after the construction of a weir in the main channel at rkm 1843.[75] Since the recharge system proves to be rather inefficient according to the model results, the increase in yield is insignificant compared to the long-term impact of Variant C without recharge,[76] specifically, the total value of forest yield would increase only from 46 to 51% of pre-dam conditions.

7.6.3 REBUTTAL OF SLOVAK ASSERTIONS

The implementation of the Original Project would have resulted in considerable long-term losses to forestry in Hungary, as demonstrated above. The construction and operation of Variant C has actually led to a significant drop in groundwater levels.[77] It can be seen from *Plate 7.2* and *7.4* that remedial measures including a considerable side-arm recharge and the construction of low weirs in the main channel as envisaged in 1989 by the Government Plenipotentiaries[78] could not re-establish pre-dam groundwater levels. Slovak assertions that a flow into the side-arms combined with "underwater weirs" would be beneficial to forestry or could even reverse pre-dam degradation of groundwater levels along the Danube[79] has been refuted, at least for the Hungarian side.

The "evidence" presented to demonstrate the benefits to forestry in Slovakia consists of an alleged increase in diameter growth for white poplar and ash trees of 0.2 and 0.3 mm respectively[80] without mentioning the location, elevation, size of sample, etc. Alluvial forests grow very quickly, and growth in the diameter of hybrid poplars in the Szigetköz used to reach up to 30 mm per year under optimum conditions before the damming. An observed increase of 0.2/0.3 mm is

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74 Z Somogyi et al., *Assessment of Long-term Changes in the Productivity of Forest Stands in the Szigetköz that can be Expected under Different Water Regimes*, Budapest, 1995; HR, Annexes, vol 3, annex 6.

75 This recharge system corresponds exactly to the *Slovak proposal* in SC-M, illus CM-12: the investigated recharge even exceeds by far the Slovak proposal of 40-50 m^3/s (SC-M, para 8.31).

76 See *Plate 6.4*

77 See HC-M, vol 5, *Plate 3.13*.

78 Protocol of the negotiations of the Government Plenipotentiaries on the co-operation in implementing the GNBS, Bratislava, June 8-9, 1989; SM, Annexes, vol 4, annex 58.

79 SC-M, paras 7.94, 7.97 and 8.31.

80 SC-M, para 8.33, fn 59.

insignificant and can be attributed to many factors, including even errors in measuring.

Nutrient and oxygen supply to the floodplain forest associated with large floods can never be replaced by an artificial recharge system. In this respect, extremely turbulent flood flows which inundate large areas of the active floodplain and carry a high suspended load with abundant nutrients and rich content of oxygen cannot be compared to an artificial intake from the reservoir.[81]

7.7 SOILS AND AGRICULTURE

In the previous Chapter *(7.6)*, the effects of remediation measures on conditions in the active floodplain were discussed in the context of forestry. For soils and agriculture, the main areas of concern lie outside the active floodplain, in the protected areas.

The effects of the Original Project and Variant C on soils and agriculture were discussed in the Hungarian Counter-Memorial,[82] and detailed observations of the observed impact of Variant C are presented in *Chapter 6*, above. It is clear from the discussion of groundwater in *Chapter 7.3* above, that the impact of enhanced discharge to the side-arm system and/or low weirs in the Danube is expected to be minimal, especially, in terms of improving groundwater conditions in the protected areas to sustain the natural sub-irrigation supply of soil moisture and hence agricultural productivity.

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81 SC-M, para 8.32.

82 *Scientific Evaluation*, HC-M, vol 2, chaps 5.1.6; HC-M, paras 1.124-1.126 and 3.67-3.70.

CHAPTER 8

SEISMOLOGY AND EARTHQUAKE ENGINEERING

8.1 SUMMARY OF HUNGARIAN POSITION

Seismic design parameters for the project were set at a joint meeting of experts, held in Bratislava, in November 1965.[1] The seismic design parameters were based purely on the historical record of earthquakes and their locations,[2] without reference to the geological structures and mechanisms causing them. Since 1965 there has been a growing awareness of the risks associated with large projects; new methods of quantifying and dealing with risks have evolved, together with new and improved design methods. Despite advances made in risk assessment and design methods, no comprehensive re-appraisal of seismic hazard was attempted prior to 1989.

The new methods of risk assessment and design require a knowledge of the deep geological structures, their relationship to seismic activity, and the dynamic performance of the superficial soils. The exploration work that had been carried out prior to 1989, although voluminous, did not fully address these issues. Furthermore, tectonic models, which form the basis for seismic hazard evaluation, were poorly developed.

Gabčíkovo is situated near the centre of the Danube Basin, which is filled (*inter alia*) with Quaternary deposits.[3] Prior to 1990, little was known about the nature and extent of the deposits,[4] and structure of the underlying basement rocks was poorly understood. Hungarian experts were concerned over the lack of detailed knowledge in the region, and the attendant risks. The seismic design parameters,

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1 A translation of the Memorandum of the meeting is provided. (See HR, Annexes, vol 3, annex 43.

2 In particular, the record of the Komárom earthquake of 1763.

3 The term Quaternary refers to a geological sub-Era, which extends from about 2 million years ago (2 Ma) to the present.

4 P Dzuppa, L Nemesi, and W Seiberl, *Geophysical Results of the International DANREG Project* (Presented to the XIX General Assembly of the European Geophysical Society, Grenoble, April 25-29, 1994); HR, Annexes, vol 3, annex 8. In their address they state, of the Quaternary deposits: "The young sandy and gravelly sediments...represent one of the largest fresh water reservoirs in Europe. Interestingly enough, its extent and thickness, however, were hardly known before the integrated survey of the DANREG project".

and the seismic performance of the various structures and foundations were felt to be questionable, and possibly inadequate.

As a result of exploration work on the Czechoslovak side, geophysicists postulated the presence of a fault near Gabčikovo. The location of the barrage was changed by the designers, in response to the presence of the fault. If the fault was to be considered as a potential earthquake source, moving the barrage by 700 m would only protect the structure from differential displacement across the fault; the effects of ground shaking would not be diminished by the relocation of the barrage over such a small distance. If changes in ground level could be expected due to movement on the fault, then other such faults along the headrace would, potentially, be equally as damaging.

Inconsistency in response of the designers to the presence of the Gabčikovo fault, and the lack of consultation on this issue between the parties, led to the concern expressed in the Hungarian Declaration. The present view of Hungarian,[5] however, is that the Gabčikovo fault, if it exists, is not capable of producing a dislocation at the ground surface, nor should it be regarded as an earthquake source.

The region is one of moderate seismicity. Both Hungarian and Slovak parties have recognised the need for a high standard of earthquake engineering in order to meet the perceived levels of risk associated with the project, and its importance. The Slovak Memorial,[6] for example, states that the structures should have "the ability to handle possible worst case scenarios"; this approach is consistent with that suggested in the Hungarian Counter-Memorial.[7]

Ground exploration on the Hungarian side has shown the soils of the Danube delta to be variable, and in places loose and susceptible to liquefaction.[8] The embankments of the headrace canal are founded on these materials over the 18 km extent of the headrace. Complete or even partial liquefaction in the foundation of the embankments, would be accompanied by lateral spreading and over-topping, followed by a rapidly developing breach of the embankment. Hungary has

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5 See, e.g., Z Balla, *Deep Structure and Seismic Hazard of the Gabčikovo-Nagymaros Region,* Budapest, September 1994; HC-M, Annexes, vol 4 (part 2), annex 21.

6 SM, para 2.61.

7 *Scientific Evaluation*, HC-M, vol 2, chap 6.

8 The term liquefaction refers to the loss of strength observed in loose silts, sands and gravels during earthquake shaking. The loss of strength is accompanied by increased water pressures in the deposit, and is often evidenced by sand boils at the ground surface, and landsliding and subsidence.

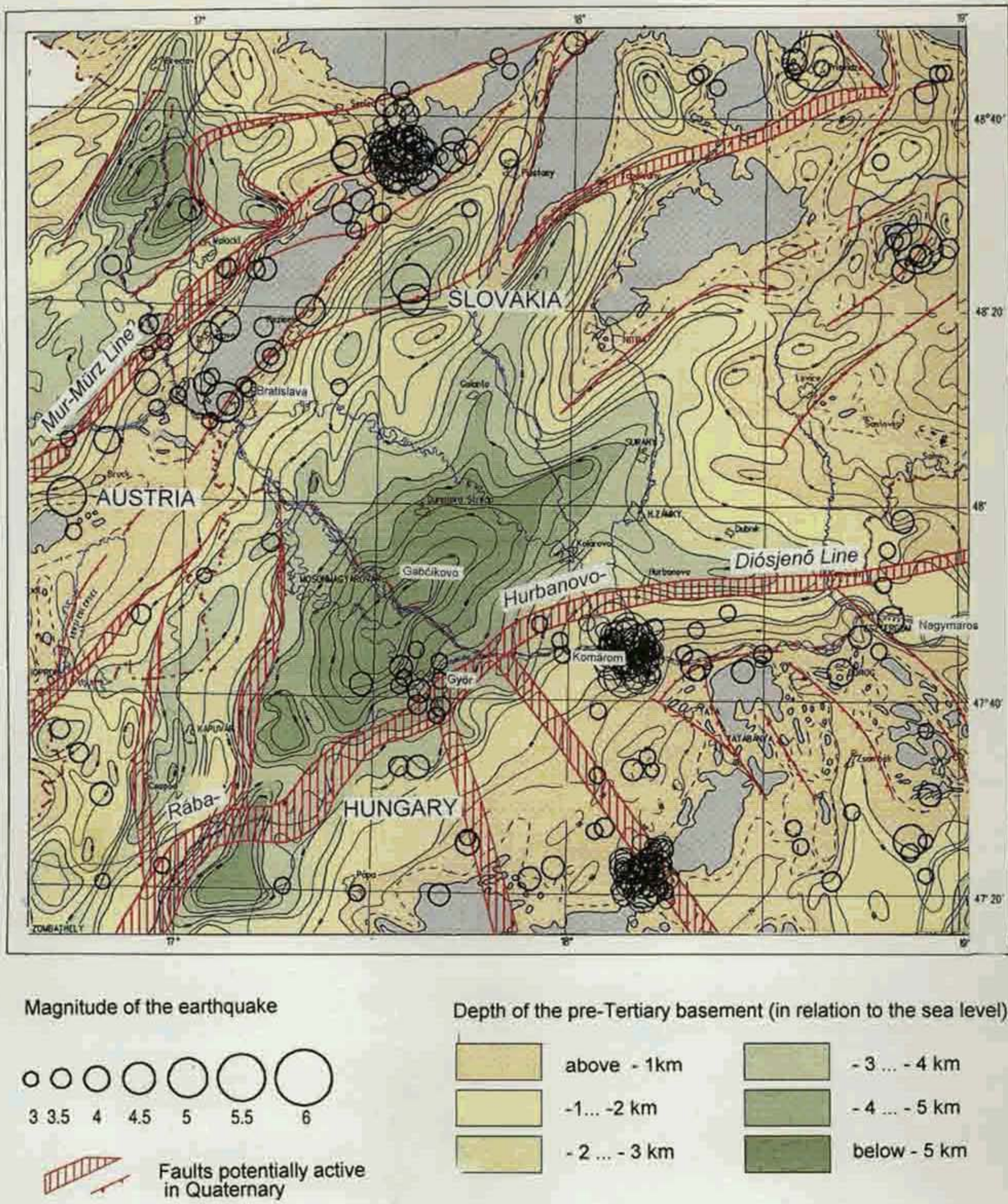

Plate 8.1 Earthquake Epicenters and Potentially Active Tectonic Lines superimposed on the Depth Map of the Pre-Tertiary Basement

Epicentre map was constructed using earthquake catalog (Zsíros *et al.* 1988) updated by Szeidovitz *et al.* (1995). Fault system interpretation after Horváth and Fodor (1995). Depth map after Kilényi *et al.* (1991), upgraded by Nemesi *et al.* (1995) using the new DANREG results expressed concern on the effects of liquefaction and of a flood wave moving downstream on the embankments upstream of Nagymaros.[9]

The known epicentres of earthquakes in the region, having a Richter magnitude greater than 3.0, are shown on *Plate 8.1*. Recent studies have identified two earthquake source zones: the Mur-Mürz Line, and the Győr-Becske Line. Earthquakes of the Mur-Mürz Line are those to the NW of Gabčikovo, and are associated with NE-SW trending faults. Earthquakes of the Győr-Becske Line are those centred near Győr, and to the east of Győr on a line running parallel to the Rába-Hurbanovo-Diósjenö Line through Komárom.

Dunakiliti and Gabčíkovo lie between earthquake source zones, and Nagymaros lies *within* the Győr-Becske source. In the formulation of the seismic design parameters in 1965, a particularly low significance was attached to earthquakes in the vicinity of Győr;[10] this area is currently considered to be within a source zone capable of generating large events.[11] The proximity of Győr to Gabčíkovo and the location of Nagymaros within a source zone are obvious concerns, and these have been expressed in the Hungarian Counter-Memorial.

Recently, studies have been made by the Hungarian Academy of Sciences to estimate seismic hazards associated with the project, using modern methods of evaluation, and the source models described above. Both probabilistic[12] and deterministic[13] methods have been used; both methods are commonly used in seismic hazard evaluation, and are accepted in international practice. Both gave comparable levels of shaking for the case of a maximum credible earthquake, or "worst case scenario". Furthermore, both indicated levels of shaking sufficient to cause liquefaction at Dunakiliti and Gabčíkovo, and peak accelerations of at least three times greater severity than indicated by design parameters set in 1965.

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9 Had the Nagymaros project been completed; see HM, para 5.105.

10 As may be seen from annex 43, (HR, Annexes, vol 3), a design intensity of 7 MCS (=7MSK) was assigned to Győr in 1965 memorandum.

11 This view is apparently supported by the Czechoslovak Academy of Sciences. In a letter to the Soviet Academy of Sciences, concerning the Paks project, it is stated that the Győr area can be interpreted as a "zone of possible earthquake generation". For a translation of the letter, see HR, Annexes, vol 3, annex 52.

12 Probabilistic analyses are made by statistical treatment of historical records of earthquakes. Earthquake intensities referred to in 5.103 of the HM are the result of such an analysis.

13 Deterministic analyses consider the effect of an earthquake of specified magnitude and distance from the site. I Bondár, *Effect of Local Geological Conditions on the Accelerations Expected in the Area*, Budapest, 1992; HC-M, Annexes, vol 4 (part 2), annex 22.

Design of the embankments of the headrace under earthquake conditions, has been based on simple pseudo-static analyses,[14] without allowance for liquefaction of the foundation materials. In addition, the design detail of the water-side membrane of Variant C can be demonstrated to be deficient, even with the application of simple pseudo-static methods.[15]

Further refinement of the hazard assessment and evaluation of the dynamic performance of the embankments and their foundations, using state-of-the-art methods, is required. The hazard analyses that have been carried out by Hungary justify the concerns expressed by the Hungarian Declaration and suspension of construction at Nagymaros; they are not intended as a detailed risk analysis; the need for such an analysis, and agreement between Slovakia and Hungary on mutually acceptable levels of risk, remains.

8.2 PRESENTATION OF NEW DATA ON GEOLOGY, TECTONICS AND SEISMICITY

In 1982, the Hungarian Central Office of Geology, after recognising the inadequacy of geological data in the region, initiated a programme of deep exploration work in the Kisalföld region. Much of the field work was completed by 1989. Despite the additional work, difficulty remained in correlating data in the vicinity of the national border between Slovakia and Hungary. This difficulty is illustrated by comparison of the 1987 Czechoslovak and Hungarian maps of pre-Tertiary basement. As may be seen from *Plate 8.2*, neither the contours of depth or the formation materials are consistent across the border. The DANREG project, which was initiated in 1989, specifically addressed the lack of high quality data, and poor correlation of existing information across the borders.

The DANREG project has involved substantial geophysical field work and cooperation between the countries on a level of technical research. Amongst other findings, the project has provided an appreciation of the structure of the Danube Basin in the vicinity of Gabčíkovo (refer to the contours of pre-Tertiary basement given in *Plate 8.1*), and improved definition of the Rába-Hurbanovo dislocation (see *Plates 8.3* and *8.1*). Full cooperation on a technical level was, however, prevented by political intervention: an example of this was the refusal, in 1993, of the Slovak Ministry of Foreign Affairs to allow the extension of a critical, jointly planned, seismic survey across the border into Slovakia. The survey line, Du-5/93, shown in plan on *Figure 8.1*, was terminated at the border rather than continuing across it. The north-eastern end of the profile is shown on *Figure 8.2*. As may be seen from *Figure 8.2*, a number of faults are may be interpreted on the Hungarian

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14 SM, Annexes, vol 3, annex 30.

15 See *Scientific Evaluation*, HC-M, vol 2, chap 6.3.3.1.

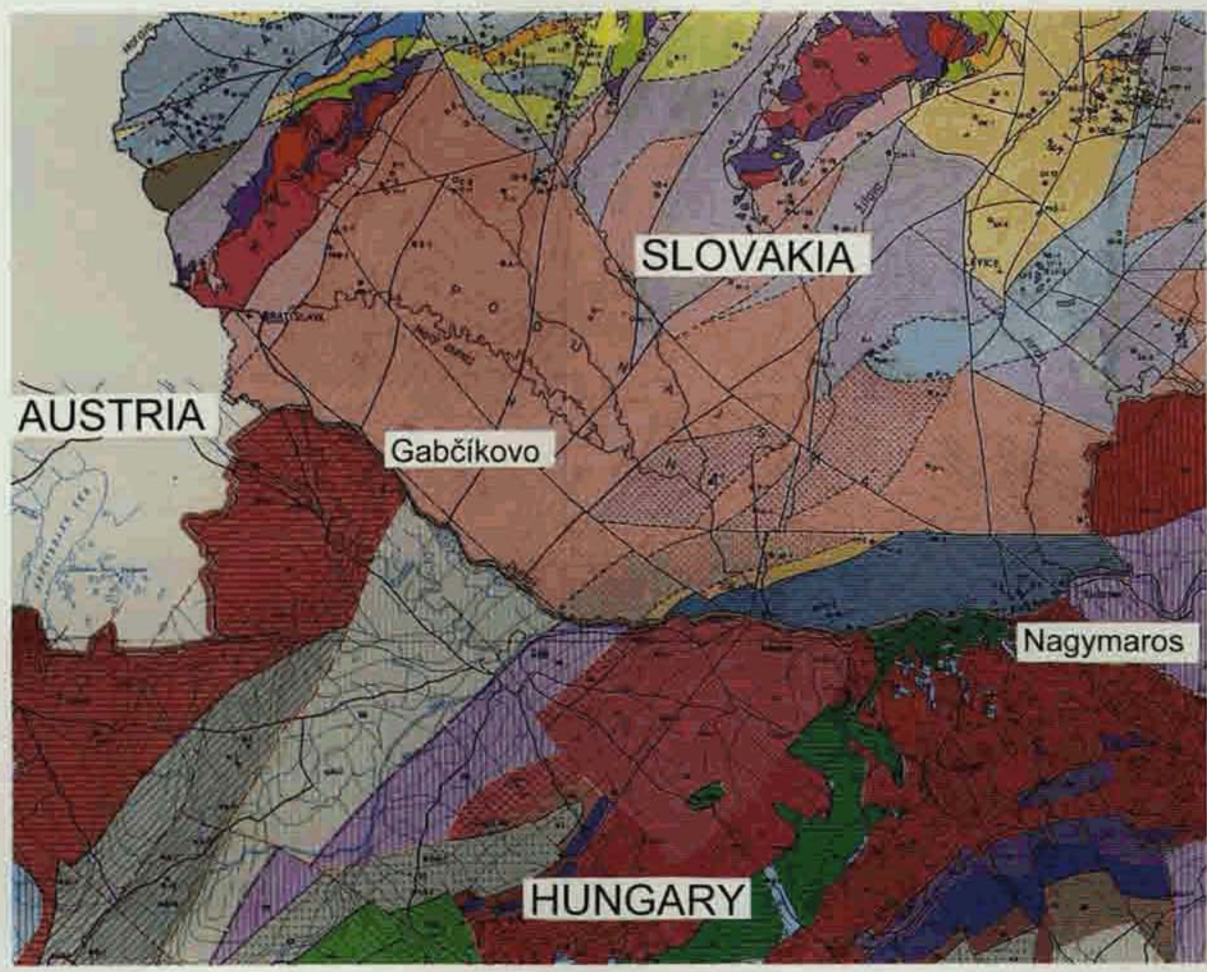

Plate 8.2 Comparison of Czechoslovakian and Hungarian Tectonic-Structural Geologic Maps

Slovakian part: excerpt of the Tectonic Map of Basement of Tertiary in Inner West Carpathians (Fusan *et al.*, 1987).
Hungarian part: excerpt of the Geological Map of Hungary without Cenozoic Sediments (Fülöp *et al.*, 1987)

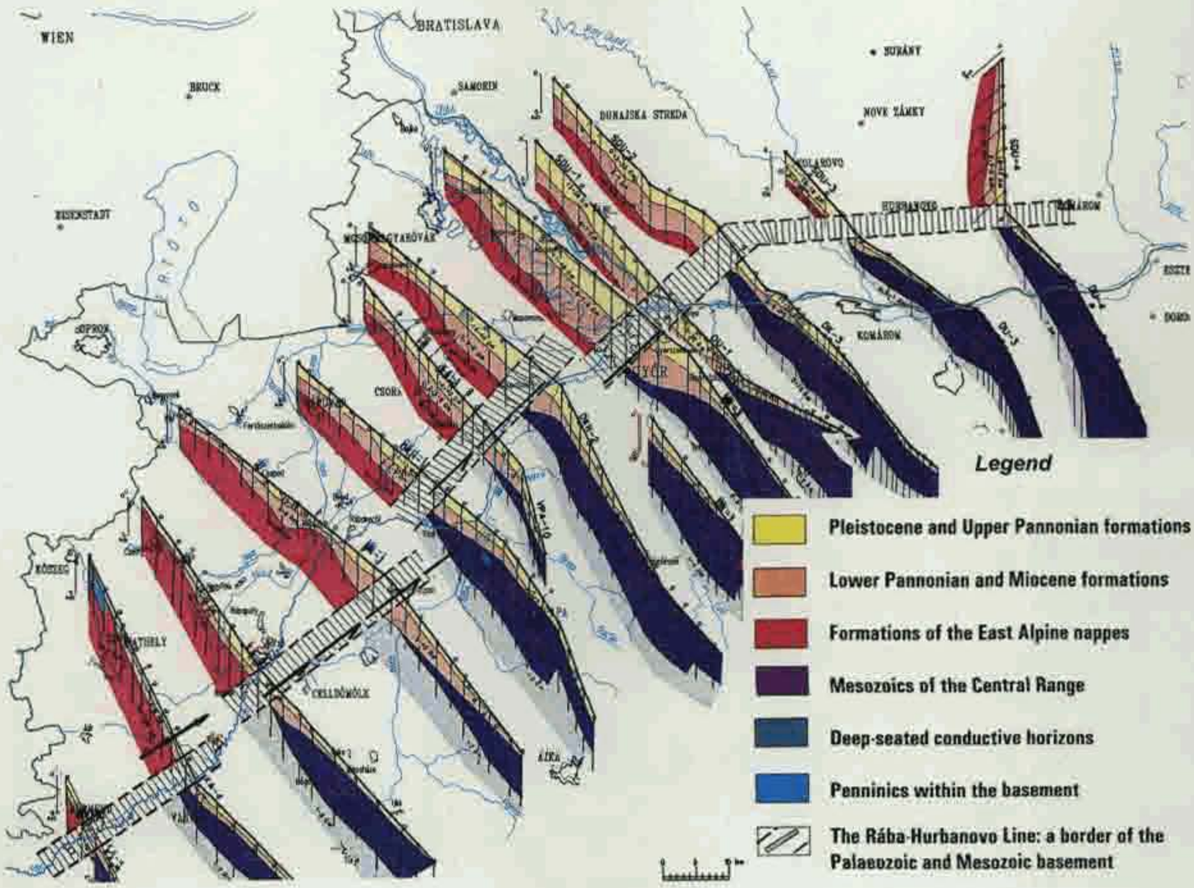

Plate 8.3 The Rába-Hurbanovo Line

as revealed by magnetotelluric soundings, measured partly in the framework of the binational DANREG survey. After Dzuppa *et al.*, 1994.

side, but the quality of the record diminishes as the end of the line, and the border, is reached.

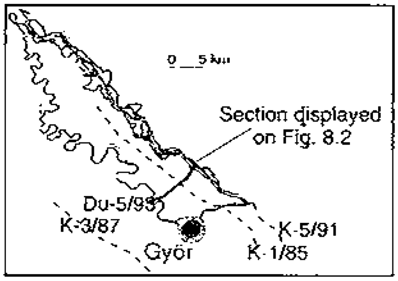

Figure 8.1: Deep seismic lines in the Szigetköz

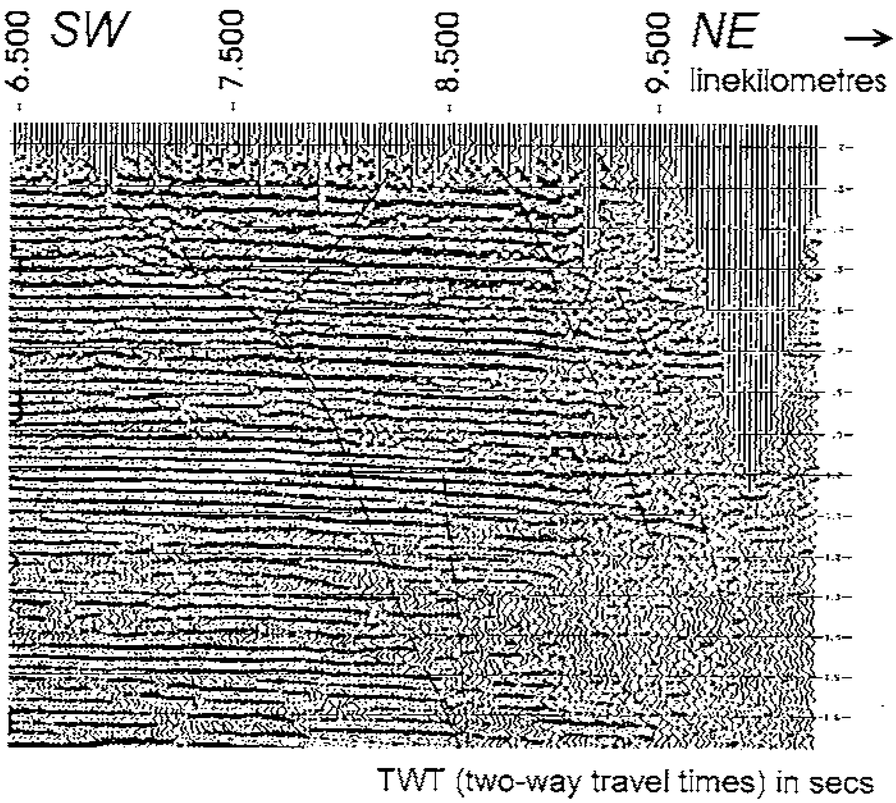

Figure 8.2: Apparent depth (time) section, indicating the possible existence of the Danube tectonic zone (Excerpt of the unfinished Du-5/93 reflection seismic profile, performed by ELGI Budapest in the framework of the DANREG project, 1993)

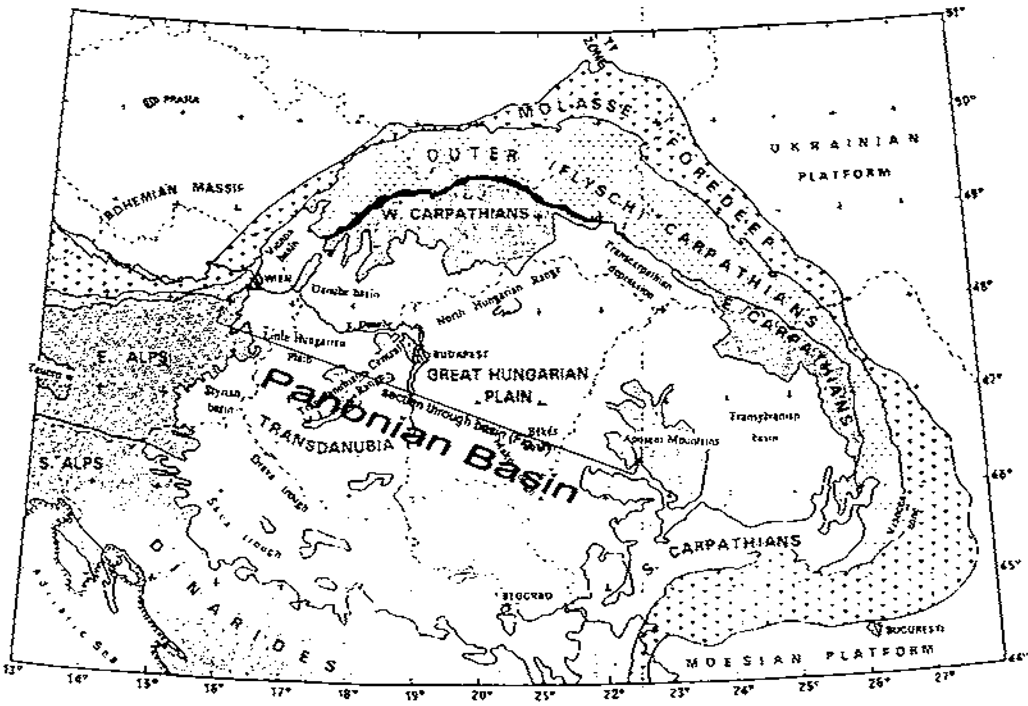

Figure 8.3: Location of the Pannonian Basin

Substantial advances in tectonics have taken place since 1989, with the development of a coherent model for the Pannonian basin.[16] Additional work by Horváth (1993),[17] and Horváth and Cloetingh (1995),[18] provides a tectonic background essential to the assessment of seismic hazard. Tectonic phases of the development of the basin are presented in a simplified form in *Figures 8.3* and *8.4*. As can be seen from *Figure 8.4*, the principal phases are:

a. Thrust and compression, pre-Miocene (more than 23 Ma)
b. Crustal separation, extension and rollback in the Miocene era (23 Ma to 7 Ma)
c. Basin locking in the late Miocene (about 7 Ma)
d. Re-establishment of compression, accompanied by crustal buckling in the Plio-Quaternary (7 Ma to present).

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16 The Pannonian Basin incorporates both the Little and Great Hungarian Plains and the Danube Lowland of Slovakia. A summary of research into formation of the basin is provided by L Fodor in *Evolution Tectonique et Paleo-Champs de Contraintes Oligocenes a Quaternaires de la Zone de Transition Alpes Orientes-Carpathes Occidentales. Formation et Development des Basins de Vienne et Nord Pannoniens.* (PhD thesis, University of Paris, reg. 1991).

17 F Horváth, Towards a mechanical model for the formation of the Pannonian Basin, 1993, *Tectonophysics* 226: 333-357.

18 F Horváth and S Cloetingh, *Stress-induced late stage subsidence anomalies of the Pannonian Basin*, 1995, (In press).

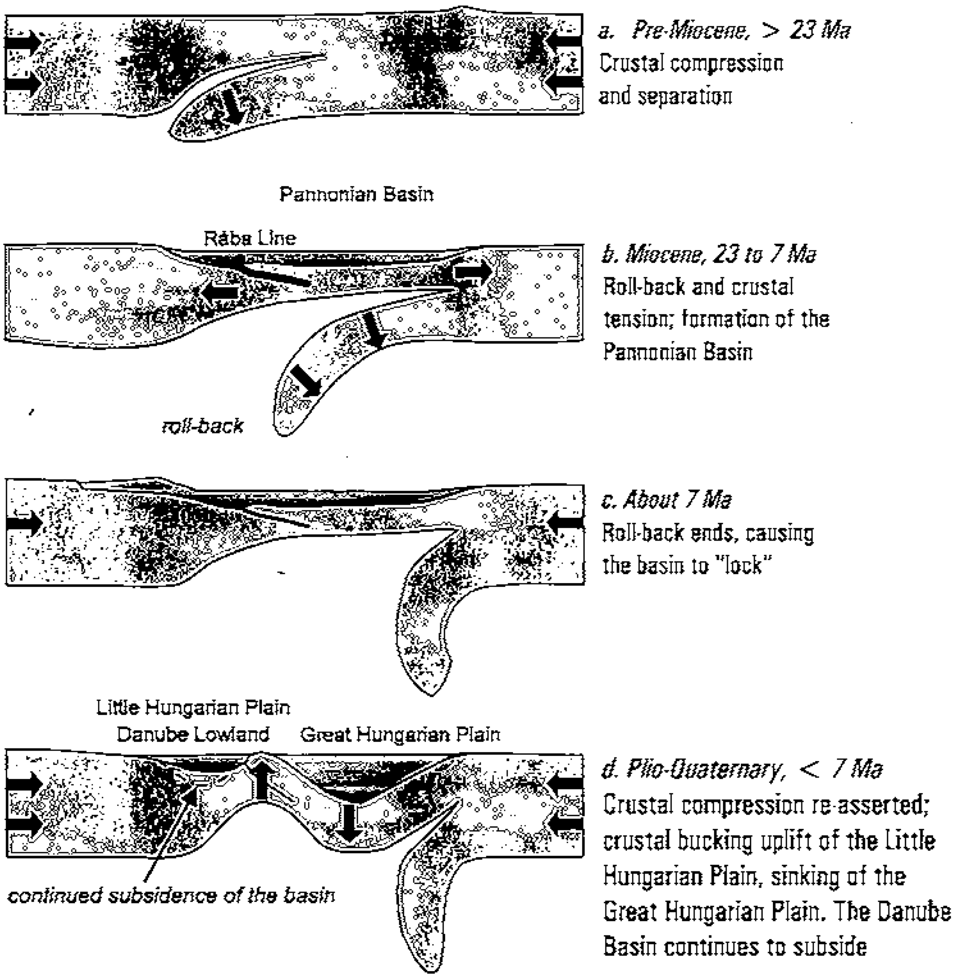

Figure 8.4: Tectonic development of the Pannonian Basin. Sections present the different phases of the crustal development forming the basin. Section indicated on Figure 8.3.

The re-establishment of compression in the Pannonian Basin is quite recent in geological terms, and continues to the present day. It has resulted in uplifting of the larger part of the Little Hungarian Plain and the Transdanubian Range, and sinking of the Great Hungarian Plain. Despite the recent uplifting of the Little Hungarian Plain, sinking of the Danube Basin of the Kisalföld has persisted. Differential crustal movements along the margins of the Danube Basin and along the Danube, to the east of Győr, have been substantial throughout the Quaternary and are continuing. Evidence for this tectonic model includes geological, geophysical, geomorphological and macroseismic data, and measurements of rock stress. The model is consistent with active strike-slip source zones operating on the Mur-Mürz and Győr-Becske Lines, as has been assumed in the recent Hungarian appraisal of seismic hazard.

