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THE USE OF ENVIRONMENTAL RESOURCES IN THE CROSSFIRE OF INTERESTS – THE CASE OF GABCIKOVO–NAGYMAROS PROJECT

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Abstract

The past years have proved with a series of obvious evidences that preliminary profit evaluation of planned investments and enumeration of their effects to the social level of well-being is impartial unless effects on environment are acknowledged in the balance. After all, economic activities, having any kinds of positive effects on the society, always use natural resources. It is a grave mistake to regard these resources as costless or free of charge. However, their application and use are virtually free, the pollution of the reservoirs or the abuse of reserves prevent us using them for other purposes; a feature that can be definitely measured on economic scale. Ignoring this value leads to investments reducing social well-being. The Gabcikovo-Nagymaros Project – according to our calculations – is of this kind. The net balance shows environmental costs of similar or slightly higher magnitude than the actual profit.

Keywords: cost-benefit analysis, value of natural capital, environmental economics aspect of hydro power plant.

1. Introduction

When an investment is planned, amount and value of natural resources to be used in order to reach certain economic returns must be assessed. The following example is to show analytical methods for these questions and social advantages of the evaluations. The subject of present research is the plan of the Gabcikovo–Nagymaros Dam. In this case, by diverting the majority of water discharge of the Danube in a 35 km long section into an artificial canal, natural resources (habitats, ground water level etc.) are sacrificed for electricity, shipping and the interests of husbandry of water resources.

Our study simplifies the above mentioned problem to the question of preservation of natural values vs. generation of electricity. This schematisation is done on the basis of profit-and-loss evaluation of SZEKERES et al. (1999). It pointed out that out of the countless economic values of the dam, electricity production bore the highest impact. (Surprisingly, the extended development of the fairway brings only moderate profit.) Similarly, the loss of agriculture, forestry, fisheries and hunting are negligible as compared to the loss of natural values (flora and fauna, habitats, biodiversity).

This study ignores the building of the second dam. The reasons for that lie in our calculations (see KIS et al. (1999)), verifying that this would be an unprofitable investment, even without the consideration of the loss of natural values. If the dam at Pilismarót were realised, even under the best possible conditions (9% discount rate, 2% nominal inflation, 0.5 HUF/kWh maintenance cost) the investment would bring a HUF 74.4 billion loss (−74.4 billion HUF net profit).

Our calculations are mainly based on cash flow assumptions; only profit/loss is counted that is handy for calculations purposes and easy to understand for decision makers. Real profit/loss manifests not only in cash flow, but includes social expenses and benefits. In the Gabcikovo–Nagymaros case the greatest social expenses are externalities.

The process of the investigation is the following: A simple model is set, providing the profits of electricity generation for a 50-year period on the strength of water-discharge of the Danube, parameters of the dam, possible division of water and discount rate based on the expected electricity prices. In the next step this profit is compared to the value of natural resources to be sacrificed for electricity. This comparison will enable us to draw conclusions of the investment, mainly concerning its social (economic well-being) effects. Due to its great extent, the model will not be introduced in full detail, the relationships and data used for the modelling, the reasoning and their interdependence can all be found in KIS et al. (1999).

2. Fundamental Assumptions and Operation of the Model

In this section, the operation of the model developed to analyse the plans of the Gabcikovo–Nagymaros Dams will be presented, including necessary assumptions for the inputs of the model, in order to foster the understanding and the evaluation of our results.

