

## **USAGE OF ECOSYSTEM FOREST FUNCTIONS EVALUATION FOR THE ASSESSMENT OF INVESTMENT PROJECT REALIZATION INFLUENCE TO FOREST ECOSYSTEMS ON THE EXAMPLE OF NATURAL PRESERVE KLÁNOVICKÝ LES – CYRILOV**

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**Abstract.** Investment project for 18 holes golf resort realization is situated in the locality of Klánovický les. Locality is a part of the natural park Klánovice-Čihadla and supra-regional bio-centre Vidrholec. Prevailing area of locality creates the west part of natural preserve Klánovický les – Cyrilov. Cadastral area Klánovice is incorporated to the 1st proposed zone of suburban recreational forests of capital Prague. Evaluation of influence of proposed golf resort to forest ecosystems of locality Klánovický les was elaborated with usage the method Quantification and Evaluation of forest functions by Prof. Vyskot and coll. 2003. Used method evaluates all-society forest functions in ecosystem conception, where all groups of forest functions produced by forest ecosystem are on equivalent importance, but do not have equivalent quality. Ecosystem damage was carried out for main stand types (types of forest ecosystem) within the most presented functional (forest) management group (most presented site types) in all of the groups of all-society forest functions – bioproduction, ecological-stabilization, hydric-water management, edaphic-soil-conservation, social-recreation and sanitary-hygienic function. The resulting average ecological damage was financially expressed by CZK and transferred to Euro.

**Key words:** forest functions, ecological damage, protected area

### **INTRODUCTION**

Investment project for 18 holes golf resort realization is situated to locality Klánovický les. Klánovický les is nevertheless very important forest locality with high social effects – suburban recreational forest, forest important for nature protection and conservation etc. It is clear, that the ecological damage on this locality will arise by the realisa-

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tion of proposed investment project. The knowledge of quantity of ecological damage is necessary for the decision process in investment project realisation.

The below article deals with evaluation of ecological damage on forests ecosystems influenced by proposed investment project realization.

## MATERIAL AND METHOD

### Locality

Klánovický les (next only locality) is situated in the east part of Vidrholec – the largest forest complex surrounding Prague. It is localized on northeast between border of Velká Praha and city part Kyje. Locality is an important sample of biocoenosis only a sparsely presented in frame of Prague area. It is also an important recreational area for inhabitants of newly built districts.

Locality is a part of natural park Klánovice-Čihadla and supra-regional bio-centre Vidrholec. Prevailing area of locality creates the west part of natural preserve Klánovický les – Cyrilov. Cadastral area Klánovice is incorporated to the 1st proposed zone of suburban recreational forests of capital Prague.

Potential natural vegetation of locality [Neuhäuslová et al. 1998] is created by mosaic of without-knee grass oak woods (*Molinio arundinaceae-Quercetum*) and wood rush oak woods (*Luzulo albidae-Quercetum petraeae*). Present vegetation communities are created by a wide complex of hunger pine woods and oak woods on sand sites. Forest stands, on the parts of locality where the tree species composition was not changed to pine and spruce monoculture during last fifty years, tree composition was kept corresponding to the habitat conditions. Wood rush oak woods (*Luzulo albidae-Quercetum petraeae*) with sheep fescue (*Festuca ovina*) and wavy hair grass (*Avenella flexuosa*) are present on dry sand sites. Without-knee grass oak woods (*Molinio arundinaceae-Quercetum*) with dominant reed bear grass (*Molinia arundinacea*) are presented in water logging sites [Kubíková et al. 2005].

### Theoretical background

Evaluation of influence of proposed golf resort on forest ecosystems of locality Klánovický les was elaborated with usage of Quantification and Evaluation method of forest functions by Vyskot et al. [2003].

Used method evaluates all-society forest functions in ecosystem conception, where all groups of forest functions produced by forest ecosystem are of equivalent importance, but do not have equivalent quality. It means that the object evaluated by used method is the quantity of forest functions.