8.3 CRITIQUE OF THE MAHEL' REPORT

Annex 26 of the Slovak Counter-Memorial presents a view of the tectonics in the immediate vicinity of Gabčíkovo, referred to here as the "Mahel' Report". The tectonic model for the early formation of the Danube Basin, described in the report, is essentially one of crustal tension and associated thinning and sinking of the crust. In this respect, the model is consistent with current research in Hungary. The report describes the current phase of tectonics as thermal subsidence, which takes place without seismic expression. As described above, however, there is now strong evidence for a new phase of tectonism, which extends into the Quaternary; this has greatest implication on the activity of the strike-slip faults of the Mur-Mürz Line and Győr-Becske Line, which are seen by Hungarian experts as the most important sources in terms of seismic hazard.

The Mahel' Report notes the activity of faults at the margins of the basin, but makes no attempt to associate records of earthquake epicentres with major tectonic features, or to evaluate the hazards posed by these features. This is an essential element in the assessment of earthquake hazard, particularly when considering the proximity of earthquake epicentres near Győr to the Gabčíkovo works and headrace and the location of Nagymaros within an earthquake source zone. Instead, the report focuses on the interpretation of a limited number of re-analysed seismic sections; it is noted in the report, that no evidence for movement within the last 0.7 million years, was found on features interpreted as faults, within the Slovak side of the Danube Basin.

Unconformities within the basin deposits, which are evident in the seismic sections presented in the report, are indicative of recent periods of uplift followed by sinking; such unconformities are consistent with the tectonic model for the Pannonian Basin, developed recently in Hungary. When considering the relatively new phase of regional crustal compression, identified in Hungarian research, quiescence of the major tectonic features in the area cannot be guaranteed.

It is suggested in the Mahel' Report,[19] without supporting evidence and out of context with the rest of the report, that the large thickness of Danube Basin deposits would have a "silencing" effect on the "earthquake menace". On the contrary, it is well documented that large thicknesses of soft or loose deposits tend to amplify low frequency strong ground motions; this effect was evident in a recent study by Bondár,[20] in which a comparable geological setting to that at Gabčíkovo was analysed.

The Mahel' Report presents a model for the development of the Danube Basin, based on some re-worked seismic sections, and postulates a current tectonic setting for the basin. The current regional tectonic setting is, however, ignored; nor has there been any attempt to discuss earthquake epicentres, source zones, or mechanisms. The report does not constitute an analysis of seismic hazard.

8.4 REBUTTAL OF SLOVAK ASSERTIONS

The Slovak Counter-Memorial chooses to interpret a lack of detailed *geological* data as "alleged ignorance of the region's *seismic* conditions".[21] The fact that the DANREG programme has been necessary, is indicative of the lack of knowledge of deep geological structure that existed in 1989. The following observation was made by Dzuppa *et al.*,[22] in relation to the poor correlation of geological data across the border and the DANREG project:

> "To fit the geological knowledge together at the borders is a process of necessity. Without this it is impossible to pursue a correct mineral prospecting, water management, geothermal energy management, protection of the environment, soil and groundwater, etc., or to assess the earthquake risk."

On the Hungarian side, considerable effort has been made to improve the geological understanding of the region; geophysical exploration work has continued and the research into geological and tectonic models has been carried out since 1989. Improved knowledge of geological and tectonic conditions allow improved appraisals of seismic hazard. The seismic design parameters set in 1965 were based on outdated methodology, and required revision. The information available prior to 1989 was inadequate to carry out a comprehensive re-evaluation of seismic hazard using modern methods of analysis and design.

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19 SC-M, Annexes, vol 2, annex 26 at p 410.

20 HC-M, Annexes, vol 4 (part 2), annex 22.

21 See SC-M, para 7.105 (emphasis added).

22 P Dzuppa, L Nemesi and W Seiberl, *Geophysical Results of the International DANREG Project*. Presented to the XIX General Assembly of the European Geophysical Society, Grenoble, April 25-29, 1994; HR, Annexes, vol 3, annex 8.

The Slovak Counter-Memorial refers to the "colossal" extent of research work and exploratory drilling carried out in relation to the "region's geology, seismic and tectonic status",[23] which was carried out for the project. The work that was carried out, was to satisfy the requirements of engineering design, rather than to investigate deep geological structure or formulate tectonic or dynamic models. The refinement of seismic hazard evaluation requires the best possible understanding of present-day tectonics, and a thorough knowledge of the overburden profile and its dynamic properties.

It was apparent prior to 1989, that re-appraisal of seismic risk was necessary. The capability of the region to produce strong motion has been appreciated for some time; it is not a "myth", nor was it "invented by Hungary".[24] Lokvenc and Szántó state: "The area is quite seismically active. Seismicity at Komárno has been recorded at 8.5±0.5° on the Mercalli scale".[25] A detailed listing of earthquakes in the region is provided in Annex 9,[26] and epicentres are shown on *Plate 8.1*. It is evident, contrary to the assumptions made in 1965, that all future strong motion in the region would not necessarily emanate from exactly the same epicentre as the large shocks felt previously at Komárom. In modern hazard evaluation, it is assumed that an earthquakes can occur anywhere within source zones. Such zones are identified using macro-seismic data,[27] and well-researched geological and tectonic models. It is Hungary's contention that the seismic design parameters set in 1965 do not adequately reflect the importance of the project, as perceived by both sides, or the seismic hazard.

The Slovak Counter-Memorial suggests that the "basic finding" of the study by Mahel' *et al.*,[28] is that the earthquake risk is smaller than that considered by the project designers. As noted in paragraphs previously, the report does not constitute a seismic hazard study; it presents an incomplete view on neotectonics of the region. It is not a "basic finding" that seismic risk has been over-estimated.

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23 SC-M, para 7.106.

24 Section 4, SC-M, chap VII, p 195.

25 Refer to SM. Annexes, vol 3, annex 30 at p 272.

26 The largest epicentral intensity (=8.5 MSK) is that of the Komárom event of June 28, 1763, having an estimated Richter magnitude of 5.6. The Zólyomlipcse/Slovenská Ľupča earthquake, 1443, has an estimated Richter magnitude of 6.0 (HR, Annexes, vol 3, annex 9).

27 Macro-seismic data comprise the records of all data, including small events.

28 Mahel' *et al.*, *Comparison of Older and Present Views on Geological-Tectonic Structure of the Danube Basin in Relation to Seismic Situation of the Water Work Gabčikovo*; SC-M, Annexes, vol 2, annex 26.

The text of the Slovak Counter-Memorial states that there has been no movement on the Gabčíkovo fault in the last 2 Ma, yet in the report this is given as 0.7 Ma.[29] In the light of recent research, is agreed that there is little evidence to suggest that the Gabčíkovo Fault might provide an earthquake source. Nevertheless, the inconsistent approach of the designers to the presence of the fault was cause for concern prior to 1989. Furthermore, other source zones are present in the immediate vicinity, which are of greater concern.[30]

The Slovak Counter-Memorial states: "In fact, the G/N project structures are located in an area without any registered earthquake epicentres throughout the whole historic period".[31] This is incorrect; the area around Győr, immediately to the south-east of Gabčíkovo is regarded as a potential seismic source.[32] The fact that only relatively small events have been recorded in this area is probably a feature of the short and incomplete nature of the historical record. The quite considerable damage that occurred in Győr in 1763 is noteworthy.[33] Recently, small earthquakes have been observed at distances of between 15 and 20 km south-east of Gabčíkovo,[34] in this area. *Figure 8.5* shows the distribution of observations made during these events.

The Rába-Hurbanovo-Diósjenö Line is dismissed as unimportant in paragraph 7.110 of the Slovak Counter-Memorial. The distribution of earthquake epicenters, however, suggests an active earthquake source[35] parallel to the Rába-Hurbanovo-Diósjenö Line, shown in *Plate 8.1*; as demonstrated in the Hungarian Counter-Memorial and discussed in above, this source lies within about 20 km of Gabčíkovo. At Gabčíkovo, and Dunakiliti, the principal concern is the effects of earthquake shaking rather than fault displacement.

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29 SC-M, para 7.108; SC-M, Annexes, vol 2, annex 26, p 400.

30 E.g., the Győr-Becske and Mur-Mürz Lines, as outlined in *Scientific Evaluation*, HC-M, vol 2, chap 6.

31 SC-M, para 7.112.

32 Győr lies within the Győr-Becske source; Also, see Chapter 8.1 and HR, Annexes, vol 3, annex 52.

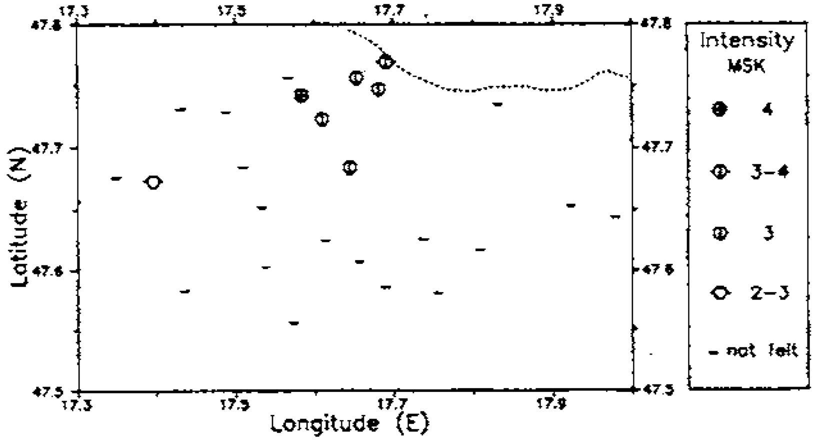
33 G Szeidovitz, *Komárom*. Paper presented at the 1st ESC Workshop on "Historical Earthquakes in Central Europe", Vienna 1987. Contemporary records can be found in the Hungarian National Archives, Budapest as Arch.Regnicol.Lad.CCC Fasc."A"No 10, *1763*.

34 From T Zsiros, *Macroseismic observation in Hungary*, (Seismological Observatory, Hungarian Academy of Sciences):

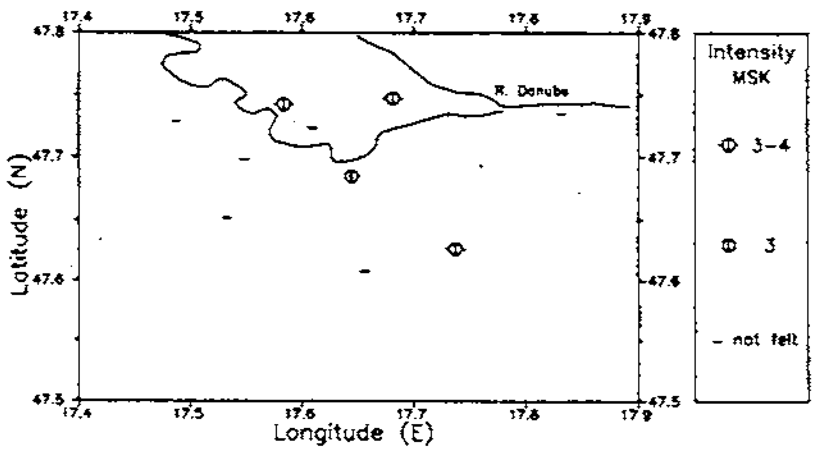
(1) 22 August 1990, maximum intensity felt = 4 MSK, at Győrzámoly.

(2) 12 July 1993, maximum intensity felt= 3.5 MSK, at Győrzámoly, Kisbajcs and Töltéstava.

35 Referred to in the HC-M as the Győr-Becske Line.



Intensity of the Győr earthquake, 22 August 1990



Intensity of the Győr earthquake, 12 July 1993

Figure 8.5: *Intensity distribution of Győr earthquakes, 1990 and 1993*[36]

36 Extract from T Zsiros, *Macroseismic observations in Hungary, (1989-1993)*, 1994. Sesimological Observatory, HAS.

In the Slovak Memorial, criticism is levelled at the assessed levels of intensity referred to in the Hungarian Memorial;[37] these are based on probabilistic analyses using established methodology.[38] The intensities are comparable to those expected at an epicentral distance of 20 km from a Richter magnitude 6.0 to 6.5 earthquake; an event of this size is considered by Czechoslovak and Hungarian experts, to be the largest likely to occur in the region.[39] The assessment is not, therefore, unreasonable as a "worst case scenario".[40]

The Slovak Counter-Memorial states: "Furthermore, Gabčíkovo is situated on a layer of gravel up to 500 m thick which is wholly without tectonic disturbance and would absorb the shock of even an earthquake far exceeding any recorded in the historical period".[41] Far from the region being quiescent, recent vigorous tectonic movements are suggested by Hungarian research, and the data presented by Mahel' *et al.* As discussed in above, the suppositition that the great thickness of gravel would absorb the shock, is incorrect. No study comparable to that presented in the Hungarian Counter-Memorial appears to have been carried out by the Slovak side, which might form a basis for such a statement.

It is suggested in the Slovak Counter-Memorial,[42] that the existing embankments are safe up to 7.5 to 8.0 MSK. It is demonstrated in the Hungarian Counter-Memorial that this is less than is necessary to meet an appraisal of a "worst case scenario".[43] In any case, the analyses that have been carried out are simple pseudo-static analyses, apparently without consideration of liquefaction in the foundation materials. The independent studies referred to in the Slovak Counter-Memorial, have not properly researched this aspect of design.[44] It was stated in the Slovak Memorial that liquefiable material was removed from the

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37 8.7 to 9.0 MSK, HM, para 5.104, Similar levels of shaking have been found using a deterministic approach as outlined in *Scientific Evaluation*, HC-M, vol 2, chap 6.

38 A C Cornell, *Engineering Seismic Risk Analysis*, Bull. Seismological Society of America, 1968, 58(5): 1583-1606.

39 A simple probabilistic analysis given in annex 9 (HR, Annexes, vol 3), suggests a return period of about 100 to 200 years for an earthquake of this magnitude in the region. Also, refer to *Scientific Evaluation*, HC-M, vol 2, chap 6.

40 SM, para 2.61.

41 SC-M, para 7.112

42 SC-M, para 7.112.

43 See *Scientific Evaluation*, HC-M, vol 2, chap 6.

44 The HQI report, referred to in SM, para 2.60, cites a liquefaction assessment using the Seed-Idriss approach: there has not been any attempt by HQI to re-appraise the risk, and apply accelerations appropriate to a maximum credible event. As outlined in the *Scientific Evaluation*, HC-M, vol 2, chap 6, liquefaction can be demonstrated in the case of a maximum credible event.

foundations.[45] Lokvenc and Szántó[46] outline the removal of fine-grained compressible materials, in order to reduce settlement of the embankments to acceptable levels. Lokvenc and Szántó do not cite liquefaction as a reason to remove foundation materials; liquefiable materials are not necessarily highly compressible under typical static embankment loading. From ground investigations carried on Hungarian territory and considering the thickness of Holocene deposits, which are up to 30 m in the Gabčíkovo region, it is unlikely that all liquefiable materials were removed.[47]

In the Slovak Counter-Memorial,[48] it is claimed that a seismic network is in place, and that no station has registered an earthquake of any value. The Seismological Observatory, Hungarian Academy of Sciences is not aware of the presence of a network. If a network were in place, it could not have failed to detect the earthquakes observed at Györ in 1990 and 1993, shown on *Figure 8.5*. A proposal was however made for the joint installation of a seismic network in the region in 1988,[49] in response to concern over seismicity. Accurate location of the epicentres and solution of the fault break, achievable if a network were in place, would be of great value to seismologists in both countries in refining the assessment of earthquake hazard. It is possible that the Slovak Counter-Memorial has confused the installation of strong motion recorders with that of a seismic network. Strong motion recorders are intended to record extreme events, whilst instruments comprising a network are extremely sensitive, and will record even very small events. Strong motion recorders are not suited to the requirements of a seismic network.

The Slovak Counter-Memorial, in concluding,[50] suggests that the risk has been thoroughly studied by both parties, and has been fully taken into account. From the foregoing discussion this is clearly untrue. There has been no systematic study of risk; Hungarian concern over this and other issues led to the suspension of construction at Nagymaros.

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45 SM, para 2.61.

46 SM, Annexes, vol 3, annex 30.

47 HC-M, para 1.167.

48 SC-M, para 7.113.

49 A translation of a memorandum of a meeting held on 6-7 December 1988 is provided in annex 53, (HR, Annexes, vol 3). The network was to comprise 5 stations, with very sensitive equipment capable of detecting small events as well as large events. The network would have allowed the accurate determination of earthquake location and depth, and nature of the ground motion. The analysis of data accumulated over a relatively short time scale could be used to develop an understanding of the mechanisms causing earthquakes. Despite the benefits of this, such a network has not been installed to date.

50 SC-M, para 7.114.

B. APPENDICES

APPENDIX 1

INDEX OF CERTAIN WORDS AND PHRASES IN THE SLOVAK AND HUNGARIAN MEMORIALS AND COUNTER-MEMORIALS

Slovak Memorial	Slovak Counter-Memorial	Hungarian Memorial	Hungarian Counter-Memorial
Absurd, 5.56	Absurd, 1.37, 2.15, 7.97, 8.60, 9.67, 10.19	Absurd, 6.40	
Alleged, 2.62, 3.29, 3.30, 3.35, 4.01, 4.03, 4.11, 4.38, 4.50, 6.136, 7.08, 8.09, 8.17, 8.50, 8.52, 8.55, 8.81, 8.101, 8.103, 8.105	Alleged, 1.08, 1.18, 1.36, 1.42, 2.09, 2.35, 2.37, 3.06, 3.36, 3.56, 3.59, 4.11, 4.13, 4.14, 4.15, 5.06, 5.11, 5.14, 5.52, 5.92, 6.02, 6.07, 7.01, 7.02, 7.03, 7.05, 7.14, 7.15, 7.21, 7.36, 7.40, 7.51, 7.53, 7.66, 7.78, 7.105, 7.110, 8.05, 8.19, 8.28, 9.25, 9.48, 9.95, 9.98, 10.02, 10.18, 10.40, 10.50, 10.53, 10.60, 10.95, 10.96, 10.101, 10.122, 10.133, 11.09, 11.28, 11.29, 11.66, 12.08	Alleged, 7.48, 10.16, 10.68	Alleged, 6.51, 6.100
Arrogant, 8.114	Arrogant, 10.10		Arrogant, 2, 1.01 (both quoting SM, para 8.114)
Astonishment, 4.36, 4.79	Astonishment, 1.34		
	Audacity, 5.87, 12.15		
	Cavalier attitude, 10.09		
	Conspicuously false, 1.46		
	Daring, 1.46		
	Debatable, 2.03, 9.51		
	Deliberate and calculated refusal, 8.10		
	Deliberately misleading, 7.46		
	Demagogic, 1.17		
Distortion, 6.132	Distortion, 1.46, 1.47, 2.34, 2.57, 9.23, 9.89, 9.92, 11.61	Distortion, 10.74	

Slovak Memorial	Slovak Counter-Memorial	Hungarian Memorial	Hungarian Counter-Memorial
Dubious, 6.100	Dubious, 1.40, 2.03		
Erroneous, 8.103	Erroneous, 4.01, 6.05, 10.86, 10.101, 11.02		
	Extravagant, 1.36		
	Fabrication, 4.16		
	Fallacious, 12.13		
False, 4.36	False, 1.46, 2.77, 4.13, 5.24, 5.25, 5.63, 6.10, 7.83, 7.109, 8.10, 8.58, 10.118		
	Falsification, 8.10, 11.04		
	Falsity, 11.04		
	Grotesque, 10.114		
	Head in the sand, 7.83		
Ignores, 3.55, 4.75, 7.24, 7.43, 7.79, 7.82, 7.87, 8.16, 8.58, 8.64	Ignores, 1.42, 2.47, 3.03, 3.27, 3.48, 4.03, 4.06, 4.07, 4.13, 5.45, 5.82, 6.15, 7.02, 7.04, 7.16, 7.20, 7.34, 7.47, 7.48, 7.79, 7.82, 7.85, 7.94, 7.100, 7.103, 7.118, 7.121, 7.133, 7.135, 7.136, 9.01, 9.12, 9.15, 9.65, 9.78, 9.101, 10.01, 10.05, 10.09, 10.31, 10.39, 10.42, 10.76, 10.80, 10.90, 11.09, 11.14, 11.23, 11.24, 11.28, 11.43, 12.10	Ignores, 3.36, 4.16, 5.14, 6.66, 6.69, 7.18, 7.106, 7.114, 9.28	Ignores, 1.08, 1.10, 1.84, 1.127, 2.98, 2.122, 4.21, 4.23, 4.25, 6.58, 6.68, 7.19
Incorrect, 3.56, 4.17, 8.14	Incorrect, 2.23, 2.57, 2.60, 2.89, 3.03, 4.13, 4.18, 4.46, 5.29, 5.52, 5.54, 5.58, 6.05, 6.17, 7.06, 7.115, 8.34, 9.12, 10.11, 10.25, 10.96, 10.103, 10.118		Incorrect, 12, 1.160, 6.72
	Indifference, 1.45, 1.49, 2.28, 2.74, 2.76, 4.02, 4.03, 5.57, 7.67		
	Insinuation, 1.25		
	Misapplies, 9.01, 9.101		

Slovak Memorial	Slovak Counter-Memorial	Hungarian Memorial	Hungarian Counter-Memorial
	Ridiculous, 10.121		
	Ruthlessly, 10.121		
	Self satisfaction, 1.23		
	Self serving, 5.97, 10.73		
	Senseless, 5.78		
	Sham, 5.93		
	Shirk, 2.25		
	Shred, 7.97		
	Struck with astonishment, 1.34		
	Stunning, 5.87		
Supposed, 3.30, 3.52, 3.56, 4.01, 4.79, 6.16, 6.59, 6.103	Supposed, 1.16, 1.46, 4.14, 4.18, 4.40, 5.57, 6.02, 8.45, 10.122, 11.09	Supposed, 4.09, 6.39	Supposed, 2, 1.178, 6.67
	Suspicion, 1.08		
	Tendentious, 1.42		
	Total disregard, 5.65		
Unsubstantiated, 2.88, 2.119	Unsubstantiated, 7.02, 7.11, 7.105, 7.114, 8.19, 9.20, 9.88, 9.90, 9.93, 10.41, 10.59, 11.45, 11.57		
	Utter indifference, 2.74		
	Wholly without sense, 8.08		
	World of make-believe, 11.06		
Wrong, 2.62, 3.28, 9.12, 9.16, 9.23	Wrong, 1.48, 2.35, 2.38, 2.42, 4.31, 4.35, 5.73, 5.80, 7.106, 8.19, 8.54, 10.02, 10.126, 10.129, 11.09, 12.20	Wrong, 8.24, 8.29, 8.51, 10.80	Wrong, 1.160, 5.15

APPENDIX 2

SOME MISREPRESENTATIONS IN THE SLOVAK COUNTER-MEMORIAL

Emphasis in bold added; underlining indicates emphasis in original

SC-M Para	Misrepresentation	The Actual Position
1.20	Variant "C" – a step which Slovakia has always stressed as being **provisional in nature**, and which it is today.	Slovakia began labelling Variant C as "provisional" in October 1990, after a Slovak Legal Committee advised that "the CSFR has to refer to Variant C as a provisional solution in its negotiations with Hungary." HR, Annexes, vol 3, annex 64. But as stated by Engineer Obložinský, the "2nd phase [of Variant C] will use clack-valves to make the regulation of water level possible in the reservoir up to the planned height. The provisional alternative could, in this way, no longer be considered provisional." See HR, Annexes, vol 3, annex 60.
1.49	Such **indifference to chronology** is a **constant** throughout Hungary's Memorial. To give just one other example, it is quite remarkable that in its table of "the Treaty of 1977 and Related Agreements", Hungary takes **no account of the dates** of the different treaties and agreements that it lists as having been concluded.	The table at the end of HM, chap 4 indicates the dates that each treaty was concluded. The same can be said of the agreements or instruments that would automatically terminate with the termination of the 1977 Treaty; these are comprehensively listed in HM, para 4.53. The relevance of these dates is discussed throughout chapter 4.
2.12.	It is these [economic] aims that are set out in the very first paragraph of the 1977 Treaty's preamble, **which Hungary fails to cite...**	HM, para 4.05 discusses the economic aim outlined in the first paragraph of the 1977 Treaty's preamble.
2.20	On several occasions, the Hungarian Memorial depicts the 1977 Treaty as "a blueprint, and not a rigidly pre-determined scheme". But this is inaccurate if, **as the Hungarian Memorial frequently suggests, it is intended to deny the obligatory nature of the Treaty.**	With regard to the obligatory nature of the Treaty, HM, para 4.15(c) clearly states that "where the parties wished to impose an obligation in relation to the Project, this was done in the 1977 Treaty itself."

SC-M Para	Misrepresentation	The Actual Position
2.34	From the preamble it is argued that the main aims of the Treaty were economic and political (the boosting of socialist integration), while from the three articles mentioned above [Articles 15, 19 and 20] it is argued that the **overriding goals were the protection of water quality and the natural environment.** No attention is paid to the **inconsistency** between these two interpretations.	As pointed out in HM, paras 6.12-6.29 a number of articles of the Treaty were directly aimed at environmental protection. But far from implying the protection of the environment as an "overriding goal" of the Treaty, HM, para 4.21(5) states that the Treaty was "*consistent with* the maintenance of water quality and with environmental protection generally." No further claim is made.
2.76	In a rather loose way, Hungary compiles references to provisions of treaties and agreements that it finds useful to its basic hypotheses **with complete indifference to whether they are still in force.**	HM consistently provides the status of treaties or agreements it discusses, and the modifications these may have had on earlier Agreements. To give one example, HM, para 4.33 states that the provisions of the Treaty concerning the Regime of State Frontier (1956) "were supplemented by the bilateral Convention Regarding the Regulation of Issues Surrounding Boundary Waters concluded at Budapest on 31 May 1976. Under Article 23(3), the Boundary Waters Convention replaced the 1954 Agreement concerning the Settlement of Technical and Economic Questions pertaining to Frontier Watercourses. It was intended to be *additional* to the 1956 Treaty concerning the Regime of State Frontiers." Similar examples may be found at HM, para 4.28 and chapter 4, note 32.
4.18	The position paper [prepared by the Hungarian Academy of Sciences at the end of 1983] considered political, technical, economic and environmental issues (in that order) and recommended that a comprehensive, two year environmental impact study be carried out. But it did not find that the Project engendered any irremediable risks to the environment.	The position paper (HM, vol 5, Annex 2) stated that the *questions related* to GNBS could be *classified* into these four groups. It did not state that it had considered all four groups. This is pointed out in the following paragraph of the position paper, which states: "The present standpoint of the Presidency *does not deal with the political questions* which might occur in the above mentioned classifications, because it was not authorised..." HM does not assert that the Position Paper found the Project to engender any irremediable risks to the environment. HM, para 3.48 states that the Position Paper's recommendation was "a comprehensive environment impact statement...to be made within two years."

SC-M Para	Misrepresentation	The Actual Position
6.07	**Both Memorials provide evidence** that the Hungarian Government was **well informed** concerning the essential elements of Variant "C" long before Hungary's termination announcement of 19 May 1992, let alone before the start of the damming of the Danube on 24 October 1992.	The numerous documents annexed to the HM demonstrate that the Czech and Slovak Government failed to give detailed, essential information to the Hungarian Government. As stated in HM, para 7.64-65, Hungary possessed only summary information on Variant C before the damming of the Danube. Essential documents relating to Variant C, including relevant technical data, were not provided to the Hungarian Government until December 1993, long after Hungary's termination of 19 May 1992. Even then the data provided was limited and incomplete.
7.01	Hungary's decision to suspend its performance at Nagymaros, just as its later abandonment of works and purported termination of the 1977 Treaty, was not initiated by the discovery of new research data. Nor was this decision, or those that followed, inspired by an expert and scientific re-examination of pre-existing data. **As Hungary has admitted in its own Memorial,** its alleged concern about water quality, environmental or other risks **was not accompanied by Hungarian research into the possible impacts.** Thus, in a review of Hungarian studies relating to the G/N Project, it is asserted: "Between 1989 and the summer of 1992 there were no investigations of appropriate detail into the problems related to the hydropower scheme and neither were joint projects carried out."	As the quotation from HM, Appendix 3 indicates, although studies were conducted between 1989 and 1992, these studies failed to examine the problems in "*appropriate detail*." This in no way suggests that "no studies" were conducted. In fact, the statement came in the context of reviewing 21 Hungarian studies produced in 1989-1991, all dealing with hydrological aspects of the Project. The reference to the lack of appropriate detail reflects the complexity of the issues, *e.g.*, concerning the hydro-geological structure of the alluvial cone under the Szigetköz, and the connection between surface and groundwater.
7.14	The Hungarian Memorial, in its Appendix 3, centres on and quotes from two assessments of the then existing studies prepared in early 1992. What is striking is that the two separate committees **allegedly came to radically different conclusions** – according to the ad hoc committee [of the Hungarian Academy of Sciences] the Project would result in the pollution of the Žitný Ostrov/Szigetköz aquifer, while the view of the more obviously specialised Committee of Water Management Sciences **was wholly to the contrary**.	As HM, pages 409-411 demonstrate, both committees concluded that the Project would pollute the aquifer. The only contradiction that existed between the two conclusions was the question of whether repeated dredging could avoid potential damage. The Committee of Water Management Sciences felt dredging could alleviate any problems, while the ad hoc committee – relying on results of numerous investigations – stated that "[d]uring and after dredging, algae, iron, sulphur bacteria, coli bacteria, streptococcus and Pseudo-monas pollution incidents were frequently detected."

SC-M Para	Misrepresentation	The Actual Position
7.24	It is important to locate the reserves precisely, not simply to refer to "the largest bank filtered water resource in Europe", which **confuses the Žitný Ostrov/Szigetköz aquifer and the Budapest supply wells downstream of Nagymaros.** The two are in no way connected.... It is **only the second of these that is truly a bank-filtered resource**, with wells located only a few metres away from the Danube, and truly of importance to Hungary in terms of drinking water supply.	Groundwater can be defined as a bank filtered resource if the dominant part of the water originates from the river and the travel time of the water from the river is less than two years, which is true for the Szigetköz as well as for the water tapped by the wells downstream of Nagymaros. Groundwater in the Szigetköz is – or, before Variant C was – a bank filtered water resource with a great potential for utilisation. This misrepresentation reflects Slovakia's unwillingness to provide a careful and evidenced response to the concerns raised about both regions affected by the Project.
7.26	Hungary's second contention is that there are no barrage systems similar to the G/N System, which is portrayed as a unique experiment. **This is confusing,** for just two paragraphs later Hungary makes a reference to **"similar schemes"**.	The parameters of the Original Project are unique in the sense that barrages on the Danube or the Rhine never have such high head at the power station in low gradient reaches. In addition, the extremely low gradient of 8-12 of the Nagymaros reach results in an extraordinarily long impoundment with a relatively small gain in energy. A further difference is that peaking mode at other rivers only allow for a very limited flow above the natural flow, (at the Rhine 300 m^3/s, whereas in connection with the Original Project water accumulated for 18.5 hours would have been released in 5.5 hours allowing for more than five times the normal flow at 900 m^3/s discharge). See HC-M, paras 1.209, 1.211 and HC-M, Annexes, vol 2 at p. 19 (Figure 2.5 b) and at p. 24. None of the barrages on the upper and middle Danube operate in peaking mode; they are all run-of-river barrages. None involve an integrated scheme covering more than 100 km of river.
7.31	According to Hungary's Memorial: "The organic content of the Danube water and its nutrient state render it unfit for retention in a reservoir." This will **no doubt come as a shock to Germany and Austria**, which have, respectively, 26 and 10 hydroelectric power plants on the Danube, each with its own reservoir.	HM, para 5.41 refers to the *Hungarian-Slovak section of the Danube*, not the German and Austrian stretches of the Danube. This is apparent from the citation in support of this statement: "VITUKI Hydrological Institute, Evaluation of the Water Quality of the Hungarian-Czechoslovak Section of the Danube."

SC-M Para	Misrepresentation	The Actual Position
7.46	In order to boost its claim that an ecological state of necessity existed in 1992, **Hungary has, in public, exaggerated the importance to it of the Žitný Ostrov/Szigetköz aquifer**. To take one example, in its 1992 Declaration, Hungary describes the importance of its share of the aquifer with its "capacity of 1 million m^3/day permanent drinking water supply the average need of the Hungarian capital". In fact, the capacity is 0.3 million m^3/day, none of which is used to supply Budapest....Hungary's concern that this resource should not be contaminated is legitimate. But to link this concern to an imminent threat to Budapest's drinking water supplies is **scientifically untenable and deliberately misleading of public opinion** .	The aquifer has never been linked to Budapest's current water supply. The 1992 Declaration did not say that the Szigetköz aquifer was currently used to supply Budapest. As the 1992 Declaration states: "Thus both countries have riverbeds of great length, Hungary about 40 km and Slovakia more than 70 km, that can be *used later* for water supply, according to detailed water quality and hydrogeochemical analyses. On the Hungarian side, this means a *capacity* of 1 million m^3/day permanent drinking water supply – the average need of the Hungarian capital – while in Slovakia this amounts to 2 million m^3/day." The capacity of 0.3 million m^3/day asserted by the SC-M is simplistic and represents potential abstraction from existing (pre-dam) recharge. Significantly higher yields are available from the aquifer through the development of bank-filtered resources. Recent estimates indicate potential yields of 1.3 million m^3/day. See *Scientific Rebuttal*, HR, vol 2, ch 4.4.1.
7.66	The existence of the "threat" to these supplies [bank-filtered water wells down-stream of Budapest] allegedly caused by the Project is, **as admitted by Hungary**, based on **no more than simple speculation,** resting on **mere possibilities** that might have led to a deterioration in the water from the bank-filtered wells. In Appendix 3 to its Memorial, Hungary reviews three risks of damage to the Budapest supply wells, each of which is described as no more than a vague possibility: it is stated that water quality upstream of Nagymaros "could have" deteriorated (thus leading to a possible deterioration in the quality of water filtering into the wells); that the release of sediment through the Nagymaros weir "could have created rather uncertain conditions"; that there "could have" been erosion problems downstream of the weir. **This uncertainty** is in striking contrast to Hungary's contention in its 1992 Declaration of the certainty "that irreversible damage afflicts the...drinking water reserves of millions of people".	Far from admitting its concerns were based on "simple speculation" or a "mere possibility", the Hungarian Memorial clearly indicates that these harmful environmental effects were more likely than not to occur. This is confirmed in HM, page 432 (Appendix 3) in its opening paragraph under the title "Effects of the hydropower scheme": "Downstream of Nagymaros the river barrage system *would have caused problems* of the bank-filtered drinking water resources." It is the extent of these problems that could not be ascertained because, as noted at page 432, "no detailed investigations that could have quantified these effects had been made."

