

Criteria for the location of urban forests in densely populated and scarcely wooded areas

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Abstract

Several policy and scientific documents emphasize the importance of the realization of new urban forests in densely populated and scarcely wooded areas. This paper aims at the development of a methodology to select the most suitable locations for the establishment of new large urban forests, taking into account the highest chances for success. The most suitable and feasible locations are selected by means of a multicriteria analysis.

In this respect three phases of the multicriteria analysis can be distinguished:

1. The excluding phase: leading, by means of excluding criteria, to the fixation of a number of locations which are potentially suitable to afforestation; they are called potential locations.
2. The classifying phase: testing the potential locations to their suitability; this phase aims at the selection of a limited number of (theoretically) most suitable locations. It is based on the following groups of criteria:
 - criteria related to the potential recreational quality;
 - structure strengthening criteria;
 - criteria related to the potential ecological quality.
3. The feasibility phase: finally the most suitable locations are tested on their feasibility; leading, via an analysis of possible conflicts with other area claims, to the selection of the most feasible location(s). Because of the strong pressure on the land use in the densely populated areas, this phase is very important to optimize the realization chances of the afforestation. The three main criteria are:
 - the acceptability for the agricultural sector;
 - the acceptability for the nature and landscape values;
 - the acceptability for the urban functions.

As a result of the three phases of the multicriteria analysis the most suitable and feasible locations are selected.

In the classification phase as well as in the feasibility phase the different locations are divided into classes, according to the scores reached by the different criteria in their totality or each separately. The criteria and also the weights attributed to those criteria must correspond to the wanted profile of the planned forest, meaning they have to enclose spatial elements as well as functional and ecological elements.

The feasibility phase can be completed with an analysis of the opportunity criteria, i.e. criteria which are mainly related to the short term realization of the project, e.g. rest lands and fallow lands or lands used by farmers without direct succession.

The necessity to contact all involved actors in order to be successful is strongly stressed.

Keywords: *urban forests, forest extension, multicriteria analysis*

1. Introduction

In recent years there is an increasing effort in the EU in order to extend the wooded area. There are three reasons which make the European Commission believe that strengthening of afforestation efforts within the European Union is necessary (Kremer, 1993):

1. The global context. According to the relevant principle (8A) of the UNCED declaration on forests (Rio, 1992) and to the Helsinki conference of 1993 (resolution No.1, Art. 14) all countries should take actions towards afforestation.
2. The Common Agricultural Policy. With respect to the reform of the C.A.P., afforestation has become a reasonable and environmentally sound alternative use of agricultural land.
3. The growing demands for wood and non wood forest services and products

New forests should be established mainly in abandoned and set-aside agricultural land (Anz, 1992). The Council Regulation 2080/92 stresses that the afforestation of agricultural land is especially important for four reasons: from the point of view of soil use, for environmental reasons, to reduce the shortage of forestry products and to control agricultural production.

According to the spirit of the Regulation, the future new forests have to function as multiple-use forests. They should correspond to the wishes of the society. The latter consists, however, of different partners with often contradictory wishes.

New forests should be planned, based on a scientific approach. The main topics concern the amount, the objectives, the location (and size), the time-scale and the accompanying measures (Lust, 1994). Of course all these topics are partially interrelated. It is likely that the most practical question will focus on the location of new forests. From a general point of view some valuable recommendations are easy to formulate.

1. The connection with existing woodlands.
2. The restoration of ancient woods (Peterken, 1993).
3. The connection of fragmented forest areas. (Opdam, 1993).
4. Protection of threatened sites.
5. Creation of (recreational) forests near urbanized areas.

With respect to the latter recommendation, priority must be given to the establishment of forest areas in regions with an obvious lack of outdoor recreation facilities. As a rule of thumb it can be accepted

that one hectare accessible forest per 100 persons is needed (Lust, 1997; Buysse 1993). It clearly means that a city of 250,000 inhabitants requires an accessible forest area of some 2,500 ha in the vicinity of the city. This area can be achieved in one or several locations, with the possibility of connection-patches.

In the preparatory phase of the Landuse Structure Plan of Flanders¹, the above mentioned criteria for the location of new forest regions have been taken into account to a large extent.

In Flanders, a region with more than 400 inhabitants pro km² but very little afforested (less than 10%), it is obvious that, with respect to the establishment of new forests, major attention should be paid to the creation of urban forests, with mainly a recreational function.

There are, however, serious problems with the realization of these urban forests. Indeed, on the one hand the pressure on the land use is very strong and on the other hand the cost price is also rather high. Fallow land is not available. Consequently, the land must mainly be taken from the agricultural sector. But despite a general over-production in agriculture and the great environmental problems created by this sector, the agricultural organisations in Flanders often resist large-scale afforestation. Besides one should also consider the different other visions, e.g. the one of the general rural planning and also the one of the nature conservation. Summarizing, the problems related to the location of urban forests can be listed as follows:

- only little land is available;
- not every available land is eligible for an (urban) forest.

The establishment of a new urban forest requires that the locations are selected in a justified way. This can be realized by means of a multicriteria analysis, elaborated by a multidisciplinary group. In this phase the role of foresters is relatively limited.

