Pilot study of cost proportionality analysis according to the *“new Leipzig approach“* in the catchment of the Stanovice Reservoir in the Czech Republic

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Abstract

The growing demand for clean water has led to the adoption of the EU Water Framework Directive (Directive 2000/60 EC; WFD). The new legislation has had a major impact on water management and national economies and instituted numerous requirements, including *"good status"* of all water bodies by 2015. However, achieving *"good status"* is associated with large investments, often beyond the capabilities of polluters. In justified cases, member states may request an extension of the deadline based on disproportionality of the costs of meeting the WFD requirements. The Framework Directive doesn't provide a clear explanation how the cost proportionality should be assessed. Within the EU, it is possible to meet a number of different approaches. These approaches are mostly based on cost-benefit analysis. One of the alternative approaches is the German methodology *"new Leipzig approach"* which is the subject of this pilot study in the catchment of the Stanovice reservoir in the Czech Republic. Based on the results of the mentioned methodology, the application of the measures seems to be cost proportionate and thus the exemption should be refused. This analysis thus represents an alternative approach to the Czech official methodology based on CBA, which is also currently being applied in this catchment.

General introduction

With the constantly increasing requirements on water quality, demand for *"good status"* of water bodies also grows. It is 15 years since the adoption of the Water Framework Directive (WFD) this year; it was created in response to the growing demand for clean water and an integrated approach to water body management across the EU member states. The primary environmental goals of the directive include the provision of protection, improvement of status and renewal of all water bodies, aiming at achieving their *"good status"* by 2015. *"Good status"* of a surface water body refers to such a state where its ecological and chemical conditions are at the minimum "good". Both ecological and chemical status of surface waters are assessed according to a number of criteria (Biological quality such as composition and abundance of fish or benthic invertebrates, hydromorphological quality such as the dynamics of flow, physico-chemical quality such as temperature or nutrient conditions, chemical quality according to environmental quality standards, which specify concentrations for specific pollutants). The WFD applies to this field a "one out, all out" approach, which means if part of a water body fails on any one of the criteria, it will fail to achieve *"good status"*. The total status is assessed against the scale of high, good, moderate, poor and bad.

The existence of the Directive and its implementation have a major impact on the economic policy of all EU member states. The binding targets of the Directive are very ambitious in relation to a large portion of water bodies. Achieving their *"good status"* thus, may significantly increase member states' monetary requirements of authorities in charge for the implementation of required water management measures, including potential social impacts on the populations, e.g., due to increased sewage or water charges. Under certain conditions, however, the Directive sets exemptions that may be applied to justify non-achievement of a good water body status by 2015. These exemptions can be both short-term and long-term and they must always be based on at least one provision of an applicable article of the directive.

Measures adopted to achieve *"good status"* of water bodies require costs, which may be disproportionate in many cases in contrast to the expected benefits. In these specific cases, member states may apply for a temporary exemption and extension of the deadline for achieving *"good status"* for reasons of disproportionate costs. Nevertheless, the Water Framework Directive grants a relatively high level of discretion relating to the definition of the cost proportionality threshold (e.g. Nocker et al., 2007; Jensen, Jacobsen, Olsen, Dubgaard, & Hasler, 2013; Martin-Ortega, Balana, Perni, & Slee, 2013; Klauer, Sigel, Schiller, Hagemann & Kern, 2015). Designing appropriate methodologies and procedures for assessing proportionality of costs has become a challenge and the subject of debate among the professional public across the member states in recent years.

In the literature, there are two different fundamental attitudes to evaluating cost proportionality, which are also used in the practice. Proportionality of society-wide costs is either evaluated using cost-benefit analysis (CBA) and its modifications (e.g, Hanley & Black, 2006; Jensen et al., 2013; Martin-Ortega et al., 2013; Galioto et al., 2013; Vojáček, Slavíková, Macháč, & Smejkal, 2013) or using criteria with which the costs of measures are compared (e.g. Brouwer, 2004; Courtecuisse, 2005; Laurans, 2006; Klauer et al., 2007; Klauer et al., 2015).

Currently certified methodology for assessing cost proportionality in the Czech Republic is based on the CBA (Slavíková, Vojáček, Macháč, Hekrle & Ansorge; 2015). By contrast, German methodology is built on criteria. Klauer et al. (2015) makes a comparison of the costs of measure implementation with expenditures in water management in the area made so far and with additional benefits, which are caused due to the realization of measures. This approach/methodology is known as the *"new Leipzig approach"*. Low time and cost demand is considered as the main advantage of this procedure.

The subject of this study is the application of the *"new Leipzig approach"* in the case within the Czech Republic. The aim is to carry out a pilot study and to verify the possibility of transfer of the procedure abroad. The catchment area of the Stanovice reservoir was selected for the purpose of the study. This catchment belongs among areas which faces phosphorus contamination and eutrophication of surface waters. For this reason some parts of the catchment don't achieve the "*good status*".

First in the study the chosen area and possible measures to solve the problem are characterized. Then according to the *"new Leipzig approach"*, the current and past costs of investments in water management and environmental protection within the Czech Republic are determined. In the following steps, we determine the costs of achieving the *"good status"*, costs corresponding to the size of the territory from the past, the distance of the target to achieve the "*good status*" and additional benefits from achieving the "*good status*". From previous steps the costs of measures were compared with the past costs taking into consideration the additional benefits. The final section includes the discussion of possible applications of the *"new Leipzig approach"*.