SC-M Para	Misrepresentation	The Actual Position
7.127	Hungary argues that, in 1980, it commenced a review of its financial undertakings as a result of "the changing world economy and the deteriorating economic position of the Socialist bloc countries" and as a result sought a postponement of the Project. But this is undermined by its assertion that, **as from the perspective of 1977,** "there was never the slightest possibility" that the Project would be completed in accordance with the 1977 Treaty timetable.	HM, para 4.15 continues the sentence by stating "this was not because of fault attributable to one or the other party but simply because neither could afford to do so, given their other priorities, and the failure of the promised Soviet economic assistance." As agreed by both Parties, not until 1980 was it revealed that the promised Soviet aid would not be forthcoming, indicating clearly that the quoted assertion was made from the perspective of the early 1980s.
8.01	The Hungarian Memorial's exposition of the actual or potential environmental damage arising from Variant "C" – as opposed to the original Project – is noticeably **uncertain in tone**. It is first stated that the impacts of Variant "C" "may be less than the 1977 Barrage System would have been". However, it is claimed a few lines later that this impact is, in fact, "likely to be more severe". In order to avoid **such confusion**, it is essential to focus on the key differences between Variant "C" and the G/N Project.	HM, para 5.108 states that "*[i]n a number of respects* the impact of Variant C on the region may be less than the 1977 Barrage system", while HM, para 5.109 states that "*[i]n other respects* the impact of Variant C is or is likely to be more severe." No confusion exists between the two statements.
9.10	It [the Treaty] thus represents an example of the kind of **environmentally sound** integrated river basin development project **that has been recommended by experts in the field and endorsed by the international** community.	The EBRD has stated in relation to the Project that "[w]e will definitely not be involved in a contentious project of dubious economic value and negative environmental impact which is argued between two of our member countries. We intend to concentrate our efforts on projects supporting rational and environmentally sound development." The World Bank has also voiced concern, stating that it would not finance the Gabčíkovo project "without the most thorough environmental assessment, in accordance with World Bank policy." HR, vol 3, annexes 91 and 92.

SC-M Para	Misrepresentation	The Actual Position
9.23	Hungary is arguing that, because of environmental effects **that it alone perceived,** the duty to consult and negotiate in good faith to which the parties were subject under the Treaty was modified, imposing a special duty on Czechoslovakia.	Many others have perceived these effects. The Environmental and Natural Protection Committee of the Slovak National Council elaborated its view of the Project, stating "the consequences on the natural environment...are of a magnitude unparalleled in the history of the country." See HR, Annexes, vol 3, annex 63 and HC-M, para 1.35. See also the discussion of NGOs acting in the field of the protection of the environment, including Greenpeace, the Sierra Club, World Wildlife Fund USA, Ecologia USA, World Wildlife Fund Germany and Equipe Cousteau. HM, paras 3.58, 3.74, and 3.94; HC-M, paras 2.123-2.124.
9.24 9.83	This [Hungary's] view of the "precautionary principle", according to which it would apply to **all situations in which there is a likelihood of transboundary environmental harm,** is, to say the least, a novel one. Hungary, in contrast, seeks to give the [precautionary] principle sweeping application, so that it would apply to **any alteration** of the natural environment.	HM, para 6.67 clearly states the scope of the precautionary principle: "As an aspect of the obligation of prevention, the precautionary principle seeks to avoid serious environmental damage. It is of particular cogency when there is a danger that the deterioration of the environment would be irreversible."
9.64 9.103	In the light of the position of the international community revealed in the foregoing survey, it is surprising that Hungary would take the **absolute** position that environmental considerations **foreclose development of the freshwater resources** it shares with Slovakia. Prevention of environmental harm has never been understood by the international community in the absolute sense in which it is used by Hungary **to require a State to forego entirely the development of its natural resources.**	Hungary does not foreclose development of the Danube, but rather advocates the development of this resource in an equitable and reasonable manner. See HM, paras 7.69-7.82; also HC-M, 6.03-6.61.

SC-M Para	Misrepresentation	The Actual Position
9.69	Hungary has provided <u>no</u> **scientific evidence** of <u>**any**</u> adverse environmental consequences of the G/N Project, **other than the ones that had been disclosed by the preparatory studies** planned to be mitigated by appropriate measures envisaged by the Treaty and to which Hungary agreed.	HC-M, paras 1.20-1.171 discuss the inadequate knowledge of biological resources in the region affected by the Project and the failure of preparatory studies to deal with topics covered by EIAs. The numerous environmental impacts associated with the Project are discussed in the *Scientific Evaluation*, HC-M, vol 2.
10.05 10.29	But Hungary ignores entirely the Vienna Convention on the Law of Treaties and advances an entitlement based on necessity – **which it examines only in the context of termination,** believing that to be sufficient to justify suspension at earlier dates. Hungary appears to think that it has no need to offer to the Court any proper legal analysis of the right to suspend and renege on its Treaty obligations....**Hungary offers no legal grounds whatever for suspension** and abandonment at Dunakiliti and at Gabčíkovo.	As stated in HM, para 9.19 "international law allows a State to take action which is necessary to avoid irreversible harm to an essential interest of that State or of its people, or to the environment. The necessity of such action is a circumstance precluding wrongfulness." As pointed out in HM, para 9.39, this claim of necessity justified the suspension of work at Dunakiliti. As regards suspension and abandonment of works at Gabčíkovo, HM para 9.42 notes "the dispute about possible modification of the 1977 Treaty to allow work to proceed at Gabčíkovo became subsumed in a more basic dispute about the very continuation of the Barrage System as a whole, given the combination of radically changed circumstances and the continuing threat of unilateral action on the part of Czechoslovakia."
10.06	Hungary's summary at paragraph 9.18 of its Memorial of the factors which justified suspension and later abandonment is revealing. **First, the Project timetable was not a matter to be taken seriously....**	HM, para 9.18(2) states "[t]he timetable laid down for work on the Project *had never been treated as matter of strict legal obligation*." This does not imply that the timetable was not a matter to be taken seriously.

SC-M Para	Misrepresentation	The Actual Position
10.09	This **cavalier attitude towards treaty obligations** ignores the fact that, in trying to move the Project forward as best it might in the face of previous Hungarian prevarications, Czechoslovakia had reserved its legal rights as to compensation. The strong implication of Hungary's comment [that "[t]he timetable laid down for work on the Project had never been treated as matter of strict legal obligation"] is that it could **simply call delays as it chose, without penalty,** regardless of the terms of the Treaty and its associated agreements, and regardless of the interests of its Treaty partner.	This comment contains no such implication. As the following sentence in HM, para 9.18(2) states, "[d]elays in implementation...had been *negotiated* before and could be *negotiated* again", signifying Hungary's reliance on negotiation rather than unilateral action. Nor does the HM profess these delays would be "without penalty". HM, para 9.18 states clearly that "[a]ny problems caused by the delay *could be compensated for.*"
10.11	As to the "essential obligation on the parties under the Treaty" being the resolution of difficulties by negotiation, not only is that an incorrect statement of the essential obligation under the Treaty, but Slovakia has also shown in detail the consultations and negotiations that Czechoslovakia engaged in.	HM, para 9.18(4) states: "The essential *continuing* obligation on the parties under the treaty was *to seek to resolve difficulties by negotiation in good faith*, and this Hungary sought to do."
10.80	It is significant that Hungary **does not include the implementation of Variant "C" as a fundamentally changed circumstance.** It implicitly acknowledges that Variant "C" simply represents a partial application of the agreed Treaty terms.	HM, para 10.74 lists several fundamental changes of circumstance, among those is the fact that "the 'single and indivisible operational system' had dissolved,...the barrage at Gabčíkovo being constructed as a unilateral scheme uncontemplated by and outside the scope of the 1977 Treaty...."
10.102	**Hungary does not offer any legal analysis as to why Variant "C" should be regarded as a repudiation of the Treaty**, satisfying itself with telling the Court: "Variant C amounted to a repudiation by Czechoslovakia of the Treaty... as clear a repudiation as one might wish."	HM, paras 7.04-7.43 and 10.103-10.106 extensively demonstrate that the decision to plan and construct Variant C was a serious breach of the 1977 Treaty, a clear example of the "repudiation of the treaty" referred to in Article 60(3)(a) of the Vienna Convention.
11.08	[I]t has been definitively proved that Variant "C" is not a source of pollution.	Slovak expert committees established by the Slovak Republic to investigate the environmental consequences of Variant C have warned of Variant C's likely adverse environmental impacts. See HR, Annexes, vol 3, annex 70. A thorough discussion of these impacts is found in the *Scientific Evaluation*, HC-M, vol 2. See also *Scientific Rebuttal*, HR, vol 2.

APPENDIX 3

COMECON AND THE "IDEOLOGICAL NEUTRALITY" OF THE PROJECT

A. INTRODUCTION

1. The second preambular paragraph of the 1977 Treaty[1] –

> "Recognis[ed] that the joint utilisation of the Hungarian-Czechoslovak section of the Danube will further strengthen the fraternal relations of the two States and significantly contribute to bringing about the socialist integration of the States members of the Council for Mutual Economic Co-operation..."

But according to Slovakia–

> "...this reference is surely not sufficient to turn the Treaty into [a COMECON Treaty]...such a reference is no more than the sort of stylistic formality to be found in many treaties that involved some form of economic co-operation between the member States of the former Council for Mutual Economic Assistance...the 1977 Treaty is not significantly different from other agreements between non-socialist States which provide for the common development of rivers forming international boundaries."[2]

Slovakia concludes that such agreements "...are evidence, if any is needed, of the 'ideological neutrality' behind the G/N Project."[3]

2. Hungary does not share this view. There can be little doubt that the 1977 Treaty could only have been adopted in the context of socialist integration. This is evident from its objectives, its terms, its economic underpinnings. This Appendix demonstrates that the 1977 Treaty was redolent of socialist economic ideals in substance, and representative of COMECON ideology in conception.

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1 HM, vol 3, annex 21. For its analysis see HM, vol 1, paras 4.07, 4.08, and 4.21.

2 SC-M, paras 2.05-2.07.

3 SC-M, para. 2.08, fn 10.

B. THE COMECON NATURE OF THE TREATY

3. Substantively, there are significant differences between the 1977 Treaty and other international agreements between non-socialist states on the joint development and utilisation of contiguous rivers. For instance, the Convention between France and Switzerland concerning Hydroelectric Utilisation of the Emosson, signed at Sion on 23 August 1963[4] – mentioned specifically by Slovakia[5] – provided for concessions to be granted to private companies for the construction and operation of hydroelectric plants and preserved the rights of governments to regulate and control any adverse consequences.[6] Yet the legal institution of concessions was missing from socialist civil codes, as it contradicted the basic tenet of exclusive state property in natural resources and in the primary means of production. A related difference is that agreements granting concessions characteristically provide for settlement of disputes by arbitration, a practice that

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4 *RGDIP* 279, arts 2, 3 (1969). Cf also France-Federal Republic of Germany, Convention concerning utilisation of the Rhine between Strasbourg/Kehl and Lautenbourg/Neuburgwein, 4 July 1969, Recueil des traités et accords de la France, Paris, 1969, p 110. The GNBS is more like the Grand Canal d'Alsace, though the 1919 Versailles Peace Treaty (Art 358) granted exclusively to France rights relating to the taking of water and the production of hydraulic power. Even then, these rights were operated by a concessionaire, nominated by the French Government. See Germany-France-Switzerland, Agreement concerning the Scheme for the Kembs Lateral Canal, Strasbourg, 20 May 1922, 26 LNTS 266, Art 1.

5 SC-M, para 2.07, fn 8.

6 For other similar examples see Italy-Switzerland, Agreement on the Reno di Lei Hydraulic Power Concession, with Additional Protocol, Rome, 18 June 1949, *Legislative Texts and Treaty Provisions concerning the Utilisation of International Rivers for other Purposes than Navigation* (United Nations Legislative Series, vol 4, 1963), Treaty No 231, Arts 1, 4; Federal Government of Austria-Free State of Bavaria, Agreement concerning the Österreichisch-Bayerische Kraftwerke AG, 16 October 1950, ibid, Treaty No 137, Art 1; Republic of Austria-Federal Republic of Germany-Free State of Bavaria, Agreement concerning the Donaukraftwerk-Jochenstein-Aktiengesellschaft, 13 February 1952, ibid, Treaty No 138, arts 1, 5; France-Italy, Provisional Agreement and Exchange of Notes regarding the operation of the Gran Scala Power Station, Rome, 12 January 1955, ibid, Treaty No 181, Art 2; Swiss Confederation-Italian Republic, Convention concerning the Use of Water Power of the Spöl and additional Protocol, Berne, 27 May 1957, ibid, Treaty No 235, arts 1, 2; Grand Duchy of Luxembourg-Land Rhineland Palatinate, State Treaty concerning the Construction of Hydroelectric Power Installations on the Our, with Annexes, Trier, 10 July 1958, Ibid, Treaty No 202, arts 1-2. Other international treaties prescribe the distribution of hydroelectric power by sectors, i.e., there is no joint development and utilisation, and the means of unilateral utilisation by the parties (which may also take the form of concessions) is guaranteed by various prohibitions. See, e.g., Spain-Portugal, Convention to regulate the Hydroelectric Development of the International Section of the River Douro, Lisbon, 11 August 1927, 87 LNTS 131; Union of Soviet Socialist Republics-Norway-Finland, Agreement Concerning the regulation of Lake Inary by means of the Kaitakoski Hydroelectric Power Station and Dams, Moscow, 29 April 1959, 346 UNTS 192; Norway-Union of Soviet Socialist Republics, Agreement on the Utilisation of Water-power on the Pasvik/Paatso River, Oslo, 18 December 1957, 312 UNTS 274.

was unacceptable according to the Socialist doctrines of international law as between the state and private parties.

4. Nor is it possible to dismiss the second preambular paragraph of the 1977 Treaty as a mere "stylistic formality". Contrary to the Slovak assertion,[7] no other Hungarian-Czechoslovak bilateral treaty expressly mentioned COMECON integration in its preamble. Rather, a general formula was used, as, for example, in the preamble to the Treaty on Medical and Hygienic Co-operation of 1982:[8]

> "...led by their desire to support an even closer co-operation in the fields of medicine and hygienics, and in accordance with the principles of socialist health care, as well as the high-level planned, state managed and prophylactic health services available to the citizens of both countries, free of charge for all, in keeping with the unity of medical science and practice and broad participation of the members of society in the performance of tasks..."[9]

5. In contrast to this general formula – which is seen in many other agreements – the 1977 Treaty preamble contains an explicit reference to COMECON integration. This operates as a *renvoi* to COMECON principles and objectives, in effect incorporating them by reference.[10] In accordance with Article 31 (3) of the 1969 Vienna Convention on the Law of Treaties, COMECON principles thus form part of the context of the Treaty and help explain its objects and purposes. An explicit reference such as this was common in multilateral treaties on scientific-technical co-operation ("accepting, as guidelines, the

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7 SC-M, para 2.06.

8 Government Decree 80/1982, /XII.27./MT, Official Compendium of Acts and Decrees, 1982, vol 1, p 544.

9 *Mutatis mutandis* a similar formulation appears in the bilateral Treaty on Cultural and Scientific Co-operation, Budapest, 22 October 1986: "...led by their desire to effectively contribute to the lasting and brotherly friendship and ideological unity of the socialist community, and the struggle against hostile ideologies by the development and deepening of their scientific, cultural educational and artistic cooperation." 1987 Decree Law no. 1, Official Compendium of Acts and Decrees, 1987, vol 1, p 149. The bilateral Convention on Touristic Co-operation, Bratislava, 22 June 1972, is even less specific: "...in order to strengthen the friendly relations between their countries the parties strive to promote mutual awareness of the achievements of the building of socialism and communism, and therefore provide the most favourable conditions possible to support and develop tourism..." 1973 Decree Law no. 10, Ibid, p 218.

10 See also Hungary and Czechoslovakia, Treaty on Co-operation and Mutual Assistance, Budapest, 14 July 1968, Art 2 of which expressly provides that:

> "In the spirit of the international distribution of labour, the High Contracting Parties will deepen their mutually beneficial economic and scientific co-operation and support the co-operation process within the framework of COMECON to further the economic development of both countries." 1969 Act no. 1, Ibid, p 3.

recommendations of COMECON"), treaties whose COMECON treaty nature can hardly be denied.[11]

6. Another COMECON element is the direct influence of its "Complex Programme" on the 1977 Treaty. Articles 15 (Protection of water quality) and 19 (Protection of nature) closely follow the distinction adopted in the Complex Programme between the protection of nature and the protection of waters against pollution. Nature protection is addressed in item 2, Chapter 5 of the Complex Programme ("Co-operation in science and technology"), while water quality is addressed in Chapter 14 ("The main directions of the development of co-operation in water management").[12] The political decisions leading to the adoption of the Complex Programme and the realisation of the GNBS Project are to that extent interrelated. As is clear from its terms, the 1977 Treaty was specific to the socialist system and openly professed its integration with COMECON ideals.

C. COMECON'S INVOLVEMENT IN HUNGARIAN-CZECHOSLOVAK AFFAIRS RELATING TO GNBS

7. Equally important is the history of COMECON influence and participation in the Project's conception, planning, and implementation. The unique nature of the 1977 Treaty in Hungarian-Czechoslovak bilateral relations, and its similarity to typical COMECON agreements, was not accidental. On the contrary, it was a logical outgrowth which reflected the influential involvement of COMECON, dating from as early as 1954.

8. The Hungarian Memorial described COMECON activities in this field.[13] A chronology of events is annexed to this Appendix. This part of the Appendix summarises and interprets the key acts of COMECON relating to the GNBS. The

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11 See, e.g., the following multilateral COMECON treaties: On Scientific and Technical Co-operation in the field of the Complex Automation of Forestry Work, Dresden, 19 November 1972, Decree 6/1975. /II.26./ MT; On the Establishment of an International Monitoring and Test Station for the Industrial Production of Eggs and Poultry Meat, Dresden, 19 November 1972, Decree 8/1975. /II.27./ MT; On Scientific and Technical Co-operation in the Field of the Automation and Electrification of Agricultural Processes, Moscow, 18 January 1972, Decree 3/1975. /II.26./ MT; On Scientific and Technical Co-operation in the Field of the Elaboration of the Major Problems of Food Industry Packaging Materials, Moscow, April 17, 1972, Decree 9/1975. /II.27./ MT; On Scientific and Technical Co-operation in the Field of the Elaboration of the Scientific Foundations of Ergonomical Criteria and Norms, Sofia, 19 December 1974, Decree 24/1975. /VIII.26./ MT; On Scientific and Technical Co-operation in the Field of Research on Malignant Tumours, Moscow, signed 3 December 1973, Berlin, promulgated 24 March 1977, 2/1978. /I.29./ MT.

12 Text appears in 1971 Government Decision no. 2024/1971 (VIII. 27) on the XXV Assembly of COMECON.

13 HM, paras 3.07, 3.12, 3.13, 3.21, 3.27, 3.29.

evidence, direct and circumstantial, demonstrates the significant role played by COMECON in the planning and conclusion of the 1977 Treaty.

9. In 1954 COMECON began to deal with the problem of hydroelectric power plants to be constructed on the contiguous Hungarian-Czechoslovak sector of the Danube.[14] In this process, Hungary's and Czechoslovakia's national interests were seen within the framework of the interests, priorities, and overall development of socialist states as a whole. COMECON's involvement implied some well-known COMECON fundamentals. These included: the principle of the planned development of a socialist economy; continuous growth of this economy through the primacy of heavy industries in conjunction with extensive increases in energy production, and the strengthening of cohesion in the camp of "popular democracies" through bilateral cooperation. Refusal to proceed with the Project would have been equivalent to an admission of doubts as to these "socialist values". Thus a process, started under the impulse of these factors in 1952 by Hungary and Czechoslovakia,[15] was undertaken within the framework of COMECON.

10. COMECON's involvement was not limited to conceptualising a system of hydroelectric power plants on the Danube. It continuously supervised the realisation of the Project through various standing bodies. In 1956 a Committee was established in Moscow alongside COMECON to deal with the draft of the comprehensive utilisation of the Danube.[16] COMECON's Permanent Committee for Energy Affairs also advised on the GNBS,[17] as, later, did a Conference of Heads of Water Management Authorities.[18] COMECON also acted as a conduit for proposed plans, scientific literature, and research studies relating to the Original Project.[19]

11. By 1956, COMECON had integrated Hungarian-Czechoslovak hydroelectric power plants into its ambitious efforts to assure a comprehensive harnessing of the Danube's water potential from Bratislava to the Black Sea.[20]

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14 HM, para 3.07.

15 HM, paras 3.02, 3.04-3.05.

16 Work Program of the Committee established for electrical energy exchange between countries participating in COMECON and on the Draft of the Comprehensive Utilisation of the Danube, with attached Minutes, Moscow, 8-9 May 1956; HR, Annexes, vol 3, annex 33.

17 HM, paras 3.13, 3.21; See also HM, Annexes, vol 4, annex 4.

18 Ibid.

19 Protocol on the Joint Negotiations aimed at the Investigation of the Utilisation Scheme of the Danube, from Wolfstahl-Bratislava to the Village of Fajsz, Budapest, 10-15 January 1958; HM, Annexes, vol 4, annex 3.

20 HM, para 3.12.

Thereafter, negotiations between Hungary and Czechoslovakia were subsumed in a broader scheme designed to further socialist economic and political integration. The trilateral expert meetings of 1958[21] illustrate the approach taken and the interests considered.[22] In 1963, following the scheme of utilisation recommended by COMECON, Hungarian and Czechoslovak government delegations approved for the first time the concept of a Water System of Locks between Bratislava and Nagymaros.[23]

12. COMECON's role was evident at critical moments prior to the adoption of the 1977 Treaty. After the 1956 Hungarian revolution, COMECON directives served as guiding principles in the recommencement of Hungarian-Czechoslovak talks on the GNBS and provided a means whereby the Hungarian government could show its devotion to socialist ideas.[24] The link between COMECON ideology and the GNBS can also be seen in the events that took place during the Prague Spring of 1968. At this moment in history, Czechoslovakia sought to escape from the Project.[25] The delays in implementation were brought to the attention of COMECON, which again emerged to push the project forward in 1970.[26]

4. THE SIGNIFICANCE OF COMECON'S "COMPLEX PROGRAMME" OF 1971

13. A version of the Joint Investment Programme was completed in 1967, but with no final commitments having been made.[27] The political decision to go ahead with the GNBS was taken in 1971,[28] shortly after the highest body of COMECON, its XXV Assembly, adopted the "Complex Programme", which mandated "the construction and operation of joint ventures for the production of electric energy."[29]

14. Slovakia denies the relationship between these two events:

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21 HM, para 3.15.

22 HM, para 3.15; see also Information Document for the Political Committee of the Hungarian Socialist Workers Party, 6-7 October 1958; HR, Annexes, vol 3, annex 37.

23 SC-M, vol 2, annex 31.

24 SM, vol 4, annex 132.

25 HM, para 3.26.

26 HM, para 3.27.

27 HM, para 3.24.

28 HM, para 3.28.

29 HM, para 3.27.

> "It is not plausible to interpret the CMEA's recommendations as obligations imposed on the parties from outside: as Hungary itself admits, these recommendations (which in any event were unanimously adopted, i.e., with Hungary's consent) had no obligatory nature until adopted by the Governments of the States concerned."[30]

Although it is true that member countries of COMECON had to "consent...being entitled to state its interest in any question", in practice, countries normally felt obliged to "consent". As a matter of political reality, member countries were not free to ignore prescriptions such as that in the Complex Programme according to which hydroelectric energy had to be utilised to a greater extent.[31]

E. COMECON'S APPROACH TO THE ENVIRONMENT

15. Apart from the formal distinction between the protection of water quality and the protection of nature, which fails to take account of the integrated nature of the environment, the 1977 Treaty was not oriented to the protection of the environment. In this it reflected the general approach of the socialist countries toward ecological problems and toward their prevention and remedies. That approach is well documented. Academician Kapica once stated: "Socialism, by its very essence, is more adequate for solving ecological problems than capitalism."[32] The opinion of Academician Feodorov was similar: "Once a socialist society is established over the whole of our planet, ecological crises will cease."[33] He linked this doctrine with the optimistic view that damage to nature can be remedied: "Science will definitely be able to solve this problem and find a way to calculate such effects within the ecological process. Besides, compensating measures can also be taken..."[34] From this perspective it is a short step to assume the *a priori* advantage of socialism: "a society whose development is consciously directed (as Marx has shown) will definitely ensure the proper, harmonic interaction between man and nature."[35]

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30 SC-M, para 2.10.

31 Complex Programme, Chap10, item 9.

32 See L.I. Grekov, "Man and his environment", no 3-4 *Magyar Filozófiai Szemle* (Hungarian Philosophical Review), 1975, p 301. A copy of the original document has been deposited with the Court.

33 Ibid, p 302.

34 Ibid, p 303.

35 Ibid, p 304. AJ Meduhnin also expressed the orthodox socialist standpoint as regards environmental problems: "An entire new course of the race between socialism and capitalism opens up at this point: the battle against ecological crisis and for the purity of the environment. At present we are ahead in this race..." See Ibid, p 315.

16. A similar approach underlies the 1977 Treaty: no significant environmental problems are assumed to exist, but if any should arise they can automatically be taken care of by reason of socialist superiority and the progressive development of science. Similarly, the Slovak Counter-Memorial simply asserts that "any environmental problems that may arise...can then be responded to in a timely fashion."[36] This is inconsistent with a preventive approach, endorsed by the international community even before 1977. Slovakia's present approach to the environment echoes Czechoslovakia's earlier veto of proposals for a CMEA Water Quality Treaty.[37]

17. The 1959 COMECON Statutes define manifold economic co-operation as one of the main instruments of building socialism and communism (Preamble), and also state that "The economic and scientific-technological co-operation between the member states is realised in accordance with the principles of socialist internationalism..." (Article 1, item 2). The "Complex Programme" became the blueprint for "socialist internationalism", and the vehicle by which the principles were integrated into the member states of COMECON. Yet in reality "socialist internationalism" was an aspect of the doctrine of the limited sovereignty of socialist countries, as embodied by the 1977 Constitution of the USSR (Art 30). This involved, in fact as in theory, the dictatorship of the communist party.[38] The unconditional superiority of politics was openly declared,[39] along with democratic centralism, which entailed that highest level decisions were not open to further dispute but had to be carried out without objection.[40] It extended to the party-governed nature of science, which required "adherence to the views sourcing from the recognition of the essence of historic development."[41] This made it difficult to judge the real value of the scientific research conducted; the task of science was to justify the preconceptions of power. No doubt the effect of these tenets varied with the internal conditions of each socialist country, and their strength declined during the 1980s. But in the case of vital issues – the correctness of the decisions of the communist party or the relations between socialist countries – they continued dominant.

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36 SC-M, para 9.94.

37 See HM, para 3.35.

38 As paragraph 3 of the 1972 Hungarian Constitution stated: "The Marxist-Leninist party of the working classes is the leading force of society."

39 J Matejcik, "Development of the political system of the Czechoslovak Socialist Republic", in D.A. Kerimov & Sándor Lakos, *The Political System of Socialism*), Budapest, 1980, p 133 (in Hungarian). A copy of the original document has been deposited with the Court.

40 *Encyclopaedia of Legal and Constitutional Studies*, Budapest, 1980, p 387 (in Hungarian). A copy of the original document has been deposited with the Court.

41 Mihály Samu (ed), *Political and Legal Theory*, Budapest, 1978, p 27 (in Hungarian). A copy of the original document has been deposited with the Court.

F. SOVIET PARTICIPATION IN ISSUES RELATING TO GNBS

18. The Hungarian Memorial describes direct and indirect Soviet participation in the process leading up to the 1977 Treaty and its aftermath.[42] This part of the story need only be briefly recapitulated.

19. COMECON involvement and Soviet participation were of course interrelated. Apart from COMECON's role, the USSR itself was involved in the political and technical planning of the Barrage System. In 1954, Hungary and Czechoslovakia entered into consultations with Soviet experts.[43] This seems to have involved substantial participation in the form of recommendations, fact-finding, evaluations, conciliation and supervision.[44]

20. In 1956 the CMEA Standing Committee for the comprehensive utilisation of the Danube received the preliminary proposals of the Soviet Committee and Gidroprojekt, a Moscow engineering institute, prepared planning guidelines and a working programme for the construction of hydroelectric power plants.[45] In 1961, Gidroprojekt's comprehensive plan for the Danube section between Bratislava to the Black Sea was approved and recommended by the COMECON Permanent Committees for Electric Energy, Agriculture and Transportation.[46]

21. Whenever negotiations between Hungary and Czechoslovakia became dilatory, the Soviet Union's wishes were made clear. In one such instance, Czechoslovakia began consultations with the Soviet Union to discuss a version to be built exclusively on the territory of Czechoslovakia in Hamuliakovo. The Soviets suggested that the Cilistovo version would be the better scheme.[47] In other words, the comprehensive scheme envisaged by COMECON was to be realised.

22. Soviet economic and military interests in the Project should not be overlooked. The construction of hydroelectric power plants along the Danube created a market for Soviet industry through deliveries of plans, machinery and equipment, and had benefits in terms of Soviet oil supply to Eastern Europe as

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42 HM, paras 3.16-3.43.

43 HM, para 3.10.

44 HM, paras 3.16, 3.19, 3.21.

45 HM, para 3.13.

46 HM, para 3.21.

47 SC-M, vol 2, annex 2.

well as military navigation requirements.[48] It was on such grounds that the Soviet Union initially agreed to provide financial assistance to the Project.

23. The economic viability of the Project was premised upon significant Soviet financial support. The first request for credit was made in 1958; it was repeated in 1963, when Hungary and Czechoslovakia proposed a continuation of negotiations in the context of long-term Soviet credit.[49] Aid was again promised by the Soviet Union in 1977, prior to the conclusion of the Treaty.[50] This led to the conclusion, later in 1977, of an Agreement between Hungary and the USSR, under which equipment (including turbines) and specialist services were to be provided.[51]

24. Soon after the entry into force of the 1977 Treaty, the changing world economy and the deteriorating economic position of the Socialist bloc countries forced Central and Eastern European States to reconsider their development programs and priorities. In 1980, it was revealed that the promised Soviet aid would not be forthcoming.[52] The "joint investment" was thus left to depend on its own merits. Both Hungary and Czechoslovakia began discussing "whether to postpone the project by two or even more years because of the lack of investment resources."[53]

25. COMECON's influence and participation in the affairs of the Barrage System cannot be dismissed as mere coincidence. Far from being "ideologically neutral",[54] the GNBS was a clear example of what Czechoslovak Environment Minister Vavroušek later characterised as the "appalling toll of environmental destruction and the cruel arrogance of huge dams and inappropriate industrial projects" which has been the COMECON legacy to Central Europe.[55] Under these circumstances the Treaty was acutely vulnerable to criticism with the sweeping changes, political and economic, which occurred in the region in and after 1989.

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48 HC-M, para 1.19.

49 Proposal to the Committee of Economics on the proposals to be made on behalf of the Hungarian party during Hungarian-Czechoslovak government negotiations concerning the joint hydroelectric utilisation of the Danube, February 1958; HR, Annexes, vol 3, annex 35.

50 HM, para 3.33.

51 Agreement on Cooperation concerning the Construction of the Nagymaros Dam on the River Danube, as Part of the Gabčikovo-Nagymaros Barrage System, HM, Annexes, vol 3, annex 23. See also HM, para 4.08.

52 HM, para 3.42.

53 Ibid.

54 SC-M, para 2.08, fn 10.

55 J Vavroušek, "Institutions for Environmental Security" in G Prins (ed), *Threats without Enemies*, London, Earthscan Publications, 1993, p 88.

CHRONOLOGY OF SOVIET/COMECON INVOLVEMENT IN THE ORIGINAL PROJECT

1952	
18 July	➢ Joint Governmental Committee established to study hydroelectric possibilities for the shared section of the Danube.[1]
2 August	➢ Czechoslovakia presents design for a dam and reservoir exclusively on its own territory, but agrees to begin study on joint utilisation of the Danube.[2]
1954	
2 December	➢ Parties propose to consult Soviet Union regarding the utilisation of the Danube.[3]
1955	
28 September	➢ Czechoslovakia consults with Soviet Union over a version to be built exclusively on its territory at Hamuliakovo.[4]
October	➢ State Planning Office of the Soviet Union responds that Cilistovo version of utilisation is preferable because there needs to be a comprehensive solution for utilisation of the Danube for energy purposes.[5]
1956	
19 March	➢ Committee founded in Moscow, alongside COMECON secretariat, to deal with exchange of electric power between COMECON countries and to draft a plan for comprehensive utilisation of the Danube.[6]
April	➢ Plenary session of COMECON resolves that the Wolfsthal-Nagymaros section be dealt with in the framework of the comprehensive plan. COMECON States design material for their respective sections of the Danube; forwarded to Soviet Gidroprojekt Institute responsible for coordination on behalf of COMECON.[7]
28 April	➢ Preliminary proposal of Soviet Committee to COMECON includes preparation of outline plan for comprehensive utilisation of the Danube and a draft program.[8]

30 April	➢ Seventh Session of COMECON passes comprehensive Resolution on the utilisation of the Danube from Bratislava to the Black Sea.[9]
8-9 May	➢ Negotiations chaired by Soviet Union stress advantages of electric energy co-operation. Suggestions and proposals are to be submitted to COMECON Council.[10]
30 May	➢ COMECON's Permanent Commission for Energy Affairs (PCEA) adopts basic elements for the comprehensive utilisation of the Danube.[11]
1957	
September	➢ PCEA adopts guidelines and a working programme for the construction of hydroelectric power plants, prepared by Gidroprojekt. Focus is on power plants at Wolfsthal, Nagymaros and the Iron Gate.[12]
27 November	➢ PCEA recommends that Hungary and Czechoslovakia determine a scheme of utilisation which maximises energy production.[13]
17 December	➢ Trilateral meeting of Hungarian, Czechoslovak and Soviet experts.[14]
1958	
10-15 January	➢ Trilateral meeting resolves to establish technical sub-committees with Soviet participation and submit an approved scheme to COMECON by May 1958.[15]
February	➢ Gidroprojekt directive on economic parameters governing the dam sent through COMECON to each planning agency, with a view to eventual approval by PCEA.[16]
April	➢ PCEA resolves that plans for hydroelectric power plants be handed over to COMECON by October 1958.[17]
19 May	➢ Joint Hungarian-Czechoslovak Technical Expert Committee accepts recommendations of Soviet consultants; proposes multi-stage hydroelectric plant operating with power canal on the upper section and a second plant at Nagymaros.[18]

July 5	➢ Hungarian report recommends approval of scheme, referring to Czechoslovakia's wishes to implement the power plant unilaterally should Hungary fail to approve.[19]
6 October	➢ Hungarian and Czechoslovak government committees agree that GNBS be included in their long range national economic plans prior to 1975. Joint expert committee to formulate a recommendation for consideration by Gidroprojekt.[20]
6 October	➢ Agreement on joint production of hydroelectric power plants praised as "proof that the cooperation implemented within the framework of COMECON is efficient."[21]
1959	
24 June	➢ Both parties request the Soviet Union to supervise technical design phase.[22]
1960	
23 January	➢ Hungarian, Czechoslovak, and Soviet experts consider technical plans of the Nagymaros hydroelectric power plant.[23]
March 27-April 1	➢ The joint Hungarian-Czechoslovak technical committee approves outline schedule of construction works on basis of Soviet consultation.[24]
1961	
September	➢ Comprehensive plan for the Danube section between Bratislava to the Black Sea, devised by Gidroprojekt between 1956-1961, is approved by COMECON Permanent Committees for Electric Energy, Agriculture and Transportation.[25]
1963	
23 March	➢ COMECON recommends and Joint Technical Experts Committee adopts left-bank version of power canal.[26]
22 April	➢ Referring to scheme of utilisation chosen by COMECON, Hungarian-Czechoslovak government delegations approve GNBS concept.[27]

16 November	➢ Consultation material approved by the joint Hungarian-Czechoslovak expert committee is submitted to the Gidroprojekt.[28]
1970	
24 July	➢ COMECON's Executive Committee adopts a Report of the Conference of Heads of Water Management Authorities "concerning co-operation for the settlement of problems in the region of the Danube Basin."[29]
6 August	➢ COMECON adopts a Complex Programme for the Further Deepening and Improvement of Co-operation and the Development of Social and Economic Integration of the COMECON, which orders "the construction and operation of joint ventures for the production of electric energy" and "the increase of the proportion of hydroelectric energy in the balance of fuels and energy."[30]
1972	
May	➢ PCEA report stresses need for co-operative establishment of great electric power plants, including hydroelectric plants, and optimal use.[31]
1974	
11 April 1974	➢ Secretary General of COMECON confirms COMECON's commitment and involvement in the Project.[32]
25 October	➢ Parties request the Soviet Union to grant long-term credits from 1978 on.[33]
1975	
16 January	➢ During trilateral consultations, Hungary and Czechoslovakia seek Soviet Union loan of 300 million convertible rubles in order to allow commencement in 1978.[34]
27 February	➢ Hungarian Prime Minister applies for Soviet Union loan, emphasising that the Project would be part of COMECON's "Complex Programme".[35]

1977	
July	➢ Soviet Union assures both parties of its support for the Project and promises loans to both countries.[36]
16 September	➢ 1977 Treaty concluded.
30 November	➢ USSR-Hungary Agreement on Cooperation concerning the Construction of the Nagymaros Dam on the River Danube, as Part of the Gabčíkovo-Nagymaros Barrage System concluded.[37]
1978	
23 March	➢ Soviet Prime Minister Kossygin requires that the request for construction equipment be considered in the course of the co-ordination of the countries' national economic plans for 1981-1985.[38]
1980	
7-22 February	➢ Meeting of USSR-Hungarian experts discuss modifications to the original construction plans, deadlines, etc.[39]
Spring	➢ Hungary learns that Soviet assistance will not be forthcoming.[40]

1 Closing Protocol of the Negotiations between the Government Delegations of the Hungarian People's Republic and of the Czechoslovak Republic concerning the utilisation of the hydro-power of the Danube along the reach from the mouth of the Morva to Visegrad, Budapest, 18 July – 2 August 1952; HM, Annexes, vol 3, annex 10.