In such processes it is very important to clearly determine the aimed profile of the new forest, in this case the establishment of an urban forest. The profile description should mainly take into account the following elements: spatial elements, functional elements and ecological elements. It means that the forest should function:

- with a well determined objective and for a determined target group;
- in a determined space;
- within determined time windows.

The objective and the target group, for whom the forest is established, actually determine at least partially the criteria space and time windows.

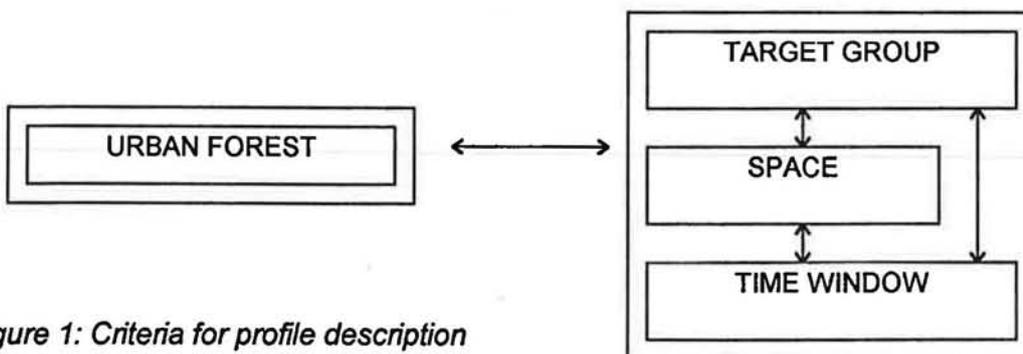


Figure 1: Criteria for profile description

¹ The Landuse Structure Plan of Flanders is a new instrument from the Flemish government concerning sustainable landuse planning. Main goal of the plan is to improve the general quality of life in urbanized areas and to strengthen the open space structures. This plan will determine the landuse planning till 2007.

This study starts from the basic idea that, while establishing an urban forest, it is aimed at a forest with a high recreational value, especially for the city dwellers, but simultaneously a significant ecological added value is obtained for the urbanized region. Each forest, however, is multifunctional from nature. Consequently, an urban forest fulfils not only a recreational function, but also an ecological, structure strengthening and economic function.

With the realization of the urban forest, the option is also to strive for soft recreation. The location should be large enough to fulfil all its functions, meaning it should mainly provide enough space for its social-educational and its ecological functions. It should also not be disturbed by hindering infrastructure in the neighbourhood, such as heavy industry.

An urban forest needs a suitable location in function of a high number of potential visitors. In this respect it concerns both daily recreationists, living at a short distance from the location, and weekend recreationists, who can live at a larger distance from the location. It means that the location of the forest should also consider both the daily and the weekly life environment of the target group. It should take into account that the motives of the recreationists are differing from nature oriented visitors, over people looking for rest, to normal users, who consider the forest as an attractive location for spending their leisure time.

Also determinant for the location of the urban forest was the guarantee of ecological quality. A first requirement to this is a sufficient big area. This way it is possible to plan one or more resting zones, suitable to develop specific nature values. It also means that the assessment should consider the existing nature values as well as the potencies of nature development outside the forest sphere. The potential coherence with existing nature values will be optimized.

Green areas are part of the urban regions and consequently they are also structure determining elements in the area. In that respect the role of the forest as a natural border of the city area is an important structure strengthening element of the urban forest. At the same time the forest can fulfil an excellent function as buffer and protection area.

The main objective of this study is to develop a scientific methodology in order to determine suitable locations for the realization of an urban forest in an area characterized by dense population, a low afforestation index and a strong pressure on the land use. Not only theoretical but also feasible locations must be selected.

In order to succeed in this process, it is very important to consult all actors involved. That way the chances for success strongly increase.

This study especially reports on the approach, which has been followed for the selection of a location of an urban forest in/or around Ghent, a city in Flanders with 250,000 inhabitants. The almost complete absence of (accessible) forests in its surroundings is featuring for this situation.

2. Methodology

In order to detect the most suitable locations for the realization of an urban forest in the agglomeration of the city of Ghent, a step by step approach was used.

1. The region that closely surrounds the whole urban agglomeration is considered as **search area**. In this area the zones, which are absolutely not suitable as a location for an urban forest, are excluded by means of the exclusive criteria.

The first phase, which is called **the excluding phase** (cfr. Gijsberts & Leroy, 1992), results in a study area, in which parts of the search area remain (Fig. 2). Then these parts are tested on the profile

which is proposed for the urban forest. The suitable remaining parts are considered as potential locations for the urban forest.

2. In the next phase, called **the classifying phase**, the potential locations are assessed on their suitability for afforestation. This process leads to the most suitable locations for the establishment of the urban forest (Fig.2). These locations are selected by means of recreational, ecological and structure strengthening criteria.

3. In the third phase, **the feasibility phase**, the most suitable locations are submitted to a feasibility test, executed by means of practical feasibility criteria. Firstly the acceptability of the urban forest is tested for the different sectors (agriculture, nature, industry,...), which eventually also might claim that space. As far as still necessary, the locations are then still submitted to opportunity criteria for forest establishment.

The final result is the selection of the most suitable and feasible location for the urban forest.

Figure 2 presents the described methodology. The funnel represents the search area, which is progressively reduced by means of the criteria of the different phases, but finally leads to the most suitable and feasible location for the urban forest.