Characteristics of the catchment area of the Stanovice reservoir

Stanovice reservoir is situated near Karlovy Vary in Western Bohemia in the Czech Republic (see Figure 1). There are two inflows-brooks into the reservoir (Lomnický potok and Dražovský potok) that have an impact on water quality. Including these brooks, the area covers 92 km^2. According to Povodí Ohře (2014) the primary purpose of the Stanovice reservoir is supplying drinking water for the Karlovy Vary area. There are also several minor functions, such as electricity generation and fishery and flood protection of Karlovy Vary.

Figure 1: Location of Stanovice reservoir

Source: Own construction using Google maps and Povodí Ohře (2014)

According to Povodí Ohře (2009b), the present status of water in the Stanovice reservoir water body was unsatisfactory. The status was potentially unsatisfactory at the inflow of the Lomnický brook into the reservoir. The water is subject to natural enrichment with Fe, Mn, COD-Mn and humins. The water quality is affected primarily by anthropogenic effects from the catchment area (population, agriculture), which is why a moderate revival occurs in the reservoir in the summer months, and it is monitored closely with a view to potential cyanobacterial growth. The main sources of phosphorus are point sources (wastewater) and diffuse sources (mainly agriculture). According to information from the T. G. Masaryk Water Research Institute (Výzkumný ústav vodohospodářský T. G. Masaryka), achievement of *"good status"* requires a reduction of phosphorus inflow into the reservoir by 60-200 kg a year compared to the present status. This study calculated with a reduction of 200 kg of phosphorus annually at the inflow to the reservoir. According to Ansorge & Drozd (2014), there are only 16 small settlements in the study catchment area of the Stanovice reservoir, therefore, the contribution of phosphorus is distributed evenly between point (municipal wastewater) and diffuse sources (agricultural activities).

In the Stanovice reservoir catchment, 243 possible measures for wastewater and agriculture sources have been identified. Measures relating to construction and renovation of wastewater treatment plants, sewer systems, dead-end and accumulation cesspits, retention wetlands, biological reservoirs and domestic wastewater treatment plants, and measures relating to intensification of the treatment process at wastewater treatment plants were proposed for the point sources. Agricultural phosphorus inflow measures involved in the case of the Stanovice reservoir include 5 types of measures (building of a broad-base terrace, grassing of sloping areas, changes of crop rotation, leaving crop residue, and introduction of no-tillage methods). Table 1 summarises the basic characteristics of the catchment area.

Table 1: Basic characteristics of the Stanovice reservoir catchment area

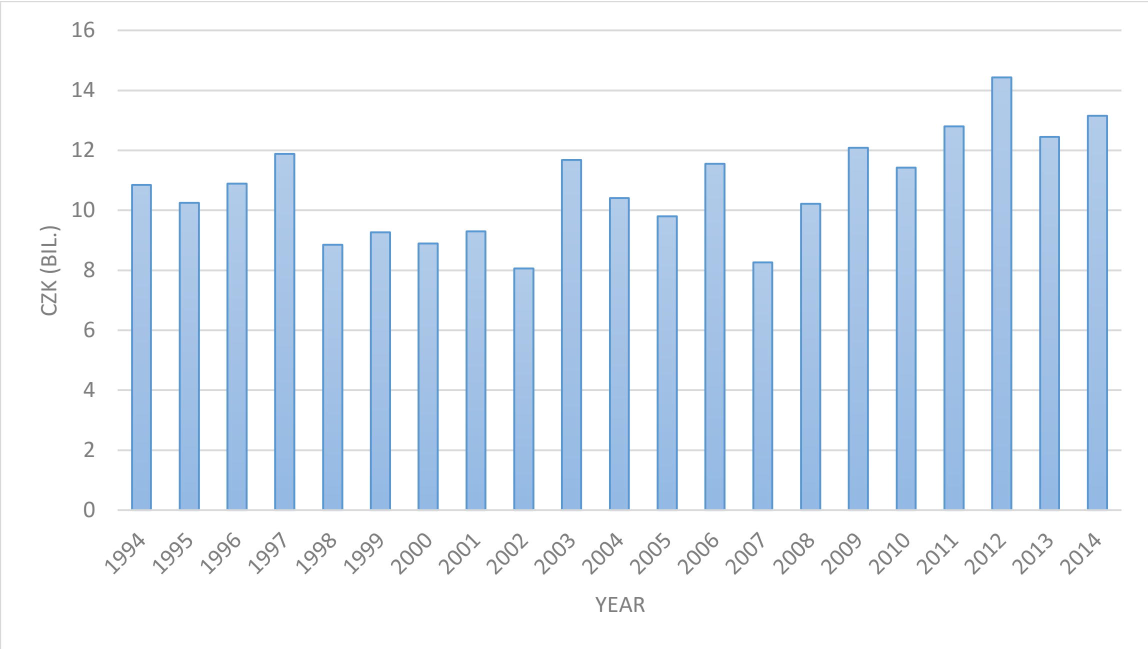
Area	92 km^2
Location	Western Bohemia
Natural and other conditions	Homogeneous
Reduction target	200 kg/year
Number of potential measures	243
Types of measures	Point and Agricultural phosphorus inflow measures