2 HM, para 3.05.

3 Closing Protocol of negotiations between Governmental Delegations of the Czechoslovak Republic and the Hungarian People's Republic regarding the utilisation of water energy in the Devin-Visegrád section of the Danube, Budapest, 20 November-2 December 1954; HM, Annexes, vol 3, annex 14

4 Memorandum on the Hungarian-Czechoslovak negotiations concerning the utilization of the upper Danube, 28 September 1955, HR, Annexes, vol 3, annex 32.

5 SC-M, vol 2, annex 2.

6 Work Program of the Committee established for electrical energy exchange between countries participating in COMECON and on the Draft of the Comprehensive Utilisation of the Danube, with attached Minutes, Moscow, 8-9 May 1956; HR, Annexes, vol 3, annex 33.

7 Report on the hydroelectric utilization of the joint Hungarian-Czechoslovakian Danube section, 5 July 1958; HR, Annexes, vol 3, annex 36.

8 Work Program of the Committee established for electrical energy exchange; HR, Annexes, vol 3, annex 33.

9 HM, para 3.12.

10 Work Program of the Committee established for electrical energy exchange; HR, Annexes, vol 3, annex 33.

11 Report of the Seventh COMECON Session; HM, Annexes, vol 4, annex 2. See also HM, para 3.12.

12 HM, para 3.13.

13 SM, vol 4, annex 132.

14 Letter from V Siroky, Prime Minister of the Czechoslovak Republic, to János Kádár, Prime Minister of the Republic of Hungary, 11 December 11 1957; HR, Annexes, vol 3, annex 34.

15 HM, Annexes, vol 4, annex 3

16 Ibid.

17 Report on the hydroelectric utilization of the joint Hungarian-Czechoslovakian Danube section, 5 July 1958; HR, Annexes, vol 3, annex 36.

18 HM, para 3.16.

19 Report on the hydroelectric utilization of the joint Hungarian-Czechoslovakian Danube section, 5 July 1958; HR, Annexes, vol 3, annex 36.

20 HM, Annexes, vol 4, annex 4.

21 Information Document for the Political Committee of the Hungarian Socialist Workers Party on the government committee negotiation, Prague, 6-7 October 1958; HR, Annexes, vol 3, annex 37.

22 Letter from Antal Apró, First Deputy Prime Minister of the Hungarian Government, to Comrade Münnich, 24 June 1959; HR, Annexes, vol 3, annex 38.

23 Minutes of the consultation of the leaders of the Hungarian-Czechoslovak Expert Committee dealing with the utilization of the Danube, 22-23 January 1960, HR, Annexes, vol 3, annex 39.

24 Letter from Imre Dégen, Executive Director of Water Management, to Antal Apró, Deputy Chairman of the Hungarian Revolutionary Worker-Peasant Party, 2 May 1960; HR, Annexes, vol 3, annex 41.

25 HM, para 3.21.

26 HM, para 3.21.

27 SC-M, vol 2, annex 31.

28 Hungarian-Czechoslovak-Soviet negotiations concerning the hydro-electric power plant system on the Danube, Moscow, 16 November 1963; HR, Annexes, vol 3, annex 42.

29 HM, para 3.27.

30 HM, para 3.27.

31 HM, para 3.29.

32 HM, para 3.33.

33 HM, Annexes, vol 4, annex 7. See also HM, para 3.33.

34 Minutes of the Meeting of the Hungarian-Czechoslovak-Soviet Consultations in the Preparation for Realization Gabčikovo-Nagymaros Barrage System, 16 January 1975; HR, Annexes, vol 3, annex 45.

35 HM, para 3.34.

36 HM, para 3.33

37 HM, Annexes, vol 3, annex 23. See also HM, para 4.08.

38 Letter from A. Kossygin, Soviet Prime Minister, to Lubomir Strougal, Czechoslovak Prime Minister, 23 March 1978; HR, Annexes, vol 3, annex 46

39 Minutes of the consultation regarding the Gabčikovo-Nagymaros Barrage System conducted with Soviet experts, 7-22 February 1980; HR, Annexes, vol 3, annex 47.

40 HM, para 3.42.

APPENDIX 4

THE ECONOMIC ANALYSES OF THE GABČÍKOVO-NAGYMAROS BARRAGE SYSTEM:

A REPORT

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I. INTRODUCTION

I have been asked to assess the quality of certain economic analyses of the Gabčíkovo-Nagymaros Barrage System envisaged by the 1977 Treaty between Czechoslovakia and Hungary. I also review the ways in which these analyses appear to have informed decisions with respect to implementation of the project. My assessment is conducted in the context of the development of project analysis and decision-making processes in Europe, North America and the international development agencies during the same period. I have also been asked to provide my own professional judgment of the economic viability of the GNBS project and the economic rationality of Hungary's decision to suspend construction of Nagymaros.

Following this introduction, I review the development of cost-benefit analysis and its application by national and international agencies during the 1970s, paying particular attention to how the rapid changes in energy prices during the 1970s affected economic understanding and project design internationally (Section II). I then assess the approach to economic appraisal used in eastern Europe during the period GNBS was designed and implementation was being considered (Section III). The next two sections review the early economic analyses made of GNBS in 1975 (Section IV) and 1978 (Section V). Maintaining the international context of my assessment, I review developments in environmental economics during the 1970s and their incorporation into project analysis internationally during the 1980's (Section VI). The next four sections review the economic analyses of GNBS carried out in 1983 (Section VII), 1985 (Section VIII), 1986 (Section IX), and 1989, both prior to and after the decision to suspend the construction of Nagymaros (Section X).

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National governments in Europe and North America as well as international agencies began to have increasing difficulty evaluating projects with complex environmental effects during the 1970s in Europe and North America and internationally during the 1980s. With the political transition in Hungary, GNBS merged into this international pattern of questioning projects which entail major environmental transformations. Recent developments in the economics of sustainability help us see in retrospect why project evaluation has proven difficult throughout the world with the rising concern over sustainability (Section XI).

In the context of all of the foregoing material, I set forth my own professional judgment (Section XII). I conclude that the economic analyses undertaken in the 1970s and 1980s provide no evidence that the GNBS was an economically sound project or that it would be sound under current conditions. On the contrary, the analyses provide considerable reason to suspect that the project has always been uneconomic. This conclusion is further strengthened in light of the environmental costs which have never been fully evaluated in monetary terms. If a similar project were proposed today in Europe, or for funding by an international agency, it would probably be rejected *a priori* and almost certainly be rejected after a full evaluation if the agency deemed it worthwhile to undertake a full analysis. Thus Hungary's decision to suspend construction of Nagymaros was both relatively informed and rational and consistent with developments in economic theory and decision-making internationally.

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The Gabčíkovo-Nagymaros Barrage System (GNBS) was based on engineering analyses initiated in the early 1950s and development planning carried out within the process of the Council for Mutual Economic Assistance (CMEA). At various times economic analyses of the project were performed within the framework, and apparently meeting the standards, of the historical and political-economic context. A review of these analyses shows that they were not undertaken within the framework and did not meet the applicable standards of international project evaluation. This finding is critical because Hungary and Czechoslovakia could have foreseen the shortcomings of the GNBS and either modified its design or abandoned it sooner if the information generated by adequate economic analyses had been available, and if it had been subject to a decision-making process that was open and receptive to economic rationality as internationally applied.

During the 1980s, the decision-making process became more open, questions about the economic rationality of the project began to be asked publicly, and environmental concerns paralleling those that had arisen earlier outside of CMEA were increasingly being expressed. The economic information that became available, furthermore, did not indicate GNBS was viable even when environmental costs were not considered. With the quality of economic information, types of concerns, and decision-making process merging with those outside CMEA, Hungary abandoned construction of Nagymaros temporarily in 1989 and permanently terminated the 1977 Treaty in 1992. This review of the Project analyses supports the economic rationality of that decision.

Early Efforts at Analysis

Water projects provide power, flood control, navigation, and other benefits by modifying the environment and the GNBS was no exception. Internationally, engineers with the collaboration of economists had long figured ways of estimating the benefits of the favorable environmental transformations of water projects. Beginning in the late 1960s internationally, people increasingly began to express concerns about the costs of development projects. Environmental economists responded to this concern by developing techniques for estimating the costs of unfavorable environmental transformations including natural habitat loss, air and water pollution, and aesthetic and recreation losses. While these techniques are by no means perfect, they have provided useful information for public decision-making with respect to development policies and projects around the world. As the political process opened up in Hungary, environmental concerns began to be expressed and incorporated in the debate about the economic rationality of proceeding with GNBS. The economic analyses of the project, however, failed to respond to these concerns formally.

In 1974 the Minister of Finance and the President of the National Planning Office of Hungary issued a Joint Decree On Investments specifying how development projects would be evaluated for their economic viability.[1] The first economic analysis apparently was prepared to secure a loan from the Soviet Union. This very brief analysis was prepared by the "Water Affairs Planning Company" and formally accepted through a resolution by the Ministerial Council of the People's Republic of Hungary on November 20, 1975.[2] The annex to the resolution presents a very sketchy summary of an economic evaluation, perhaps appropriate at the time under the expectation of a subsequent analysis with greater detail. It is interesting to note, however, that even this preliminary analysis indicated that the project was not economically viable by international standards.[3] The Joint Contractual Plan (JCP) *Summarizing Documentation* elaborated in 1978

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1 Joint Decree 3/1974 (VIII.16) of the National Planning Office and the Minister of Finance On Investments, August 16, 1974. HR, Annexes, vol 3, annex 44.

2 Resolution No. 3540/1975 of the Ministerial Council, On the Investment Proposal for the GNBS, November 20, 1975. A copy of the document has been deposited with the Court.

3 The difficulties of comparing findings based on the procedures stipulated by the Joint Decree and findings based on international standards of project analysis are discussed in Section III of this review.

provided very specific details of the project.[4] What is labeled an "economic evaluation" in this document ("the 1978 economic evaluation") largely consisted of a listing of the costs.[5] It was not an economic analysis as understood anywhere outside of CMEA. Rather, beyond the listing of costs, the textual analysis reflected an engineering approach to decision-making in centrally planned economies.

In 1983, the Water Construction Engineering Company undertook its own evaluation apparently in response to concerns about the advisability of seeking foreign loans for the project ("the 1983 economic evaluation").[6] While that analysis showed definitively that the project did not seem appropriate by the investment criteria laid down by the Joint Decree, GNBS was made to look good by comparing it to an even worse energy project, a coal-fired power plant which apparently had very high costs.

In 1984, the Water Construction Engineering Company commissioned Dr. István Varga, Chair of Water Construction at the Budapest Technical University, to prepare an economic assessment of the GNBS (the 1985 economic evaluation).[7] While this study addressed the benefits of the project, the framework of the analysis, particularly the comparisons made and the manner in which inflation was handled, distorted the conclusions in favor of implementing the project.

In February 1986 the National Office of Water Management provided an economic analysis which attempted to address the rising concerns about the project.[8] A somewhat better documented analysis with minor modifications in the calculations was provided in July 1986.[9] While the formal analysis indicated the project was marginal by the standards used at the time, the broader interpretation provided in the text argued that the project was viable because of the many

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4 GNBS Joint Contractual Plan, Summarizing Documentation, June 16, 1978, a summary of which is contained in HM, Annexes, vol 3, annex 24.

5 GNBS Joint Contractual Plan, Summarizing Documentation, 0-6 Economic Part, June 16, 1978. A copy of the document has been deposited with the Court.

6 The Economic Efficiency Study of the Gabcikovo-Nagymaros Barrage System, February 9, 1983. A copy of the document has been deposited with the Court.

7 Istvan Varga, The Dynamic Analysis of the GNBS, February 13, 1985. Published in Vizugyi Koslemenyck, vol 4, pages 555-577, 1985. A copy of the document has also been deposited with the Court.

8 Modified Investment Proposal for the Gabcikovo-Nagymaros Barrage System. State Investment and Evaluation of its Technical-Ecological-Economic Aspects, National Office of Water Management, February 1986. A copy of the document has been deposited with the Court.

9 Modified Investment Proposal for the Gabcikovo-Nagymaros Barrage System, State Investment and Evaluation of its Technical-Ecological-Economic Aspects, National Office of Water Management, July 1986. A copy of the document has been deposited with the Court.

benefits that could not readily be quantified including flood control, navigation, and recreation. Indeed, the project was presented as a general regional development project whose wider benefits justified the development. Some attention is directed to the concerns about protecting the environment, but the engineer's vision of development pervades the text in sentences such as: "The water control works to be carried out within the framework of the investment will create a civilized environment in the whole affected area."[10]

Those earlier analyses suffered from significant flaws in framework and further flaws in their execution. From an international perspective, one of the major shortcomings was that the project analyses were not undertaken in the context of a macroeconomic framework describing future directions in the economy, in energy technologies, and the stability of energy prices. Internationally, this macroeconomic framework within which development planning took place had changed due to the experiences resulting from the energy crises of the 1970s and early 1980s. No such transformation in understanding informs the economic evaluations of GNBS. Equally importantly, the economic analyses, even when the results indicated GNBS was not viable, were not taken seriously by the authorities. The combination of poor economic information and a political system that was neither open to nor interested in economic rationality by international standards allowed the project to go ahead, albeit with considerable difficulty. A somewhat more sophisticated effort was made at project analysis in 1989[11], but by then, with the project under different stages of construction by the two parties and within the constraints of meeting political deadlines, the difficulties of doing an adequate economic analysis had seriously compounded. At least by this time, however, the political process was more open and receptive to economic rationality by international standards. The 1989 economic analysis did help identify the economic dilemmas of proceeding from the Hungarian perspective. It was adequate to document that the project should probably never have been initiated. Supplemented by the costs of the environmental impacts of the Project, about which there was considerable interest but limited information at the time, that analysis might well have been definitive.

Had the economic analyses before project implementation been conducted to the same economic standards as project analyses in Europe and North America and as used by the international development agencies during the late 1970s and early 1980s, the possible difficulties which in fact arose would more likely have been foreseen. Perhaps the parties would never have initiated the project. In any case, they would have been in a better position to respond to the difficulties as they arose in the process of project implementation during the 1980s.

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10 Modified Investment Proposal, February 1986, *op cit.*

11 National Planning Office, Feasibility Calculations for the Bös-Nagymaros System of Barrages, October, 1989. A copy of this report has been deposited with the Court.

II. THE DEVELOPMENT OF COST-BENEFIT ANALYSIS AND ITS USE SINCE THE ENERGY CRISIS

The technological visions of engineers dominated development planning in Europe and North America well into the 20th century. In the "frontier environment" of North America especially, engineers determined the course of railroads and located and designed the major dams. Economists, however, played an increasingly important role in Europe and North America beginning in the 1930s.[12] Economists provided insights with respect to the directions development was taking and how these directions could be influenced at the macro level through taxation policies and government expenditures. An additional important role of economists was to analyze alternative projects initially designed by engineers -- from water projects in North America to highway options in Europe -- through the use of cost-benefit analysis. As the techniques of cost-benefit analysis evolved during the 1950s and 1960s, it became increasingly clear, especially for projects which had effects over many decades, that the manner in which the future was projected was very important in understanding the viability of the project. With this realization, the roles of economists with respect to macroeconomics and project analysis began to merge as the need to establish the broader context of individual projects became increasingly important.[13]

An economic analysis of an energy project in Europe and North America by the late 1970s would have presented a full analysis of energy demand projections, of the costs of alternative ways of providing the same energy, and of the costs of conserving energy instead of expanding the supply. Four years after the energy crisis of 1974, in the world outside of CMEA in 1978, planners, economists, legislators, and the public at large were well aware that energy prices could change dramatically in only a few years. They were also well aware that different ways of generating electricity had different advantages with respect to their price stability, environmental consequences and national or regional self-

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12 Joseph A. Pechman, The Role of the Economist in Government: An International Perspective, New York University Press, New York, 1989; A. W. Bob Coats, The Sociology and Professionalization of Economics, London. Routledge, 1993.

13 Ian Little and James Mirrlees, Manual of Industrial Project Analysis, OECD, Paris, 1968, later modified and commercially published as Project Appraisal and Planning for Developing Countries, Basic Books, New York, 1974; Edward J. Mishan, Cost-Benefit Analysis, Allen and Unwin. London, 1975; Lyn Squire and Herman G. van der Tak, Economic Analysis of Projects, Johns Hopkins University Press, Baltimore, 1975. There were earlier expositions on cost-benefit analysis, but these present nearly a consensus on methods, reflect broad international experience with project analysis, and demarcate the standard to this day. Clearly, there have also been many books written since these, but they tend to address special problems within cost-benefit analysis or the special problems of applying the methods to particular economic activities. While these references will occasionally be footnoted throughout this review of GNBS, whenever international standards of cost-benefit or project analysis are mentioned, it is in these works that discussion of the methodological issues can be found.

sufficiency.[14] The economic policies of CMEA buffered the shock of the energy crisis that was so dramatically experienced elsewhere. Consequently there was less concern within CMEA for the relationships between energy use and economic development. Beyond CMEA, there were numerous national, continental, and global analyses of energy supply alternatives and possible energy futures. An economic analysis of a particular energy project would have summarized the expanding energy literature, both to make sure that the authorities and public reviewing the analysis were informed and to assure that the planners were addressing the particular features of the proposed project in the broader energy context.

A key debate outside of CMEA during the 1970s centered on whether the possibility of long-term energy shortages meant the end of economic growth. A key question was whether energy use and gross national product necessarily had to grow together in fixed proportions.[15] International comparisons quickly showed that there were great differences between countries in the ratios of energy use to economic activity per capita.[16] Further historical analyses showed that energy intensive sectors such as primary manufacturing did not increase proportionately with economic growth while labor intensive sectors such as services grew more than proportionately. This combination meant the ratio of energy use to economic activity declined with economic growth. After adjusting for the mix of economic activities across countries, however, further comparisons still showed significant differences, indicating that some countries were considerably more efficient than others.[17] This finding provided critical impetus to less efficient countries to

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14 See, for example: International Institute for Applied Systems Analysis, Report by the Energy Systems Study Group, Wolf Häfele, program leader, titled Energy in a Finite World, distributed widely in draft in 1980 and published by Ballinger, Cambridge, Massachusetts, 1981. This study integrated resource limits and environmental considerations in a world systems model that was very impressive. At the same time, it apparently was less than it was claimed to be and several members of the team broke off and argued that the analysis was subtly but systematically biased to promote nuclear energy. See: Bill Keepin, A Critical Appraisal of the IIASA Energy Scenarios, IIASA Working Paper WP-83-104, October 1983 also published as: A Technical Appraisal of the IIASA Energy Scenarios, Policy Sciences, vol 17, pages 199-275, 1984. See also the subsequent articles by Brian Wynne, pages 277-320, and Michael Thompson, pages 321-339 who document the reasons for open assessment of and debate over formal analyses, especially where many assumptions can be hidden in the complexity of a large and inaccessible computer model.

15 Schurr, Sam H. (ed), Energy, Economic Growth, and the Environment, Washington, D. C. Resources for the Future, 1972.

16 Schipper, Lee J and Allan Lichtenberg. Efficient Energy Use and Well-Being: The Swedish Example, Science 194:1001-1013, 1976.

17 Workshop on Alternative Energy Strategies. Energy: Global Prospects 1985-2000, A Project Sponsored by Massachusetts Institute of Technology, Ballinger, Cambridge, Massachusetts, 1977. Joel Darmstadter, Joy Dunkerley, and Jack Alterman, How Industrial Societies Use

initiate policies and support programs to increase the efficiency of energy use. In some countries, the use of electricity was made more efficient through demand side management (DSM) programs. The comparative studies of the 1970s documented that the CMEA countries both had an unusually high proportion of energy intensive industries for their level of economic activity per capita and used energy inefficiently as well.[18] Having temporarily insulated themselves from the effects of the energy crisis as well as politically insulated themselves from the economic literature about the energy crisis, CMEA countries continued to emphasize the development of energy-intensive sectors and to use energy inefficiently throughout their economies until after the political transformations which changed the process of economic planning and opened their countries to the economic incentives of international prices.

A second lesson of the energy crisis was the realization that the macroeconomic future is more uncertain than it had been thought to be. This realization encouraged a search for projects which were economically robust in the sense that they would perform well under a range of possible economic futures. Development planning in Europe and North America moved away from large, long-term, capital-intensive projects and toward a mix of smaller, less capital-intensive projects utilizing an array of technologies and resources.[19] This move was accompanied by similar changes in the activities of the regional development banks and the international development agencies. Improving efficiency of energy use through a multitude of technological adjustments complemented the move toward cogeneration of electricity, small-scale renewable energy technologies for electricity generation, and the use of inexpensive gas-fired turbine generators. Much of this diversification was directed at reducing oil use. Between 1978 and 1985, oil use per unit of real GDP in Germany and France, for example, decreased at 5.1% and 6.3% respectively.[20] When large projects, such as those comparable to GNBS, were proposed in Europe and North America, they had to be compared with the advantages in economic robustness of proceeding with a multitude of smaller adjustments. For this reason, combined with increasing awareness of the environmental impacts, many large hydroprojects around the world were either

Energy: A Comparative Analysis, published for Resources for the Future, Johns Hopkins University Press, Baltimore, 1977.

18 United Nations, Department of Economic and Social Affairs, Statistical Office, Energy Statistics Yearbook, various years since 1950. William L. Liscom (ed), The Energy Decade 1970-80. World Energy Information Service, Ballinger, Cambridge, Massachusetts.

19 National Research Council, Committee on Nuclear and Alternative Energy Systems, Energy in Transition, 1985-2010, Final Report of the Committee prepared for the U.S. National Academy of Sciences, published by W.H. Freeman, San Francisco.

20 OECD, Economic Outlook, no 48, page 35, Paris, December 1990.

delayed for redesign and possible implementation in the future or simply left to languish.[21]

In the context of the GNBS Project it became evident that no proper cost-benefit analysis was undertaken, and that if one had been undertaken the economics of the Project would have looked very different. Within CMEA, formal economic analysis was not as well developed, the results of economic analyses were not widely disseminated, and relatively few lessons were learned from the energy crisis. Consequently GNBS remained a viable project in the minds of the central planners who promoted it, and few were in a position to question their position.

III. THE D INDEX AS A MEASURE OF ECONOMIC VIABILITY

The development of the framework for the economic appraisal of development projects and the ways in which economic analyses were used in project approval had a separate history within the CMEA. The strengths and weaknesses of the framework for project appraisal used in the economic analyses of GNBS are reviewed in this section.

A joint decree of the President of the National Planning Office and the Minister of Finance in 1974 directed that each project must have an investment proposal and that a D index must be calculated and presented in the investment proposal.[22] The D index is roughly equivalent to a ratio of benefits and costs. Thus one might suspect that the use of the D index would parallel that of a benefit-cost ratio in international practice where a project with a benefit-cost ratio of less than 1.0 is considered uneconomic. The joint decree, however, did not stipulate that the D index should be greater than 1.0, leaving the significance of the index in practice vague.

The joint decree also provided guidelines as to how the calculation of the D index should be undertaken so as to assure uniformity in the analyses of different projects. These guidelines provide interesting insights into the weaknesses of the approach.

The initial investment proposal for each project and whatever modifications followed were internal documents. Thus more public documents such as the Joint Contractual Plan (JCP) referred to economic analyses having

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21 See "Some Major Dam Disputes", HR, vol. 2, Appendix 5 for a review of some of these projects.

22 Joint Decree 3/1974 (VIII.16) of the National Planning Office and the Minister of Finance on Investments, Budapest, HR, Annexes, vol 3, annex 44.

been conducted but neither described the analyses nor, typically, even reported their results.

The D Index is defined as follows:

$$D = \frac{\sum_{i=0}^{15} (J_i - E_{p_i}) 0.893^i}{\sum_{i=0}^{15} E_{fi} 0.893^i - E_m 0.893^{15}}$$

Where:

J_i = net income in year i (annual revenue minus annual noncapital costs)

E_{pi} = complementary investment costs (cost of additional projects) in year i

E_{fi} = development costs in year i

E_m = remaining value of assets at the end of year 15

Internationally, economic criteria include net present value, the ratio of benefits to costs, and internal rate of return.[23] Each of the criteria have strengths and weaknesses. There can be multiple solutions to an internal rate of return calculation, for example, if there are substantial costs at both the beginning and the end of the period of analysis. The D index is not equivalent to any of these internationally used criteria, yet it does have some of the properties of the international criteria. In my judgment, however, most economists from OECD countries and those working in international and regional development agencies would be concerned that the D index has more of the weaknesses than of the strengths of the other conventional indices. Some of the weaknesses, however, are in how the D index was used rather than in the structure of the formula itself.

The primary structural problem in the D index is built into the divisor. Professor Varga points out in his 1985 analysis that D can be less than zero. This is possible because the divisor is the difference between the value of the construction costs of the project minus the present value of the project at the end of the period of analysis. The actual value of the project at the end of the period of analysis can increase due to an increase in the demand, and hence rising prices, for the services of a project. With the period of analysis set at 15 years (a convention

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23 Little and Mirlees, *op cit*; Mishan, *op cit*; and Squire and van der Tak, *op cit*.

of use, not a structural limitation), long-lived projects can have this property. Furthermore, projects which had this property could have a higher D index by building them earlier, but if they were built too early, their D index could turn negative. Thus structurally, the D index approach can favor large projects and can favor building them earlier rather than later. The indices used internationally do not have this characteristic, though the internal rate of return can also lead to ambiguous results. It is probably not a coincidence that this property of the D index also correlates with the "big projects early" approach to development taken by the majority of engineers globally, and in particular by development planners in CMEA.[24]

The Joint Decree establishing the D index also stipulated particular variables that should be used. The discount rate was fixed at 12% and the time period was fixed at 15 years. The Joint Decree contains some good guidance with respect to what costs to include in an economic evaluation, but it also contains some guidelines which clearly do not meet international standards. For example, it states:

> *Only those costs should be taken into account as other costs which qualify as input expenses, even from a people's economy point of view. For example, expenses for engagement of tools, wage expenses, taxes, duties, costs for using land, and domestic interest do not qualify as expenses from a people's economy point of view. The allowance for depreciation also need not be taken into account among expenditures.*[25]

It seems clear that if the planners did not consider the cost of using land a cost of the project, they would not have considered using the cost of using environmental services.

The treatment of price inflation is one of the major shortcomings of the economic analyses undertaken of GNBS. It seems those difficulties can be traced, in part, to the joint decree. With respect to future prices, the decree indicates:

> *In determining the factors of the indicator, starting from information which can be acquired under the conditions corresponding to the time of production, the expected future prices have to be taken into account ...*

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24 For documentation of how engineers' visions of water development have affected North America, see: Elmer T. Peterson, Big Dam Foolishness: the Problem of Modern Flood Control and Water Storage, New York, Devin-Adair Co., 1954; Donald Worster, Rivers of Empire, Pantheon Books. New York, 1985. For the former Soviet Union, see Marshall Goldman, The Spoils of Progress: Environmental Pollution in the Soviet Union, MIT Press, Cambridge, Massachusetts, 1972. That water engineers have big project early vision of the future is supported by my professional experience with the U.S. Bureau of Reclamation (dating from 1962) and the U.S. Army Corps of Engineers (dating from 1966).

25 HR, Annexes, vol 3, annex 44, page 3.

> *Determination of data on future circumstances can take place only with a certain margin of error. For this reason, the magnitude of uncertainty and the expected risk must be carefully analysed.*
>
> *In case of basic data, the related uncertainties must be shown individually or by groups.*
>
> *Of special importance are the careful estimations of the uncertainty limits of the development costs, the income from sales, and the expected costs of the more important basic materials over the planned period of growth or implementation and production.*
>
> *As a result of the calculations, the most probable expected value of the "D" indicator and its realistically expected worst and best values must be determined and presented on the prognosticated prices.*[26]

These closing passages of the decree provide good advice on treating the uncertainty of the future, and even the uncertainty of the more immediate development costs, through multiple calculations of the D index followed by the presentation of the most probable and probable worst and best outcomes. The problem is one of omission. The decree does not distinguish between real price changes, where the costs of, for example, earth moving equipment increases relative to that of gas-fired turbines, and inflationary price changes, where the costs of both earth moving equipment and gas-fired turbines, as well as all other goods, go up in terms of the amount of currency that must be paid.

The first type of price changes is "real," in that if the price of earth moving equipment increases relative to gas-fired turbines, this would indicate that a project which uses considerable earth moving equipment needs to have its development costs adjusted upwards. The benefits of the project, which can be attained through gas-fired turbines, must be seen as decreasing over time because of the projected decreases in the real cost of gas-fired turbines. Clearly taking into account this real change in prices lowers the D index, as well as other economic indices, informing the planners that perhaps they should not construct GNBS, but rather rely on gas-fired turbines instead.

Inflationary price changes, on the other hand, because they affect all goods and services approximately the same, do not affect choices between different ways of attaining the same goal. But if inflationary price changes are included in the analysis, it has the same effect as using a lower discount rate. In market economies, for example, when inflation is zero, the interest people receive in the bank may be 6%. When inflation is 6% per year, people insist on and banks are able to pay approximately 12% interest so that the real incentive to saving is still 6% . The real return on investment is unaffected by general price increases so

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[26] HR, Annexes, vol 3, annex 44, pages 4-5.

long as they are foreseen. The 12% interest rate is a nominal interest rate in that it includes the effect of inflation. Now, running the problem the other way, if the rate of discount is fixed at 12% by the joint decree and inflation is zero, then the real rate of discount is still 12%. If the calculation of the D index incorporates 6% inflation, then the real rate of discount used in the analysis is only approximately 6%.[27] Real discount rates will even be negative if the rate of inflation is greater than the discount rate used in the analysis. Under these circumstances, very bad economic investments can look favorable.

Again, it should be repeated that every index has some problems. In cases where these problems are expected with a particular index, a different index is sometimes considered internationally. But the D index has special problems. Limiting how it is used compounds the problems, and the problems do not seem to be appropriately discussed in the presentation of the results. Professor Varga, for example, in his 1985 analysis notes that problems could arise with the index but does not indicate the circumstances under which these problems might arise. The presentation of analytical results should include sufficient information on the interpretation of the analysis to inform those who ultimately must decide on the project and, for those ultimate authorities who are informed, to reassure them that those executing the analysis are aware of the pitfalls. This kind of sophistication is especially critical for an indicator with the problems of the D index.

One thing is apparently missing in the Joint Decree. It does not seem to say anything about how the D index is to be used, only that it should be calculated. It is an adjusted ratio of benefits to costs where the adjustment is guided by the limitation to a 15 year time period of analysis as stipulated by the Joint Decree. As a ratio of benefits to costs, one would expect that an economically viable project would have a D index greater than 1.0. The decree, however, is apparently silent on this. Projects were apparently expected to have diverse indirect economic development benefits beyond their direct benefits of energy production, flood control, and navigation improvement, so even if the direct benefits were less than the costs, a project could be deemed economically viable.[28] Such benefits would be called secondary benefits in international terminology and are not included in cost benefit analysis because developments in one place usually take resources away from another except during periods of high unemployment of labor, capital, and other resources. Thus, by international standards, it would be appropriate to consider a D index of less than 1.0 to indicate the project is not viable. One caveat

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27 For low rates of inflation, one can simply subtract the rate of inflation from the nominal rate of interest to determine the real rate of interest. The true relationship is:

$$realrateofinterest = \frac{(1 + nominalrateofinterest)}{(1 + rateofinflation)}.$$

28 Based on discussions with Professors Sándor Kerekes, Sándor Péter, and László Zsolnai of the Budapest University of Economics, September 9, 1994.

must be added, however, because international economic analyses included more of the primary benefits, such as navigation and flood control benefits, than were included in the analyses of GNBS.

IV. THE ECONOMIC ANALYSIS SUPPORTING THE INVESTMENT PROPOSAL (1975)

During 1975, an extensive economic analysis of GNBS apparently was undertaken and a D index was calculated. Unfortunately, the only information available from that analysis at this time appears as a short annex to a ministerial resolution of November 20, 1975 which reads in part: "According to the attached annex, the Ministerial Council accepts the investment proposal for GNBS as a basis for international negotiations [for a loan from the Soviet Union]."[29] While this annex is only four pages (in English translation) and says very little about the economic analysis, what it does say is extremely revealing.

Items 1-11 of the annex list the participants in the project, give a physical description of the project, and estimate the yearly income and the total costs of the project, but provide no economic analysis.