Fig. 1 shows basic assumptions of the model. Measurements of water discharge of the Danube are only available at Bratislava. Since there is no remarkable affluent between Bratislava and Dunacsúny, the measurement results at Bratislava hold at Dunacsúny. This point the water flow is divided into two parts (the ratio depends on agreements), one part is directed into the artificial canal, the second stays in the old riverbed. The water mass of the canal is used for electricity generation. The amount and time distribution of generated energy depend on water discharge, water drop (difference of the water level of head race and that of tail race), mechanical parameters of the power station and its mode of operation. The water mass staying in the old riverbed flows through the turbine of the Dunacsúny power plant, providing fairly small amount of electricity compared to Gabcikovo. The generated electricity of Dunacsúny depends on water discharge, water drop and mechanical parameters of the plant. The income of generated electricity at the two sites minus the maintenance costs provides then the business profit of the dam system for the next 50 years in question. The discounted future profit is the present value of the profit. The profit/loss calculation considers only future cash flows, thus past expenses and gains of non-cash flow types (e.g. social costs and benefits), and past investment costs and benefits (investment cost, income from the sold electricity in the past) are put aside.

Concerning water discharges, the recommendations of VITUKI (Water Supply Research Institute) were accepted; for standard years the average discharge of 1960 (1906 m^3/s), for dry years the average discharge of 1971 (1538 m^3/s) and for wet years the average discharge of 1965 (2848 m^3/s) were used. The amount of generated electricity is calculated as the product of the period of generation and the power of the plant. The maximum capacity of the Gabcikovo dam was set to 720 MW, since this is the built-in capacity of the plant for the time being. Note that complex modelling, embracing fine hydro-geological details was impossible to accomplish due to time and resource limits, thus 'only' accurate, yet not exact, results are gained. The accuracy, however, is supported by independent studies (MVM Ltd., Slovakian sources) that resulted in amounts of electricity in the same order of magnitude, based on similar assumptions. Our train of thoughts is also confirmed by the empirical data of electricity generation of the past few years.

In case of a water power station investment costs are the heaviest expenditures, maintenance cost can be kept low. At Gabcikovo the maintenance cost is around 1 HUF/kWh, and definitely lower than 2 HUF/kWh[1].

Evaluating the domestic electricity market thoroughly, we decided to set off-peak electricity price to 5.27 HUF/kWh, and peak electricity price to 10.54 HUF/kWh for the model (the two prices represent a factor of two), thus daily average price is 6.8 HUF/kWh. We assumed that these prices are going to stay unchanged for the 50 years in question, and that they are equally valid for the two countries. Furthermore, we supposed that the present system of peak hours (45 hours a week) would remain unchanged for the period under review. It is obvious though that the unity of peak hours will change and the system will move from the present peak-off-peak situation towards a multi-peak system, shaped by market mechanisms, and that the tariffs of the individual peaks will differ from one another. The separation of model prices of peak and off-peak electricity may be regarded as the use of higher and lower average electricity prices.

We assumed also that Slovakia produces electricity at a similar price as Hungary does[2].

Electricity prices, just like other monetary figures, are of 1998.

In the calculations real discount rates were used, that is discount rates exceeding inflation. For the modelling we used 12.5% discount rate, and for the sensitivity analysis the effect of 9% and 16% discount rates were examined. A couple of energetics experts suggested that in case of electricity generated at Gabcikovo or Pilismarót, discount rate lower than 9% should be considered due to governmental

[1] Source: telephone communication with István Szeredi, July 1999.

[2] The market price may differ substantially though, but the difference is due to distorting pricing not to different costs. Regarding our analysis expenses are more important.