Quantification of forest functions is divided into evaluation of real potential of forest functions (RPff) and real topical effect of forest functions (REff). Real potential of forest functions (RPff) expresses quantified functional potential of forests (values of produced functions) under optimal ecosystem conditions. Real topical effect of forest functions (REff) expresses topical quantified functional effects of forests (values of produced functions) under topical ecosystem conditions.

RPff and REff are expressed for groups of all-society forest ecosystems functions, bioproduction function (BP), ecological-stabilization function (ES), hydric-water management function (HV), edaphic-soil-conservation function (EP), social-recreation function (SR), sanitary-hygienic function (ZH).

The values of Real potentials of forest functions are expressed by value degrees in classification levels (0-6). Grade 0 means functionally unsuitable forest ecosystem, grade 6 means extraordinary level of function potential. Total real potential of forest functions ( $\Sigma$ RPff) is given by sum of real potential of forest functions value grades for particular functions of some forest ecosystem. Total real potential of forest functions is classified by so-called Class of  $\Sigma$ RPff. Class I presents total real potential of forest functions very low, class VI means extraordinary  $\Sigma$ RPff.

Real potentials of forest functions for the Czech Republic forests are elaborated in tables within the used method. They are presented for so-called stand types (ST) in frame of the functional management groups (FMG). Stand type means mask for the forest ecosystem tree species composition; where capital letter of arabian alphabet masks tree species (group of tree species) presentation, the number codes tree species (group of tree species). Functional management group constitutes the group of functionally similar forest sites (habitatas).

The real effect of forest functions of certain forest ecosystem is formed as a percentage of its potential value (potential ability to produce particular function) – a percentage of Real potential of forest functions. REff is calculated from RPff with using so-called function-reducing criteria. There are defined function-reducing criteria: forest ecosystem age (development phase), stocking and health conditions.

The factor of a topical social interest (FAZ) is formed for topical social interest in forest expression. It is given as a social conventional factor; it is not a part of ecosystem evaluation but its social addition. FAZ is defined as a system of coefficients modifying RPff or REff.

Used method claims that the damage on forest ecosystem arises from the disturbance or destruction of its functions. In case that the damage on forest functions relies to actual forest age, the financial expression of real effect of forest function is used for the damage evaluation. However the influence of planned golf resort in Klánovický les is long-term; it means that financial expression of Real potentials of forest functions is used for the ecosystem damage evaluation.

The financial expression of real potentials of particular functions (RPFL) is determined according to a general formula:

$$FRP_{FL} = \frac{CD \cdot PP \cdot U}{3} \cdot RP_{FL} \cdot P$$

where:

- FRP<sub>FL</sub> – financial expression of a value of the real potential of a function in CZK,
- RP<sub>FL</sub> – value (value degree) of the real potential of a function,
- CD – decennial average wood price at the roadside in CZK per 1 m<sup>3</sup> announced by the CR Ministry of Agriculture,
- PP – average annual potential production of forests in the Czech Republic, m<sup>3</sup>·ha<sup>-1</sup>, determined by a special directive (6.3 m<sup>3</sup>·ha<sup>-1</sup>),
- U – stand rotation,
- P – area of the unit (stand, stand part), ha.

The additive financial expression of the all-society economic effect value of forest functions is provided on the base of financial expression of real potentials of particular all-society functions (RPff) in selected stand after its reduction to actual real effect REff by function-reducing criteria of age, stocking and health conditions. Used price level is 908 CZK per 1 m<sup>3</sup> of wood (arithmetical average price of wood at the roadside announced by the CR Ministry of Agriculture for years 1997-2006).

### Method

Predicted damage was expressed on the base of habitat and forest stands conditions synergization to the result average characteristic of the observed area. The ecosystem conditions of locality were evaluated on the base of field work and accessible data. Obtained informations were processed by method Vyskot et al. [2003].

Modified data set of forest stands (stand groups) was differenced to the stand types on the base of tree species composition and habitat types (group of forest types), resp. functional management groups. Real potentials of forest functions and the total real potential of forest functions were identified to particular stand types within functional management groups. Non-standardized stand types were identified with RPff with usage of stand types substitution.