Item 12 of the annex is titled: "The cost plan for related investments not taken into account in the development cost of the main investment."[30] The entry under this item is "No such cost plans." This is significant, because it documents that even though this project had been planned and discussed for twenty years, the costs beyond the costs of constructing the barrages and installing the turbines and necessary costs of relocating roads and powerlines had not been considered. The costs of navigation improvements and port relocation, for example, were not yet being considered.

Item 13 is titled: "The profitability of the development." The entry under this heading is simply "703.6 million forints." This same figure was given under item 7 as the estimated yearly revenue of the project from electricity sales. Either the initial extensive analyses never distinguished between revenue and profitability or whoever tried to summarize that analysis for the annex was unable to determine from the analysis the difference between revenues and profitability. When considering an investment, it is only profitability that matters. Looking at revenue is like the old joke about the naive and the soon to be defunct businessman who says, "I lose a little bit on each sale but make it up in the quantity of sales." In any case, this confusion was allowed to stand in the annex as presented to and then

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29 Resolution No. 3540/1975 of the Ministerial Council on the Investment Proposal for the Gabčikovo-Nagymaros Barrage System. A copy of the document has been deposited with the Court.

30 *Id.*

distributed by the Ministerial Council. One can only conclude that this confusion was a part of the basis on which the investment proposal was justified.

Item 14 deserves complete replication.[31]

14. The index from a people's economy point of view of economic efficiency of the investment (D).

Taking into account the period of preparation of the investment as being a part of the implementation period	*D = 0,404*
Taking the period of implementation as beginning with the commencement of actual implementation	*D = 0,760*

These ratios are unusually low and surely indicate the project is not economic unless there is reason to believe that the project has extensive benefits that were not included in the evaluation. No elaborations or interpretations of these low ratios, however, are given. The results could be low because the analysis inappropriately was based on subsidized electricity prices rather than the actual cost of producing electricity by the lowest cost alternative means. Perhaps navigation benefits would have been sufficient to make the project viable but these were not included in the analysis. Such low D indices without explanation again indicate that neither the planners communicating the results nor the Ministerial Council receiving the information were aware of or concerned about economic rationality by international standards.

The lower of the two D indices is the one calculated according to the directives given in the joint decree. The second estimate is higher apparently because the cost of capital during construction of the project was not included. By international standards, however, the cost of capital during construction must be included. Indeed, one of the reasons large, controversial projects such as GNBS have fallen into disfavor internationally is because it has proven difficult to build them on schedule, further adding to the cost of capital during construction and hence the overall costs of the project. This, of course, is also exactly what happened with GNBS. Smaller, less controversial projects can be built quickly and hence have relatively little cost of capital during construction.

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31 *Id.*

There is insufficient material on how the analysis was conducted and no interpretation of the results, so the Council of Ministers were no more informed after this presentation than they were before. And yet, had the authorities been interested in economic rationality or had the political system been open to critical query by international standards, these results would have stopped the project until more detailed economic analyses and/or project redesign provided more favorable results. These minimal unfavorable results should have at least alerted the authorities to the need for a serious economic analysis. It is not unusual for preliminary estimates to be derived at an early stage of planning that are then followed by a more thorough analysis for review at a latter stage of planning. The more thorough analysis, however, did not appear at this next stage.

V. THE "ECONOMIC EVALUATION" SUPPORTING THE JOINT CONTRACTUAL PLAN (1978)

The description in Section II of the development of economic analysis of energy projects in Europe and North America as well as through the international development agencies during the 1970s, highlights why the initial economic evaluation of GNBS was inadequate. A sound economic analysis of GNBS, even from a narrow energy perspective, would have been based on macroeconomic analyses of the regional economy and its likely future. It would have considered the alternative of a combination of smaller projects, policies for influencing the direction of development, and projects to implement demand side management as alternative measures for meeting economic development goals.[32] There is no evidence that the analysis presented in the *Summarizing Documentation* to the Joint Contractual Plan was undertaken in the context of a macroeconomic understanding that included the lessons from the energy crisis, and no evidence that any alternative measures were seriously considered. The analysis does not have a macroeconomic overview of the relationship between energy and development, not even an economic overview based on pre-energy crisis understandings. Further, economic analysis of how the project affects navigation, flood control, fisheries, and other factors including those relating to social and environmental aspects were missing.

By international standards, there is no evidence that "economists" actually undertook any part of the 1978 evaluation. Rather, what is presented as economic argumentation in the "*Economic Part*" of the documentation for the Joint Contractual Plan is merely a summary of information pertinent to engineers. The evaluation consists of three "chapters."[33] The first is simply an introduction of a

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32 Little and Mirrlees, *op cit*; Mishan, *op cit*; and Squire and van der Tak, *op cit*.

33 GNBS Joint Contractual Plan, Summarizing Documentation, 0-6 Economic Part, June 16, 1978. A copy of the document has been deposited with the Court.

little more than 100 words. The next 49 pages (in English translation) set out tables of specific construction items and how their costs are to be shared by the parties. This second chapter contains no analysis of the benefits of the project, only the division of the costs of the project as it was designed.

Chapter 3, titled *Economical Evaluation*, opens with the following introductory statements:

> *The System of Lock is a multipurpose, infrastructure type investment which simultaneously utilizes the Danube section between Bratislava and Budapest and facilities general economical development of the area concerned.*
>
> *Evaluation of the economical efficiency of the investment is possible on the basis of calculable positive and negative effects as well as benefits and drawbacks described in words.*
>
> *The character of the investment requires national economical interest to be placed above the resulting effects on individual users. In addition to the non-calculable effects, the social effects and the impact on international relations of this significant scheme must be jointly evaluated.*
>
> *Exploitation of the Danube as a common Hungarian-Czechoslovák energy source and improvement of the navigation conditions in this important European transport route - in addition to the further significant results - form part of the close cooperation of the COMECON countries mainly in the field of the energy sources optimal utilization.*
>
> *Considering the fact that the Hungarian and Czechoslovak organization differ from each other, and moreover that the rate of the budgetary items given in forint (Hungarian currency) and korona (Czechoslovak currency) is not constant, a unified and common economical evaluation of the whole system expressed in two currencies cannot be accomplished.*
>
> *Detailed evaluation of the economical effectiveness will be made by both parties individually according to the relevant regulation in the joint investment project. General statements of this evaluation and summing up of the main effects of the investment follows.*[34]

There is neither economic framework nor content in any of these six, single sentence, paragraphs comprising the entirety of the section titled *Economic Evaluation* in Chapter 3. The second statement boldly declares that an economic analysis can be done, but without providing any evidence that it could be carried out or that such an analysis actually had been carried out. The fifth statement equally boldly declares that an economic analysis cannot be done because of the

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34 *Id.*

complications of exchange rates, a difficulty that should not perplex an economist for long. The sixth and final statement says detailed economic evaluation will be made by both parties individually after they had already agreed to the objectives and detailed means or reaching them specified in the Joint Contractual Plan. This last statement indicates that those who prepared and agreed to the summarizing documentation to the JCP made no distinction between economists who analyze the merits of projects before implementation and accountants who follow the performance after operation has begun.

Following this introduction are eleven pages in which almost all of the material consists of physical descriptions of the project. Section 3.5, *Technical and Economic Justification of the Planned Solution*, indicates in the second paragraph that economic evaluations were undertaken,[35] and argues in this paragraph and the next (referring to *technical-economical analysis)* that economic analyses provided the bases for the project design. Without any evidence of such analyses and with the contradictions presented in the second, fifth, and sixth opening statements, it cannot be thought that the economic analyses referred to here were undertaken in a serious manner.

The rapid changes in energy prices experienced during the 1970s outside CMEA led to extensive analyses of the costs and different advantages and disadvantages of different forms of energy. The *06 Economic Part,* chapter 3, makes some references to the advantages of having additional hydro capacity in the regional power system but makes no reference to the costs of alternative ways of producing energy. One of the basic principles of cost-benefit analysis is that the benefits of producing a good by one means cannot be greater than the costs of producing the same good by an alternative means.[36] The application of this principle helps assure cost effectiveness. Absent any evidence that alternative costs were considered, it must be concluded that this principle was not applied. In this sense also, the 1978 economic evaluation was critically deficient by the international standards of the time.

Additional Considerations. Note that the foregoing documentation of the inadequacy of the economic analysis supporting the JCP in 1978 is limited to the production and demand for energy. Techniques for cost-benefit analysis used internationally had long incorporated formal ways of determining the economic values of other benefits and of considering whether these extra benefits justified the extra costs of providing the benefits.

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35 This section indicates that the results of the economic analyses can be found in Paragraph 1.3, but that paragraph merely notes that "On the basis of these studies...were selected as the optimal version." Paragraph 1.3, in short, provides no results or additional information. *Id.*

36 Otto Eckstein, Water-Resource Development: The Economics of Project Evaluation, pages 168-175, Cambridge, Harvard University Press, 1958.

The 1978 analysis of the navigation benefits is limited to physical descriptions of the improvements in navigability. The increase in the average tonnage of 4.4 million between 1968 and 1970 to an average of 4.8 million between 1971 and 1975, combined with the navigation improvements of GNBS, is extrapolated without explanation to tonnages five times greater by 1996-2000. A cost-benefit analysis conducted by international standards would have been based on historical trends in shipping by categories of goods, projections for these goods in the context of macroeconomic forecasts, analyses of shipping by alternative transport modes, and documentation on the trends in costs of alternative modes.[37] None of this information is presented in the *Summary Documentation*, whether to inform an economic analysis of the navigation benefits or to provide relevant data directly to governments.

Techniques had also developed internationally well before the late 1970s for incorporating the benefits and costs of flood control.[38] Changes in water availability and quality to economic sectors indirectly affected a water development project. Cost-benefit analyses of water projects in the 1970s outside of CMEA also included economic estimates for enhancements and degradations of fisheries. Similarly, the value of the land inundated would probably have been included in an analysis of a comparable water project in Europe or in North America, though perhaps not yet in many developing countries. The 1978 "economic evaluation" did not try to quantify any of these environmental benefits or costs, even those for which market values would have been available outside of CMEA.

Summary of the Economic Information Available in 1978. An adequate economic analysis would have been undertaken by this stage of decision-making elsewhere in Europe or in North America or for projects financed by the international development agencies. One can only conclude that, at least up to and including the development of the *Summarizing Documentation* to the JCP prepared in 1978, economic reasoning by international standards was neither utilized in the initial conception and subsequent design of the project nor for the purposes of informing a public decision-making process within and between the parties to the plan. At this time, the plan was sufficiently in place that an agreement was reached on the division of the costs of very specific components of the project. The project had not been subjected to economic evaluation and very little economic information was presented to the governments proceeding on the plan. The references in the Summarizing Documentation to economic analyses having been performed without any presentation of the nature or results of the analyses

37 Eckstein, *id.*, summarized how such an analysis should be undertaken in 1961. Eckstein cites P.D. Locklin, Economics of Transportation, 3rd edition, Chicago, Irwin, 1947, indicating that such techniques had been well developed in North America for some time.

38 Eckstein, *id*, pages 101-160.

carry no weight. The primary purpose of economic analysis internationally has always been to inform the parties ultimately responsible for the decision of the economic viability of the project.[39]

GNBS was an engineering vision of how the Danube should be transformed into a "civilised environment." It was a vision that could be implemented through the development planning process of CMEA without proper economic analysis for presentation either for internal use by government authorities or to an open decision-making process that included public participation.

VI. BACKGROUND ON THE DEVELOPMENT OF ENVIRONMENTAL ECONOMICS (THE 1970'S AND 1980'S)

A central issue in the transformation in Eastern Europe during the 1980s, and of much of the rest of the world beginning a decade earlier, was the change in perception of the relationships between economic development and the environment and how this transformation affected the economic analysis of projects and their viability. A water development project would have no energy, irrigation, drainage, navigation, or recreation benefits if it did not transform the environment. Over the years, engineers and economists working within development agencies in Europe and North America as well as the international development agencies devised increasingly sophisticated ways of including the favorable environmental transformations in their economic analyses, conveniently ignoring the unfavorable changes. This biased the analyses in favor of development. "Environmental economics" has emphasized the unfavorable transformations of the environment. The inclusion of environmental costs could rightly balance the analyses.

A. A Short History of Environmental Economic Analysis. During the 19th century, economics acquired the reputation as "the dismal science" because classical economists kept raising the specter of resource scarcity. Malthus argued that the differences between the rates at which food and population could increase over time resulted in famine and war.' Ricardo argued that the quality of resources yet to be exploited were lower than those already in use. John Stuart Mill foresaw the day when resource limits would force the marginal productivity of labor and capital to zero and development would level out in a steady-state. W. Stanley Jevons worried that coal fueled the economic and hence geopolitical success of the British Empire and that coal was sure to run out before the end of the century.

39 One can argue, of course, that the planners and engineers designing the project were the parties ultimately responsible for the decision. This interpretation only serves to emphasize the importance of the opening up in the process of governance during the 1980s.

Thus for much of the 19th century, resources were central to economic understanding.

While concerns about resource scarcity continued to be expressed within the economic's profession, the rapid pace of technological innovation and industrial development during the latter 19th century led most economists to believe that people were going to be able to overcome all scarcities and environmental problems through the progress of science. Scientific and technological optimism reigned supreme in Western market economies and in the profession of neoclassical economics until the environmental movements and energy crises of the 1970s. The same scientific optimism and sense of destiny that included material control over nature was captured in the term "scientific socialism." It is also important to note that Karl Marx and his followers did not believe that land, and certainly not land owners, should earn an economic return. As noted in the discussion of the D Index in Section III, this argument became embedded in practice. Thus, for a combination of reasons, development advocates, whether espousing markets or central planning, gave little thought to resource depletion and environmental transformations from roughly 1870 to 1970.

In the latter 19th century, John S. Mill noted that markets did not allocate environmental resources which could be freely enjoyed by all. A. C. Pigou formalized this concern in a theory of market failure arguing that when goods and services are external to the market, the market does not work efficiently.[40] The basic problem is that the industries, for example, that pollute the air do not pay the damages suffered by those who previously enjoyed the amenity and health benefits of clean air. These are external to the market. As a consequence, industrial products are less expensive than they would have been if the environmental amenities and health benefits of clean air were considered in the market. With lower industrial prices, more industrial goods are produced than would have been the case had air been internal to the market. Thus markets do not work efficiently because everything is not internal to the market. What is external, the externalities, distort some prices more than others, but to some extent the whole system of prices is different than it would be if externalities could be internalized and the market made efficient. It is this concern which has driven economists to determine the value of non-market environmental factors, for even when they cannot be made internal to the market, they can be made internal to project evaluation and macroeconomic accounting.

Environmental and resource economics maintained a low profile within the economic's profession until popular concern brought these subjects into *Principles of Economics* texts beginning in the 1970s. Until recently, it would be fair to say that the development of environmental economics in North America and in Europe took fairly separate directions. In North America, the emphasis has been on

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40 A. C. Pigou, The Economics of Welfare, London, Macmillan, 1920.

estimating the economic values of environmental services. In Europe, the dominant concern has been to understand the relationships between economic and environmental systems.

In North America, beginning in the 1950s, economists initiated an inquiry on the value of national parks for recreation and of streams for sport fishing.[41] This concern with measuring the value of recreation services extended to questions of environmental services more broadly, especially the importance of air and water quality, during the 1970s. With the rise in public concern about the environment in the early 1970s, many economists in North America moved into the subdiscipline of environmental economics to estimate the health values of clean air and water, the aesthetic values of clean air, and eventually the values of such difficult concepts as biodiversity. Numerous environmental economists, as well as economists soon to be environmental economists, were hired by the new U.S. Environmental Protection Agency as well as by analogous agencies at the state level. In 1974, the Association of Environmental and Resource Economists was established in North America. Much of the environmental valuation research has been published in the association's *Journal of Environmental Economics and Management.* Environmental valuation in North America has influenced, but by no means driven, the choice between environmental policies, the design of projects, and the level of monetary liability in environmental damage suits brought through the legal system.[42]

In Europe, on the other hand, while there certainly has been concern with the values of individual environmental services, there has been a distinctive drive to characterize the systemic relationships between environments and economies. In retrospect, we can now see how at the time American economists were beginning to value outdoor recreation services, the British economist, K. William Kapp in 1950 was pointing out how the system of national accounts used to inform our understanding of the macro functioning of economies failed to incorporate key information on how ecosystems supported the economies.[43] Environmental

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41 Harold Hotelling, Memo to Roy A. Prewitt, incorporated in a report by Prewitt: The Economics of Public Recreation - An Economic Survey of Monetary Evaluation of Recreation in National Parks, prepared for the U.S. National Park Service, 1949; Marion Clawson, Measuring the Demand for and Value of Outdoor Recreation, Reprint #10, Washington, D. C. Resources for the Future, 1959; William G. Brown, Ajmer Singh, and Emery N. Castle, An Economic Evaluation of the Oregon Salmon and Steelhead Sport Fishery, Technical Bulletin 78, Agricultural Experiment Station, Oregon State University, Corvallis, 1964.

42 The North American environmental economics literature is reviewed in M. L. Cropper and W. E. Oates, Environmental Economics: A Survey, Journal of Economic Literature, vol XXX, pages 675-740, 1992.

43 William K. Kapp, The Social Costs of Private Enterprise, Cambridge, Massachusetts, Harvard University Press, 1950.

accounting at the national level was explored during the 1970s by France,[44] Holland,[45] Japan,[46] Norway[47] and the OECD with respect to developing countries.[48] This interest in environmental accounting on the national scale was well developed within government agencies in Europe two decades before it was taken seriously by North America government. Indeed, the best work on environmental accounting being done by U.S. economists in this period was for developing countries.[49] These studies show that the system of national accounts errs significantly, especially in predicting measures of economic growth, due to the exclusion of resource depletion and environmental degradation from the accounts.

In addition to the work by European nations on environmental accounting, important work on economic and environmental systems was coordinated through international institutions based in Europe. The Organization for Economic Cooperation and Development established a strong team of environmental economists in its Paris office beginning in the early 1970s. These OECD economists produced or commissioned key background papers and sponsored workshops on the relationships between environmental policies and economic growth, energy use and development, and other factors.[50] OECD also sponsored workshops on environmental valuation and pollution taxes, paralleling the work in North America.

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44 J. L. Weber, The French Natural Patrimony Accounts, Statistical Journal of the United Nations Economic Commission for Europe, vol 1, pages 419-444, 1981; Jacques Theys, Environmental Account in Development Policy: The French Experience, published in Yusuf J. Ahmad, Salah El Serafy, and Ernst Lutz (eds), Environmental Accounting for Sustainable Development, A UNEP-World Bank Symposium, Washington, D. C. The World Bank, 1989.

45 Roefie Hueting, New Scarcity and Economic Growth, Amsterdam, North Holland, 1980.

46 Economic Council of Japan, Measuring Net National Economic Welfare of Japan, Tokyo, 1974.

47 Statistisk Sentralbyra, Natural Resource Accounting and Analysis: The Norwegian Experience: 1978-1986, Oslo, 1987.

48 Michael Ward, Accounting for the Depletion of Natural Resources in the National Accounts of Developing Countries, Development Centre, OECD, Paris, 1982.

49 Henry M. Peskin, Environmental and Nonmarket Accounting in Developing Countries, published in Ahmad *et al, op cit* 1989; Robert Repetto *et al*, Wasting Assets: Natural Resources in the National Income Accounts, World Resources Institute, Washington, D. C. 1989.

50 See, for example, OECD. Problems of Environmental Economics, Paris, 1972; Environmental Damage Costs, Paris, 1974; Energy and Environment, Paris, 1974; The Polluter Pays Principle, Paris, 1975; Economic Measurement of Environmental Damage, Paris, 1976; Macroeconomic Evaluation of Environmental Programmes, Paris, 1978; The Influence of Technology in Determining emission and Effluent Standards, Paris, 1979; Pollution Charges in Practice, Paris, 1982; Environment and Productivity, Background Paper for the International Conference on Environment and Economics, June, Paris, 1984; The Benefits of Environmental Policies, Paris, 1985; and Energy and the Environment: Policy Overview, Paris, 1989.

In addition to OECD, the International Institute for Applied Systems Analysis (IIASA) was another European-based international institution which undertook environmental economic analysis. IIASA, established to provide scientific linkages between East and West, was set up in Laxenburg, Austria, and initiated programs on energy resources and environmental economics soon after its own beginning in 1972. IIASA provided an important point of exchange of ideas between international and CMEA researchers, including many Hungarians.

The United Nations Economic Commission to Europe also began to address the relationship between energy policy and environmental protection in the mid-1970's,[51] calling for international cooperation on ways of predicting and effectively avoiding adverse environmental consequences of economic activities.[52]

In 1983, the United Nations General Assembly established the World Commission on Environment and Development (WCED) which was chaired by Gro Bruntland of Norway, was based in Geneva, and included István Láng of Hungary. While the WCED certainly did not itself develop or apply environmental economic theory, it did hold hearings all around the world on the problems of environment and economic development. These hearings and the commission's own deliberations leading to the synthesis published as *Our Common Future* (1987) were critical in establishing a global consensus that economic development depends on sustaining critical environmental functions and systemic properties.[53] It was this "galvanizing" of world perception that the environment is important to the economy that, in the later 1980s, drew environmental economics into the limelight of economic policy in many nations.[54] This global transition in understanding forced the World Bank and other international development agencies to formally include the environment in their economic analyses.[55] It led to the adoption of a constitution for the European

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51 See, for example, UN/ECE decision A(XXXI) (1978), Energy problems in Europe, calling for work on, *inter alia*, economic growth and energy efficiency, cost-benefit analysis to assessing energy conservation, and environmental aspects of energy conservation: UN Doc E/ECE/836/Add.1, page 31. See also UN/ECE decision A(XXXII). The Overall Economic Perspective of the ECE Region up to 1990, UN/Doc E/ECE/836/Add.1, page 40.

52 See UN/ECE Principles on the prevention and control of water pollution, including transboundary pollution, UN/ECE Decision B(XXXV), UN Doc. E/ECE/836/Add.1, paragraph 14 (1980).

53 World Commission on Environment and Development, Our Common Future, Oxford University Press, Oxford and New York.

54 See, for example, David Pearce, Anil Markandya, and Edward B. Barbier, Blueprint for a Green Economy, Earthscan Publications, London, 1989.

55 Philippe Le Prestre, The World Bank and the Environmental Challenge, Associated University Presses, London and Toronto, 1989; World Bank, Development and Environment, World Bank Development Report, Oxford University Press, Oxford, 1992. For an indication of how this has transformed the framework of thinking about energy projects financed with the participation of

Bank for Reconstruction and Development in 1990 which committed that institution to promoting "in the full range of its activities environmentally sound and sustainable development."[56]. This period also involved considerable communication and joint project work by European and American economists resulting in an exchange of analytical strengths. The European Association of Environmental and Resource Economists was formed in 1989, and its journal, *Environmental and Resource Economics*, began publication in 1991.

In addition to the American and European approaches to the field of environmental economics, an international effort began with a meeting in Stockholm in the early 1980s and developed into what is now known as ecological economics. The International Society for Ecological Economics was formed in Barcelona in September, 1988 and the journal of *Ecological Economics* began in 1989. Participation in this group includes both economists and ecologists seeking to learn each others ways of understanding their respective systems and striving for new syntheses which will support sustainable development. In 1990, the World Bank hosted the first international conference of the newly formed society.[57] Subsequent conferences have been held in Stockholm and in San José, Costa Rica.

B. Economics and Public Decision-Making during the Environmental Transition. In Europe, North America, and within the international development agencies, the contribution of economics to rational public decision-making has continually expanded and changed. The last decade clearly has seen the greatest rate of transformation.

Initially, the rapid rise in the public perception of environmental problems directly challenged how economic development was being undertaken. Environmentalism also challenged the use of economics in public decision-making. Economists in national and international development agencies, however, quickly began to augment their analysis during the 1980s with the theories and methods developed by environmental and resource economists during the 1970s. This change and expansion in economic analysis is still underway. The World Bank, for example, has an Environment Department within its research arm dedicated to expanding the range of practical methods of addressing environmental issues and getting these methods adopted throughout the operations arm of the Bank. The incorporation of environmental economic analysis has rarely proven definitive in determining a project's design or whether it is approved for implementation. This is partly because environmental economics seeks to understand and value more difficult phenomena and partly because there is less

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the World Bank, see Corazón M. Siddayao. Energy Investments and the Environment: Selected Topics, Economic Development Institute, The World Bank, Washington, D. C. 1993.

56 23 I.L.M. 1083, at art 2(1)(vii) (1990).

57 An influential book came out of the first meeting: Robert Costanza (ed), Ecological Economics: The Science and Management of Sustainability, Columbia University Press, New York.

agreement within environmental economics, relative to economics as a whole, as to the most appropriate techniques. Rather, environmental economic analysis, in the best of circumstances, has merely assisted in the design of development projects and the decision to implement them or not. For projects which are especially environmentally controversial, environmental economics has, at best, given economists a language with which to participate in the debate.[58] And the EBRD has pledged in its Agreement "to have environmental management at the forefront of its operations to promote sustainable economic development in central eastern Europe."[59] To that end it has adopted Environmental Procedures which would, *inter alia*, ensure that throughout the project approval process those responsible can take into account environmental implications in order to ensure that environmental costs are estimated.[60]

VII. THE 1983 ANALYSIS

The rapid developments in cost-benefit analysis occurring internationally during the 1970s and 1980s had little effect on project evaluation in Eastern Europe. Environmental impact assessments for the project began to be demanded and increasingly sophisticated analyses were undertaken during the 1980s. The quality of economic analysis, by contrast, increased more slowly. Five years after the JCP, an economic analysis of GNBS was prepared by the Water Construction Engineering Company in response to ongoing concerns about the availability of foreign loans.[61] This analysis, while qualitatively dismal by international standards, did present critical information that responded to the questions faced at the time. Indeed, in light of the results of this analysis, it is difficult to comprehend how the project ever moved ahead.

Following the instructions of the 1974 joint decree on project evaluation, the study undertook a sensitivity analysis of the robustness of the project under alternative assumptions about the future. The "efficiency" as measured by the D index of GNBS was compared with the efficiency of producing electricity at Bicske coal-fired power plant from deep mined coal.[62] The initial price of

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58 This interpretation is in accord with the best recent treatise on environmental economics and project analysis. See the last chapter of Nick Hanley and Clive L. Spash, Cost-Benefit Analysis and the Environment, Edward Elgar, Hants, England, 1993.

59 See EBRD, Environmental Procedures (1992), at page iii.

60 *Id.*

61 The Economic Efficiency Study of the Gabcikovo-Nagymaros Barrage System, February 9, 1983. A copy of the document has been deposited with the Court.

62 The analysis indicates that the estimates of costs for the coal-fired power plant and mine come from "the ATB proposal, 'Modification of Certain Data of the Development Goals of the Heat Power Plant at Bicske and the Deep Cultivation Eocene Coal Mines, NIM, May, 1979'." *Id.*

electricity was taken as the price at the time of the study. The alternative scenarios were based on alternative initial costs for coal and alternative rates of increases in the price of electricity and of fuel costs -- 0%, 4%, 7%, and 10% per year -- during the duration of the project. The analysis also considered the effect of a four year delay in construction of GNBS, looked at the effects of extending the analysis from 15 to 25 years, and considered the implications of charging all of the construction costs against the energy benefits, *i.e.*, treating the other benefits as zero. The calculated D indices for GNBS and the coal-fired power plant under the alternative scenarios are presented in the following table.[63] Note that I have indicated in parentheses the equivalent real discount rates implied for the analyses under each of the price rise scenarios.

The analysis documents three things. First, unless the rate of inflation is very high (*i.e.* the rate of discount very low) and the twenty-five year time period is used, GNBS is not economically viable according to the D index. The joint decree stipulated fifteen years as the period of analysis, and based on this period, the project is not viable even if the appropriate discount rate were to go as low as 2%. There is good reason, however, to extend the time period from fifteen to twenty-five years, especially for projects that require some five years for construction. Even with this extension, however, GNBS is not viable unless a discount rate below 5% is deemed appropriate. Second, as calculated, GNBS is clearly much more economically viable than the coal-fired power plant. The D indices for the power plant and mine combination, not including the associated environmental costs, are even much lower than those for GNBS. Third, the effect of the four year delay turns out to be quite significant in this analysis.

A responsible public authority, rational by international economic standards, viewing these results would conclude that the coal-fired power plant was certainly an extremely bad investment and that GNBS is probably a poor to very bad investment. Again, while there are numerous details of the D index approach which make a definitive assessment of the economic viability by international standards difficult starting with this analysis, the results presented in the table should have at least forestalled the project until a more definitive analysis had been undertaken. The writers of the report, however, conclude from the second and third points noted above that since GNBS is so much more viable than the coal-fired plant and mine combination and since delay significantly hurts the economic viability of the project, it is appropriate to obtain foreign financing and go ahead with the project. The first point, that the D indices are unusually low for

Adjusting construction costs to the then current time period using 1979 estimates for the coal-fired plant and 1974 estimates for GNBS caused some difficulties and may be a source of errors.

63 The 1983 analysis also attempts to estimate a rate of return but instead seems to be calculating payback periods (which range as high as 385 years for the coal-fired power plant). *Id.*

GNBS even without considering the environmental costs, was simply ignored in the interpretation of the results.

	energy price / fuel cost/ yearly increase (equivalent real discount rate used for benefits)			
	D index with energy development cost as a burden of energy production 1981-1995			
	0% (12%)	4% (7.7%)	7% (4.7%)	10% (1.8%)
G0N0	0.3377	0.5318	0.7272	0.9779
G4N4	0.1990	0.3598	0.5309	0.7613
heat plant with 0.60 Ft/kwh fuel cost	0.0236	0.1346	0.2636	0.4335
heat plant with 0.78 Ft/kwh fuel cost	-0.0690	-0.0106	0.0540	0.1414
	D index with energy development cost as a burden of energy production 1981-2005			
G0N0 Variant	0.3370	0.7007	1.0835	1.6576
G4N4 Variant	0.2831	0.6214	1.0156	1.7052
heat plant with 0.60 Ft/kwh fuel cost	0.0167	0.2528	0.5534	1.0298
heat plant with 0.78 Ft/kwh fuel cost	-0.1162	0.0053	0.1602	0.4064
	D index with entire development cost as a burden of energy production 1981-1995			
G0N0 Variant	0.2789	0.4393	0.6007	0.8077
G4N4 Variant	0.1564	0.2828	0.4173	0.5984
	D index with entire development cost as a burden of energy production 1981-2005			
G0N0 Variant	0.3114	0.5778	0.8950	1.3692
G4N4 Variant	0.2225	0.4884	0.7983	1.3403

The explicitness of this analysis does provide an additional insight. It shows that most of the costs of the project are associated with energy production. The viability is further reduced when all of the costs are included, but not by much. Furthermore, the lack of attention over the years to the other potential benefits indicates that those who were behind the project really saw it as a power production project.

In the final analysis, the strongest conclusion one can draw from the 1983 evaluation is that comparing a likely bad investment with a known really bad investment makes the likely bad investment look better.

VIII. THE VARGA ANALYSIS OF 1985

In 1984, the Water Construction Engineering Company commissioned Dr. István Varga, Chair of Water Construction of the Budapest Technical University, to prepare a study assessing the economic significance of the planned and ongoing GNBS project.[64] With the aid of Klára Stachó, an economist with the State Development Bank, and Pál Réschl, a mechanical engineer with the Hungarian Electricity Works Trust, Dr. Varga completed an analysis dated February 13, 1985 titled *The Dynamic Economic Analysis of the GNBS.* While the 1985 analysis has many of the appearances of an economic evaluation, it has fundamental flaws in its design and execution.

One might suspect that an analysis commissioned by the Water Construction Engineering Company and undertaken by an engineer who is the chairman of water construction at a technical university would not meet international standards of economic analysis. This is indeed the case. Dr. Varga erred in several fundamental ways, most of which biased the results of his analysis in favor of implementation of the project. On the other hand, these flaws are only visible because Dr. Varga presented his methods, assumptions, and findings quite fully. A review of this 1985 analysis can be more detailed than the reviews of the other analyses because Dr. Varga quite fully elaborated his analysis.[65]

Dr. Varga makes four critical assumptions. To his credit, these are made explicit:

> The social requirements related to the benefits of the project, as represented by the various national economic sectors at the time of decision making will remain permanent for the whole life-span of the project.
>
> The costs of the project include the costs of remedying the possible drawbacks arising from the projects' implementation.
>
> The variants (development strategies) representing the interests of non-productive sectors are, in themselves, economically feasible.

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64 Istvan Varga. The Dynamic Analysis of the GNBS, February 13, 1985. A copy of the document has been deposited with the Court.

65 This is not the same as saying that the analysis itself was elaborate. The point is that what analysis was done was elaborated sufficiently so that his techniques, assumptions, and hence findings could be subjected to critical review and hence would complement an open political process.

Those effects that cannot be reliably assessed - i.e. quantified - have no significant impact on the validity of the overall economic evaluation.[66]

The first assumption in effect says that the analysis assumes that the future looks like the present. No macroeconomic forecast has been made of how energy, transportation, or other needs might transform in the future. Thus the 1985 analysis explicitly does not conform to international standards for it is not based on an economic analysis of how the future seems most likely to unfold.[67]

The second assumption in essence says that whatever unexpected problems might arise can be remedied within existing budget allocations. In short, this analysis assumes that the numerous environmental complications being identified at the time could be corrected without any additional costs. Thus the study effectively ignores the primary public concerns at the time of the analysis. Rather than simply making this assumption, the analysis could have considered the possible range of such costs and identified the likelihood that the project would be able to absorb such additional costs and still be viable.

The third assumption is that the additional infrastructure such as ports and other facilities necessary for the full benefits of GNBS to be realized are themselves economically viable projects. This assumption credits all of the benefits of full development to GNBS without absorbing any of the overall benefits to offset the costs of supporting infrastructure necessary to the project but which may not be economical in itself. While there are always issues as to where to draw the line that separates the project from "the rest of the economy" with which the project interacts, facilities which cannot stand alone without the project are typically included in the project.

The fourth assumption merely makes explicit that an incomplete analysis is only valid if the portions not included would have no effect on the results. While every study will in some sense be incomplete, the Varga analysis is incomplete in precisely those areas for which the public was increasingly concerned and for which duly conducted economic analyses might have settled the public debate.

Within these limiting assumptions, the Varga study looks at three different rates (Variants I, II, and III) of implementation of the supporting infrastructure to GNBS under two different alternative strategies: (Alternative A) full implementation of GNBS and (Alternative B) implementation of everything except the hydroelectric generation facilities, using other means for generating the electricity generated by GNBS. In addition to these comparisons, it also looked at how GNBS compared with investments in two power plant complexes, Bukkbarany, a coal fired plant, and Paks II, a nuclear plant.

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66 Istvan Varga, *op cit.*

67 Little and Mirrlees, *op cit*; Mishan, *op cit*; and Squire and van der Tak, *op cit.*

Using the internationally standard criteria of whether the net present value is greater than 0, the Varga analysis concludes that Variants IIA and IIIA (proceeding with GNBS with a moderate to rapid investment in supporting infrastructure) are economically feasible and that Variants IA (proceeding with the supporting infrastructure slowly) and IB, IIB, and IIIB (building GNBS but not installing the electric generating facilities) are not economically feasible.