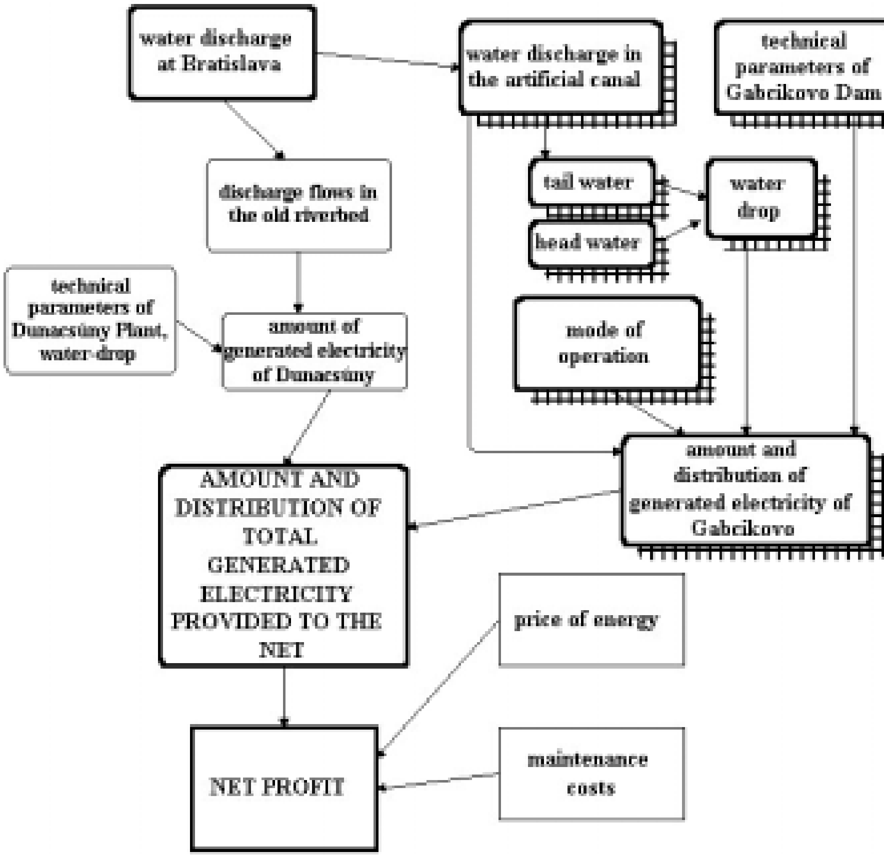

Fig. 1. Structure of the Gabcikovo model

guarantees. We disagreed with this opinion, since such a guarantee would not lower the risk but would shift that from the investors to other parties: MVM Ltd., some of the producers or certain groups of consumers.

Based on the average life span of water power plants, a 50-year long time span was considered in the model, starting from 2000. Some of the used inputs (e.g. price of electricity) may substantially change in such a long period, however, due to the applied 12.5% discount rate these variations would not change the results considerably.

3. Scenarios

The basic scenarios include the constant mode of operation and the peak mode operation providing Szigetköz with 400 m^3/s water-flow. Besides, the effects of shifting to moderate peak mode and peak mode (when substantial amount of water is let into the old riverbed) will be presented.

The three fundamentally different scenarios differ from one another in the ways the operator of the dam exploits the advantages of higher income of electricity generated in peak time, that is to what extent the peak time generation is forced at the expense of the off-peak.

1. In constant throughput (flow-through) mode the water mass of the artificial canal is let to flow through the turbines, the increase of peak time energy generation is not aimed.
2. In case of moderate peak (or scheduled) operation, part of the water mass reaches the dam in the off-peak hours, is retained in Dunacsúny reservoir, and this extra water mass adds up to the basic water flow in the determined 7 peak hours to generate energy.
3. In peak mode, based on the Dunacsúny reservoir, the flow rate of the river at the dam varies excessively in order to maximise the electricity generation capacity at peak time. The theoretical maximum of peak mode was neglected in our modelling. Following the VITUKI recommendations, we assumed that even in peak mode the water flow of the artificial canal should reach the 1000 m^3/s limit, unless low water level and ecological requirements demand it otherwise. The theoretical maximum of the peak mode is not modelled, because its realisation will surely never happen.

Note that in reality a combination of these well circumscribed scenarios will possibly be accomplished. In this ‘hybrid mode’ parameters would change on a daily basis (fluctuation of water level, daily alteration of electricity price in a competitive market), according to the circumstances.

Another difference in the scenarios besides the way of operation is the division of the water mass between the artificial canal and the old riverbed.(See *Table* 1) The parting of water is the key element; it is the weight factor between energy production and preservation of natural values. The more water the riverbed of the old Danube receives, the better the chance to conserve the natural state of Szigetköz is. This feature is characterised by the measure of water mass allowed to flow through Szigetköz.