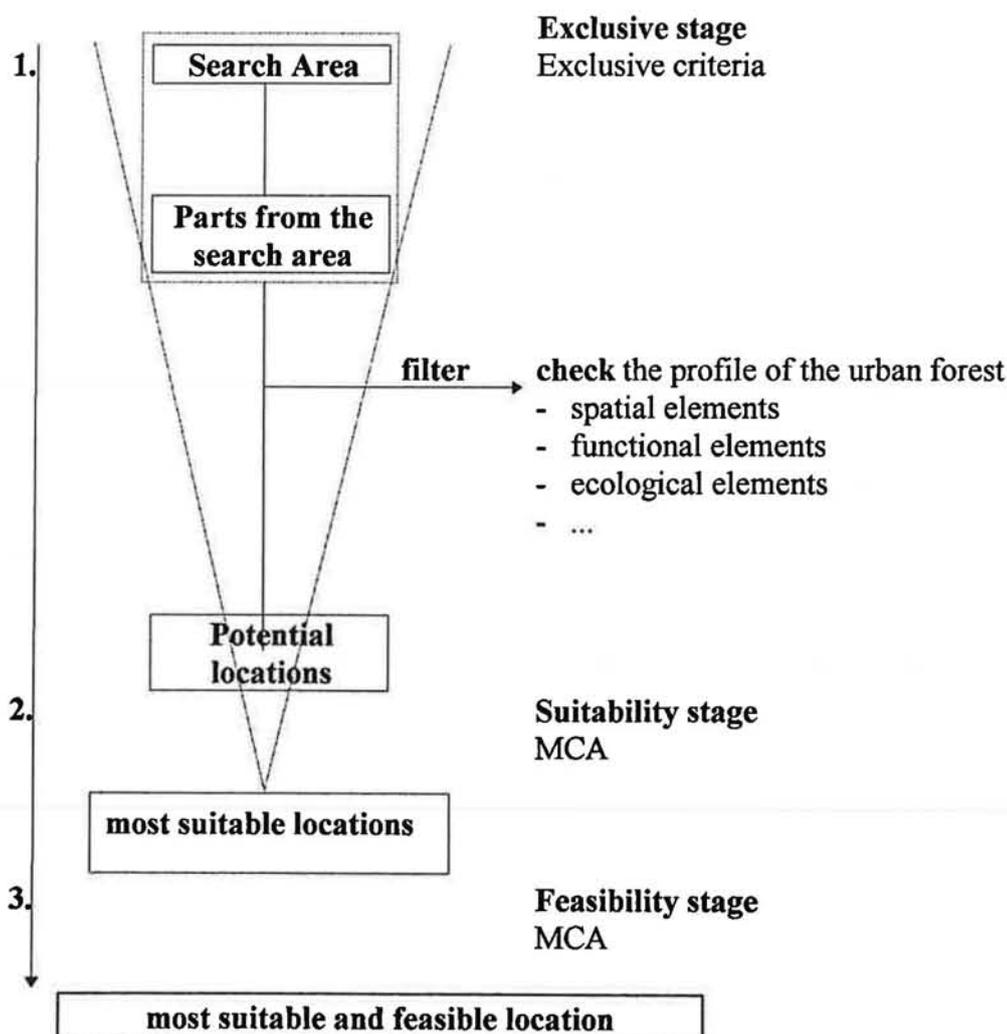


Figure 2. survey of the methodology from the multicriteria-analysis

3. The multicriteria analysis

As mentioned above the global approach for the selection of the most suitable and feasible location for the urban forest is divided into three phases: the excluding phase, the classifying phase and the feasibility phase.

3.1. The excluding phase

In this phase it is usual to work on a scale 1 : 100,000. Four steps are undertaken.

1. First step: definition and delineation of the total search area, the non built-up area, nearby the urban agglomeration.

In the beginning work was started with the "morphological agglomeration", which is defined as follows: "the whole of the city centre, the built up urban areas and the city surround". Afterwards the so called "Spatial Development Structure of the City of Ghent" has been used, meaning the structure plan that has been established by the local authorities.

Finally the realisation of the "social objective" was also taken into account for the delineation of the total search area. It means that one had already examined for which social target groups the need on recreational urban forest is the highest.

(It has been practically decided for the city of Ghent to limit the search area by a perimeter of three kilometers around the Great Ring of the City).

2. Second step: exclusion of zones larger than 10 ha not suitable for afforestation due to juridical or physical reasons.

This way, the following areas are excluded: recognized nature reserves, bird protected areas, classified landscapes, joint residential areas, large water areas, etc.

3. Third step: indication of barriers within the remaining search area.

Strong barriers, such as highways, departmental roads, railways or joint ribbon building, form advance barriers for delineation of potential locations of an urban forest.

4. Fourth step: indication of potential locations by the delineation of search areas of at least 100 hectares.

Within the already selected search areas, the joint areas of at least 100 ha are retained.

By means of those four steps, 12 potential locations have been retained for the urban forest of Ghent.

3.2. The classifying phase

In this phase the potential locations, selected in the excluding phase, are submitted to a multicriteria analysis.

In all 14 criteria are elaborated, divided over three categories (Table 1):

- criteria related to the potential recreational quality;
- structure strengthening criteria;
- criteria related to the potential ecological quality.