The procedure mentioned above was applied in forest stands (forest stand groups) influenced by potential golf resort realization. Influenced forest stands were obtained by the projection of the golf track layer and forest management map layer in GIS.

For financial expression of hectare value of real potential of forest functions is used price level of mediate biproduction 920 CZK per 1 m<sup>3</sup> of wood (arithmetical average price of wood at the roadside announced by the CR Ministry of Agriculture for years 1997-2006), the exchange ratio from CZK to Euro was used 28 CZK = 1 Euro. Final financial expression of ecosystem damage was modified by FAZ index.

## RESULTS

### Observed area characteristic regarding to real potentials of forest function determination

Observed forest stands are managed in frame of forest management department 30, 31, 35 and 36 of forest management complex 110002 – Újezd nad Lesy. Presentation of forest types groups and their differentiation to functional forest management groups presents Table 1.

Tree species composition of presented forest ecosystems is various. Admixed broad-leaf-coniferous forest prevails and creates the mosaic of Klánovický les. The most presented tree species are: Scots pine (*Pinus sylvestris*) and Pedunculate oak (*Quercus petraea*), plentifully are presented birch (*Betula verucosa*) and Norway spruce (*Picea abies*). As for tree species which are not original, Red oak (*Quercus rubra*) and pine (*Pinus strobus*) are presented. Tree species composition projects to stand types formation. Presentation of forest types groups in the observed area is given in Figure 1.

Table 1. Presentation of forest types groups and functional forest management groups in locality Klánovický les  
Tabela 1. Prezentacja typów lasu i typów siedliskowych w rejonie Klánovický les

Functional forest management groups Typy siedliskowe	Forest types groups Typy lasu	Area Powierzchnia	
		ha	%
27 – gley hunger sites of lower altitudes 27 – glejowe ubogie siedliska na niższych wysokościach	1P – fresh birch oak-wood 1P – świeży las brzoźowo-dębowy	68.53	40.2
23a – acid sites of lower altitudes 23a – kwaśne siedliska na niższych wysokościach	1K – acid oak wood 1K – kwaśny las dębowy	87.40	51.3
23b – acid sites of lower altitudes 23b – kwaśne siedliska na niższych wysokościach	1S – fresh (hombeam) oak wood on sands 1S – świeży las grabowo-dębowy na piaskach	2.99	1.8
25b – culture sites of lower altitudes 25b – żyzne siedliska na niższych wysokościach	1V – wet hombeam oak wood 1V – wilgotny las grabowo-dębowy	11.46	6.7
Total – Ogółem		170.4	100.0

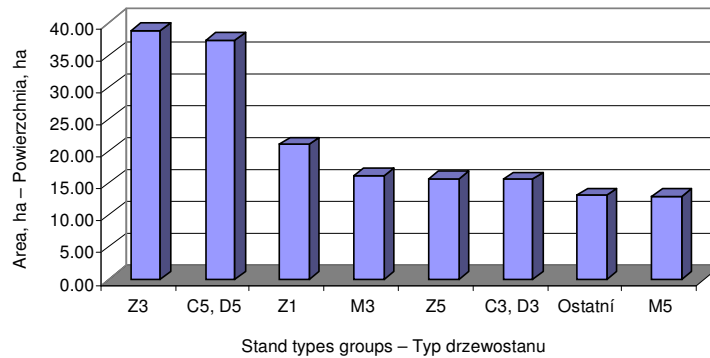


Fig. 1. Total presentation of forest types groups in observed area in locality Klánovický les. Z3 – admixed forest stands with pine presentation 31-50%, C5, D5 – forest stands with oak presentation more than 71% (C5 – 91-100% D5 – 71-90%), Z1 – admixed forest stands with spruce presentation 31-50%, M3 – admixed forest stands with pine presentation 51-70%, Z5 – admixed forest stands with oak presentation 31-50%, C3, D3 – forest stands with pine presentation more than 71% (C3 – 91-100% D3 – 71-90%), M5 – admixed forest stands with oak presentation 51-70%