The required minimum 400 m^3/s is a guarantee that even in the case of low water level enough water reaches Szigetköz.

Finally, out of the outlined options the following scenarios were set for further detailed analysis. For each scenario the possible monthly production rate was determined, based on the discharge data of normal, dry and wet years 1971, 1960 and 1965 respectively, and the average monthly discharge. For long term profit/loss calculations only the latter (average monthly discharge) was used.

4. Results of Models

4.1. The Amount and Distribution of Electricity Generation in the Different Scenarios

Table 1. Possible scenarios for the operation of Gabcikovo dam

No.	Mode	Water flow reaching Szigetköz	Note
1.	Constant	400 m^3/s	
2.	Constant	25%, min. 400 m^3/s	
3.	Constant	45%, min. 400 m^3/s	
4.	Constant	65%, min. 400 m^3/s	
5.	Moderate peak	400 m^3/s	
6.	Moderate peak	25%, min. 400 m^3/s	
7.	Moderate peak	45%, min. 400 m^3/s	
8.	Moderate peak	65%, min. 400 m^3/s	
9.	Peak	400 m^3/s	At least 1000 m^3/s always reach the artificial canal.
10.	Peak	25%, min. 400 m^3/s	At least 1000 m^3/s always reach the artificial canal.
11.	Peak	45%, min. 400 m^3/s	At least 1000 m^3/s always reach the artificial canal.
12.	Peak	65%, min. 400 m^3/s	At least 1000 m^3/s always reach the artificial canal.

The results of electricity generation (on a monthly basis) of the examined scenarios are summarised in *Table 2*. The figures of the third through sixth rows indicate the net power provided to the grid in a dry year, a normal year, a wet year and in the case of average water level, respectively.

The amount of produced energy varies in a broad range, depending on scenario and water level of the given year. The more water reaches Szigetköz, obviously the less energy can be generated with the water mass remaining at Gabcikovo[3]. At a given mode of operation different parting of water may result in a 1400 GWh/year difference in energy production in an extreme case.

Note that the most energy can be provided if the water flow reaching Szigetköz is constantly 400 m^3/s. Diverting 25% yields similar figures, with the only difference that from March till October the quarter of the net discharge is greater than 400 m^3/s, resulting in some loss of generated electricity. In average years and wet years the water mass is excessive for electricity production. In these years the least amount

[3]At the same time, however, the power generation at Dunacsúny grows. The *net* generation (Gabcikovo and Dunacsúny together) will drop though, since the lower capacity turbines at Dunacsúny (only 2*20 MW) can only partially compensate for the loss at Gabcikovo, furthermore, the drop of the water level is much smaller in Dunacsúny than in Gabcikovo.

Table 2. Total net power capacity of Gabcikovo and Dunacsúny plants, for different scenarios (GW/year)

SCENARIOS mode of operation	Water discharge at Szigetköz	Dry year	Average year	Wet year	Average water flow
1. Constant	400 m^3/s	1711	2192	3134	2330
2. Constant	25%, min. 400 m^3/s	1683	2123	2932	2253
3. Constant	45%, min. 400 m^3/s	1431	1740	2349	1833
4. Constant	65%, min. 400 m^3/s	1050	1225	1650	1280
5. Moderate peak	400 m^3/s	1709	2191	3104	2328
6. Moderate peak	25%, min. 400 m^3/s	1681	2121	2926	2252
7. Moderate peak	45%, min. 400 m^3/s	1429	1738	2349	1831
8. Moderate peak	65%, min. 400 m^3/s	1032	1224	1648	1278
9. Peak	400 m^3/s	1695	2157	3065	2288
10. Peak	25%, min. 400 m^3/s	1670	2096	2890	2223
11. Peak	45%, min. 400 m^3/s	1429	1734	2322	1824
12. Peak	65%, min. 400 m^3/s	1033	1225	1635	1280

of electricity can be provided to the net if 65% of water discharge enters the old riverbed.