Source: Own analysis

Investment costs in water management and environmental protection

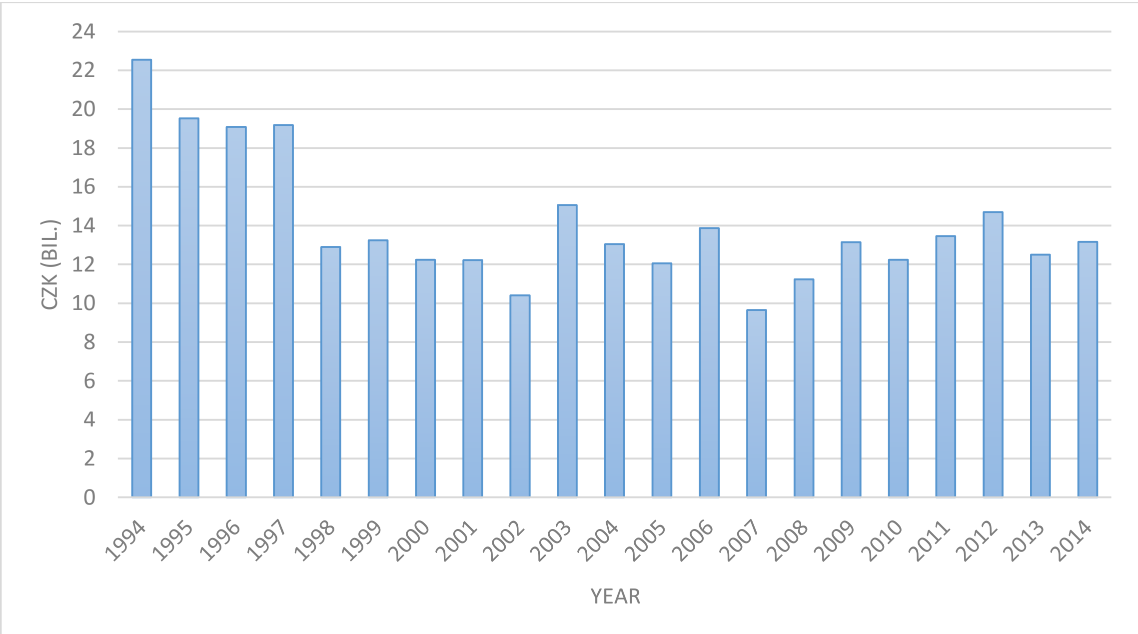
A comprehensive database of investment in water management in the Czech Republic isn´t kept. Necessary data are collected and analyzed by several institutions at different levels. At the national level, data of investments costs are collected mainly from the Czech Statistical Office (2015a). We use a time series of the criteria "Environmental Protection Investment", particularly the one related to Wastewater Management and the other one to Soil, Groundwater and Surface Water Protection and Remediation. In total, we have 21 observations which started in 1994 (after the splitting of Czechoslovakia into the Czech Republic and the Slovak Republic). Considering the long time series it is necessary to adapt the data for inflation and express all investments in the prices of the current period.

Figure 2: Investment in nominal prices (Nominal expenditures)



Source: Own analysis using Czech Statistical Office (2015a)

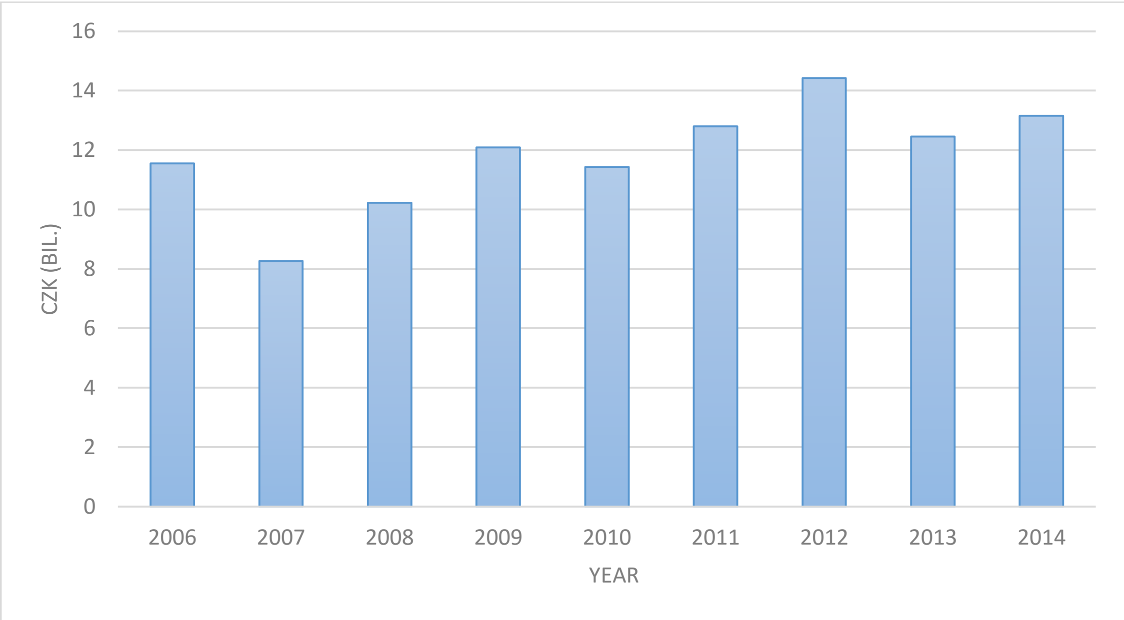
Figure 3: Investment in 2014 prices (Real expenditures)



Source: Own analysis using Czech Statistical Office (2015a)