A number of these criteria are further subdivided in subcriteria.

The assessment of all these criteria does not occur according to an absolute rate. Indeed the evaluation is mainly based on the proposed profile of the urban forest and on the local situations. It means that the present results are not directly transferable to other cases. The assessment must allow in the first place the comparison of the different locations.

Table 1. Criteria for the classifying phase

Criteria related to the potential recreational quality

- Density of population
 - Concentration of population within a radius of 3 km
 - Number of inhabitants from areas poor on gardens within a radius of 3 km
- Accessibility
 - Accessibility on foot
 - Accessibility by bike
 - Accessibility by public transport
- Absence of hindering infrastructure
 - Absence of heavy industry
 - Absence of road infrastructure
- Absence of soft recreational open air facilities in the neighbourhood

Structure strengthening criteria

- Potentially spatial bordering of the urban area by forest
- Potentially hindering of the spatially joining of certain residential areas
- Subunit of a green axis of Gent
- Subunit of the natural structure
- Scenicly accentuating of cultural-historical elements by afforestation
- Degree of cohesion
 - Linking of great open areas (extension facilities)
 - Degree of fragmentation
- Potential protection function

Criteria related to the potential ecological quality

- Potential cohesion with existing nature values in the direction of the forest sphere
- Geographical diversity within the area
 - Texture classes
 - Water housekeeping types
 - Differences in altitude
- Presence of forest
 - Current presence of forest
 - Presence of ancient woodcores or woodrelics
 - Former presence of forest

A score is attributed to each criterium, ranging from 1 to 5, whereby 5 is the most suitable to a recreational urban forest.

In order to take into account the importance of the criteria, weights are attributed. To check the possible influence of the weights, different scenarios are used, whereby a certain criteria gets a plus-value, mainly in function of the proposed profile of the urban forest. They are compared with the blank scenario, whereby all criteria get the same weight.

The multicriteria analysis is elaborated for each group of criteria. In each category a percentual score is made, whereby the suitability is expressed in percent of the maximum score

Finally, in the overall multicriteria analysis, the percentual results of the different categories are added up, after weighing of the different categories.

3.2.1. Criteria related to the potential recreational quality

As it is obvious that an urban forest should have a high recreational value, the selection of suitable locations has to pay due attention to the potential recreational quality of these locations.

3.2.1.1. Criteria

Four groups of criteria are distinguished, whereby three groups have two or more subcriteria.

1. Criteria taking into account the population density

This criterium is divided into two subcriteria. Of course these subcriteria are adapted to the local situation, meaning they do not have a general value and cannot be used in the same form with other cases.

- Population density within a radius of 3 km around the border of the location. The scores are built up as follows: score 5 > 80,000 inhabitants, score 4 = 60,000 to 80,000 inhabitants, score 3 = 40,000 to 60,000 inhabitants, score 2 = 20,000 to 40,000 inhabitants, score 1 < 20,000 inhabitants².

- Number of inhabitants of garden-poor areas within a radius of 3 km. This criterium is based on the hypothesis, that people without gardens need more recreational areas. The best location should be searched in function of the "real" city dweller

Only inhabitants of areas, where less than 75% of the houses have a garden, are eligible for this criterium and, consequently, are considered as city dwellers.

The scores are built up as follows: score 5 > 20,000 city dwellers, score 3 = 10,000 to 20,000 city dwellers and score 1 < 5,000 city dwellers.

2. Criteria taking into account the accessibility

Three subcriteria are distinguished, according to the nature of the accessibility, namely on foot, by bike and with the public traffic.

- Accessibility on foot

It is examined which percentage of the population (within a radius of three km from the border of the potential urban forest) are able to easily reach the forest or not. As hard barriers (not or very difficult

² It is important to keep in mind that the used numbers of inhabitants for the scores are suitable for the local situation and cannot be used as absolute numbers.

surmountable borders) are considered: highways, departemental roads, wide water courses and railways. When the barriers are surmountable (e.g. level crossing, bridge over a canal or a highway), a new radius is designed from this passage. The urban forest is badly accessible for those people who, due to these barriers, are living outside this new radius

	easily accessible	badly accessible
score 1	0 to 10% of the population	41 to 50% of the population
score 2	11 to 20% of the population	31 to 40% of the population
score 3	21 to 30% of the population	21 to 30% of the population
score 4	31 to 40% of the population	11 to 20% of the population
score 5	41 to 50% of the population	0 to 10% of the population

Then both scores are added up, so that maximally a score of ten can be reached. The final scores are attributed as follows:

- score 5: sum of the partial scores = 9 to 10,
- score 4: sum of the partial scores = 7 to 8,
- etc.

- Accessibility by bike

The results are based on both the existing and the planned bike routes from the city centre. The assessment occurs in consultation with the urban bike officer; The following scores are attributed:

- score 5: accessible today and good quality;
- score 4: accessible today, but bad quality;
- score 3: accessible on short term (2010);
- score 2: accessible, but on long term (after 2010);
- score 1: not accessible, even not on long term.

- Accessibility with public transport

This criterium is elaborated in collaboration with officers of the public transport. The following scores were proposed:

- score 5: good connection with the location and the frequency reaches more than one connection per hour;
- score 3: good connection with the location, but the frequency is (partially) limited to one per hour;
- score 1: no direct connection with the location or the number of direct locations is limited (less than 1 per hour).