Electricity generation calculated at the monthly average flow rate is slightly higher than that of the average year (1960). According to VITUKI experts, the cause for that is the slightly more extreme weather of the past few years (much drier than should be), that is the average taken from the last 90 years somewhat exaggerates, and a reduced discharge should be considered as average.

4.2. Gabcikovo Electricity as Domestic Energy Source

Energy provided by Gabcikovo can be considered either domestic or import energy sources. In this section, we are going to examine what the price of total energy is, if both countries regard it as domestic source, that is a more precious, more expensive kind. In this case uniform electricity price may be used for calculation purposes, which also enables us to present the total net profit in *Table3*[4]. Indicated numbers of the table are annual figures, net profit refers to the full lifetime of the project, that is for 50 years.

In the following only average monthly discharge rates are considered. The figures of dry, wet and average years are neglected, mainly because they are considered less trustworthy, and that exact determination of the ratio of the three types throughout the 50 years is rather difficult.

[4]If we use different electricity prices for the two countries, the net profit could be calculated as a

Table 3. Calculated generated capacity and net profit for average monthly discharge rate for the different scenarios, in the case of domestic electricity prices

SCENARIO		Off-peak	Peak	Total	Net profit
Mode of operation	Water flow at Szigetköz	(GWh/yr)	(GWh/yr)	(GWh/yr)	(mn HUF)
1. Constant	400 m^3/s	1 651	680	2 330	107 956
2. Constant	25%, min. 400 m^3/s	1 596	657	2 253	104 388
3. Constant	45%, min. 400 m^3/s	1 298	535	1 833	84 910
4. Constant	65%, min. 400 m^3/s	907	373	1 280	59 293
5. Moderate peak	400 m^3/s	1 559	769	2 328	111 641
6. Moderate peak	25%, min. 400 m^3/s	1 507	745	2 252	108 040
7. Moderate peak	45%, min. 400 m^3/s	1 214	617	1 831	88 284
8. Moderate peak	65%, min. 400 m^3/s	829	449	1 278	62 443
9. Peak	400 m^3/s	1 196	1 092	2 288	123 868
10. Peak	25%, min. 400 m^3/s	1 214	1 009	2 223	118 142
11. Peak	45%, min. 400 m^3/s	1 179	645	1 824	89 281
12. Peak	65%, min. 400 m^3/s	907	373	1 280	59 293

Electricity generated in peak time, according to constant mode operation scenarios, takes only less than 30% of total energy produced. In moderate peak case this ratio reaches 33–35%, in case of peak mode operation it varies between 29 and 47% depending on the individual scenario. This great fluctuation is the direct consequence of the precondition that in peak mode the water flow must exceed, in off-peak period it must be 1000 m^3/s in the artificial canal, unless low water level and ecological requirements demand it otherwise. If Szigetköz is only provided with 400 m^3/s constant flow, excess amount of water remains for electricity generation. This case the above mentioned constraint does not limit the peak time water supply significantly. Hence 47% of total electricity is provided in a few 'peak hours'. In contrast to this situation, if 65% of total discharge is let into the old riverbed, a small amount will only be available for energy production, which is almost impossible to retain (even partially), on the ground of the aforementioned constraint, for peak production. Interestingly enough, in the latter case (65% of water is let to flow through Szigetköz) the moderate peak operating mode offers greater peak time electricity generation capacity than the peak mode operation. Thus, the strict regulation of peak mode operation loses sense.