Rys. 1. Ogólna prezentacja typów lasu na badanym terenie w rejonie Klánovický les. Z3 – drzewostany mieszane z udziałem sosny 31-50%, C5, D5 – drzewostany z udziałem dębu powyżej 71% (C5 – 91-100%, D5 – 71-90%), Z1 – drzewostany mieszane z udziałem świerka 31-50%, M3 – drzewostany mieszane z udziałem sosny 51-70%, Z5 – drzewostany mieszane z udziałem dębu 31-50%, C3, D3 – drzewostany z udziałem sosny powyżej 71% (C3 – 91-100%, D3 – 71-90%), M5 – drzewostany mieszane z udziałem dębu 51-70%

### Real potential of forest function evaluation

Table 2 presents real potentials of forest functions for most presented stand types in locality within functional management groups.

Table 2. Real potentials of forest functions for the most presented stand types in functional management groups in the west part of Klánovický les  
Tabela 2. Rzeczywisty potencjał funkcji leśnych dla głównych typów lasu w poszczególnych typach siedliskowych w zachodniej części rejonu Klánovický les

FMG	ST	Area, ha Powierz- chnia, ha	RRff						ΣRPff	ΣRPff class
			BP	ES	HV	EP	SR	ZH		
27	Z1P3P5P9x	15.83	4	4	2	3	4	5	22	IV
23a	C5	17.50	4	3	2	3	2	4	18	III
23b	M5P1P9x	0.93	3	4	2	3	5	5	22	IV
25b	M1P3P9x	1.70	4	3	2	3	4	5	21	IV

Explanatory notes: FMG – forest management group, ST – stand type, area – stand type area in frame of given FMG, RPff – real potential of forest functions, BP – bio-production forest function, ES – ecological-stabilization forest function, HV – hydric-water management forest function, EP – edaphic-soil protection forest function, SR – social-recreational forest function, ZH – sanitary-health hygienic forest function, ΣRPff – total real potential of forest functions, ΣRPff class – class of total real potential of forest functions.

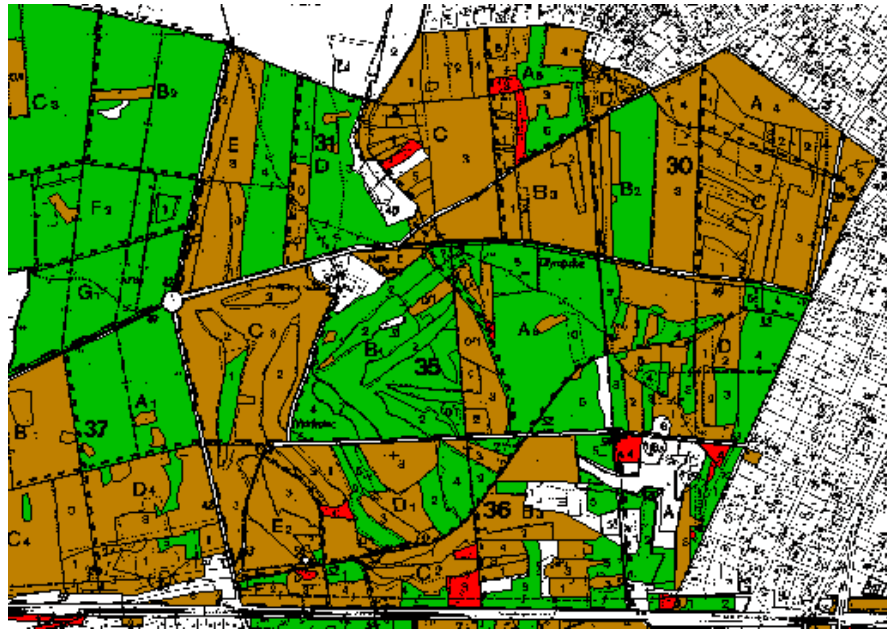
Objaśnienia: FMG – typ siedliskowy, ST – typ drzewostanu, area – powierzchnia typu drzewostanu w ramach danego typu siedliskowego, BP – funkcja bioprodukcyjna, ES – funkcja ekologiczno-stabilizacyjna, HV – funkcja gospodarki wodnej, EP – funkcja ochrony gleby, SR – funkcja rekreacyjna, ZH – funkcja sanitarno-higieniczna, ΣRPff – ogólny rzeczywisty potencjał funkcji lasu, ΣRPff class – klasa ogólnego rzeczywistego potencjału funkcji lasu.