3. Criteria taking into account the absence of hindering infrastructure

Two subcriteria are considered, namely the heavy industry and the road infrastructure.

- Absence of heavy industry

Dominating wind direction is not considered. The size of the locations, however, is taken into account:

- score 5: locations, not situated in or bordering on an industrial area;
- score 3: large locations bordering on an industrial area;
- score 1: locations situated in or bordering on an industrial area.

- Absence of road infrastructure

- score 5: locations not or only to a very limited extent bordered by road infrastructure;
- score 4: large locations, moderately bordered by impeding infrastructure;
- score 3: small locations, moderately bordered by impeding road infrastructure;
- score 2: large locations, strongly bordered by impeding infrastructure;
- score 1: small locations, strongly bordered by road infrastructure.

3.2.1.2. Assessment of the potential recreational qualities

The question arises, whether with the assessment a same value must be attributed to all criteria.

There are different possibilities:

- each of the eight (sub)criteria has the same value;
- each of the four groups has the same value;
- a specific weight is given to a certain criterium.

It is accepted, as a blank scenario, that each of the four groups has the same value. In the following scenarios, however, the criterium "absence of soft recreational facilities" receives a lower weight. This is due to a certain extent of ambiguity of this criterium, as recreational poor zones are favoured in the multicriteria analysis.

In order to test the plus value of certain criteria, it was opted to give a double weight to each of the different groups.

Table 2. Scenarios for the assessment of the potential recreative quality

- Scenario 1: the blank scenario: the four main criteria are considered as equivalent and obtain the same weight, namely 6. So the total value of this criterium equals 24. Within each main criterium the subcriteria get a value of 2 or 3, so that the total value of the subcriteria each time equals 6.
- Scenario 2: the criteria related to the population concentration are emphasized by doubling their value.
- Scenario 3: the accesibility of the locations is emphasized by doubling the value of the subcriteria.
- Scenario 4: the absence of hindering infrastructure is emphasized by doubling the value of the subcriteria.
- Scenario 5: the criterium "absence of soft recreational facilities" becomes only value 1. This way, the influence of this criterium, which is considered as ambiguous, is checked
- Scenario 6: the three main criteria get the same value, namely 6, whereas a somewhat lower value is given to the more ambiguous criterium.

Finally this scenario was taken as the basic scenario, because it corresponds mostly to the profile of the desired urban forest.

For each location, the scores of the criteria are multiplied with their weight and afterwards added up. So the maximal score for the blank scenario reaches $24 \times 5 = 120$ and the minimal score goes up to $24 \times 1 = 24$. The maximal score is variable in the other scenarios, according to the weights attributed to the of criteria of each group.

Finally the procent of the maximal score is calculated by location. So this figure is a good indicator for the potency of an urban forest on this location for the recreational quality.

The results are divided into three classes:

- high up to very high potencies $\geq 60\%$
- moderate recreational potencies: $\geq 50\%$ and $< 60\%$
- low or very low recreational potencies: final score $< 50\%$

It appears quite clearly from the six scenarios that there exists an unambiguous classification of the locations on the one hand with good or very good recreational potencies and on the other hand with low or very low potencies.

3.2.2. Structure strengthening criteria

These criteria are indicators for the potency of the forest to strengthen the spatial quality.

Such criteria are hardly taken into consideration with the more general forms of forest extension, e.g. on abandoned agricultural lands. They are, however, very significant with the establishment of urban forests, which, next to their recreational role, also fulfil an important function in the spatial order and consequently highly contribute to the quality of life of the city.

3.2.2.1. Criteria

The structure strengthening criteria are split up into four groups.

1. Criteria referring to the bordering of urban structures

- Potential spatial border of the urban area: the extent to which the forest, which will be established, forms a border for the urban area.

The locations having a direct contact with the urban area obtain a score 5, the locations without contact become a score 1 and those which are separated by physical borders, such as roads and large water courses, are marked with a score 3.

- Potential hinder of the spatially linking of certain residential areas.

A location receives a score 5 when the potential forest is able to form a corridor between two residential areas. It receives a score 1, when the forest is not located between residential areas.

2. Criteria related to the recreational structure: unit of a green axis

This criterium refers to the degree of connection of a location on the green axes, foreseen in Spatial Development Structure Plan of the City of Ghent. The location receives a score 5, when it is an

essential unit of such a green axis, a score 3 when it is moderately important and a score 1 when it is less important.

3. Criteria referring to the structure of the open space

- Unit of the existing natural structure

This criterium refers to the importance of the location within the natural head structure, on macro-scale.

A score 5 means that the location is a very important unit of the natural structure. The scores 3 and 1 respectively refer to moderate and less important units of the natural structure.

- Scenically accentuating of cultural-historical elements with afforestation

It is examined to what extent an afforestation contributes to the strengthening of the cultural-historical value of the landscape.

A score 5 means a strong contribution, such as locations joining castle parks or afforested landscapes, whereas a score 1 is given to locations which, due to their important cultural-historical value, exclude a large scale afforestation. To this belong a.o. traditional valley pastures or other characteristic micro open field landscapes (asches).