Since it seems unlikely that GNBS would be economically feasible without the electricity generating facilities included, the exploration of Alternative B is not very interesting. Furthermore, building a project without providing its supporting infrastructure (Variant I), also seems like an obvious way to make a project not viable. The negative conclusions reached as to these options are not very informative and hence are of little value. Dr. Varga tries to argue that these negative conclusions help document the need to proceed with the full project. The critical issue, however, is whether the positive conclusions actually support moving ahead with the project. In addition to the inherent limitations of the analysis identified by Dr. Varga in the four assumptions listed above, the analysis has three significant defects.

First, while the analysis compared some alternatives, it did not compare the interesting alternatives. The logical alternative to hydroelectricity production through GNBS is to meet electricity needs as they arise with the lowest cost alternative available at the time. One part of the Varga analysis assumes that GNBS would replace a changing mix of fuels, largely gas in 1995 to largely coal in 2010. The analysis also considered Bukkbarany and Paks II as alternatives. At the same time, the Varga analysis recognized that electricity generation through the use of gas-fired turbines was projected to increase significantly in the future. Even in the mid 1980s, gas-fired turbines were seen as the best addition to make to the system at the time. As noted in the Varga analysis, one of the advantages of GNBS is that it can produce peak power at Gabčíkovo with Nagymaros in place and even the base-load power can be modulated relatively easily. The mix of fuels shifting toward coal and the two power plants the Varga analysis compares with GNBS do not have these advantages. Thus the comparison is inappropriate both because the alternative projects are not the least cost alternatives and because they also cannot be turned off and on easily for the purposes of meeting peak power demands.

Second, the Varga analysis projects inflation in costs and prices while using a fixed 12% discount rate. Standard international procedure is to ignore expected general inflation in prices and use current prices or prices adjusted by an index of inflation to a specific date.[68] As noted in section III, cost-benefit analysis should pay attention to expected changes in real prices between goods such as an expected increase in the price of electricity relative to that of, for example, farm

68 Little and Mirrlees, *op cit*, for example, discuss the treatment of prices on pages 105-114.

products or industrial goods. The Varga analysis, by including inflation in general prices while using a fixed 12% discount rate results in real rates of discount being much lower. It is not clear from the Varga study what rates of inflation were actually assumed. Average rates of inflation over the period of construction are indicated to be in the range of 26% to 45%, but the actual annual rates of inflation depend on the rate of expenditures over the construction period and the length of the construction period. The rates of inflation in energy prices are noted in the text to range from 62% to 125% between 1984 and 1996, or at annual rates of between approximately 4% and 7%. This means that the real rate of discount used in the analysis ranged between approximately 5% and 8%. While these rates are not unusually low, they are considerably lower than the 12% claimed in the analysis. The higher rate of 12% may be sufficiently high to absorb some of the economic uncertainties of the future and environmental limitations of the analysis and still meet an actual rate of interest of, say, 6%. The 1985 analysis, in short, uses a discount rate somewhat lower than market rates and the analysis has no allowance for risks, whether economic or environmental, built into the discount rate.

But the fundamental problem of including inflation in the analysis is that of asking "who is to say what inflation might be?" Selecting a higher rate of inflation is analogous to selecting a lower rate of interest when the discount rate is set at a fixed nominal value. At some rate of inflation, the project becomes viable. While this is obvious to economists who understand present value calculations, it is by no means obvious to most readers of cost-benefit studies and certainly was not explained by Professor Varga, assuming he himself was aware of the issue. Incorporating price inflation in an economic analysis can simply be a way of insuring that the end result favors implementation of the project.

Third, the analysis did not look at the economics of not constructing Nagymaros. How the major components of a project economically complemented one another and how the economic and environmental costs of the separate components were borne by the parties were clearly critical issues deserving consideration in light of the political debate at that time.

Summary of the 1985 Analysis. The 1985 economic analysis assumed away the critical issues for the viability of the Project. A key issue not investigated was whether or not the Project was sufficiently robust still to be economically viable in light of costs associated with its environmental impacts. Even as a conventional analysis, it treated inflation in a manner which meant that the real rate of discount was much less than the claimed 12%. In addition, it never properly investigated whether the energy and transport benefits of the project could be more cheaply produced by alternative means. Lastly, the analysis did not investigate the economics of not proceeding with Nagymaros. The combination of these individual moderate deficiencies meant the overall analysis was very deficient relative to the need for economic analysis at the time. And indeed, the report apparently had relatively little influence in informing, quieting, or redirecting the debate over the Project.

IX. THE 1986 ANALYSIS

In February 1986 the National Office of Water Management provided an evaluation of the economic efficiency of the proposed investment in GNBS.[69] This study was further elaborated in July 1986.[70] The analysis addressed the energy benefits and the costs of the Project, arguing that the next most cost effective way of producing electricity was by nuclear power. The estimated development and operating costs of Paks II nuclear power plant were used as the benefit of producing power through GNBS. While the text of the analysis refers to having calculated best and worst case scenarios, only the value of the D index for the expected case is presented. This value was determined to be 1.048 in the February analysis, a figure indicating the project would be efficient, though very marginally so and only if the scenario selected as most likely by the planners was indeed the most likely. The further analyses conducted during July, however, determined that the most likely D index was 0.981, clearly indicating that the project was not economically justified. Planners with only slightly different expectations of the future might easily have decided that a D index far less than 1.0 would have been the more appropriate one to report.

The text of this analysis is not nearly as explicit as that of the Varga analysis, but it appears that the analysis contains the same problem of having included an expectation of inflation of 5% which lowers the real rate of discount to 7%. Again, this is not an unreasonable rate of discount, but it does not allow any leeway for unexpected costs or costs such as environmental costs, which were not included at all. This may not be a problem either if the calculated D index turns out to be well above 1.0, but this is clearly not the case here.

This 1986 analysis made a minor effort to identify some of the benefits beyond power but did not derive monetary estimates. With respect to environmental concerns the report reads as follows:

> *From the point of view of the protection of the environment, it is important that the establishments of the barrage system and its operations cause no pollution whatsoever ... The investment contains the measures and establishments related to counteracting other environmental effects. The water control works carried out within the*

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69 National Office of Water Management, Modified Investment Proposal for the Gabčíkovo-Nagymaros Barrage System, State Investment and Evaluation of its Technical-Ecological-Economic Aspects, February 1986. A copy of the document has been deposited with the Court.

70 National Office of Water Management, Modified Investment Proposal for the Gabčíkovo-Nagymaros Barrage System, State Investment and Evaluation of its Technical-Ecological-Economic Aspects, July 1986. A copy of the document has been deposited with the Court

framework of the investment will create a civilised environment in the whole affected area.[71]

The 1986 analysis therefore assessed potential liabilities on the assumption that the Project posed no threat to water quality. Any such threat would accordingly alter the economic analysis.

X. THE ECONOMIC ANALYSIS BEFORE THE 1989 DECISION

As Hungary opened up politically during the latter part of the 1980s, discussion of Gabčíkovo-Nagymaros broadened from exchanges between engineers and central planners to a discourse involving the public at large. Environmental understandings which had not entered the narrow exchange increasingly informed and framed the broader political debate. Hungarians also became increasingly aware of how environmental understanding in Europe, North America, and the international development agencies had changed public decision-making. More sophisticated environmental impact assessments of GNBS were insisted upon and undertaken, drawing the Hungarian Academy of Sciences into the public debate. As the environmental impacts became better known, questions as to what it would cost to correct the problems and whether the whole project was economic arose with greater strength and frequency. As already argued, the *Summarizing Documentation* to the JCP of 1978 contained no economic information or analyses by international standards while the analyses of 1983, 1985, and 1986 were both flawed and not designed to provide a resolution to the environmental controversies of the time. The Varga analysis was eventually published in an academic journal.

In 1989, the National Planning Office, in compliance with a resolution made by the Cabinet, requested the various agencies to submit material for an economic analysis of the continuation or abandonment by Hungary of GNBS.[72] This analysis has several significant strengths relative to earlier efforts. First, this was apparently the first analysis to seriously consider the economics of the Nagymaros barrage apart from the overall project. As noted earlier, the *Summarizing Documentation* to the JCP intimated that such analyses had been undertaken, but no evidence of such studies was provided either to document their existence or to furnish information for public decision-making. Second, it also appears to be the first analysis to seriously incorporate the environmental costs of correcting problems of water quality exacerbated by the Project. Third, while the analysis was not undertaken in the context of a macroeconomic overview of the relationships between energy and economic development, it appears to be the first

71 Modified Investment Proposal, February 1986, *op cit.*

72 National Planning Office, Feasibility Calculations for the Bős-Nagymaros System of Barrages, October, 1989. A copy of this report has been deposited with the Court.

analysis to seriously consider the economics of the timing of the construction of alternative energy production and water treatment facilities.

At the same time, it is important to realize that the 1989 analysis still does not approach basic international standards for project analysis, let alone begin to incorporate the environmental factors increasingly being considered internationally at the time. Several of the deficiencies in the analysis weigh, *a priori*, in favor of implementation of Nagymaros. As in the Varga analysis of 1985, the treatment of inflation results in fairly low real interest rates which favors the construction of a large project such as GNBS. The real rate of interest in the analysis varied from 3.6% in the early years to 6.7% in the later years. While these are not unrealistically low for an economic analysis conducted to international standards, they are sufficiently low to offer little protection against the numerous uncertainties and irreversibilities clearly identified in the study but not formally treated. The assumption that the same amount of power must be produced also favors the Original Project. In light of the faster pace of construction of Gabčíkovo by Czechoslovakia, it was appropriate to presume that Gabčíkovo would be completed, but this supposition also favors the completion of Nagymaros since the dams were designed to work together. As an alternative, the analysis might also have considered monetary estimates of the environmental impacts of GNBS maintained by Hungary. Of course by not including such estimates, the analysis also, *a priori,* favors proceeding with construction of Nagymaros. Some of these impacts, such as the effect on commercial fisheries, would not have called for the use of recent innovations in the valuation of non-market environmental goods and services. Absent a full scale economic analysis, it would be difficult to determine the relative significance of these factors in the decision to proceed with or abandon construction.

Other shortcomings in the 1989 study could have favored or not the implementation of Nagymaros. They are simply shortcomings. By international standards, the navigation benefits should have been estimated through a formal analysis of transportation costs by alternative modes with and without the project as well as compared to the costs of dredging the river channel. By international standards, it is not clear whether the navigation benefits of the project offset the costs associated with navigation. As in the Varga study, the additional infrastructural costs of the project and their benefits should also have been formally analyzed. Equally important, given the acknowledged uncertainties with respect to future benefits and costs, some sensitivity analyses should have been conducted.

The National Planning Office carefully presents the way the 1989 analysis was conducted and carefully interprets the results of the analysis. The analysis took many months, leading to a final report in October 1989. The strongest message in the final report is that the Office is aware of many shortcomings in the analysis and that it is very concerned, not only with what has been left out, but with the high level of uncertainty of what has been analyzed. For example:

The weight of uncertainty factors is unusually large. They tend to decrease economic results if the project is carried on according to the original plans, or to increase costs if the Nagymaros barrage is abandoned.

(1989 Study, page 8 of translation)

In this sense, the study, rather than reducing the uncertainties of the decision, reflects with greater clarity the specific nature of the uncertainties and the difficulties of the decision at the time.

While not approaching international standards for project analysis, the 1989 study effectively casts substantial doubt on whether the construction of GNBS as a whole should ever have been initiated.

As regards the yields of the project, we have only dealt with energetical performance. This also plays a role in the fact that the development project is inefficient both according to the original plan and under the scenario of abandoning Nagymaros. On the basis of this we may say that the development or realisation of any further variants (operating mode, etc.) will not lead to favorable economic results.

(1989 Study, page 8 of translation)

The 1989 study also indicated that there was probably not a great difference in the economic implications of proceeding with or abandoning Nagymaros.

The most important conclusion yielded by these calculations is that there is no significant difference as regards investment cots between the original project and the abandonment of the Nagymaros barrage. The same can be said for the burdens of the budget related to financing the investment. This situation supports our view that the matter must be decided along the lines of ecological problems, and international political and economic matters. Abandonment will not present any irresolvable problems as regards the energy supply of the country.

(1989 Study, page 7 of translation)

Though this conclusion, as an economic conclusion, is not as strongly supported by the analysis as desired, the addition of environmental costs to the analysis would have swayed the results in the favor of abandonment, exactly as argued.

The 1989 study was certainly good enough to make the point that an appropriate economic analysis should have been done a decade earlier. Indeed, over the previous decade, numerous analyses had been undertaken, all of them reflecting badly on the project. But these were not made available and were certainly not released to the public. Decisions had been made in the context of how engineers understood development to be best promoted. By 1989, the parties must have been aware that outside CMEA economic decisions were made on market-based criteria. They were also aware that environmental valuation was influencing project analysis. Having such an awareness of international standards of project analysis and environmental valuation, however, does not imply having the capability of undertaking such analyses. Doing economic analyses to international standards requires a team of experienced and appropriately trained economists and particular types of economic data. The difficulties of undertaking basic economic analyses are compounded for economies in dramatic transition; there are special problems to overcome when doing an economic analysis of a project that is already underway; and the methods for performing environmental valuation are still evolving. In this context, the economic analysis undertaken in 1989 reflects the turmoil of the transition that to some extent Eastern Europe, including Hungary, is still experiencing.

XI. FURTHER DEVELOPMENTS IN ENVIRONMENTAL ECONOMIC THEORY AND PRACTICE

As indicated earlier, the application of environmental valuation techniques to project analysis internationally has not definitively resolved many conflicts between environment and development. Large project development has clearly slowed down because many projects have been abandoned and because controversies continue to impede the implementation of other projects, leaving them in the planning stage indefinitely.[73] One reason environmental economics has not been successful in settling controversies is because the intention of environmental economists was to determine social priorities rather than to provide the critical economic information to assist decision-making by those with political responsibility for doing so. This observation backs the rationality of Hungary's making the decision through democratic politics rather than solely on the basis of economic analysis.

A. The Problem of Irreversibilities. At various times in this review, mention has been made of the considerable concern with the irreversibility of various environmental impacts associated with GNBS. The question of irreversible environmental impacts has been addressed within environmental economics since a key article was written in 1974 by Nobel Laureate Economist Kenneth J. Arrow co-authored with Anthony C. Fisher.[74] After writing extensively in the area with various economists, Fisher concludes in his subsequent text on environmental economics:

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73 See "Some Major Dam Disputes", HR, vol 2, Appendix 5.

74 Kenneth J. Arrow and Anthony C. Fisher, Environmental Preservation, Uncertainty, and Irreversibility, Quarterly Journal of Economics, vol 88, pages 312-319, 1974. Numerous subsequent articles were published by Professor Fisher while he was in the Energy and Resources Program at the University of California at Berkeley.

The combination of technical change (which in effect expands the supply of conventional inputs, but not the in situ *resources) and a shift in preference in favor of environmental amenities is likely to lead to a rise in the value of the* in situ *environmental resources. Because their loss to one or another form of development is, as we have argued, likely to be difficult or impossible to restore in important cases, the balance between the present and the future must be weighed carefully indeed. Modifications to the usual benefit-cost criteria, which suggest proceeding very cautiously where an irreversible step is contemplated, can guide decisions about the fate of natural environments in the absence of information about all of the costs and benefits of development.*[75]

This particular view is especially appropriate because it identifies both how technological change has reduced the costs of obtaining conventional resources while increases in standards of living have increased the demand for environmental resources and amenities. This fits the expectations for Hungary in the transition for it had good reason to expect to be able to obtain new technologies more easily as it opened to European markets. And it expected its income to rise significantly in the decades ahead. Second, the quote emphasizes that with irreversibility, conventional benefit-cost analysis needs to be modified to favor the interests of people in the future. There is widespread agreement amongst environmental economists that these considerations are critical. During the several decades since the issue of irreversibility was brought into the limelight, however, there has not emerged a consensus as to how the economic criteria of project analysis should be adjusted when significant irreversibilities are identified.[76] Rather, increasingly it is being recognized that economists must acknowledge the problem and present to the political process their estimates of the costs and potential benefits of reducing irreversible damage.

B. The Economics of Assuring Assets for Future Generations. For many years, environmental economists presumed that sustainability would be attained when all environmental externalities were internalized, i.e. when the market was made to work efficiently. There had also been a long standing concern in economics with the welfare of future generations. This concern was informally mixed into the literature on the economics of sustainability.[77] Many economists advocated using

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75 A. C. Fisher, Resource and Environmental Economics, Cambridge University Press, Cambridge, 1981.

76 M. L. Cropper and W. E. Oates, "Environmental Economics: A Survey", Journal of Economic Literature, vol XXX, pages 675-740, 1992.

77 See, for example, R.I. Sikora and B. Barry (eds), Obligations to Future Generations, Philadelphia, Temple University Press, 1978; D. MacLean and P.G. Brown (eds), Energy and the Future, New Jersey, Rowman and Littlefield, 1983; E. Brown Weiss, In Fairness to Future Generations: International Law, Common Patrimony, and Intergenerational Equity, New York, Transnational Publishers, 1989.

a lower discount rate in order to protect future generations, but this resulted in numerous other problems with respect to economic efficiency. It was not until 1990 that a formal model was developed by Richard Howarth that showed how protecting the rights of generations affected the efficient allocation of natural resources over time.[78] This model and its implications has been thoroughly explored and the results published widely in peer reviewed journals.[79] This research documents that there are many efficient solutions to how resources and environmental services are allocated over time depending on how the rights to resources and environmental services are distributed across generations. The values of resources and environmental services are different for each distribution of rights and, furthermore, as more rights are distributed to future generations, the rate of discount goes down. Whether sustainability is achieved depends on whether future generations have sufficient rights, not simply on whether environmental externalities are internalized. Economic analysis alone is not sufficient to determine what society should do, *i.e.*, whether it should distribute more rights to future generations or not. This is a political decision. But this political decision is best informed by the economic implications of the decision, *i.e.*, information with respect to the trade-offs in well-being between present and future generations that can best be established through economic analysis.

XII. A PROFESSIONAL JUDGMENT OF THE ECONOMICS OF GNBS

An adequate economic evaluation of GNBS by current international standards would require many professional economist years. While I have reviewed many of the key documents relating to the economics of this project, I have not directed a team of economists and undertaken a formal assessment of the economic viability of the project. It would be an especially daunting task under the current circumstances with Variant C having been implemented by Slovakia. On the other hand, there are many projects proposed which do not receive full economic evaluation because professional economists judge *a priori* that these projects are not economically viable based on their knowledge of similar or related projects. In

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78 Richard B. Howarth, Economic Theory, Natural Resources, and Intergenerational Equity, PhD thesis completed in the Energy and Resources Program, University of California at Berkeley, 1990.

79 T. Tietenberg, Environmental and Natural Resource Economics (3d), New York, Harper Collins, 1992; R.C. Bishop, "Economic Efficiency, Sustainability, and Biodiversity". Ambio 22 (May), pages 69-73 (1993); E.S. Goodstein, Economics and the Environment, New Jersey, Prentice Hall, 1995; M.A. Toman, J. Pezzey, and J. Krautdraemer, Neoclassical Growth Theory and Sustainability, in Handbook of Environmental Economics (D. Bromley ed), Oxford, Basil Blackwell, 1995; R.K. Turner, D. Pearce, and I. Bateman, Environmental Economics, New York, Harvester Wheatsheaf, 1994.

my judgment, GNBS falls in this category of projects. If a project similar to the original GNBS were proposed today in Europe or North America or for funding by an international agency, it would not receive a full evaluation and would probably be rejected *a priori.*[80] While such judgments are frequently made *a priori*, in the case of GNBS, the findings of the various economic analyses, though of poor quality, complement such a professional judgment.

Over the past two decades, there has been a dramatic shift in the types of water development and energy generation projects being proposed. Both the shift in perception about the uncertainty of the future and the increased concern over environmental impacts have reduced the economic viability of large projects. Since the energy crises of the 1970s, a sizable portion of energy needs have been met by demand side management, by increasing the efficiency with which energy is used. During much of the 1980s, much of the remaining demand for energy was met through a multitude of small to medium generation projects including cogeneration and the use of renewables. Since the mid 1980s, gas-fired power plants have met the small remaining increases in demand and replaced the capacity of retiring plants. The energy crises of the 1970s followed by the price declines in the 1980s made us aware of the volatility of energy prices which favors shorter term projects. High interest rates during much of the 1980s also worked against large, capital intensive projects. The increasing perception that governments should use criteria closer to market criteria reduced government involvement in large projects.

While issues of market uncertainties and shifting philosophies of the role of the public sector have been significant world wide, they have been far greater for Hungary during the past fifteen years. To be sure, Hungary was fairly well insulated from the price shocks of the 1970s energy crises, but the breakdown of loan and trading arrangements within CMEA in the early 1980s paralleled by Hungary's greater opening to the global economy during the 1980s meant large changes for the economy. Under these circumstances, the uncertainties with respect to what the economy might look like in a decade or two are immense. This has not been an ideal time for long term investments. It has certainly not been the time for long term investments planned within a political, economic, and financial system which failed and was rejected.

The rise of environmental concerns in Europe and North America and eventually worldwide has complemented the shift in energy strategies already indicated by narrow economics. Demand side management, renewable energy technologies, and cogeneration tend to have small and generally reversible

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80 See, for example, letter of 18 May 1992 from The World Bank to Mr. John Hontelez, Chairman, Friends of the Earth International, HR, Annexes, vol 3, annex 91; Letter of 19 May 1992 from the European Bank for Reconstruction and Development to Reflex Environmental Protection Society, HR, Annexes, vol 3, annex 92.

environmental impacts. Thus, for narrow economic and for environmental reasons, new hydropower in Europe and North America has played an insignificant role in meeting energy needs for several decades.

The international development agencies have become increasingly aware of the environmental problems of large and medium water development projects, have become embroiled in major controversies over their participation in several projects in particular, and are increasingly wary of taking on new investments in this controversial area.[81] The international development agencies, for example, were not interested in assisting Slovakia with the financing of Variant C.[82]

Another reason investment in large water projects in Europe and North America has slowed dramatically is because the remaining sites for investment are of low quality. Indeed, there is a general perception that water development was excessive when it was driven by the engineers' vision of development. Not only have the best sites been used, but there is now discussion of removing dams because their environmental costs are beginning to appear to be greater than their material benefits.[83] The stretch of the Danube River for which GNBS was planned is one of the largest flood plains in Europe. Flood plains are about as different from canyons, the typical site of hydropower development, as is possible.

The economic analyses undertaken under various auspices in Hungary are not definitive for the many reasons noted in the foregoing review. Nevertheless, while imperfect, they provide no evidence that GNBS is an economically sound project, but provide considerable reason to suspect it is not. The numerous D indices very near to well below 1.0 provide strong evidence that the project would have been an economic failure if implemented as planned. Within the political-economic context of the time, the analyses of 1975, 1983, 1985, and 1986 have low to very low D indices even when relatively low real discount rates are used and environmental costs are not considered. By the 1980s, international economists confronted with D indices as low as those determined in the Hungarian analyses would have urged the abandonment of the project or much more critical inquiry into the costs and benefits. It appears that the project was not eliminated

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81 For a technical analysis backing the policy change, see: John A. Dixon, Lee M. Talbot, and Guy J.-M Le Moigne, Dams and the Environment, World Bank Technical Paper Number 110, Washington, D. C., 1989.

82 See letter of 18 May 1992 from The World Bank to Mr. John Hontelez, *op cit*; Letter from the European Bank for Reconstruction and Development to Reflex Environmental Protection Society, *op cit*, which closes with the words: "We intend to concentrate our efforts on projects supporting rational and environmentally sound development."

83 Dam removal as a solution to environmental problems is reported occasionally in the U.S. and has been a solution considered among several in an about to be released study of the National Research Council with respect to the decline of the North American Pacific Salmon fishery (information based on my personal participation in the study).

from further consideration only because of the belief among engineers promoting water development that such projects have a multitude of indirect benefits that will economically justify the project no matter what. This same belief was prevalent in North America into the early 1960s among engineers, but access to cost-benefit analyses and open scrutiny of their methods, results, and interpretation by economists and the public exposed how this belief resulted in inappropriate environmental transformations.[84]

And this leads to the broader framing of my professional judgment. The decisions by Hungary in 1989 to abandon construction of the Nagymaros Barrage and to make the ban permanent in 1992 reflect the major transitions in environmental perception, social communication, economic understanding, and political decision-making that occurred throughout Eastern Europe during the 1980s. When the Joint Contractual Plan to build the Gabčíkovo-Nagymaros Barrage System was agreed to during the 1970s, development was envisioned to occur through large engineering projects implemented through central planning. By the latter 1980s, development was also perceived to occur through individual initiative coordinated by "an invisible hand." When the JCP was drawn up, communication was from the top down with little opportunity for ideas from the people to be publicly expressed and effect change at the top. During the 1980s, communication in Hungary and elsewhere in Eastern Europe opened up dramatically. With this opening, environmental concerns about the negative aspects of earlier development approaches began to be voiced. These environmental concerns, released in only a few years, had been transforming public decision-making in Europe and North America over several decades. In 1989, these environmental concerns were in the process of transforming the development philosophies and operations of the international development agencies. In the final analysis, especially for controversial projects, project evaluation should be undertaken to inform a broad-based social decision-making process. Environmental, and to some extent economic, information became more available and more widely discussed as decision-making became more democratic. Reflecting these momentous social transitions, the 1989 decision to suspend further construction of Nagymaros was relatively informed, open, and rational. The 1989 decision paralleled and complemented, and was consistent with, both the directions developing in economic theory and important trends in decision-making internationally.

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84 Based on my professional participation in the process. See also footnote 24.

APPENDIX 5

SOME MAJOR DAM DISPUTES

This Appendix describes examples of cases in which the construction of a dam has been terminated or significantly altered by action of a court, tribunal or other legal authority (national or international) on the grounds, *inter alia*, that the dam would be likely to have serious adverse effects on the environment or for violation of an essential procedural obligation (such as an environmental impact assessment requirement). The examples reflect the importance given by courts and other legal authorities to national and international environmental protection obligations. The International Court of Justice is faced with issues which are familiar to decision-making bodies and which are capable of being addressed by courts and tribunals.

The examples which follow are illustrative rather than exhaustive, both at the national and international levels. They are selected by reference to countries which are at a similar level of industrial and economic development to Hungary and Slovakia. They indicate various approaches towards integrating and applying environmental concerns. They reflect recent tendencies in water resources management which show a distinct decline in public and governmental acceptance of unsustainable developments which might adversely affect water resources. This Appendix demonstrates that increased environmental concern has resulted in significant changes in water resource policies in Europe and North America over the past two decades. This has resulted in the reconsideration and even cancellation of major dam projects and in the implementation of comprehensive river restoration programmes.

This Appendix is not intended to suggest that Hungary opposes barrage construction in general. To the contrary, Hungary supports an integrated approach to the development of the Danube's resource potential which would avoid long-term adverse effects to Hungary and the region, and which would be inconsistent with values increasingly accepted at the international level (especially biodiversity in temperate zones). In accordance with these criteria, the Gabčíkovo-Nagymaros Project is not sustainable in terms of its likely environmental impacts.[1]

Some of the projects described below (in particular those relating to river restoration) have already been mentioned in the Hungarian Counter-Memorial.[2] A summary description was given on sediment management instead of barrage

1 See especially HM, Chap 5, and *Scientific Evaluation*, HC-M, vol 2.

2 HC-M, paras 1.205 and 1.213.

building in the Upper Rhine and the Austrian Danube.[3] In this Appendix the history of these projects and the process of decision-making towards more sustainable development is outlined in more detail. These examples, together with the case law described, indicate that Hungary's re-evaluation of the impacts of the Gabčíkovo-Nagymaros Project was (and is) consistent with the practice of national and international courts and of other legal authorities adopting an integrated approach to environment and development.

(1) THE GARRISON DIVERSION UNIT CASE (INTERNATIONAL JOINT COMMISSION)[4]

The 1909 Boundary Waters Treaty and the International Joint Commission (Canada/US)

Two of the examples described in this Appendix are international. They relate to disputes over the interpretation and application of the 1909 Treaty Relating to the Boundary Waters and Questions Arising along the Boundary Between the United States and Canada.[5] Although that Treaty does not expressly require the parties to integrate environmental considerations into their decision-making processes, Article IV of the 1909 Treaty provides in part that:

> "It is further agreed that the waters herein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other."

The 1909 Treaty created the International Joint Commission (IJC), composed of six members, three appointed by Canada and three by the United States. The IJC has administrative, judicial, consultative and arbitral functions. It has dealt with two international disputes which are of interest for present purposes: the Garrison Diversion Unit case and the High Ross Dam case.

The facts of the Garrison Dam case

The United States Congress authorised the Garrison Diversion Unit (GDU) in 1965. The project's purpose was to irrigate some 250,000 acres, to provide municipal and industrial water supply to 14 communities, and to furnish recreational, fish and wildlife opportunities in North Dakota using water diverted

3 HC-M, Annexes, vol 4 (part 1), annex 7.

4 International Joint Commission, Report to the Governments of Canada and the United States on Transboundary Implications of the Garrison Diversion Unit, 1977.

5 Washington, 11 January 1909, in force 5 May 1910; reprinted in P Sands *et al*, Principles of International Environmental Law, Vol. IIA, 551 (Manchester University Press, 1994).

from the Missouri River. Since many of the features of the GDU were in the Hudson Bay Drainage Basin, most of the drainage and waste waters from the irrigated areas would flow into transboundary streams and could have an adverse impact on Canada.

The Province of Manitoba in Canada officially expressed its alarm that leaching of the irrigated solid of the GDU would degrade the water quality of various rivers and lakes on the Canadian side, and that return flows would increase the amount and frequency of flooding. Manitoba was also concerned that the GDU would lead to the introduction of foreign biota into Manitoba waters and could have an irreversible adverse impact on existing aquatic systems and biodiversity, and on commercial and recreational fishing in Manitoba.

In 1970 discussions were instigated between Canada and the United States. In October 1973 Canada, in a diplomatic note, requested urgently "that the Government of the United States establish a moratorium on all further construction of the Garrison Diversion Unit until such time as the United States and Canadian Governments could reach an understanding that Canadian rights and interests have been fully protected in accordance with the provisions of the Boundary Water Treaty".[6]

The reference to the International Joint Commission

In 1975 the transboundary implications of the GDU were referred to the IJC. The IJC was requested to:

- report on the existing conditions of water quality, water quantity, biological resources, and present and anticipated water uses;
- report on the impact of the GDU on water and biological resources;
- make recommendations as to such measures as might be taken to assist the Governments in ensuring that the provisions of Article IV of the Boundary Waters Treaty of 1909 were honoured; and
- estimate the costs of such measures.

The International Joint Commission's findings

The IJC in its deliberations took into account the testimony given at public hearings, a report prepared by the International Garrison Diversion Study Board (established by the IJC in 1975) and written submissions. On the basis of this evidence the IJC concluded, *inter alia*, that:-

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6 Ibid, p 7.

- "the construction and operation of the [GDU] as envisaged would cause significant injury to health and property in Canada as a result of adverse impacts on the water quality and on some of the more important biological resources in Manitoba";[7] and
- modifications to the GDU as envisaged in the proposal would reduce, but not eliminate, all of the adverse impacts in Canada.

Accordingly the IJC recommended "the portion of the Garrison Diversion Unit which affects waters flowing into Canada not be built at this time".[8]

Several features of the GDU Report are relevant to the present case. First, the IJC's Report recommending a halt on construction came *after* a significant proportion of the construction in relation to supply works had already been completed.[9] It reflects an acceptance by an international body to take into account and act upon new information indicating the extent of environmental risks. A pumping plant had been fully completed; 90% of the construction of the 73.6 mile (118.5 kilometre) McCluskey Canal (to convey water from the Lake Audubon impoundment to the Lonetree Reservoir) had been completed; and 70% of the construction of the Lonetree Reservoir was complete.[10] Construction on the Lonetree Dam and the James River Dikes, and on those components downstream, had not yet begun.[11] The IJC stated that:

> "despite the expenditure of great sums of money and the best intentions of all men, GDU even as modified presents an unacceptable risk of the introduction of unwanted foreign biota to the Hudson bay drainage Basin to the detriment of the people of Canada and to the general ecology of the region and beyond."[12]

Accordingly, the Commission concluded that the only acceptable approach was to delay construction of those features of the GDU which might result in transfers of

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7 Ibid, p 105.

8 Ibid, p 4. The Commission also concluded that "it would be prudent to verify the predicted quantity and quality of return flows from the GDU", and that it was essential that research be carried out "to determine the ultimate fate of nitrogen" in one of the Canadian rivers "*before* there is development of irrigation" (emphasis added). The Commission also recommended the conditions under which it believed this portion of the GDU might later proceed.

9 Ibid, p 15.

10 Ibid, pp 13-15.

11 Ibid.

12 Ibid, p 114.

biota which could cause adverse impacts in Canada, even where "most of the impacts can be mitigated".[13]

Second, in reaching its conclusions and recommendations the Commission adopted a wide view of the phrase "transboundary implications" to embrace "all of the foreseeable implications involved in the Project from water-quality and water-use viewpoints as well as from the social and environmental aspects".[14] Without "such perspectives many relevant matters may not be considered and some significant direct or indirect environmental and social benefits or costs in Canada might be overlooked".[15] This approach takes into account "the total environmental consequences not only of the [GDU] Project itself but of the many activities geographically or functionally related to it".[16] The Commission noted that "[e]xperience has taught us that the impact of resource developments must be analyzed from a total systems concept, and the most fundamental of all is the biosystem. International boundaries may separate countries, but such political arrangements should not divide natural ecosystems".[17]

Third, in relation to the preservation of environmental resources (including biodiversity) in the region the IJC adopted an approach recommending the Governments...

> "to be conservative and proceed very cautiously with new and untried engineering works, the failure of which might seriously affect the equilibrium of a large natural system such as the Hudson Bay Drainage Basin that has been achieved over many centuries...The two Governments may at some future time decide that the benefits of the Project to the two countries outweigh these adverse biological consequences."[18]

The IJC stated that it was...

> "concerned that even with the best engineering talent available and with the best operating practices possible, the very complexity of the scheme, the immensity of the physical features, the large number of human beings involved in carrying out the responsibility, and the possible mechanical failures, what cannot happen, will happen."[19]

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13 Ibid, p 114.

14 Ibid, p 97.

15 Ibid, p 96.

16 Ibid.

17 Ibid, p 97.

18 Ibid, p 109.

19 Ibid, p 108.

(2) HIGH ROSS DAM CASE (INTERNATIONAL JOINT COMMISSION)

Factual background

This case concerned a proposal by Seattle City Light's long-standing plans to supplement its electricity production by enlarging the capacity of the Ross Lake, an existing reservoir that straddles the international border between the United States (State of Washington) and Canada (Province of British Columbia). To accomplish this goal the utility proposed to raise the Ross Lake by 130 feet to a total height of 1725 feet above sea-level. Raising the dam would generate a maximum 241 megawatts of additional capacity, and would flood more than 5000 acres of popular recreational land in British Columbia.[20] For the latter reason the proposal was opposed by British Columbia and Canada.