Compared to constant mode, in moderate peak and peak modes the total amount of energy drops, however, the composition of the produced electricity shifts towards the more precious peak sort. The combination of the two effects results in a greater net profit; in case of moderate peak this is extra HUF 3.1–3.7 bn, or 3.4–5.3%, in case of peak mode operation HUF 4.3–15.9 bn, or 5.1–14.7% (neglecting the last scenario, resulting in no changes at all). This growth of benefit is not substantial, does not yield remarkable advantages that would support any kind of

function of electricity shared by Hungary and Slovakia.

peak mode operation of the plant. Peak mode operation is only advantageous if the least amount of water is let into the old riverbed; the total net profit brings extra 13–14% yield. However, if we assume that for peak mode operation the construction of a lower dam is necessary (e.g. at Pilismarót), the net building cost of the second dam lessens the net benefits of Gabcikovo, thus peak mode operation is a less favourable option than moderate peak or constant mode operation.

4.3. Division of net Profit between both Countries

The share of Hungary from the generated electricity at Gabcikovo rates between 16–50%. *Table 4* summarises the net profit of the two countries in case of different scenarios, if the electricity share of Hungary is 50, 33 and 16%, respectively. The proportion of received electricity is a function of the share of building costs of the dam and ancillary projects between Hungary and Slovakia. Since no respected data are available, the aforementioned three figures (showing a large scatter) are used.

Table 4. Share of net profit between Hungary and Slovakia for the different scenarios

		Net profit (mn HUF)						
			Hungary			Slovakia		
Mode of operation	Water discharge at Szigetköz	Total	16%	33%	50%	84%	67%	50%
1. Constant	400 m^3/s	107 956	17 273	35 625	53 978	90 683	72 331	53 978
2. Constant	1100 m^3/s	72 155	11 545	23 811	36 078	60 610	48 344	36 078
3. Constant	25%, min. 400 m^3/s	104 388	16 702	34 448	52 194	87 686	69 940	52 194
4. Constant	45%, min. 400 m^3/s	84 910	13 586	28 020	42 455	71 324	56 890	42 455
5. Constant	65%, min. 400 m^3/s	59 293	9 487	19 567	29 647	49 806	39 726	29 647
6. Moderate peak	400 m^3/s	111 641	17 863	36 842	55 821	93 778	74 799	55 821
7. Moderate peak	1100 m^3/s	75 395	12 063	24 880	37 698	63 332	50 515	37 698
8. Moderate peak	25%, min. 400 m^3/s	108 040	17 286	35 653	54 020	90 754	72 387	54 020
9. Moderate peak	45%, min. 400 m^3/s	88 284	14 125	29 134	44 142	74 159	59 150	44 142
10. Moderate peak	65%, min. 400 m^3/s	62 443	9 991	20 606	31 222	52 452	41 837	31 222
11. Peak	400 m^3/s	123 868	19 819	40 876	61 934	104 049	82 992	61 934
12. Peak	1100 m^3/s	76 892	12 303	25 374	38 446	64 589	51 518	38 446
13. Peak	25%, min. 400 m^3/s	118 142	18 903	38 987	59 071	99 239	79 155	59 071
14. Peak	45%, min. 400 m^3/s	89 281	14 285	29 463	44 641	74 996	59 818	44 641
15. Peak	65%, min. 400 m^3/s	59 293	9 487	19 567	29 647	49 806	39 726	29 647

The table indicates the proportion of the net profit of both countries, and clearly shows the loss of profit of Slovakia as a function of the water mass let into the old riverbed, which is a basis for claiming compensation during the negotiations. Compensation for the loss of profit, however, may be assent, for example, in a way to lessen the share of Hungary for the benefit of Slovakia. If the Hungarian share is reduced from 50 to 25%, the situation of Slovakia remains the same, and the constantly decreasing Hungarian electricity consumption may cover the costs of ecological needs of Szigetköz.

Another option, opposing the previous solution, is to increase the Hungarian share in the investment, for example, by buying into the Gabcikovo complex. Certainly, such a financial step should be anticipated by a study more detailed and thorough than this one, figures of *Table 4* show how much the supplementary share is worth as a function of share of water.