- Cohesion of the open space

The afforestation should contribute to the strengthening of the degree of morphological and functional cohesion of the open space.

This criterium is divided into two subcriteria:

- Cohesion with a large open space

This is positively evaluated. Locations, well connecting with an open space, by which extension possibilities are eventually still present, are given a high score (5), whereas surrounded locations are given a low score (1).

- Degree of fragmentation

This is considered as a negative criterium.

This subcriterium is determined by three elements, namely the number of buildings, the number of secondary roads crossing the location and the maximal joint open space within the location.

A subscore is given to each of these elements, ranging from 1 to 3. Afterwards the sub-scores are added up. Then the degree of fragmentation is determined by the sum of subscores and a score is attributed ranging from 1 (unfavorable) to 5 (favorable).

Finally the criterium "cohesion with the open space" is evaluated as the sum of the two subcriteria. A score 5 is attributed when the location optimally scores. A bad score is attributed when the location is scoring low for one of the subcriteria.

4. Criteria related to the potential protection functions of the forest

The protection function of the forest is defined as the extent to which the forest separates two difficult compatible or incompatible functions

In this case six potential protection functions are distinguished, whereby the future urban forest of minimal 100 ha can act as a buffer: residential area-industrial area, residential area-road infrastructure, residential area-nature area, nature area-agricultural area, industrial area-nature area, nature area-road infrastructure.

A high score is attributed when the location simultaneously fulfils more than three protection functions, whereas a low score is attributed when the location fulfils at the most one protection function.

3.2.2.2. Assessment of structure strengthening criteria

The same procedure is followed as with the assessment of the potential recreational qualities.

- Scenario 1: the blank scenario: all (sub)criteria receive the main weight.
- Scenario 2: a double weight is attributed to the subcriteria of the urban structure.
- Scenario 3: a double weight is attributed to the recreational structure.
- Scenario 4: a double weight is attributed to the (sub)criteria of the "structure open space"

The elaboration of the multicriteria analysis with different scenarios (weights) does not cause any fundamental changes in the classification of the different locations: the five most suitable locations remain the same in each scenario.

For the functioning of the model, however, a basic scenario must be chosen. As it is the objective to realize a recreational urban forest, it is finally opted to give the highest value to the group of criteria referring to the urban structures. Consequently, the scenario 2 is considered as basic scenario.

As with the criteria related to the potential recreational quality, the locations are divided into three groups:

1. suitable and very suitable locations: final score $\geq 60\%$
2. moderately suitable locations: final score $\geq 50\%$ en $< 60\%$
3. unsuitable to very unsuitable locations: final score $< 50\%$.

Table 3. Overview of scenarios according to different weights for the structure strengthening criteria

Criteria	Weights according to the different scenarios			
	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Urban structures				
- border urban area	1	2	1	1
- separation residential areas	1	2	1	1
Recreational structure				
- strengthening green axis	1	1	2	1
Structure open space				
- natural structure	1	1	1	2
- cultural-historical landscape	1	1	1	2
- morph. and funct. cohesion	1	1	1	2
Potential protection functions	1	1	1	1

3.2.3. Criteria related to the potential ecological quality

Constraints for an urban forest are not only the good location and the high recreational value, but due value should also be given to ecological possibilities.

In this group attention is paid to the existing nature values of the area, the geographical variation and to the presence of forest.

3.2.3.1. Criteria

3 groups of criteria are distinguished, of which two with 3 subcriteria.

1. Potential cohesion of existing nature values related to the forest sphere

As vegetation is the most direct parameter for the indication of existing nature values (Londo,1984), the division of this criterium is based on the biological assessment map.

- Score 5: biologically very worthwhile area, whereby afforestation can give a plus value to the area.
- Score 4: biological worthwhile area, whereby afforestation can give a plus value to the area.
- Score 3: no worthwhile nature is present within the area.
- Score 2: biological worthwhile area, whereby the establishment of a large scale forest is harmful to the current nature value.
- Score 1: biologically very worthwhile area, whereby the establishment of a large scale forest is harmful to the current nature value.

With the scores 5 and 4, it is assumed that the afforestation is not necessarily executed within the biological very worthwhile or worthwhile area. In most of the cases, the afforestation will more join with the biologically very worthwhile or worthwhile area.

When specific circumstances appear, it can be deviated from the biological assessment map.

2. Geographical diversity within the area

Van der Werf (1991) emphasizes that three elements play an important role in relation to the diversity of the forest types: soil texture, water housekeeping and altitude.

- Soil texture

Six soil texture classes are distinguished on the soil map, together with the eventual presence of profile development and of peat. So, in all, 10 types of texture classes are taken into account. The attribution of the score is based on the number of types of texture classes:

- score 5: presence of more than 6 types of texture classes within the area;
- score 3: presence of 4 to 6 types of texture classes within the area;
- presence of less than 4 types of texture classes within the area.

- Water housekeeping

Six types of water housekeeping are distinguished on the soil map. The score are given as follows:

- score 5: appearance of > 4 types of water housekeeping within the area;
- score 3: appearance of 3 or 4 types of water housekeeping within the area;
- score 1: appearance of < 3 types of water housekeeping within the area.