In 1941 Seattle first applied to the IJC for permission to raise the water level of Ross Lake to 1725 feet above sea-level. On 27 January 1942 the IJC issued an Order approving Seattle's application.[21] The Order required Seattle to compensate the Province of British Columbia and any Canadian private interests that may be affected for damage caused in British Columbia and stated that Ross Dam could "not be raised beyond the height at which the water impounded by it would reach British Columbia" unless and until the City of Seattle and the Province reached a binding agreement providing for indemnification.[22] Between 1942 and 1980 Seattle tried unsuccessfully to obtain British Columbia's agreement to raise the water level.

The reference to the International Joint Commission

In 1980 British Columbia brought the matter before the IJC, and made four alternative requests of the Commission:

(1) to nullify the 1942 Order and dismiss the matter;

(2) to rescind the 1942 Order and rescind Seattle's application;

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20 P M Parker, "High Ross Dam: the International Joint Commission Takes a Hard Look at the Environmental Consequences of Hydroelectric Power Generation – the 1982 Supplementary Order", 58 Washington Law Review 445, 445-6 (1983).

21 Order of approval, In the Matter of the Application of the City of Seattle for Authority to raise the Water Level of the Skagit River Approximately 130 feet at the International Boundary Between the United States and Canada, 27 January 1942.

22 Ibid, 451-2.

(3) to declare raising the water level to be contrary to the interests of the parties because "no suitable or adequate provision can be made for the protection and indemnity of interests which may be injured", and to issue an order limiting the water level of the Skagit River to the natural level of the boundary; or

(4) to determine that no suitable or adequate compensation had been made pursuant to the terms of the 1942 Order.[23]

The Commission's 1982 Order

In its 1982 Supplementary Order the Commission ruled that British Columbia's requests and the materials accompanying it did not constitute sufficient grounds to grant any of the four types of relief requested.[24] Nevertheless, the Commission decided that–

> "in the light of the views of the Governments of Canada and British Columbia and the Commission's responsibility under the Treaty to prevent disputes, and under present circumstances, the Canadian Skagit Valley should not be flooded beyond its current level provided that appropriate compensation in the form of money, energy or any other means is made to [Seattle] for the loss of a valuable and reliable source of electric power which would result if the Ross Dam Project is not completed."[25]

The Order emphasised the need to preserve the Skagit valley while still satisfying Seattle's needs to generate electricity. In reaching its conclusion the Commission noted, in particular, that "reasonable alternatives to the raising of the High Ross Dam are available".[26] The Commission ordered Seattle to maintain the level of the Skagit River for one year, and appointed a Special Board of two members of the Commission to co-ordinate, facilitate and review on a continuing basis activities directed to achieving and implementing a negotiated, mutually acceptable agreement between Seattle and British Columbia.

Subsequent developments: the 80-year agreement

In 1983 Seattle and British Columbia reached an agreement for a term of 80 years under which Seattle would not raise Ross Dam. Instead, Seattle would purchase

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23 Ibid, p 453.

24 The Supplementary Order is reproduced at 463-4.

25 Ibid.

26 Ibid.

from British Columbia an amount of power equivalent to that which would be produced by raising Ross Dam. Seattle would pay an amount equivalent to the raising of Ross Dam. British Columbia may generate part of that power by raising its Seven Mile Dam by 15 feet, flooding a portion of a Washington Valley owned by the city of Seattle.[27]

The Commission's 1982 Supplementary Order, and the reasons underlying it, are noteworthy from the perspective of the Gabčikovo-Nagymaros dispute. In particular, the Order emphasised the availability of alternatives and the need to preserve the environmental resources of the Skagit River. It is noteworthy that these conclusions were based upon the 1909 Treaty, no provision of which required the Commission to consider the environmental effects of proposed actions of either country.

(3) UNITED STATES: THE TELLICO DAM CASE (US SUPREME COURT)[28]

Factual background

In 1967 the Tennessee Valley Authority, a wholly public-owned corporation of the United States, began constructing the Tellico Dam and Reservoir Project on the lower stretches of the Little Tennessee River, an area described by Chief Justice Burger as being of "great natural beauty" and of "considerable historical importance".[29] Construction commenced shortly after Congress appropriated initial funds for its development. The Tellico Project was described as a multipurpose regional development project designed principally to stimulate shoreline development, generate electricity for 20,000 homes, and provide flatwater recreation and flood control, as well as improve economic conditions in an area characterised by under utilisation of human resources and migration of young people.[30] The dam would impound water covering some 16,500 acres, converting the river's shallow fast-flowing waters into a deep reservoir over thirty miles in length.[31]

By 1973 construction was "virtually completed and the dam [was] essentially ready for operation".[32] It did not open, however, as a result of opposition by local citizens and national conservation groups. They brought successful applications

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27 Ibid, 457, note 95.

28 United States Supreme Court, 437 U.S. 153.

29 Ibid, p 156.

30 Ibid, at 157.

31 Ibid, p 157.

32 Ibid, p 158.

for injunctive relief to stop the dam's completion pending the filing of an appropriate environmental impact statement under the 1969 National Environmental Policy Act (NEPA).[33] The injunction remained in effect for 21 months until late 1973 when the District Court concluded that TVA's final environmental impact statement for Tellico was in compliance with the law.[34]

The snail darter

In 1973 a University of Tennessee ichthyologist found a previously unknown species of perch, the snail darter *(percina (Imostoma) tanasi),* in the waters of the Little Tennessee River. Four months after its discovery, the United States Congress passed the 1973 Endangered Species Act, which provides, *inter alia*, that all Federal departments and agencies shall take "such action necessary to insure that actions authorized, funded, or carried out by them do not jeopardize the continued existence of [listed] endangered species and threatened species or result in the destruction or modification of habitat of such species".[35] On 8 October 1975 (eight years after Congressional approval of the Tellico dam), the US Secretary of the Interior listed the snail darter as an endangered species under the 1973 Act.

In February 1976, pursuant to Section 11(g) of the 1973 Act, the respondents filed an application seeking to enjoin the completion of the dam and impoundment of the reservoir on the ground that those actions would violate the 1973 Act by directly causing the extinction of the snail darter.

The US Supreme Court ruling

On appeal, the Supreme Court found that the Tennessee Valley Authority would be in violation of the 1973 Act if it completed and operated the Tellico dam as planned, and that an injunction was an appropriate remedy for the violation.[36] As Chief Justice Burger stated:

> "It may be curious to some that the survival of a relatively small number of three-inch fish among all the countless millions of species extant

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33 *Environmental Defense Fund* v. *Tennessee Valley Authority*, 339 F.Supp. 806 (District Court, ED Tenn.), affirmed 468 F.2d 1164 (CA6 1972). NEPA was a precursor to the 1985 EC Directive on Environmental Impact Assessment, the 1989 World bank Operational Directive on environmental impact assessment, the 1991 Espoo Convention, and Principle 17 of the 1992 Rio Declaration on Environment and Development.

34 *Environmental Defense Fund* v. *Tennessee Valley Authority*, 371 F.Supp. 1004 (District Court, ED Tenn.), affirmed 492 F.2d 466 (CA6 1974).

35 16 U.S.C. Section 1536 (1976 ed.).

36 Ibid, p 172.

would require the permanent halting of a virtually completed dam for which Congress has expended more than $100 million. The paradox is not minimized by the fact that Congress continued to appropriate large sums of public money for the project, even after congressional Appropriations Committees were apprised of its apparent impact upon the survival of the snail darter. We conclude, however, that the explicit provisions of the Endangered Species Act require precisely that result."[37]

Institutionalising caution

In reaching this conclusion the Supreme Court gave effect to the "incalculable" value of endangered species which the US Congress had acted upon, and declined to apply a cost-benefit analysis approach.[38] Chief Justice Burger noted that–

> "Quite obviously, it would be difficult for a court to balance the loss of a sum certain – even $100 million [being the cost of construction] – against a congressionally declared 'incalculable' value; even assuming we had the power to engage in such a weighing process, which we emphatically do not."[39]

The Court declined the request of the applicants to refuse the grant of injunctive relief:

> "We have no expert knowledge on the subject of endangered species, much less do we have a mandate from the people to strike a balance of equities on the side of the Tellico Dam. Congress has spoken in the plainest of words, making it abundantly clear that the balance has been struck in favor of affording endangered species the highest of priorities, thereby adopting a policy which it described as 'institutionalized caution'."[40]

(4) GREECE: THE ACHELOOS DAM CASE[41]

In a 1994 judgement the Greek Council of State annulled a decision by the Ministers of Agriculture, of the Environment, Planning and Public Works, of Industry, Energy and Technology, and of Tourism, approving the environmental terms of a project for the diversion of the waters of the Acheloos River in Greece.

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37 Ibid, pp 172-3.

38 Ibid, p 187.

39 Ibid, p 188.

40 Ibid, p 194.

41 Case No. 2759/1994, Council of State, Greece (Division E).

Factual background: the failure to carry out an adequate environmental impact assessment

By a decision dated 21 April 1992 (Decision No. 61414), these Ministries approved the environmental terms for the construction and operation of (a) an 18.5 kilometre tunnel for the channelling of waters of the River Acheloos to Thessaly, and (b) dams and corresponding water reservoirs and other related works at Pyla and Mouzaki. On 11 June 1992 three non-governmental organisations (The Hellenic Ornithological Society, the World Wide Fund for Nature – Greece, and The Hellenic Society for the Protection of the Environment and the Cultural Heritage) began proceedings to challenge the decision. Their application was referred to the State Council by a petition of 1 May 1993.

The petitioners alleged that the study on the assessment of the environmental effects of the project was not in conformity with applicable law (Law 1650/1986). This required the study of the effects on the environment to include at least:

(a) a description of the work or the activity, with information on the installation, its planning and its size;

(b) identification and assessment of the basic effects on the environment;

(c) a description of the measures for the prevention, reduction or making good of the negative effects on the environment;

(d) a study of alternative solutions and an indication of the principal reasons for the selection of the proposed solution; and

(e) a simple summary of the study as a whole.

The State Council's characterisation of the project

The State Council described the "controversial intervention" envisaged by the project as having "a multiplicity of serious implications for the natural and man-made environment of the relevant regions".[42] These included:

> "(b) the reduction of the waters of the Acheloos and of the total flow to its estuary, which is an important wetland and habitat for wild avifauna protected by the provisions of the Ramsar International Convention; (c) the construction of a series of large dams...will destroy the soil and fluvial ecosystems and replace them with lake ecosystems, and will cause a change in the local micro-climates and a serious deterioration in the aesthetics of the landscape; (d) a reduction in the supply of the waters of the Acheloos to the north of the diversion to the natural and man-made ecosystems of Western Greece, fed by it, with all the resultant

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42 Ibid, p 16.

> consequences for their stability and viability, particularly in periods of drought; (e) serious socio-economic and cultural changes resulting from the varied exploitation of the dams, which will have secondary effects on the natural and man-made environment of the regions concerned."[43]

The State Council described the diversion of the waters of the River Acheloos to the plain of Thessaly as–

> "a composite and, moreover, complicated large-scale construction project and has effects which are capable of causing serious and irreparable damage to the natural environment. It is also obvious that its total effects on the natural environment of the areas of Western Greece and Thessaly affected is not equal to the sum of the consequences of the individual construction works required for its execution assessed only on a local scale, but is many times that by reason of the dynamic rather than linear nature of the natural and man-made interacting ecosystems disturbed as a result."[44]

The State Council's ruling

The State Council therefore ruled that–

> "for the recording and evaluation of the effects of this undertaking, the drawing up of studies of effects on the environment for each of the individual construction works planned is not sufficient; *what is required is the drawing up...of an overall study of effects on the environment, in which by the use of appropriate scientific method the individual consequences previously mentioned and the resultant more distant consequences for the environment are related and assessed together, in order to arrive at and evaluate the total effects of the project on the environment resulting from the alteration of the hydrological balance between Western Greece and Thessaly.*"[45]

The State Council concluded that without such a study it would not be possible for the full effects on the environment of the diversion to be diagnosed, and for it to be judged whether the project was permissible or precluded.[46] Since the environmental impact studies related to individual construction works, and no "overall study on the effects on the environment" had been prepared, the State Council annulled the decision. This decision was reached notwithstanding the fact

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43 Ibid, p 17.

44 Ibid, p 19.

45 Ibid (emphasis added)

46 Ibid.

that the execution of certain individual works included within the greater project of the diversion had already begun.[47]

The Council of State's decision is pertinent for several reasons. It relates to a large and complex dam project. It underscores the importance given by the Council of State to respecting environmental needs and narrowly construing environmental obligations. It confirms the importance of ensuring that an environmental impact assessment is carried out on a project which can cause significant and irreversible damage to the environment. It emphasises the need to ensure that the total effects on the environment are studied in any assessment. And it provides a further example of a tribunal's willingness to intervene decisively *after* construction has commenced on a large-scale, government-funded project.

(5) AUSTRIA: THE PROPOSED HAINBURG DAM

Factual background

In the early 1980s Austria planned to construct another barrage on the River Danube at rkm 1883 near the Slovak border at Hainburg. The proposed plant would have had an electric generating capacity of 360 MW (approximately half the output of the Gabčíkovo plant), and an impoundment with a length of 45 kilometres reaching Vienna. The intention was to operate the plant on a continuous basis without peak operation. The barrage was also intended to stop river erosion, and contribute to year-long navigation irrespective of hydrological conditions.

The area of impact of the Hainburg Dam is, from an environmental perspective, similar to that pertaining to the Danube reach between Bratislava and Győr. In both reaches earlier river regulation created a river corridor inside the dykes with an active floodplain of 1-2 kilometres in width. The total floodplain area affected above Hainburg would have been about 11,000 hectares (7,100 ha of alluvial wetland forest; 2050 ha of water surface; and 1300 ha of meadows). The area is rich in biodiversity, with an abundance of floral and faunal wetland species, many of which are endangered and listed as IUCN Red List species.

Opponents of the proposed dam considered that the implementation of the barrage would have resulted in significant degradation of the riverine ecosystem between Hainburg and Vienna. It was considered that the impoundment of the river would have led to the extinction of 50% of all fish species, that water level fluctuations would have been reduced, that the implementation of a management system of

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47 Ibid, p 18.

connected side branches would not be successful,[48] and that the change in surface and groundwater regimes would have threatened the large valuable floodplain forest (which together with the Szigetköz area represents the most valuable riverine wetland habitat in Central Europe). It was also expected that a deterioration of water quality would increase the cost of water treatment after extraction at bank filtered wells. Faced with the potential destruction of a major natural habitat, Austrian citizens centred around Nobel Prize laureate Konrad Lorenz began an active campaign against the dam, which reached its climax at the end of 1984 when the first forest clearings were about to start.

Czechoslovakia complains and threatens a damages claim

Also around this time, the Government of Czechoslovakia formally complained about the proposed Dam, asked for detailed information, and threatened to bring a damages claim. On 27 November 1984 the Ministry of Foreign Affairs of the Czechoslovak Socialist Republic complained that construction of the Hainburg hydroelectric plant–

> "is a unilateral solution adopted by the Austrian party that will disrupt the accepted and smooth utilisation of the Danube as proposed by the Danube Committee. The completion of the Hainburg plant will also result in damages to the various construction measures taken by [Czechoslovakia] on the related sections of the Morva and Danube rivers since 1957."[49]

Czechoslovakia complained that construction would lead to "significant and substantial deterioration of the water management régime of the affected sections of the rivers Danube and Morva and the territory" of Czechoslovakia and "a significant decrease in the water levels of the two rivers" which would damage Czechoslovak interests.[50] Czechoslovakia also complained that the Hainburg plant–

> "will make it impossible for the Czechoslovak party to have a share in the utilisation of the hydroelectric potential on the common section of the Danube. The decrease of the water level of the Danube at the mouth of

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48 Such an approach had not proven to be successful in upstream Austrian dam projects: see N Hary and H P Nachtnebel (eds), Ecosystem Study Altenwörth (1989) (Ökosystemstudie Donaustau Altenwörth-Veränderungen durch das Donaukraftwerk Altenwörth), Österreichische Akademie der Wissenschaften, Veröffentlichungen des österreichischen MaB-Programms, Innsbruck. Similar lack of success had occurred in the Upper Rhine Barrage system: HC-M, vol 4, (part 1), annex 15.

49 *Rude Pravo*, 28 November 1984 ("Ecological balance is jeopardised. If the project is completed, Czechoslovakia will claim damages."), HR Annexes, vol 3, annex 50.

50 Ibid.

> the river Morva will disrupt ecological conditions, will damage the weirs and bring about a significant decrease in drinking water supplies."[51]

Czechoslovakia "demanded basic technical data from [Austria] necessary for the assessment of the effects of the Hainburg plant and the development of forecasts for the frontier sections of the rivers Danube and Morva on Czechoslovak territory".[52]

Finally, Czechoslovakia warned Austria that–

> "in case of the completion of the Hainburg plant it will claim damages."[53]

The Austrian Court decision

In 1984 legal proceedings were brought before the Austrian court by opponents of the project, including the World Wide Fund for Nature–Austria, for a declaration that the construction authorisation was illegal. In July 1986 the Austrian Court of Administration quashed the construction authorisation.[54] This in effect put an end to the proposed Hainburg dam.

The dam is replaced by a national park

Following the judgement of the Court and the termination of the Hainburg contract, planning began for a national park. It was concluded that a national park and conservation needs would exclude the construction of a barrage between Vienna and the Slovak border.

(6) GERMANY

As illustrated by the following three examples, developments in Germany over the past two decades relating to the sustainable development of the resources provided by the Rhine, Danube and Elbe rivers reflect an approach supporting alternatives to the development of river barrages.

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51 Ibid.

52 Ibid.

53 Ibid.

54 See, Erkenntnis des Verwaltungsgerichtshofes vom 1. 7. 1986, Zien 84/07/0375.

Cancellation of the Neuburgweier and Gemersheim barrages in the Upper Rhine

The last German barrage in the Rhine (Iffezheim), which began to operate in 1977, is located at rkm 334. An amendment to the Franco-German Treaty of 1969 was signed in 1975, stipulating the construction of another barrage at Neuburgweier (called Au-Neuburg) at rkm 353.85. The barrage was intended to prevent riverbed erosion. Comprehensive model investigations and field tests carried out between 1975 and 1980 demonstrated that the addition of sediments was a suitable alternative to maintain the stability of the riverbed, thus preventing downcutting and allowing navigation.[55] By 1981 planning of the proposed Neuburgweier barrage had been substantially completed, and the early plans for another barrage at Gemersheim (rkm 379.8) were ready. Instead of commencing construction of the Neuburgweier barrage it was decided to compare various alternative approaches on the basis of a cost-benefit analysis and an environmental impact assessment (EIA). This investigation led to a revision of the prior decision to build the Neuburgweier barrage. A new amendment to the 1969 Treaty was signed by Germany and France in 1982 stipulating the addition of bed sediment downstream of Iffezheim rather than further barrage building.

The cost-benefit analysis and the EIA considered the following alternatives:[56]

(i) construction of the Au-Neuburg and Gemershein barrages plus sediment addition in the tailwater;

(ii) construction of Au-Neuburg plus sediment addition in the tailwater;

(iii) sediment addition in the tailwater of the existing Iffezheim barrage.

The cost-benefit analysis considered aspects of navigation, energy production, flood protection and traffic (using the new river crossing in case of barrage building). But the primary objective was erosion control. Although the alternatives (including barrage building) were found to be slightly more economical than the mere addition of sediment downstream of Iffezheim, it was concluded that the investments would not be justified given the availability of more attractive potential economic investments in other parts of Federal waterways.

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55 A detailed description of the approach is provided in HC-M, vol 4 (part 1), annex 7.

56 Bundesminister fur Verkehr, Abteilung Binnenschiffahrt und Wasserstrassen (1981), Investigation of the question of whether the riverbed erosion of the Upper Rhine below the Iffezheim barrage can be prevented by the addition of bedload, by construction of further barrages, or by construction of ground sills (Untersuchungen zur Frage, ob die Sohlenerosion des Oberrheins unterhalb der Staustufe Iffezheim durch Geschehiebezugabe, weitere Staustufen oder Grundschwellen verhindert werden kann), Final Report, Bonn, October 1981.

The EIA mainly compared the impact areas which would have been used for construction and gravel mining in the floodplain (including the supply to be used for sediment addition) and the impacted river reaches. The following parameters were assessed:

> Protected areas, wetland forests, fauna, agriculture, forestry, impacts on landscape, groundwater, surface water hydrology and quality, climatic changes, and recreation.

The comparison between the three project alternatives clearly favoured sediment addition below the Iffezheim, without any further barrage building (option iii, above). This option was found to have the least negative environmental impact.

A fourth alternative, the construction of ground sills combined with armouring of the riverbed, had been assessed earlier and ruled out on the ground that it was incompatible with safe navigation. After 18 years of operation the continuous addition of sediment has proved to be a sustainable solution to modern river management.

Combining flood protection and restoration of wetland habitats: the Integrated (Upper) Rhine floodplain [57]

The Treaty of Versailles of 1919 granted all water rights along the Upper Rhine to France. As a consequence, a system of 10 barrages was built in the period to 1977,[58] and an area of 130 square kilometres was dyked out, i.e., 60% of the active floodplain was excluded from inundations. The effect was to lead to a significant deterioration of the existing level of flood protection and to cause severe damage to wetland forests and habitats.

To restore the previous flood security (corresponding to a 200-year flood event in the region of Mannheim-Ludwigshafen), an amendment to the German-French Treaty of 1969 was signed in 1982,[59] stipulating the construction of detention reservoirs on both sides of the main channel with a total storage volume of 212 million cubic metres. The planned measures mainly comprised technical structures

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57 Sources: (1) Ministerium fur Umwelt Baden-Württemberg (1994), "Rahmenkonzept des Landes zur Umsetzung des Integrierten Rhein-Programms" (in German), Series "Integriertes Rhein-Programm", No. 11, 19 pp; (2) Ministerium für Umwelt Baden-Württemberg (1994), "Grundsatzpapier–Auenschutz und Auenrenaturierung" (in German), Series "Materialien zum Intergrierten Rheinprogramm", No. 4, 61 pp

58 See HC-M, vol I, *Plate 3.*

59 "Vereinbarung zu Änderung und Ergänzung der Zusatzvereinbarung vom 16. Juli 1975 zum Vertrag vom 04. Juli 1969 zwischen der Bundesrepublik Deutschland und der französischen Republik über den Ausbau des Rheins zwischen Kehl/Strassburg und Neuburgweier/Lauterburg", signed on 06.12.1982.

which would allow peak volumes of major flood waters to be stored for temporary periods.

Early experience with the operation of the detention reservoirs evidenced the negative impact on wetland ecology of such measures. Existing German nature conservation laws as well as newly introduced EIA requirements in Germany in the 1980s necessitated a re-evaluation of the envisaged flood protection system. Thus, in 1988 an "Integrated Rhine Programme" (IRP) was created in the state of Baden-Württemberg with the intention of combining flood protection with a sustainable restoration of wetland ecosystems.

The ecological objectives of the IRP result in certain constraints on flood protection measures, including:

- flooding of the detention reservoirs should not last too long and may not exceed a level of 2.5 metres (previous technical plans envisaged flood stages up to 9 metres);
- stagnant waters are generally to be avoided; and
- during the vegetation period the detention reservoirs should be allowed to experience regular inundations according to the discharge regime of the Rhine ("ecological inundations"), to ensure typical fluctuations of surface and groundwater levels.

In view of these requirements the detention reservoirs could not be operated as planned. New calculations resulted in 13 instead of only 5 detention reservoirs to provide the same level of flood security as existed in pre-dam conditions. In addition to the altered operational plans for the detention reservoirs, detailed plans were elaborated in the programme for the preservation of existing wetland habitats and for the restoration of habitats in the floodplain which had been dyked out. This includes relocation of dyke systems, changes in forest management to develop natural wetland forests, appropriate use of agricultural areas (such as meadows instead of fields). The cost of the IRP in Baden-Württemberg was estimated to be DM 700 million.

Development of the River Elbe in Germany without barrage systems

The Elbe is the second largest river in Germany after the Rhine. With its source in the Czech Republic it used to form the border on long reaches between East and West Germany until 1990. For this reason barrage construction in Germany was restricted to a single structure at Geestach, near the river's mouth at the North Sea. After the reunification of Germany, the construction of a series of barrages was considered by the Federal Ministry of Transport to improve navigation.

However, an economic analysis proved that the costs of full regulation would far outweigh the benefits. Therefore barrage building as a general solution for the

Elbe River was cancelled, and traditional river training methods are favoured, including the construction of groynes. The target of the river training is to increase the navigational low-flow water level from 1.4 to 1.6 metres. Presently the construction of only one barrage in the Elbe at the City of Magdeburg is being considered, operating as a temporary structure which would impound a certain river reach during low-flow conditions only.

In 1994 a comprehensive research programme was established to investigate the sustainable water resources development of the Elbe. The approach includes the tributaries as well as impacts of land use on the river ecosystem but concentrates on impacts of river training methods. Sustainable development of the Elbe River will have to result in management strategies which include restoration of wetland habitats, flood protection, sustainable land use in the floodplain, riverbed stability, navigation, restoration of fluvial habitats, and pollution control.

(7) FRANCE: THE CANCELLATION OF THE SERRE DE LA FARE DAM ON THE LOIRE RIVER

Background

The Loire River has been the subject of a river training programme since 1952; with the construction of a first dam in 1956 (at Grangent). In October 1970 the Government proposed a comprehensive programme of dam-building to protect the middle Loire valley against flooding. In 1975 a work programme was approved and in 1979 a formal report was prepared at the request of the Government on the integrated management of the Loire and its tributaries.[60] Four dams were planned, including the Serre de la Fare dam. In 1983 the Government instituted the Etablissement Public D'Aménagement de la Loire et de Ses Affluents (EPALA). On 13 February 1986 EPALA, the Government and the Loire Basin Water Agency signed an agreement to carry out the Loire development programme. As a result also in 1986 local opponents of the project created a "Loire Vivante" (Living Loire) Committee, which was based at Le Puy-en-Velay, near the proposed dam.

The planned Serre de la Fare dam

This dam was planned on the Upper Loire upstream from Le-Puy-en-Velay. It was intended to serve three principal functions: to alleviate floods by reducing 100-year floods at Brive-Charensac; to sustain low waters to supply enough water to the Forez canal for irrigation; and to develop tourism on the proposed reservoir, including fisheries and water sports. The proposed structure was a barrage 75

60 J. Chapon, "Protection et aménagement intégré du Bassin de la Loire", rapport a Monsieur le secrétaire d'Etat chargé de l'Environnment, décembre 1979.

metres high, and it was expected to cost some 557 million French francs.[61] The dam was not intended to generate hydroelectricity.

An Environmental Impact Statement (EIS) was prepared for the Serre de la Fare dam in 1988. The EIS was strongly criticised on a range of grounds, including the fact that it did not include credible information on fish fauna, did not consider mitigation measures on the impacts of flora and fauna, and it failed to consider the impacts on the landscape or on hydrobiology. Environmental groups and citizens opposed to the dam were particularly concerned about the loss of flora and fauna and the inundation of several historic gorges. Beginning in 1986 organised protest began, comprising petitions, public meetings, and protests leading to the occupation of the Serre de la Fare site from February 1989 for five years.

Legal remedies

Loire Vivante commenced a series of legal actions to challenge planning and construction authorisations. These led to the eventual cancellation of the dam. On 15 December 1990 the project's opponents were granted a judgement against an administrative authorisation declaring transferable all properties necessary for the construction. On 7 February 1991 applicants were successful in obtaining a judgement from the Tribunal Administratif of Clermont Ferrand cancelling the "déclaration d'utilité publique" adopted for the dam project.[62] And by a judgement of 28 March 1991 the Tribunal Administratif declared unlawful and cancelled a declaration that land necessary to construct Serre de la Fare could be subject to a compulsory purchase order.

The dam is cancelled

On 31 July 1991 the Prime Minister (Mme Cresson) decided to cancel the Serre de la Fare dam on the ground that it would have detrimental effects on the environment.[63] On 4 January 1994 the new Government confirmed the cancellation of the Serre de la Fare dam.

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61 EPALA, Objectifs et programme d'actions, 1989.

62 See p Gazagnes, Note de jurisprudence, Revue juridique de l'environnment No 2/1991, pp 197-206.

63 See Rapport de la Commission d'Enquête sur l'aménagement de la Loire, le maintien de son débit, la protection de son environnement, Journal Officiel, 12 décembre 1992, at pp 87-9.

APPENDIX 6

THE HISTORY OF THE DISPUTE: 1989-1992

1. INTRODUCTION

1. This Appendix deals in some further detail with the history of the dispute between the parties in the period from May 1989 until the diversion of the Danube in October 1992. It does so in order to respond to points made in the Slovak Counter-Memorial. The account here is supplementary to the discussion in earlier Hungarian pleadings. Specific conclusions are summarised in paragraph 1.48 of the Hungarian Reply.

2. THE DISPUTE BREAKS OUT: MAY 1989

2. In responding to the Hungarian Memorial's discussion of the suspension of construction at Nagymaros, the Slovak Counter-Memorial takes a false starting point:

> "The Hungarian Memorial indicates that a prime catalyst of the unilateral decision of Hungary to suspend work at Nagymaros was the release in March 1989 of the preliminary report of a study conducted under the auspices of Ecologia"[1]

It then distorts the following events to construct a story according to which Hungary was determined to abandon the Project as early as May 1989, at the latest

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1 SC-M, para 5.05. This is significantly different from HM, para 3.74, which states: "In light of its well-documented concerns over the likely environmental impact of the Barrage System, a re-consideration of the Project commenced." The same paragraph speaks of the role of the Advisory Committee of the Prime Minister as well as of the dispute between the Minister of Industry and the President of the National Planning Committee, who have also surveyed the alternatives. The summary of the Ecologia Report offered in SC-M, para 5.07 is also a distortion. It quotes suggestions which were only proposed on the assumption that there was a *fait accompli*: "Given a decision to proceed with the project" (HM, Annexes, vol 5 (Part I) annex 5 at p 59). What Ecologia would have preferred - if that decision was not given - was set out in the preceding paragraph: "that impacts and alternatives be explored thoroughly before action is taken".

when the Hardi Report was produced in September 1989,[2] while negotiating in bad faith[3] about maintaining the Original Project in a modified form.

3. Hungary has shown that much more evidence than the first Ecologia Report was available by May 1989.[4] The volume of scientific support for the decision to suspend is reflected in the summaries and bibliographies forming part of appendices and annexes to the Hungarian pleadings.[5]

4. The task that remains is to demonstrate that the facts and the documents referred to by Slovakia point to a wholly different conclusion than the one it propounds.

5. The position of Hungary with respect to the events of 1989 is clear and consistent. In May 1989 the construction of Nagymaros was suspended. In July the preparations for the closure of the Danube at Dunakiliti were interrupted in order to achieve certain scientific and engineering investigations. These were expected to give answers to questions raised by numerous domestic and international bodies concerning those impacts of the Project, and which had not been, or not satisfactorily been, investigated in the past. Their purpose was no more nor less than to reach a scientifically sound conclusion, in agreement with competent Czechoslovak bodies, about necessary mitigation measures. The principles of responsible government required that such measures be taken to avoid the very real risks of serious environmental harm which the operation of either sector of the Project threatened.

5. The urgency of these steps was reinforced by mounting public pressure on the government to leave behind the practice of socialism in which economically as well as environmentally harmful large-scale investments were imposed from above by Communist Party leaders and executed by state authorities without any participation of the scientific community or the public affected by the consequences of those decisions.[6]

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2 SC-M, para 5.29.

3 SC-M, para 5.01.

4 See HR, paragraphs 1.87-1.89, 1.91.

5 See "Summary of specialist opinions" (HR, Annexes, vol 3, annex 10) and bibliographies at the end of chapters in the *Scientific Evaluation* and *Scientific Rebuttal*, as well as the HAS 1994 "Annotated References" to scientific studies relating to the GNBS Project, a copy of which has been put on file with the Court.

6 J Vavroušek describes in connection with Czechoslovakia what Hungarians also wanted to leave behind: "The totalitarian political system and centrally planned command economy were *inter alia* the inherent enemies of the environment, even though, as people, communists probably prefer clean air or water. However, in the hands of the Central Committee had been concentrated all three governing powers - legislative, executive and judicial. It was quite clear that without deep political, economic social, and other changes the populace could not hope for

6. The Slovak interpretation of the 13 May 1989 Government decision is incorrect. Contrary to its plain meaning, the Slovak Memorial suggests that the Government decision...

> "was in effect a request to Parliament to approve the elimination of Nagymaros from the Project."[7]

It says this because the decision...

> "proposed that Parliament also authorise the Government not to fulfil its duties as defined in October 1988 with relation to the continuation of the investment."[8]

7. This simply meant that the Government should be relieved from the obligation to continue construction without adequate environmental impact assessment and economic analysis. The Government was faced with a dilemma whether to continue or suspend construction at Nagymaros, in order to give it time to determine unanswered questions about the Project's impacts and potential benefits on a solid basis. The intention was that this be done in agreement with Czechoslovakia, if necessary by an appropriate amendment of the 1977 Treaty.[9]

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any improvements of environmental quality." J Vavroušek, "Environmental Management in Czechoslovakia and Succession States", (1994) 14 *Env Impact Assessment* 105.

7 SC-M, para 5.10.

8 SC-M, para 5.09.

9 The following quotation from the Government resolution of 13 May 1989 (HM, Annexes, vol 4, annex 147) refutes a number of emphatic Slovak claims: See SC-M, para 5.11 which asserts that "[t]here was nothing in the Resolution of 13 May that indicated...that the alternative of suspending work pending further investigations was being considered." Compare the resolution:

> "Proceeding from the responsibilities undertaken by the President of the Government before Parliament, the Council of Ministers has - on the basis of the proposal of the affected Ministers concerned and taking into consideration the suggestions of the Ad Hoc Committee of the Hungarian Academy of Sciences, the Advisory Body of the Council of Ministers, and the Public Committee to Supervise the Investment examined the possibilities for ordering a referendum regarding the Gabčikovo-Nagymaros investment. In relation to this, it has examined the consequences of the construction of the Nagymaros project as well as the consequences of the eventual stopping of such construction... It orders the Ministers concerned to commission further studies in order to place the Council of Ministers in a position where it can make well-founded suggestions to the Parliament...Deadline: for the completion of these investigations: 31 July 1989."

The reference in the first sentence to "responsibilities undertaken by the President of the Government before Parliament" confirms HM, para 3.70, describing Prime Minister Németh's speech to Parliament on 8 March 1989, promising to avoid irreversible steps. SC-M, para 5.11 fn 21 is therefore without substance. The text also reveals that the 13 May 1989 decision was based on a careful - albeit preliminary - interdepartmental consultation clearly refuting e.g., SC-M, para 10.50

8. This dilemma was, at the earliest possible moment, communicated to the Czechoslovak Prime Minister on 24 May 1989. Although "no agreed record of this meeting was made",[10] nothing about the exchange could have led to the conclusion that...