Figure 2 presents total real potential of forest functions distribution in observed area of locality Klánovický les – forest management department 30, 31, 35 and 36.

It stands to reason from the Figure 2, that there are presented mostly forest stands with average total real potential of forest functions. But the presentation of forest stands with high total real potential of forest functions is also significant. The forest stands with low total real potential of forest functions are presented only marginally.

### Financial expression of real potentials of forest functions

Table 3 presents financial expression of real potentials of forest functions of most presented stand types in particular forest (functional) management groups counted to 1 ha.



Color – Kolor			
Total RPff class Ogółem klasa RPff	II – low II – niska	III – average III – średnia	IV – high IV – wysoka
Total RPff Ogółem RPff	12-16	17-20	21-24
Area – Powierzchnia, ha	3.98	116.37	5003

Fig. 2. Total real potential of forest functions distribution in observed area of locality Klánovický les. Source: Territorial plan of forest development for natural forest area 17 – Polabi

Rys. 2. Rozkład rzeczywistego potencjału funkcji lasu na badanym terenie rejonu Klánovický les. Źródło: Plan terytorialny rozwoju lasu dla 17 krainy lasów naturalnych – Polabi

Table 3. Financial expression of real potentials of forest functions for the most presented stand types within particular forest management groups counted to 1 ha

Tabela 3. Rzeczywisty potencjał funkcji lasu wyrażony w euro na 1 ha dla głównych typów drzewostanu w poszczególnych typach siedliskowych

FMG	Stand type Typ drzewostanu	RPff (EUR)						Total Ogółem (EUR)
		BP	ES	HV	EP	SR	ZH	
27	Z1P3P5P9x	29.827	29.827	14.466	22.370	27.143	37.284	160.919
23a	C5	37.962	28.472	18.412	28.472	17.273	37.962	168.552
23b	M5P1P9x	28.472	37.962	18.412	28.472	43.182	47.453	203.951
25b	M1P3P9x	27.116	20.337	13.151	20.337	24.675	33.895	139.510

Explanatory notes see Table 2.  
Objaśnienia: patrz tabela 2.

### Objective FAZ expression

Factor of a topical social interest (FAZ) of forest stands (forest stand groups) was on a base of defined identification parameters determined for the particular groups of all-society forest functions subsequently (Table 4).

Table 4. Factor of a topical social interest (FAZ) of forest stands (forest stand groups)  
Tabela 4. Współczynnik zysku społecznego (FAZ) dla poszczególnych grup drzewostanów

Social forest function Społeczna funkcja lasu	FAZ	Determinant Czynnik determinujący
Ecological-stabilization Ekologiczno-stabilizacyjna	2.6	forests of nature preserves lasy rezerwatów przyrody
Ecological-stabilization Ekologiczno-stabilizacyjna	1.9	forests of supra-regional territorial system of ecological stability lasy terytorialnego ponadregionalnego systemu stabilizacji ekologicznej
Ecological-stabilization Ekologiczno-stabilizacyjna	1.3	forests of nature parks lasy parków przyrodniczych
Social-recreational Rekreacyjna	2.6	suburban forests of the first belt of recreation zones of settlement podmiejskie lasy pierwszej strefy rekreacyjnej
Sanitary-health hygienic Sanitarno-higieniczna	2.6	suburban forests with a health-recreation function (1st zone) podmiejskie lasy o funkcji zdrowotno-rekreacyjnej (1. strefa)

### Financial expression of predicted average ecosystem damage counted to 1 ha of forest ecosystems influenced by realization of proposed golf resort

Table 5 shows financial expression of predicted average ecosystem damage counted to 1 ha of forest ecosystems influenced by realization of proposed golf resort.