- Difference in altitude

The differences in altitude are very limited within the area, but nevertheless some important differences in microrelief are noticed, which will influence the microclimate and consequently also the vegetation development. So 3 classes are distinguished:

- score 5: differences in altitude greater than 10 m;
- score 3: differences in altitude between 5 and 10 m;
- score 1: differences in altitude are less than 5 m.

The parameter "hydrology" is not taken into account in this analysis, as insufficient data are available, more specifically on the quality of the superficial water.

3. Presence of forest

The three subcriteria are based on the presence of forest in course of the history.

- Current presence of forest

As the area and the province are very poorly forested (4%), more than 15% is considered as a maximum score:

- score 5: rather rich on forest (> 15% forest);
- score 3: moderately rich on forest (5-15% forest);
- score 1: poor on forest (< 5% forest)

- Presence of ancient wood cores or ancient wood relics

As ancient wood cores are very important for the migration of ancient wood plants, it is recommended to limit the search area of ancient wood plants to the location itself. Indeed the colonisation capacity of ancient woodplants is very restricted.

- Score 5: rather important presence of ancient woodland within the location (> 15% ancient woodland).
- Score 3: moderate presence of ancient woodland within the location (5-15% ancient woodland).
- Score 1: rather scarce presence of ancient woodland within the location (< 5% ancient woodland).

- Former presence of woodland

The former presence of forest has been characterized by means of the Ferraris map (1778). As the involved area was at the time relatively rich on forest, more than "30% former woodland" is considered as maximum score:

- score 5: before relatively very rich on forest (> 30% former woodland);
- score 4: before relatively rich on forest (20- 30% former woodland);
- score 3: before moderately rich on forest (10-20% former woodland);
- score 2: before relatively poor on forest (1-10% former woodland)
- score 1: before absence of forest (<1% former woodland).

3.2.3.2. Assessment of the potential ecological quality

For the analysis of this subject 4 scenarios are tested (Table 4).

Table 4. Scenarios for the assessment of the potential ecological quality

- Scenario 1: the blank scenario. The three criteria are considered as equivalent and obtain the same weight, i.e. 3. Consequently each of the subcriteria obtains a weight 1. As each criterion can receive a score up to 5, the total score can increase up to 45.

- Scenario 2: the desirability of forest establishment from the ecological point of view is considered as essential. Therefore the criterion "cohesion with existing nature values related to the forest sphere" obtains a higher weight, in this case the threefold.

As this project aims at the realization of a forest ecosystem, the criterion "presence of forest" is considered as a second important criterion. So, also this criterion obtains a higher weight than the criterion "geographical diversity".

- Scenario 3: the presence of forest is considered as essential for the realisation of a forest with high ecological potentials. This criterion obtains the weight 2.

- Scenario 4: both the criterion "cohesion with existing nature values related to the forest sphere" and the criterion "geographical diversity" are considered more worthwhile than the third criterion "geographical diversity within the area". Therefore a weight 2 is attributed to the first two mentioned criteria. In this case the maximum score reaches 75.

This scenario is finally considered, taking into account the present circumstances, as basic scenario.

With this assessment no specific attention is paid to the criterion "geographical diversity within the area", as there are only small differences within this criterion.

The overall assessment of this group occurs, just as with the former two sub-groups, by expressing the score of the three criteria in percent of the maximal feasible.

Regardless of the scenario, some five locations appear to have each time a high, up to a very high, ecological potential (final score ≥ 60). On the contrary three locations appear to be always unsuitable for the establishment of a forest from the ecological point of view (final score $> 50\%$). The other locations have a moderate to low ecological potential ($\geq 50\%$ and $> 60\%$).

3.2.4. The global multicriteria analysis for the classifying phase

The global multicriteria analysis for the classifying phase is calculated by means of the basic scenarios of the three subanalyses.

The three subgroups, however, are not considered as equivalent. Indeed most value is given to the group of the potential recreational quality. Therefore this group obtains the weight 1.5. The percentual results of the subanalyses, reached this way, are added up and again percentually expressed.

The division of the locations in suitability classes is finally based on:

1. the score of the location for the overall multicriteria analysis (see above);
2. the individual potencies of the locations for the recreational quality, structure strengthening quality and ecological quality.

Herewith the following suitability classes are used:

- most suitable locations: total score > 65% and absence of moderate potencies for the three sub-analyses;
- suitable locations: total score > 60%, but only moderate potencies for one of the three sub-analyses;
- moderately suitable locations: total score between 50 and 60% and at the least one high and one low potency for one of the three sub-analyses;
- little suitable locations: total score < 50%, but at least a moderate potency for one of the three sub-analyses;
- least suitable locations: total score < 50% and only low or very low potencies for the three subanalyses.

It appears from this study, that three locations can be considered as the most suitable ones, whereas three other locations can be classified as suitable.

The most suitable location has very high potencies for structure strengthening and ecological quality. At the same time it has high recreational potencies. Especially it has the following assets:

- afforestation can prevent the linking of residential areas;
- afforestation can strengthen an existing green axis;
- the accessibility with public transport is good;
- no heavy industry is present;
- the location has a high potency for cohesion with existing local nature values related to the forest sphere;
- almost half of this location was formerly afforested;
- the current afforestation density of the location is relatively high.

The main objection against the establishment of the urban forest in this location is the presence of disturbing infrastructure (three highways and a railway).