> "the first time Czechoslovakia received an indication of the alleged reasons for Hungary's 13 May decision was when it received two documents from Hungary at the 26 June meeting of Plenipotentiaries."[11]

This is simply not the case.[12] According to the internal memo signed by Prime Minister Németh after informing Prime Minister Adamec about the domestic political developments and the state of the economy on 24 May 1989.

> "[H]e revealed those factors which were considered by the Hungarian Government when making the decision about the suspension of construction at Nagymaros. He emphasised our intention that a thorough investigation of the risks, situations of peril and concerns that have arisen be considered as a common task since we decided on the investment jointly, and our responsibilities are joint as well."

Comrade Adamec thanked him for the frank information, adding that between friends and neighbours openness must prevail, even if sometimes it is not comfortable.[13]

According to the memo Adamec added that:

> "they are ready to investigate with us, or if necessary with the participation of a third party, either the newly emerged or earlier underestimated risks that have aroused our concerns."[14]

9. Unfortunately, the terms according to which Czechoslovakia proposed to investigate those concerns jointly did not indicate a sincere desire for substantive discussions:

> "Having translated and studied the materials, the Czechoslovak Plenipotentiary proposed *over the phone* to Comrade Udvardi, Special

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according to which "all objective appraisal of any problems of Nagymaros was carefully avoided".

10 HC-M, para 4.10, fn 9.

11 SC-M, para 5.14.

12 One wonders how Slovakia could be confident that the two Prime Ministers did not discuss the reasons for the suspension at their 24 May 1989 meeting, if they could not find an agreed record.

13 HR, Annexes, vol 3, annex 57.

14 Ibid.

> Government Commissioner of the Government of the Hungarian People's Republic *on 7 July 1989* that the Czechoslovak Party recommended the experts' *negotiations to be held on July 11 and 12 in order to meet the two-month deadline of the unilateral temporary suspension* of the construction of the Nagymaros Barrage."[15]

Suggesting five days for reviewing the Slovak scientific arguments when they still had to be delivered, translated and checked manifested an intention to avoid meaningful negotiations. It paved the way for a hardening Czechoslovak position, which in turn led to the threat of unilateral action unless the Project was completed in its entirety according to the Original Plan.[16]

10. The bilateral expert negotiations finally took place on 17 - 19 July 1989 and confirmed the grave differences between the two sides with regard to the expected impacts. The only material provided by Czechoslovakia was a brief document devoting 6 pages to such diverse topics as ecological impacts, water quality, sewage treatment, drinking water, tectonics, soils, ground water table, modes of energy production, It offered neither a bibliography nor specific reference to materials supporting the brief statements.[17] In light of this outcome[18] and the Prime Ministerial negotiations held on 20 July 1989 (at which the parties had agreed to further scientific investigations[19]), it was reasonable for the Hungarian Government to decide to interrupt preparations for the filling of the Hrušov reservoir, which was identified at those expert negotiations as one of the major sources of risk.

11. According to the internal memo of the Hungarian Prime Minister describing the meeting with Prime Minister Adamec:

> "We have also transmitted our suggestions to Comrade Adamec in writing. We jointly commissioned the competent organs of the two countries to continue the fact-finding and evaluative work, and agreed to meet before the end of October to formulate our positions on a more objective basis and in a more precise way, taking into account the

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15 Position of Czechoslovakia on materials prepared for the Council of Ministers of the Hungarian People's Republic on the decision of temporarily stopping work on the Nagymaros Barrage, HM, Annexes, vol 4, annex 167 at 395 (emphasis added).

16 This move was obviously contrary to Prime Minister Adamec's intentions, which are ignored in the SC-M.

17 Position of Czechoslovakia on materials prepared for the Council of Ministers of the Hungarian People's Republic on the decision of temporarily stopping work on the Nagymaros Barrage, HM, Annexes, vol 4, annex 167 at 396-401.

18 See the major differences of positions reflected in addenda and annexes attached to the reports of working groups participating at the 17 - 19 July 1989 meeting: SM, Annex 65.

19 See Report of M Németh, 24 July 1989: HR, Annexes, vol 3, annex 58.

scientific results to be produced by that time as well as the standpoint of the Hungarian Parliament to be formulated in September. The Czechoslovak side took note of the statement of our Government that we extend the suspension of the works aimed at the completion of the Barrage system until 31 October 1989".[20]

12. The agreement to further studies is reflected in the fact that scientific experts met in late September to discuss impacts of filling the Dunakiliti-Hrušov reservoir.[21] Slovakia believes that the outcome of that meeting was...

> "a fundamental disagreement between the parties over whether enough was known about possible ecological effects to proceed with the Project."[22]

13. Hungary thought that not enough was known, and the inconclusive investigations pursued after that date by Czechoslovakia and Slovakia, including the frequently mentioned but never presented PHARE research confirmed this approach.

14. The position of the Parties in the Autumn of 1989 is described in the previous pleadings. On 26 October 1989 Prime Minister Adamec refused to amend the 1977 Treaty, to suspend construction at Dunakiliti or to conclude an additional agreement on environmental issues.[23]

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20 *Ibid.* SC-M; para 5.21 states that:

> "if the Czechoslovak Prime Minister did not repeat the official Czechoslovak position... rejecting Hungary's suspension of work at Nagymaros... this could not magically transform the avowedly unilateral suspension of work at Nagymaros into an agreed one. Czechoslovakia's protest was formally on record."

This is contradicted by the Németh memorandum. Similarly SC-M, para 5.19 which alleged that:

> "[T]he so-called extension of the Nagymaros suspension to 31 October and the new decision to suspend work at Dunakiliti were not among the matters proposed by Hungary for discussion at the meeting."

Also contradicted is SC-M, para 5.49:

> "Not one of these acts, starting with the suspension of work at Nagymaros on 13 May 1989, was agreed to by Czechoslovakia. Each one of these acts was taken by Hungary without prior consultation with Czechoslovakia, let alone agreement, and, hence, was taken unilaterally in violation of the 1977 Treaty."

As to the June meeting this is simply untrue. There was, at the level of the Prime Ministers, prior consultation and a degree of understanding amounting to acquiescence.

21 SC-M, para 5.28.

22 SC-M, para 5.28.

23 HC-M, para 2.42.

16. In light of the failure to reach agreement the Hungarian Government on 27 October adopted an internal resolution suggesting that the Parliament adopt a decision on abandonment of works at Nagymaros; the Parliamentary resolution was to call on the Government to reach agreement with Czechoslovakia to the same effect.[24]

17. On the afternoon of 30 October, the Hungarian Government informed the Czechoslovak ambassador about this decision.[25]

18. Later on the same day, Czechoslovakia made a new offer. Although presented as a mere repetition of Prime Minister Adamec's statements made on 26 October 1989 - which it was not - the offer had several novel aspects: acceptance of a postponement (although not an outright abandonment) of the construction at Nagymaros, and the conclusion of a "separate agreement" which would limit or exclude peak operation but would include the construction of the Nagymaros Barrage according to the timetable set forth in the 1983 Protocol. The *Note Verbale* reiterated that in the absence of agreement Czechoslovakia "will be forced to commence a provisional, substitute project on the territory of the Czechoslovak Socialist Republic".[26]

19. Because of its timing, that offer could not be channelled into the Parliament's discussion held on 31 October, which was based on the report of the Government submitted to it, reflecting the views adopted on 27 October 1989. The Parliament on 31 October passed a resolution...

> "taking note of the results outlined in the report of the Council of Ministers on the inquiries conducted during the suspension of work at Nagymaros to uncover international legal, economic, ecological, and technical consequences and the inferences drawn therefrom."[27]

The Resolution authorised the Council of Ministers to initiate negotiations with the Czechoslovak Party as to the amendment of the 1977 Treaty.

20. The Hungarian Government came to the conclusion on the basis of a great number of documents[28] that no further construction should take place at Nagymaros and at Dunakiliti (although it should continue in connection with

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24 HM, Annexes, vol 4, annex 150.

25 HC-M, para 2.44.

26 HM, Annexes, vol 4, annex 28.

27 HM, Annexes, vol 4, annex 151.

28 See Summary Review of Certain Studies; HR, Annexes, vol 3, annex 10. For economic issues see Economic Analysis of the Gabčíkovo-Nagymaros Barrage System; HR, vol 2, Appendix 4.

Gabčikovo) until an agreement could be reached on the amendment of the 1977 Treaty to address the most pressing environmental concerns.

21. The Hardi Report, one of several hundred internal documents produced in 1989, is placed at the centre of Slovakia's search for Hungary's intentions, and interpreted as setting out "a blueprint... which was faithfully followed"[29]

22. The Report does not warrant such significance. Hungary offered it merely to shed light on what influential and competent independent experts thought about the Barrage System at the time,[30] acknowledging that it was produced on a voluntary basis, with substantial NGO participation. It had nothing to do with the official Governmental position. It was never presented to Czechoslovakia as reflecting the Hungarian Government's position.[31] The views expressed in the Hardi Report are those of the authors and not the Hungarian Government. In the same way, the Slovak Union of Nature and Landscape Protectors' letter of 24 May 1989 addressed to the Hungarian Government could not be interpreted as expressing the position of the Czechoslovak Government:[32]

> "Despite the fact that the construction of the Nagymaros waterworks had nevertheless commenced we adhere to the view that taking the long term perspective it is not only more saving from the ecological and the economic point of view, but also more forward looking from the political point of view to abandon the construction of the Nagymaros Hydroelectric Power Plant."[33]

3. COMMUNICATION BETWEEN THE PARTIES AFTER THE SUSPENSION

23. From the suspension of Nagymaros onwards, Hungary was always willing to negotiate with Czechoslovakia to reach a mutually agreed settlement.[34] It is

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29 SC-M, para 5.29.

30 The Hardi Report is referred to in HM, para 3.95, immediately after the WWF Report (which gets much less attention in the Slovak pleadings) to illustrate that different independent bodies came to similar conclusions concerning the environmental risks of the Barrage System.

31 SC-M, para 5.33 states that Slovakia has not seen the Report before: SC-M, para 7.10 speculates that it was produced for "internal" purposes, without actually claiming that it was commissioned by the Government.

32 At the time of writing the Hardi Report CMEA rules in force did not incorporate damages for non-performance of a contractual obligation. The maximum sanction amounted to 8% of the goods not delivered, regardless of the actual business loss suffered because of the non-delivery. There was no compulsory arbitration envisaged on an interstate level, therefore the sole method of dispute settlement was by agreement of the parties.

33 HM. Annexes, vol 4, annex 166.

34 HC-M, para 2.27.

simply not true that Hungary argued in its Memorial "from the premise that negotiations between the two Treaty parties to resolve the dispute began only after the new Governments were formed in both countries" in 1990.[35] In fact, between the decision to suspend the construction in May 1989 and the proposal to amend the 1977 Treaty in October 1989 no fewer than five meetings took place at prime ministerial or deputy prime ministerial level, together with three meetings of experts.[36] These were accompanied by a further meeting at state secretary/ministerial level in January 1990.[37]

24. Nor is it true that negotiations at the intergovernmental level were "terminated by Hungary in its Prime Minister's letter of 10 January and 6 March 1990".[38] In that letter the Hungarian Prime Minister proposed the commencement of a joint environmental study to examine the effects of the Dunakiliti reservoir and the Gabčikovo sector and concluded that this study may lead to the amendment of the 1977 Treaty.[39] Thus, the Hungarian decisions and actions did not produce "faits accomplis in violation of the 1977 Treaty", as Slovakia asserts.[40] They represented efforts of the Hungarian Government to achieve a jointly accepted assessment of the environmental impacts of the Project and to come to a mutually agreed solution of the problems. On the contrary, as is now known, preparations were as early as November 1989 underway for a Czechoslovak *fait accompli*, the implementation of Variant C.

25. For Slovakia, all this meant that Hungary "had succeeded in postponing the damming of the Danube for three successive years, during which time no new scientific studies" had been undertaken.[41] In fact, a number of studies were prepared in 1989 and 1990.[42] Taken together, they established that serious environmental risks would have been involved in peak power operation. These

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35 SC-M, para 5.54. The Slovak Counter-Memorial adds in the same paragraph that "Hungary's premise is baffling and incorrect".

36 HM, paras 3.78-3.99; HC-M, para 2.28.

37 HM, para 3.106.

38 SC-M, paras 5.55, 5.61.

39 HM, Annexes, vol 4, annex 32. On 6 March 1990 the Prime Minister repeated his call for common scientific investigations and requested the suspension of work also on Czechoslovak territory (HM, Annexes, vol 4, annex 35). In his response the Czechoslovak Prime Minister indirectly refused any scientific investigation; he merely agreed to take up negotiations with a view to the putting into operation of the Gabčikovo sector by 1991 (HM, Annexes, vol 4, annex 163).

40 SC-M, para 5.55.

41 SM, para 4.82.

42 31 Hungarian studies were prepared in 1989 and 43 in the following year: HM, para 2.37.

concerns have been confirmed by subsequent research.[43] In these circumstances Hungary was justified in assessing the situation as one of true scientific uncertainty, in which continuation of the construction would have defied the principle of responsible governance.

26. At the same time, Czechoslovakia continued its efforts to implement Variant C. Press reports announced as early as November 1989 that Czechoslovakia was marking out a new right-bank dam on Slovak territory.[44]

4. THE CONSEQUENCES OF POLITICAL CHANGES IN 1989-1990

27. The period from the end of 1989 to the beginning of 1990 was characterised in both countries by fundamental political changes. The transition from an authoritarian to a democratic political system based upon public participation, accountability and transparency in decision-making diverted the attention of the two countries from the dispute for some months. However, the new Hungarian Government took a clear stand with regard to the Project from the beginning. The first freely elected Government declared that the Gabčikovo-Nagymaros Project was a mistake and initiated negotiations to remedy the situation and to share the damages with Czechoslovakia.[45]

28. In spite of some comment to the contrary,[46] Czechoslovakia did not take the same stand, insisting on the unaltered continuation of the Project with unspecified and separate "ecological guarantees". Nothing seemed to have changed. Slovakia expresses this in the following way:

> "...it is important to observe that the changes in the Governments of both countries had little material effect on the 1991 negotiations or on the development of the dispute. Czechoslovakia maintained the same position regarding the G/N Project both before and after the change in its Government..."[47]

Slovakia ignores the magnitude of political change in the period between 1988 and 1991. It may have been true that this change did not affect the approach of Czechoslovakia during the negotiations; it certainly affected that of Hungary.

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43 See HM, paras 5.30-5.105; HC-M, paras 1.42-1.171; HR, Annexes, vol 3, annex 10.

44 HC-M, para 2.95. See HR, para 2..21.

45 HM, para 3.110.

46 President Havel called the Project a "totalitarian, gigomaniac monument which is against nature": HC-M, Introduction, para 16.

47 SC-M, para 5.56.

29. Slovakia fails to compare the nature of change in the two countries. With regard to Hungary, the political changes appeared as a gradual process, while in Czechoslovakia a more or less abrupt change in regime took place. The process started in Hungary as early as 1988, with the dismissal of the Communist Party's leader János Kádár in May and the designation of the reformer Miklós Németh as Prime Minister in November. Like other major events in the history of nations, these changes did not take the shape of an uninterrupted, continuous process. This process was shaped by the struggle of various political forces, including those of the opposition. It is unrealistic to expect completely consistent behaviour on the part of transitional regimes such as the Németh Government.[48] Nevertheless, the decision on the suspension of work on the Nagymaros sector in May 1989 – i.e., before the elections – represented the real turning point in Hungarian policy, now taking into account the environmental concerns which were being publicly and privately expressed and *relinquishing the old party line*. This is why, after the first free elections, the changes in the Hungarian Government had little material affect on the Hungarian position.

30. Having deplored Hungarian behaviour for its allegedly inconsistent policy, Slovakia criticises it for what seems to be a consistent policy. It suggests that since its decision on the suspension of work, Hungary has been pursuing a unilateral, uncompromising, rigid policy.[49] Hungary has already responded to this allegation.[50] It is interesting to note that at the same time Slovakia finds the Czechoslovak unilateral, uncompromising, rigid policy laudable, although from the very beginning both the Prague and the Bratislava Governments threatened – and later implemented – Variant C. In a surprisingly frank admission, Slovakia stated, regarding the Hungarian policy, the following:

> "But here an obstacle existed for Hungary: for Czechoslovakia had made it plain that it was not prepared to abandon the G/N Project and had mentioned that it might be forced to seek a provisional solution if Hungary persisted in its course in violation of the 1977 Treaty."[51]

5. THE INITIAL DIFFERENCE AS TO THIRD PARTY INVOLVEMENT

31. Hungary continued to seek a solution of the dispute by further scientific research. Hungary considered it wise "to set up joint expert groups and jointly chose non-partisan experts in order to assist decision-making" in the resolution of

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48 See SC-M, para 5.56, note 89.

49 See esp SC-M, paras 5.62, 5.65.

50 HM, paras 3.74-3.186; HC-M, paras 2.01-2.106.

51 SC-M, para 5.65.

the dispute.[52] At the same time Czechoslovakia applied for a PHARE fund grant in October 1990 to finance a programme on "Surface Water and Ground Water Model of Danubian Lowland between Bratislava and Komárno", admitting the inadequacy of existing research and information. The original aim of the programme was to examine the environmental consequences of the hydropower scheme in the Gabčíkovo sector[53]. According to the application, an international team would work as an "independent" group but it would act *under the auspices* of the Comenius University in Bratislava.[54] After having submitted this application to Brussels, Czechoslovakia invited Hungary to participate in the programme.[55]

32. Hungary refused to participate for two reasons: first, because it thought that the expert group could not work independently of Slovak authorities, and, second, because it was not interested merely in finding an answer to the question of *how* to solve some of the technical-environmental problems, to be generated by the hydropower scheme.[56] The issue for Hungary was *whether* the operation of the Project would have harmful ecological effects and what the consequences might be – whether in terms of quantification or even termination of the Project.[57]

33. On these grounds Slovakia argued that Hungary had been hostile towards the involvement of the EC.[58] But participating in the PHARE programme would not have meant the involvement of the EC itself. The group would have consisted of Slovak, Hungarian and other independent experts.[59] There was no provision for EC involvement in the resolution of the dispute.[60] The PHARE scheme was a

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52 HM, para 3.113.

53 The PHARE application itself was titled "Surface Water and Ground Water Model of Danubian Lowland between Bratislava and Komárno: Ecological Model of Water Resources and Management, 25 October 1990 (HC-M, Annexes, vol 3, annex 48). It stressed that "[t]he strategic position of the 'Žitný Ostrov' region and the new large hydropower scheme under completion, require a thorough and complex study of a proper impact assessment model."

54 HC-M, para 2.61.

55 The Czechoslovak invitation to participate in the PHARE Programme was handed over to Hungary on 26 October 1990 (HC-M, Annexes, vol 3, annex 49; SM, annex 82). According to Slovakia, Czechoslovakia applied for PHARE funds in October 1990 (SM, para 8.51). Hungary believes that the Czechoslovak application to the PHARE Project was made *before* the formal invitation to Hungary was issued. Hungary requested this information from the PHARE office in Brussels, but was told it was confidential.

56 "A permanent optimization and management model is to be developed by this project": see HC-M, para 2.63.

57 HM, para 3.113; HC-M, paras 2.59-2.63.

58 SM, paras 4.63-4.68, 4.69.

59 HC-M, para 2.62.

60 HC-M, para 2.63.

funding scheme and nothing more. Hungary has never been informed about the outcome of the research.

34. In fact, the idea of EC involvement had been raised first by Hungary. In December 1990 the Hungarian Prime Minister agreed with an EC Commissioner that experts of the Community would assist the two countries in the resolution of their dispute. The Prime Minister informed his counterpart concerning the agreement, but the Czechoslovak Prime Minister did not take up the idea.[61]

35. In the meantime, beginning in 1989 Hungary began to pick up indications about Czechoslovak intentions to implement Variant C. In September 1990 Hungary learned about a preliminary list of seven "alternatives", including the one which was later to become Variant C.[62] Some months following, in January 1991, the Slovak Government approved further progress in the construction of Variant C.[63] At a bilateral meeting in February Slovak experts confirmed this report.[64] It has subsequently transpired that throughout this period the implementation of Variant C was well underway.[65]

6. UNSUCCESSFUL INTERGOVERNMENTAL NEGOTIATIONS IN 1991

36. The first three high-level intergovernmental negotiations took place in 1991.[66] Hungary attempted to convince Czechoslovakia that the ecological risks of the operation of the Project would be very high and proposed the termination of the 1977 Treaty by mutual consent. Hungary was ready to compensate Czechoslovakia for its losses.[67] Czechoslovakia was unwilling to consider this proposal; instead, it stressed its aim of continuing construction work according to

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61 HC-M, para 2.65.

62 HM, para 3.123.

63 HC-M, para 2.96.

64 HM, para 3.122.

65 See HR, paras 2.18-2.43.

66 HM, paras 3.121-3.145.

67 HM, paras 3.125-3.133. Slovakia asserts that the Hungarian Memorial contradicts the draft agreement on the suspension of work which was handed over at the meeting and annexed to the Memorial (SC-M, para 5.73). This is not true. Both the Hungarian Memorial and the related Annex refer to the same thing: an agreement to suspend construction both *within* and *outside* the framework of the Project, i.e., including the construction of Variant C and the eventual restoration of the Nagymaros site (HM, Annexes, vol 4, annex 48). There is no way of interpreting the same annexed draft to suggest that Hungary admitted as early as May 1989 an intention to abandon the Nagymaros sector completely. The Németh Government suspended work at that time merely because it saw the ecological risks of the operation of the Project and wanted to conduct further scientific investigations.

the original plans. Hungary proposed at least to suspend the construction until the end of 1993, in order to provide enough time for experts to undertake joint research to assess the ecological impacts of the Project. Czechoslovakia refused this proposal as well, saying that "Hungary had produced no scientific evidence to establish the need for such a suspension".[68] Slovakia has described in its Memorial the Hungarian materials submitted as "science fiction".[69]

37. According to Slovakia, at the first meeting Hungary offered nothing new to Czechoslovakia, because a previous, April 1991 Resolution of the Parliament had tied the hands of the Hungarian Government.[70] The Resolution of Parliament empowered the Government to commence intergovernmental negotiations with Czechoslovakia in order to reach an agreement on the termination of the 1977 Treaty[71]. In connection with the third meeting Slovakia again complained about the narrow mandate of the Hungarian Government.[72] The hands of the Government were not tied by the Resolution, because such resolutions provide only guidelines and do not have the force of law. Thus the Government was by no means a victim of a Parliament's narrow-minded policy. At the same time the Czechoslovak Government had a free hand to refuse any proposal on joint research recommended by Hungary and anything else which might lead to the abandonment of the Project. Whatever Hungary did during the coming months, Czechoslovakia was determined to put the Gabčíkovo sector unilaterally into operation by 1992 at the latest. This has now been confirmed by internal Slovak documents.[73]

38. Hungary learned of the Czechoslovak decision to construct Variant C *before* the Resolution of the Parliament was passed and *before* the first meeting of the two delegations was held.[74] Furthermore, Czechoslovakia announced *during*

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68 SM, para 4.68.

69 SM, para 4.68.

70 SC-M, para 5.71. The Resolution was passed on 16 April 1991 (see HM, para 3.121).

71 The Parliament naturally could not determine the outcome of those negotiations. Any amendment of the 1977 Treaty would have been the result of the investigations to be completed during the suspension of construction prior to September 1993. This was an alternative proposal formally handed to the Czechoslovak Party in April 1991 (HM, Annexes, vol 4, annex 48). The Czechoslovak Party may have subsequently approved this proposal, thus the Parliament did not order the final cessation of work, but found "necessary the continual suspension of works aimed at the completion of the barrage system" (HM, Annexes, vol 4, annex 154, at 368).

72 SC-M, para 5.85.

73 See HR, paras 2.18-2.43.

74 See e.g., Letter from Miklós Király, Head of Secretariat of the Hungarian Minister Without Portfolio, to Ivan Lexa, Head of Secretariat of the President of the Slovak Republic, 25 March 1991(HM, Annexes, vol 4, annex 46), inquiring about the implementation of Variant C

the second meeting and confirmed *before* the third meeting that it had commenced construction of Variant C.[75] The continuity in Czechoslovakia's conduct from August 1989, if not earlier, is striking. In retrospect, one cannot avoid the conclusion that the 1991 negotiations were for Czechoslovakia a matter of form. Its position had already been determined. Either Hungary would co-operate with completing the Original Project, although with limited and "specified and espoused environmental guarantees" or Czechoslovakia would build Variant C. The assertion that the Czechoslovak decision to build Variant C was not taken until July 1991 is wholly unsupported by the evidence.[76]

39. Slovakia asserts that during the 1991 intergovernmental negotiations Hungary had rejected any EC assistance.[77] Czechoslovakia proposed at the second meeting to set up a trilateral expert Committee with EC participation but refused to suspend construction work either on the Original Project, or on Variant C.[78] Hungary was, indeed, against the proposal because it did not consider it meaningful to conduct "impartial" scientific investigations on the impact of the Project while the bulldozers on the Slovak side were at work full-time. Some months later, at the third meeting in December 1991, Hungary declared that the Committee could begin work if, within ten days, Czechoslovakia informed Hungary that no unilateral work towards the implementation of Variant C would be carried out on the Slovak side until June 1992. Otherwise Hungary would be compelled to take necessary measures, which could include the termination of the 1977 Treaty.[79]

40. According to Slovakia this judgement was "without substance", and the "audacity" of the Hungarian "ultimatum" was "stunning".[80] Explaining this statement Slovakia added that construction work on Variant C–

> "was carried out solely on Czechoslovak territory and involved only its funds. This work had no practical effect whatsoever on the flow of the river and...in no way prejudiced any findings that the [trilateral] Committee might make..."[81]

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announced by the Czechoslovak delegate at the March meeting of the Boundary Waters Commission.

75 HC-M, para 2.52.

76 See HR, paras 2.18-2.43.

77 SC-M, para 5.75.

78 HM, paras 3.143-3.149.

79 HM, para 3.145.

80 SC-M, para 5.87.

81 SC-M, para 5.88.

41. The Slovak Prime Minister pledged in a letter of December 1991 "not to carry out any work in the riverbed of the Danube up to July 1992".[82] Consequently, the work on Variant C would not be irreversible; Czechoslovakia could stop it at any moment. "At worst, [the work on Variant C] might ultimately have resulted in a waste of money and work by Czechoslovakia", as Slovakia put it.[83] However, even given the increased speed of the works, Variant C could not have been implemented before July 1992, so the Czechoslovak pledge was lacking in substance. By now, Czechoslovakia had adopted a further decision on 12 December 1991 "to put the Gabčíkovo part into operation and to complete its construction on the [Slovak] territory".[84] Accordingly, the construction work continued. That is why Hungary came at that time to its conclusion – subsequently proved correct by events.

42. For further explanation Slovakia quotes the Czechoslovak Prime Minister's letter of January 1992, which stated:

> "Provided these conclusions and results of...monitoring the test operation of the Gabčíkovo part confirm that negative ecological effects exceed its benefits, the Czechoslovak side is prepared to stop work on the provisional solution and continue the construction (*only*) upon mutual agreement."[85]

However, the word "only" is missing from the Czech original, which suggests quite a different interpretation.

43. Hungary interpreted this letter as expressing merely the willingness of Czechoslovakia to go back to the Original Project, *after* Variant C had been put into operation; on the basis of Slovak documents now available, this was the correct interpretation.[86] As pointed out in the Hungarian Memorial:

> "Czechoslovakia was unwilling to suspend construction of Variant C and would put into operation the Gabčíkovo Barrage by all means, independently of the work of the Joint Expert Committee."[87]

According to Slovakia, "this was the most perverse reading of the letter", proving again that Hungary had not been negotiating in good faith.[88] Hungary maintains

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82 Letter from the Slovak Prime Minister to the Hungarian Prime Minister, 18 December 1991; SM, Annex 99.

83 SC-M, para 5.88.

84 See Letter from the Czechoslovak Prime Minister to the Hungarian Prime Minister, 23 January 1992; SM, Annex 102.

85 SC-M, para 5.94 (emphasis added). For comparison, see SM, Annex 102.

86 See HR, Annexes, vol 3, annex 65.

87 HM, para 3.151.

that its reading is correct. The means by which "the test operation of the Gabčíkovo part" was to be carried out, at that time, was the completion of Variant C.

44. In a further communication between the two states, Czechoslovakia repeatedly rejected the Hungarian request for suspension. This brought the Hungarian Parliament to its Resolution in March 1992. The Parliament, on the grounds that the continued construction and operation of the Project would result in serious ecological and economic damage, and that Czechoslovakia had decided unilaterally to divert the Danube, authorised the Government to terminate the 1977 Treaty.[89] Accordingly, again after further high level communication aimed at finding a mutually acceptable compromise[90], the Government terminated the 1977 Treaty in May 1992.[91] By this time implementation of Variant C was virtually complete.

7. FURTHER DIFFERENCES OVER EC INVOLVEMENT

45. As pointed out above,[92] Hungary was the first to raise the possibility of EC involvement in the resolution of the dispute. After the unsuccessful negotiations Hungary turned again to the European Community, requesting the assistance of the organisation.[93] In response, the EC declared its willingness to assist the two Parties in the resolution of the dispute and informed them of its readiness to chair a trilateral Committee of experts under the condition that, among others, "each Government would not take any steps, while the Committee is at work, which would prejudice possible actions to be undertaken..."[94]

46. The construction of Variant C was a direct breach of that EC condition. The Slovak Memorial failed to refer to this condition. The Slovak Counter-Memorial, unable to ignore it, seeks to modify its meaning. Slovakia quotes an April 1992 letter of the Czechoslovak Prime Minister, which said that "[t]he Government of the CSFR...is interested in the creation of [the trilateral] Committee without preconditions".[95] Hungary interpreted this in the following

88 SC-M, para 5.95.

89 HM, para 3.157.

90 HM, para 3.161.

91 HM, para 3.165.

92 See HR, paras 2.36-2.98.

93 HM, para 3.156.

94 HM, para 3.158.

95 SC-M, para 5.98.

way: "The words 'without preconditions' meant that Czechoslovakia would not comply either with the Hungarian or the EC conditions".[96] Slovakia calls the Hungarian interpretation of the letter "incomprehensible" and "clearly nonsense".[97]

47. In fact, both the Hungarian Government and the EC Commission talked about the same thing: not proceeding with the construction of Variant C. Hungary was perfectly willing to waive its condition, provided the EC conditions were complied with. Czechoslovakia would comply with neither. Nevertheless, Slovakia asserts that "Czechoslovakia was both willing and able to meet this EC condition".[98] As evidence, Slovakia refers to a draft joint letter to the European Communities prepared by Czechoslovakia which included the following statement:

> "The results of the assessment of the Committee as such will not have any impact on the amendment or termination of obligations arising from the 1977 Treaty..."[99]

Having studied the text, Hungary came to the conclusion that whatever the trilateral Committee recommended to the parties with regard to the environmental impacts of the Project, Czechoslovakia would accept only one outcome of the investigations: the commencement of the operation of the Gabčíkovo-Nagymaros Barrage System.[100]

48. At the same time Czechoslovakia tried to create the impression that it was ready to enter into substantive negotiations with Hungary and to accept the involvement of the European Community. Slovakia refers to a mysterious Vienna meeting in May 1992, "the first trilateral talks that were *convened, but not held*, in Vienna", even though "the two sides were very close to reaching an agreement".[101] In fact, the EC ambassadors to Budapest and Prague suggested holding a meeting in Vienna. However, Czechoslovakia again refused the suspension of any work on Variant C. Hungary "did not fail to attend the

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96 HM, para 3.160. The Hungarian condition was that Czechoslovakia should suspend all construction work.

97 SC-M, para 5.98.

98 SC-M, para 5.100.

99 Draft joint letter to the Vice-President of the EC Commission Frans Andriessen. Attached to the Letter from the Czechoslovak Prime Minister to the Hungarian Prime Minister; SM, Annex 108.

100 Thus there was no reason to sign the draft letter, even though it said that Czechoslovakia "undertakes, as a gesture of good will, not to dam the riverbed on its territory before October 31, 1992..." The question was not when the actual diversion would occur but whether work on Variant C would continue. The Czechoslovak letter made no concession whatsoever on this point.

101 SM, para 4.86 (emphasis added).

meeting", as Slovakia suggests;[102] because of the disagreement no such meeting was ever "convened" in Vienna.[103]

49. Hungary also twice proposed bringing the whole dispute before the International Court in August 1992.[104] Initially the proposal received no answer. For a second time, in August 1992, Czechoslovakia rejected the proposal. "It was possibly through politeness that [Czechoslovakia] did not categorise Hungary's new tactic as deliberately dilatory", states the Slovak Memorial,[105] taking into account the fact that "time has become an extremely important factor".[106] It is no coincidence that by this time the putting into operation of the first phase of Variant C was imminent.

8. THE FINAL STAGE: DIVERSION OF THE DANUBE

50. In the Autumn of 1992 work on Variant C was accelerated. According to press reports, about two thousand people were working in the area day and night, in three shifts, with five hundred trucks delivering stones and gravel for the closure of the river.[107] Thus, as a last attempt, Hungary agreed to the setting up of a trilateral Committee, even if Czechoslovakia did not suspend work on Variant C. The first trilateral meeting took place in Brussels on 21-22 October 1992. The parties decided to set up a trilateral Committee and determined its mandate. The next day, 23 October, the diversion commenced.[108]

51. The EC convened a high level trilateral meeting some days after the diversion. The Parties reached agreement on some aspects of the dispute and signed Agreed Minutes. This stated, *inter alia*, that...

> "all works on Variant C...will be stopped at a date specified by the EC Commission... [Czechoslovakia] undertakes to guarantee to maintain the whole [not less than 95%] traditional quantity of water into the whole old

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102 SC-M, para 5.109.

103 HC-M, paras 2.71-2.72.

104 HC-M, paras 2.84-2.88.

105 SM, para 4.87.

106 Letter from Czechoslovak Prime Minister J Strásky to Hungarian Prime Minister J Antall; 2 October 1992; HM, Annexes, vol 4, annex 99.

107 HM, para 3.182.

108 HM, para 3.186.

> Danube river-bed...and to refrain from operating the [Gabčíkovo] power plant..."[109]

Neither the first nor the second obligation was ever observed.[110] Slovakia now argues that "the commitment...was intended to relate to a very short period", i.e., for three days only, and that "this issue was rendered irrelevant shortly afterwards".[111] Slovakia does not explain the reasons for the unusually short life-span of the Agreed Minutes, neither in its Memorial nor in its Counter-Memorial. In fact, over the following years, a mere 20% of the original water discharge was let into the old riverbed, and the planned construction of Variant C was accomplished by 1994.

109 Known as the "London Agreement" (HM, Annexes, vol 3, annex 31). 95% water discharge appeared as a footnote in the Agreement.

110 See HC-M, paras 2.78-2.83.

111 SM, paras 4.99, 4.102.

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