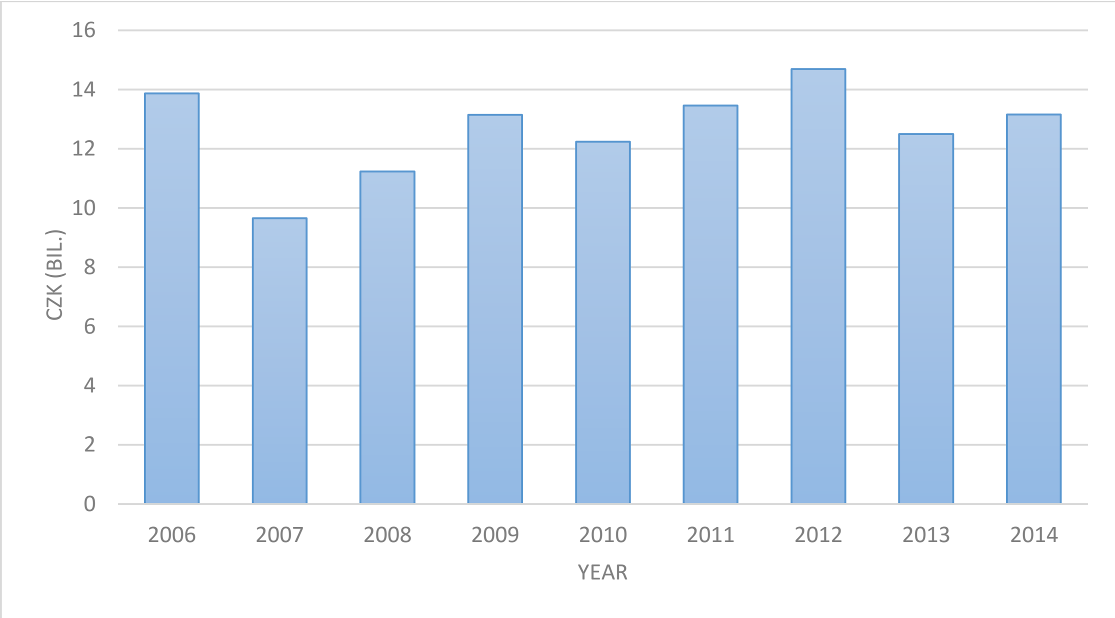
Although according to the Czech Statistical office (2015b), inflation has been rather moderate in the past 10 years, high values in late 90's suggest recalculating our numbers to 2014 prices would make the information more accurate. Indeed, expenditures in some years almost doubled in comparison to the original prices. After readjusting to the 2014 prices, we calculated an average per year investment (CZK 14,338 million). To be consistent with the *"New Leipzig Approach"* we count only the investment before 2009 (starting of the first planning cycle). As we can see from the figures above, there is no noticeable trend in recent years and the real expenditures oscillate around CZK 12 bil. A significant increase in 2003 was mainly because of additional spending on flood protection after floods in 2002. We got almost an identical number when we used data from an annual statistical report on the environment published by the Ministry of the Environment (2005 - 2014) CZK 11,976 million.

Figure 4: Investment in nominal prices (Nominal expenditures)



Source: Own analysis using Ministry of the Environment (2005 - 2014)

Figure 5: Investment in 2014 prices (Real expenditures)



Source: Own analysis using Ministry of the Environment (2005 - 2014)

We ended up with a significantly lower number when we used data from the Ministry of the Environment (2015) the Ministry's information portal Monitor (2015) CZK 7,880 million. This result is not surprising since it only accounts for money which goes directly through the Ministry and ignores all private investments. We decided to work with the highest value, which we believe is the most accurate one.

First we calculated the average investment per year, per squared kilometer. Dividing the total average investment by the total area of the Czech Republic (78,866 km^2) gives us the final result CZK 181,802. To find this average in Euros, we used the average exchange rate in 2014 published by the Czech National Bank (2015). The average investment in Euros was EUR 531 million. After dividing this number by the total area of the Czech Republic, we get a total spending per squared kilometer of EUR 6,731. This is significantly less than in Germany where EUR 25,000 per squared kilometer was invested in recent years (Klauer et al., 2015).

Step 1: Estimating the cost of achieving *"good status"*

Costs of achieving *"good status"* are determined on the basis of cost-effectiveness analysis (CEA), which was performed by Macháč, Slavíková et al. (2015). Macháč et al. (2015) identified the costs of possible measures in the catchment and found using the CEA and cost-effectiveness ratio the cheapest way, how to solve the problem with eutrophication.

Monetisation of costs was based on expert studies, catalogues of measures or a market survey in the form of a non-binding request with contractors/implementers of measures. Annual cost was calculated using the annualised cost method. The known value of present investment, operating and other costs (such as administrative costs, lost profits) are transferred to a future flow of the same costs based on annual costs, which correspond to the known present value when cumulated. Annualized costs of every measure were computed using:

$$AC = PVC \times \frac{i \times (1+i)^l}{(1+i)^l - 1} \qquad (1)$$

Source: Own construction

Where: AC – total annual costs in the annualised form
PVC –present value of costs
i – discount rate
l – expected lifetime of the measure

Direct comparison of different measures using total costs of measures is not possible, because individual measures don't differ only in their costs, but also in the size of effect of measures (annual amounts of reduced phosphorus). Authors therefore compute relative cost-effectiveness ratio:

$$Relative\ cost\ effectiveness\ indicator = \frac{\begin{matrix} total\ annualized \\ costs\ of\ measure\ (AC) \end{matrix}}{\begin{matrix} annual\ effect \\ of\ measure \end{matrix}} \qquad (2)$$

Source: Macháč et al. (2015)

Using this approach it is possible to rank measures according to their effectiveness. It is then possible to add up different measures until the goal is achieved. The application of the optimisation CEA method may be complicated by the actual nature of the measures being considered. In many cases, the various categories of measures proposed for implementation in the same area may affect one another. In extreme cases, they may be substitutes, with the application of one measure ruling out the application of another. For example, arable land cannot be simultaneously afforested and subjected to a change in the tillage technique. Van Soesbergen, Brouwer, Baan, Hellegers & Polman (2007) give more examples of possible connections between measures. Implementation of some measures may be conditioned by the adoption of others. The summed size of the effects may be different when combining different measures than when implementing them separately.

In the case of Stanovice, it is possible to identify two fundamental problems, which are connected with mutually exclusive measures and sequential measures. As stated by Macháč et al. (2015), it is necessary to use a more complex optimization algorithm of dynamic CEA.