Fig. 2 displays some indifference curves, representing different situations of Slovakia with the same profit rate. The curves relate to different profit levels, though any point of a given curve characterises similar benefit. Our assumptions remained unchanged: constant mode of operation, 12.5% discount rate, peak and off-peak electricity price 5.27 and 10.54 HUF/kWh, respectively, stable electricity prices over the 50 years in real terms, 1 HUF/kWh maintenance cost. The graphs visibly show how the Hungarian electricity share can be substituted by greater water flow into Szigetköz. Curves touching negative domains indicate that the amount of generated electricity is so low that Hungary no longer receives electricity, furthermore is forced to pay compensation. The compensation is a given percentage of the produced electricity, thus the absolute burden of Hungary does not grow exponentially, since the high percentage of compensation is levied to a fairly low volume of electricity generation.

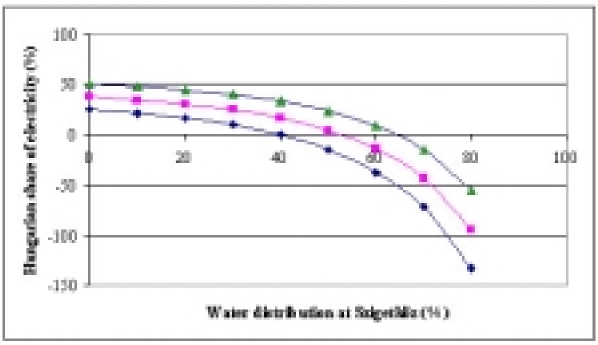

Fig. 2. Indifferent situations of Slovakia

5. The Value of Sacrificed Natural Capital

For the 90's, even strict monetarist economists acknowledged that cost/benefit calculations must include the evaluation of the value change of natural capital, and besides the calculation of the returns of man-made capital, the rate of return of natural capital must be considered. Beside theoretical agreement, the form and extent of this value change is disputed extensively. The methodological problems (that some of these values are hard or even impossible, maybe not expedient to measure in financial terms) do not necessarily mean that in economic decisions the value of natural resources (and their change) should not be assessed.

During the planning of the Gabcikovo–Nagymaros Dams, environment affected either by the operation or by the building procedure was not evaluated, only compensation provided for owners for expropriation was included. Economic calculations examined the project only from the perspective whether net profit covers investments (i.e. expropriations, planning and building of the dams etc.), that is if the cash flow balance is positive.

However, as far as the accounts of both countries are considered, in the light of recent scientific evidences and the international practice[5], natural resources invested in the project (both of its components) should be recognised.

A research group of Budapest University of Economics, Department of Environmental Economics and Technology prepared an evaluation, in order to determine the financial value of this investment (see Changes of the Value of Natural Capital in Szigetköz Region, 1998).

Table 5 contains the evaluation of aggregated economic values.

Table 5. The shrinking of aggregated economic values of Szigetköz due to Gabcikovo–Nagymaros project (bn 1997 HUF)

Components of the aggregated economic values of Szigetköz	Depreciation due to 'C' variant		Location of details in source
	2% Discount Rate	3.5% Discount Rate	
Flora	261–526	149–300	Chapter 5
Fauna	590	590	Chapter 5
Forestry	7.1	4.3	Sections 6.1–6.3
Livestock	0.37–0.62	0.21–0.35	Chapter 7
Fishery	0.36–0.46	–	Chapter 8
Agriculture	1.9–5.98	1.14–3.42	Chapter 9
Subsurface water reserve	7.35–82.3	4.71–48.44	Section 10.1
Surface water reserve	105.5	60.3	Section 10.2
Rolled sediment	1.65–4.4	0.9–2.5	Chapter 11
Buoyant sediment	–	–	Chapter 11
Total	**975–1322**	**811–1009**	

Source: Evaluation of Budapest University of Economics, Department of Environmental Economics and Technology about damages of Szigetköz, Budapest, 1998.