Table 5. Financial expressed predicted average damage calculated to area 1 ha  
Tabela 5. Przewidywane średnie szkody wyrażone w euro na 1 ha

Social forest function Społeczna funkcja lasu	Financial expressed damage Wartość szkód EUR/ha
Bio-production – Bioprodukcyjna	30.189,-
Ecological-stabilization – Ekologiczno-stabilizacyjna	28.848,-
Hydric-water management – Gospodarki wodnej	17.767,-
Edaphic-soil protection – Ochrony gleby	25.644,-
Social-recreational – Rekreacyjna	25.587,-
Sanitary-health hygienic – Sanitarno-higieniczna	40.526,-
Total – Ogółem	168.561,-



## DISCUSSION

Used methodological approach is based on the financial expression of potential functional ability of forest ecosystems and their loosing by long-term forest destruction. Also index FAZ (Factor of topical social interest) was used. We can claim that usage of these two parameters is for given problem solution correct, because in case of golf resort investment project realization forest ecosystems will be destroyed permanently.

Method Vyskot I. and coll. offers also parameter real effect of forest functions. Usage of this parameter is more suitable in case of assessment of recent value of forest ecosystem functions and its loosing.

As for index FAZ; the usage of the index is adequate for the high social interest of the observed locality.

Used price level (arithmetical average price of wood at the roadside announced by the CR Ministry of Agriculture for years 1997-2006) sufficiently ensures reduction of topical changes of bio-production prices in frame of trade of wood and another forest products.

## RECAPITULATION

On the base of ecosystem characteristics of forest stands analyses in the observed part of Klánovický les, it should be claimed that in case of lasting deforestation the predicted average financially expressed damage counted to 1 ha is:

Bio-production forest function	30.189,- EUR
Ecological-stabilization forest function	28.848,- EUR
Hydric-water management forest function	17.767,- EUR
Edaphic-soil protection forest function	25.644,- EUR
Social-recreational forest function	25.587,- EUR
Sanitary-health hygienic forest function	40.526,- EUR

Total predicted average financially expressed damage counted to 1 ha is 168.561,- EUR.

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**ZASTOSOWANIE WYNIKÓW OCENY FUNKCJI EKOSYSTEMU LEŚNEGO  
DO OSZACOWANIA WPŁYWU REALIZACJI PROJEKTU  
INWESTYCYJNEGO NA EKOSYSTEMY LEŚNE  
NA PRZYKŁADZIE REZERWATU PRZYRODY  
KLÁNOVICKÝ LES – CYRILOV**

**Streszczenie.** Projekt inwestycyjny pola golfowego z 18 dołkami ma być zrealizowany w rejonie Klánovický les, który jest częścią parku przyrodniczego Klánovice-Čihadla i ponadregionalnego biocentrum Vidrholec. Większa część powierzchni tego rejonu jest zachodnią częścią rezerwatu przyrody Klánovický les – Cyrilov. Powierzchnia katastralna Klánovice została włączona do proponowanej pierwszej strefy podmiejskich lasów rekreacyjnych Pragi. Ocena wpływu proponowanego ośrodka golfowego na ekosystemy leśne rejonu Klánovický les została wykonana za pomocą metody ilościowego określania i oceny wszystkich społecznych funkcji lasu opracowanej przez prof. I. Vyskota i współpracowników [2003]. Metoda ocenia wszystkie społeczne funkcje lasu, z których każda jest jednakowo ważna, ale ma inną jakość. Ocena szkód w ekosystemie została wykonana dla głównych typów drzewostanu (typów ekosystemu leśnego) w ramach głównych typów siedliskowych i dotyczyła wszystkich społecznych funkcji lasu: bioprodukcji, stabilizacji ekologicznej, gospodarki wodnej, ochrony gleby, rekreacji oraz funkcji sanitarno-higienicznej. Średnią wartość szkód ekologicznych wyrażono w koronach czeskich i przeliczono na euro.

**Słowa kluczowe:** funkcje lasu, koszty ekologiczne, obszary chronione

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