Based on calculations, Macháč et al. (2015) presented the possibility to reduce phosphorus inflows by 344.6 kg each year. From dynamic CEA it is concluded that the reduction of 200 kg can be achieved with annualized costs of CZK 1,147,844 (EUR 42,465). 55 % of the cost can be spent on reduction at point sources. Measures focused on point sources also contribute according to the result of CEA most significantly to the total reduction of phosphorus (123.75 kg), followed by the grassing of the sloping areas (26.45 kg) and introduction of no-tillage methods (26.36 kg). A list of the most cost-effective measures is enclosed in the appendix. Given the importance of the point sources measures, another dynamic CEA is constructed, this time taking into account only point sources reductions. It is shown that targeted reduction still can be reached, but annualized costs of this approach are considerably higher – CZK 8,917,764 (EUR 329,921). To achieve the *"good status"* this study expects the implementation of measures during the period 2016-2027.

According to our communication with Povodí Ohře we know additional policies with an impact on phosphorus inflows were considered since 2009. Povodí Ohře (2009a, 2009b) states that there were a couple of policies proposed and carried out since 2009 for the first planning cycle affecting the water bodies of the Stanovice reservoir and Lomnický potok directly. These include (in the case of Stanovice): Management of water sources' protected areas (OH100104), Minor polluters and settlements with less than 2000 residents (OH100116), Migration permeability (OH100117), Support of littoral communities (OH100120), Intervention into biocoenosis – amount of fish – ponds (OH100123) and exploratory monitoring (OH100130). Only three of them (OH100104, OH100123 and OH 100130) were applied to the Lomnický potok. These policies are general and we are unable to associate costs with specific water bodies. According to Povodí Ohře (2009a, 2009b) main emphasis was placed on monitoring. Our estimate is, that these costs are not very significant and do not have a major impact on results of achieving *"good status"* of the catchment and thus on the result of this study.

According to the Ministry of Agriculture (2015), there will be 4 policies included in river basin management plans for the second planning cycle affecting the water bodies we are interested in: improving technology in Stružná's wastewater treatment plant with focus on phosphorus reduction, clearance of biological pond in Stružná, construction of a wastewater lifting plant in Horní Dražov and building of a sewage system and a wastewater treatment plant in Tašov. All these measures are included in the cost-effectiveness analysis. The first three policies are more or less included in estimate of annualized costs – in two cases, chosen policies differ from the proposed ones, but their effectiveness is not significantly lower. In the case of Tašov the policy in question was ruled out as strongly cost-ineffective compared to other possible measures.

Step 2-1: Scaling on the area of the water body

In this part, we compute costs of investments in water management and environmental protection for Stanovice. As stated above, the average spending per squared kilometer in the Czech Republic is CZK 181,802. We also know that the relevant area covers 92 km^2. Based on this input data we can compute annual spending on the Stanovice reservoir using formula:

$$181{,}802\,\frac{CZK}{km^2} * 92km^2 = CZK\ 16{,}725{,}784 \qquad (3)$$

From this computation we can conclude CZK 16,725,784 (EUR 619,244) is annually spent on the Stanovice reservoir.

Step 2-2: Determination of distance to target

To successfully assess the cost proportionality of suggested measure we need to determine distance to target. However, we encounter a major issue in the process, because most of the indicator values, which are used in the *"new Leipzig approach"*, were not recently measured, analyzed or published for the Stanovice reservoir and its inflows. This is apparent from Table 2, which shows the current state of important indicators.

Table 2: Current state of achieving the *"the good status"* according the indicators

	Macrophytes/ Phytobenthos	Macroinvertebrates	Phytoplankton	Fish	Environmental quality standards
Lomnický potok	U	2	U	U	U
Dražovský potok	U	U	U	U	U
Stanovice reservoir	U	U	1	U	U

Source: Own construction using T. G. Masaryk Water Research Institute (2015)

Numbers represent the state of different indicators while "U" indicates unknown which is mostly connected with the fact, that the indicators were not evaluated yet or the samples weren't taken. Relying on an older date does not help much. The last measurement was carried out in 2009, but presented results only say if the targets for each indicator were reached or not. We use Melichar's (2015) research to determine the state of water reservoirs in question. He states only 3 water bodies achieved the *"good status"* in the Karlovy Vary region between 2013 and 2014, Dražovský potok being one of them. This is confirmed by the latest research by the Water Research Institute as they conclude *"good status"* was maintained. Therefore we use 0 as the distance to target by Dražovský potok. The possible measures were identified according to the state in the year 2013. However, the Dražovský potok is an inflow of the Stanovice reservoir, so it might be desirable to apply additional measures with respect to their cost effectiveness also in this water body which achieved the *"good status"*.

The situation is more complicated for the remaining two water bodies. We are still missing several important values (7 indicator values from 15) because some water samples were not taken and analyzed during the last measurement of water quality. From the past according to Povodí Ohře (2009b) Stanovice reservoir did not reach the *"good status"* in 3 main biological indicators and hydro morphology at the beginning of the first planning cycle. However, the situation has changed significantly in recent years. Evaluating the status of the Stanovice reservoir as insufficient is arguable since it is probably very close to reaching the *"good status"*. However, we are interested in its state in 2013 and the situation back then was probably worse. We estimate the distance to target to be 0.2. For Lomnický potok we use again the data from Povodí Ohře (2009a). The state of this water body is unsuitable in the long term as at least one of the important indicators exceeds the required values. For the first planning cycle it was the indicator Fish, which has been replaced by the indicator of phytobenthos recently. Based on these observations we use 0.1 as our distance to target. Our conclusions are summarized in Table 3.