It is calculable from the figures of the table that the depreciation of natural capital is assumed to be in the order of HUF 800–1300 bn, in the form of rent in perpetuity. This is about USD 3.5–6 bn loss of capital, which is rather substantial, in the same order of magnitude as the actual capital investments.

The assumptions are available only for Hungary; the Slovak party suffered no damage, according to their own reports. However, if depreciation of natural values were assessed on both sides (according to the above mentioned method), the result would be comparable to the investment, altering the ratio of both countries' investment costs significantly.

[5] In some states of the US juridical examples are available.

It is also clear that the method is new, thus, it leaves space for critique. At the same time the conclusion can be drawn that natural capital, as part of investments may make substantial amounts, hence talking about investments or proportions without neglecting natural resources is a major mistake.

Lacking any better alternatives than sharing of the produced electricity, if the ratio of investments is considered the Hungarian contribution ranges somewhere between 16 and 33%; including the depreciation of resources it may even exceed 50%. This ratio might be changed by future investments, like rehabilitation of the riverbed at Szigetköz, river management of the section under Szap or in an extreme case the building of the lower dam.

Let us now refer back to pages discussing the profits of the energy production. We have found there that energy generation, depending on the scenario, will yield HUF 9–61 bn profit for Hungary. It is visible that the sacrificed natural capital is of the same or moderately greater order of magnitude, thus the incorporation of the depreciation of natural resources is inevitable in similar projects, because it may fundamentally affect the realisation of the project.

6. Summary

Conclusions of the above analysis may be summarised in the following:

- Hungarian energy market provides sufficient amount of electricity to satisfy the demands. Moreover, further plants are planned to be completed soon, the import potential grows, the country exhibits an expressive energy efficiency potential. In the light of these facts, the energy produced by Gabcikovo is redundant, but if – as the result of the negotiations – Hungary may claim certain part of that, it is worthwhile considering to exchange that into extra water mass for Szigetköz.
- The dimension of the invested money of both governments into the Gabcikovo project is rather shadowy, thus the proportion of investment, the basis of sharing electricity, must be handled with care. The assessment of the volume of investments is hindered by inaccurate and incoherent records, changes of technological level, the difficulty to assess discount and exchange rates and the allocation of ecological damages. Provided that investment ratios determine electricity shares, Hungary deserves 16–50% of the generated electricity. By sacrificing this energy a notable amount of water can be re-directed into Szigetköz.
- Depending on the different modes of operation (constant, moderate peak, peak), the net profit changes considerably, though not dramatically. In the last two cases the generated electricity may be merchandised at a higher average price, the increase of the benefits is limited by the drop of the available peak capacity. Compared to baseline scenario (constant mode), in moderate peak mode 3–5, in peak mode 5–14% extra profit may be realised, depending on sharing water discharge. Peak mode is, however, rather harmful from environmental point of view, and most experts agree that it also requires the

completion of the lower dam. Provided that a lower dam is, by definition, an unprofitable investment, the joint plants in peak mode offer a less favourable option than the Gabcikovo power station alone, operated in constant mode.

- Providing Szigetköz with the ecologically required amount of water would cost, at 12.5% discount rate and stable price level in real terms, HUF 23–48 bn in total, HUF 2.3–4.8 bn annually. This is the value of the loss of energy due to conservation of natural values. If higher discount rates are applied, this may decrease to HUF 18–39 bn. If the water needs of Szigetköz are satisfied on the account of the Hungarian electricity share generated at Gabcikovo, the cost will further decrease, since this energy may be regarded as import, thus cheaper source. According to an estimate (Budapest University of Economics 1998), the overall value of Szigetköz exceeds HUF 1000 bn, thus from the social welfare point of view part of the energy generation capacity is worth to be sacrificed for the water supply of Szigetköz.
- The volume of net profit is a function of discount rate and the gap between the peak and off-peak electricity prices. Maintenance costs do not influence the net profit substantially.

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