Table 3: Distance to target in the year 2013

Water body	Category	Current state	Distance to target
Lomnický potok	stream	*insufficient status*	1/5
Dražovský potok	stream	*Good status*	0
Stanovice reservoir	HMWB	*insufficient status*	2/5
Average			**0.2**

Source: Own analysis

The main reason for not achieving the *"good status"* is excessive phosphorus inflow for both water bodies. The situation has improved lately, but additional measures are still needed.

Step 2-3: Determination of the added benefits

In this part we estimate additional benefits of reaching the *"good status"*. These benefits can be divided into 5 main categories: Ecology and nature protection; Freshwater provision and treatment; Flood protection; Soil protection; Tourism, recreation, cultural heritage and landscape. Based on the German methodology, we evaluate each group's importance on a scale from 0 to 3 (3 = highest additional benefits). Results are presented in Table 4. The average additional benefit is important for purposes of this case study as it enters one of the formulas given by the used methodology.

Table 4: Total additional benefits of whole catchment of the Stanovice Reservoir

Ecology and nature protection	Freshwater provision and treatment	Flood protection	Soil protection	Tourism, recreation, cultural heritage, landscape	Total additional benefit (average)
1	2	1	2	1	**1.4**

Source: Own Construction

Specific benefits of individual categories are described below:

Ecology and nature protection – Reducing nutrients loading may lead to lower population or extinction of some cosmopolitan species, which would lead to higher diversity. It can also lead to an alteration of bank vegetation and higher diversity in favor of oligotrophic species.

Freshwater provision and cleaning – We assume, that measures will lead to lower costs of water treatment because of higher water quality. The extent of improvement is not easy to evaluate. It depends on what type of phytoplankton develops in the reservoir after the measure application. It is necessary to mention that improving the state may in some cases lead to the development of blue-green algae. If technological process is not able to deal with it, lowering costs is not certain and even an increase in costs is possible.

Flood protection – Benefits in this category are negligible. The only possible effect is erosion control, which can reduce water outflow from the catchment area during torrential rains.

Soil protection – As mentioned above some measures can be classified as erosion control. Other benefits of soil protection are maintaining the constant level of soil fertility and lower usage of fertilizers, because nutrients stay in soil.

Tourism, recreation, cultural heritage, landscape – We include into benefits higher aesthetic values. Also property values tend to increase with water quality improvement, which benefits all property owners near the water bodies. Usually there are considerable benefits associated with increased recreational activity. However, given the purpose of the Stanovice reservoir these benefits are negligible, because swimming in the water reservoir is prohibited.

Step 2-4: Determination of expense factor and cost threshold

Based on the previously collected data, it can be computed "expense factor", which gives us information by how much we can afford to increase costs compared to the past. Equation 4 shows formula given by the *"new Leipzig approach"* we use in this study.

$$expense\ factor = \frac{2}{18} * distance\ to\ target + \frac{1}{18} * average\ additional\ benefits \quad (4)$$

Source: Klauer et al. (2015)

From the nature of this equation it is obvious the result cannot exceed 0.5, because the maximum value of distance to target and maximum additional benefits are 3. That means the increase in costs compared to the past cannot be larger than 50 %. Plugging our estimates of distance to target (0.2) and the average additional benefits (1.4) into Equation 4 we get the following result:

$$\frac{2}{18} * 0.2 + \frac{1}{18} * 1.4 = 0.1$$

This number suggests additional costs can increase by 10 % in each year. In step 2-1 we calculated the annual costs associated with the catchment of the Stanovice reservoir to be CZK 16,725,784. Multiplying this number by the expense factor we get:

$$16{,}725{,}784 * 0.1 = 1{,}672{,}578$$

Based on the increase in costs, total increase in additional costs connected with the goals of WFD in 2009-2027 can be easily computed. This period lasts for 18 years; therefore we multiply the annual increase in costs by 18 to get the total investment.

$$1{,}672{,}578 * 18 = 30{,}106{,}404$$

Given the methodology it is cost proportionate to spend an additional CZK 30,106,404 (EUR 1,114,639) for the application of measures over 18 years to improve water quality in Stanovice.

Step 3: Comparison of the costs with the cost threshold

In Step 1 we stated that according to Macháč et al. (2015) it is possible to reduce 200 kg of the yearly phosphorus inflows with annualized costs of CZK 1,147,844. The implementation of measures is expected in the period 2016-2027. Therefore, the costs are cumulated for 12 years. Multiplying by 12 we get the total costs of such measures at CZK 13,774,128. The comparison of costs shows that total costs of CZK 13.8 million do not exceed the cost threshold of CZK 30.1 million given by the methodology. It is possible to conclude that suggested measures are cost proportionate. Therefore this result would lead by the *"new Leipzig approach"* to a refusal of exemption for the cost disproportionality in the catchment of the Stanovice reservoir.

Discussion and Conclusion

In this study a pilot assessment of cost proportionality using the new German methodology the *"new Leipzig approach"* was carried out in the catchment of the Stanovice reservoir. Within the analysis the original procedure of the *"new Leipzig approach"* has been followed. It proved to be difficult to collect a sufficient amount of indicator values by which *"good status"* is determined and distance to target and the level of expense factors are calculated. The problems of availability of input date limit the usage of the German procedure in the Czech Republic. In this field it would be necessary to perform an analysis of input data availability. From our point of view, it makes sense to apply this procedure only if at least 2/3 of indicator values are available. If an indicator isn't evaluated frequently it would make sense to replace it with another one. The question is whether the problem of data limitations is faced by all water bodies or it's a unique case of a small pilot catchment in West Bohemia. It can be expected that the situation of the larger catchments and water bodies downstream is much better.

During the processing of the pilot study, we spent lot of time dealing with the question of how to assign values to additional benefits. According to our opinion, this assignment is very subjective and can affect easily the outcome of proportionality assessment. Simplifying the determination of additional benefits compared to the former *"Leipziger approach"* doesn't lead to the desired goal in our opinion. Holistic Approach of an expert estimation is suitable for this purpose, but in practice didn't prove (to be) useful. Experts from T. G. Masaryk Water Research Institute were able to list additional benefits, but they have not been able to assign a number (0-3). This problem could be managed by the creation of a manual for experts how to assign a number to benefits. It is questionable whether the monetization of additional benefits has a greater explanatory value. In this respect, we propose either to replace the average additional benefits as part of the expense factor with the monetized value of additional benefits, which will be added to the result of multiplying annual costs associated with the catchment by the expense factor, or to solve this problem by the above mentioned manual for experts. Such a manual could contain a more detailed description of the key benefits.
Taking into account the experience with planning process in the Czech Republic the measures aren't proposed according to the cost-effectiveness. The main criterion for the selection of measure is the feasibility of eventually the possibility of obtaining subsidies. In this regard, it is necessary to perform also the cost effectiveness analysis within the proportionality assessment. Only in this case can the exception be applied.
Questionable in our view remains the fact, whether the proportionality can be assessed based on average costs from the past in all of the Czech Republic. A major part of the costs is used in case of investment costs to realisation of large measures, which don't always have to be associated with improvements of water quality and the achieving of *"good status"*. Past spending doesn't fully meet the need for measures and quality improvement in the opinion of the authors. This is partly a political decision, how much money will be allocated from the state budget on water policy, which is not based on economic analysis. All the expenditures are already planned with regard to limited resources allocated from the state budget and other financial resources. From the past expenditure for which there is no market we can't derive the demand of measures.

The pilot study shows that the achieving of *"good status"* in the catchment of the Stanovice reservoir is connected with the reduction of 200 kg phosphorus per year and with the total costs of CZK 13,774,128 in the next 12 years. The cost threshold was determined on the basis of average past costs and investments of CZK 30,106,404. The threshold exceeds costs of measures over CZK 16 million and therefore reducing phosphorus inflows into the Stanovice water reservoir may be considered as cost proportional according to the *"new Leipzig approach"*. Based on extensive data collection, we finally managed to get the necessary data.

As we described in Step 2-2 most of the required value of indicators is unknown and we had to work with older data. We have also doubts about evaluating additional benefits of phosphorus inflow reduction. It is very difficult to evaluate benefits of environmental measures and having to choose from just a couple of predetermined states might lead to biased results.

However, this approach is definitely less time consuming and not as expensive as other possible methods such as the performance of cost-benefit analysis. Through the above mentioned arguable question, the *"new Leipzig approach"* can be regarded as alternative methodology how to assess the cost proportionality. According to the above mentioned problems application of this procedure in the Czech Republic in order to justify the exemption would require a broader discussion about the use of past costs and their relevance to the goals of the Water Framework Directive.

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Appendix

Table 5. List of the most cost-effectiveness measures in the catchment of the Stanovice Reservoir

Type of source	Name of village/ Land number (LPIS)	Policy description	Total annual costs in the annualised form (CZK)	Annual amounts of reduced phosphorus (kg)
Diffuse	843101804/12	Grassing of sloping areas	110	0.22
Point	Dlouhá Lomnice	Building of a wastewater treatment plant with intensified phosphorus removal	16,945	20.57
Diffuse	841101704/1	Grassing of sloping areas	1,211	0.92
Diffuse	841101801	Grassing of sloping areas	661	0.42
Diffuse	841101705/2	Grassing of sloping areas	551	0.31
Diffuse	841101701/3	Grassing of sloping areas	3,633	1.75
Diffuse	841102003/3	Grassing of sloping areas	3,303	1.56
Diffuse	841101804/2	Grassing of sloping areas	3,083	1.45
Diffuse	843101704	Grassing of sloping areas	2,202	0.93
Diffuse	841101804/2	Introduction of no-tillage methods	3,636	1.45
Diffuse	843101704	Introduction of no-tillage methods	2,487	0.93
Diffuse	841102004/1	Grassing of sloping areas	6,056	2.23
Diffuse	840101908	Grassing of sloping areas	1,059	0.38
Diffuse	843101804/12	Introduction of no-tillage methods	681	0.22
Diffuse	841101701/3	Introduction of no-tillage methods	5,764	1.75
Point	Dražov	Building of a wastewater treatment plant with intensified phosphorus removal	124,475	37.25
Diffuse	841101805/2	Grassing of sloping areas	1,982	0.58
Diffuse	841101704/1	Introduction of no-tillage methods	3,208	0.92
Diffuse	841102003/3	Introduction of no-tillage methods	5,533	1.56
Diffuse	842101701/1	Introduction of no-tillage methods	1,422	0.39
Diffuse	841102004/1	Introduction of no-tillage methods	8,310	2.23
Diffuse	842101701/1	Grassing of sloping areas	1,541	0.39
Diffuse	841101801	Introduction of no-tillage methods	1,665	0.42
Diffuse	844101602	Grassing of sloping areas	4,404	1.10
Diffuse	845102105/3	Grassing of sloping areas	1,271	0.30
Diffuse	843101704	Changes of crop rotation	3,611	0.78
Diffuse	841101601/1	Introduction of no-tillage methods	6,482	1.34
Diffuse	843101704	Leaving crop residue	2,295	0.47
Diffuse	844101706/1	Grassing of sloping areas	2,330	0.47
Diffuse	841101805/2	Introduction of no-tillage methods	2,949	0.58
Diffuse	843101804/12	Changes of crop rotation	989	0.19
Diffuse	845102111	Grassing of sloping areas	4,074	0.74
Diffuse	841101705/2	Introduction of no-tillage methods	1,735	0.31
Diffuse	843101804/12	Leaving crop residue	628	0.11
Diffuse	841101701/3	Changes of crop rotation	8,372	1.46
Point	Německý Chloumek	Building of septic tanks with dead-end cesspits emptied by lorry to Drahovice WWTP	38,344	6.62
Diffuse	844101706/1	Introduction of no-tillage methods	2,256	0.38
Diffuse	841101601/1	Grassing of sloping areas	8,037	1.34
Diffuse	841101704/1	Changes of crop rotation	4,659	0.77
Diffuse	841101701/3	Leaving crop residue	5,321	0.87
Diffuse	844101511/2	Grassing of sloping areas	3,707	0.60
Diffuse	841102003/3	Changes of crop rotation	8,036	1.30
Diffuse	842101701/1	Changes of crop rotation	2,065	0.33

Type of source	Name of village/ Land number (LPIS)	Policy description	Total annual costs in the annualised form (CZK)	Annual amounts of reduced phosphorus (kg)
Diffuse	841101704/1	Leaving crop residue	2,961	0.46
Point	Stružná	Clearance of biological pond	58,277	33.40
Diffuse	841102004/1	Changes of crop rotation	12,069	1.86
Diffuse	841102003/3	Leaving crop residue	5,108	0.78
Diffuse	840101908	Introduction of no-tillage methods	2,031	0.31
Diffuse	842101701/1	Leaving crop residue	1,313	0.20
Diffuse	841102004/1	Leaving crop residue	7,671	1.11
Diffuse	841101801	Changes of crop rotation	2,418	0.35
Diffuse	845102111	Introduction of no-tillage methods	5,245	0.74
Diffuse	842101701/7	Introduction of no-tillage methods	13,548	1.91
Diffuse	841101801	Leaving crop residue	1,537	0.21
Diffuse	841101604/4	Grassing of sloping areas	4,024	0.55
Diffuse	844101603/3	Introduction of no-tillage methods	1,182	0.16
Diffuse	845102002	Grassing of sloping areas	10,790	1.43
Diffuse	843101602/9	Grassing of sloping areas	4,844	0.63
Diffuse	845102002	Introduction of no-tillage methods	11,202	1.43
Diffuse	841101801/1	Grassing of sloping areas	551	0.07
Diffuse	841101803/2	Grassing of sloping areas	6,606	0.81
Diffuse	841101602/2	Grassing of sloping areas	9,579	1.16
Diffuse	841101601/1	Changes of crop rotation	9,413	1.12
Diffuse	843101703/9	Grassing of sloping areas	7,157	0.84
Diffuse	841101701/3	Building of a broad-base terrace	18,198	2.04
Diffuse	841101805/2	Changes of crop rotation	4,283	0.48
Diffuse	841101601/1	Leaving crop residue	5,983	0.67
Diffuse	849101603/5	Introduction of no-tillage methods	17,879	2.00
Diffuse	842101707/8	Introduction of no-tillage methods	1,211	0.13
Diffuse	849101603/5	Grassing of sloping areas	18,607	2.00
Diffuse	841101805/2	Leaving crop residue	2,722	0.29
Diffuse	842101604/1	Grassing of sloping areas	1,483	0.15
Diffuse	841101705/2	Changes of crop rotation	2,520	0.26
Diffuse	841102003/3	Building of a broad-base terrace	17,829	1.82
Diffuse	841101602/2	Introduction of no-tillage methods	11,468	1.16
Diffuse	844101603/1	Introduction of no-tillage methods	25,418	2.53
Diffuse	841101705/2	Leaving crop residue	1,602	0.16
Diffuse	841101803/2	Introduction of no-tillage methods	8,399	0.81
Diffuse	844101706/1	Changes of crop rotation	3,277	0.31
Diffuse	843101804/11	Introduction of no-tillage methods	9,511	0.89
Diffuse	844101306	Grassing of sloping areas	3,633	0.34
Diffuse	843101704	Building of a broad-base terrace	11,952	1.09
Diffuse	844101706/1	Leaving crop residue	2,083	0.19
Diffuse	844101602	Introduction of no-tillage methods	12,195	1.10
Diffuse	844101402/3	Grassing of sloping areas	1,872	0.16
Diffuse	840101908	Changes of crop rotation	2,950	0.26
Diffuse	842101707/8	Grassing of sloping areas	1,906	0.16
Diffuse	843101603	Grassing of sloping areas	1,211	0.10
Diffuse	841101801/1	Introduction of no-tillage methods	824	0.07
Diffuse	840101908	Leaving crop residue	1,875	0.15
Diffuse	845102111	Changes of crop rotation	7,617	0.62
Diffuse	842101701/7	Changes of crop rotation	19,676	1.59
Diffuse	841101704/1	Building of a broad-base terrace	13,576	1.08

Type of source	Name of village/ Land number (LPIS)	Policy description	Total annual costs in the annualised form (CZK)	Annual amounts of reduced phosphorus (kg)
Diffuse	840101801	Grassing of sloping areas	1,652	0.13
Diffuse	843101707	Grassing of sloping areas	3,495	0.28
Diffuse	842101701/7	Grassing of sloping areas	24,442	1.91
Diffuse	843101602/9	Introduction of no-tillage methods	8,218	0.63
Diffuse	844101603/3	Changes of crop rotation	1,716	0.13
Point	Javorná	Building of a sewage system and a waste-water treatment plant with intensified phosphorus removal	387,950	25.90
Total			**1,147,844**	**200.06**

Source: Own Construction