It is decided to take into consideration for the feasibility phase only the most suitable and the suitable locations.

3.3. Feasibility phase

This phase consists in testing the criteria giving indications concerning possible conflicts with other sectors about the use of the space, namely agriculture, nature, landscape and urban functions (table 5).

Table 5. Overview of feasibility criteria

* Acceptability for the agricultural sector
- economic importance for the agricultural sector
- restrictions of manure depositions
- presence of marginal agricultural land
* Acceptability for the nature and landscape values
- acceptability for nature values
- acceptability for landscape values
* Acceptability for urban functions
- planned extension of enterprises
- planned recreational extension
- planned residential extension

3.3.1. Acceptability for the agricultural sector

The three criteria are determined by the agricultural sector and are used by this sector to evaluate the importance of a large scale area. They are all three considered as equivalent.

The presence of voluntary withdrawing farmers and farmers without direct succession is not retained as a criterion by the agricultural sector. Indeed, the importance of the land of phasing out farmers for the sector is emphasized

1. Economic importance for the agricultural sector

Establishment of forests becomes less acceptable for the agricultural sector as the economic importance of the agriculture increases. According to the classical agricultural economic model, the economic importance of the agriculture is directly proportional to the size of the agrarian production.

The evaluation of the agricultural importance was measured on the basis of the Gross Standard Saldo (GSS), which is generally considered as a reliable indicator for the expected income of the agricultural enterprise. It is calculated by means of bookkeeping data for the whole of Belgium.

Due to pragmatical reasons the final assessment of the scores for each location was based on the GSS of the average enterprise (meaning the total GSS of all land users in the location divided by the number of land users) and the amount of enterprises per surface. The five score classes are weighted according to local standards of the GSS:

- score 5: very little economic importance of the agriculture
- score 4: little economic importance of the agriculture
- score 3: moderate economic importance of the agriculture
- score 2: big economic importance of the agriculture
- score 1: very big economic importance of the agriculture

2. Limitations for the manure deposition

This criterion also is proposed and determined by the agricultural sector. The acceptability of forest extension for the agricultural sector increases as more and heavier zone directed limitations for manure deposition are put on the land.

The limitations can be measured by means of the following variables:

- phosphorus saturated areas;
- water winning areas;
- nature areas.

The locations obtain a score ranging from 5 (limitations on the manure deposition for the whole area) to 1 (no limitations on the manure deposition).

3. Presence of marginal agricultural land

Very dry and very wet soils are, from the production point of view, called marginal lands for agriculture. At the moment, however, a lot of former marginal lands have become economically very important for agriculture. So, the agricultural sector always uses the criterium "marginal land" in combination with other factors, which together lead to "marginal agricultural land".

The agricultural authorities use the following criteria for the assessment of marginal agricultural land:

- the intrinsic value of the soil;
- the structure of the surrounding agricultural area;
- the individual specific situation.

The structure of the surrounding agricultural area is more negatively assessed, as the degree of fragmentation by non agrarian buildings or by nature is greater.

So, the locations are again divided in classes ranging from 5 (very high presence of marginal sites) to 1 (little presence).

The overall acceptability for the agricultural sector is determined as the sum of the three criteria. Different scenarios are proposed.

1. In the basic scenario a same weight is attributed to each of the three criteria. These criteria are selected by the agricultural sector itself and also used by it. The scores are converted in percent, after which the following acceptability classes are adapted:

- most suitable location for agricultural sector: > 70%;
- more acceptable locations for the agricultural sector: > 60% and >= 70%;
- moderately acceptable locations for the agricultural sector: > 50% and <= 60%;
- badly acceptable locations for the agricultural sector: > 40% and <= 50%;
- very badly acceptable locations for the agricultural sector: <= 40%.

2. Alternative scenarios are thinkable, as more or less attention is paid to some criteria, or when new criteria are added.

- The limitation on the manure deposition obtains a smaller weight. Therefore a double weight can be attributed to the two other criteria. It must be noted, however, that this criterium eventually will disappear in the future.
- The presence of voluntary withdrawing farmers is considered as a fourth criterium, e.g. on the same level with the three other criteria. The scores for this new criterium are determined as follows:

- score 5: very important presence of voluntary withdrawing farmers, > 50% of number of enterprises and of arable land area;
- score 4: number of voluntary withdrawing farmers > 50% and arable land area of voluntary withdrawing farmers < 50%;
- score 3: number of voluntary withdrawing farmers and arable land area of voluntary withdrawing farmers between 25 and 50%;
- score 2: either number of voluntary withdrawing farmers or arable land area of voluntary withdrawing farmers ≤ 25%;
- score 1: number and arable land area of voluntary withdrawing farmers < 25%.

This alternative is sometimes used.

3.3.2. Acceptability for the nature and landscape values

This criterium intends to examine to what extent the establishment of a large scale urban forest is acceptable in the location, taking into account the nature and landscape values.

Large scale afforestations can threaten a.o. the following nature values:

- worthwhile pasturelands for avifauna;
- wet meadowlands and moist pastures.

From the landscape point of view, a.o. the following values should be respected:

- maintenance of sufficient open space;
- maintenance of typical avenue character;
- maintenance of open valley character.

The acceptability is examined separately for both sectors. The following scores are accepted:

- score 5: highest acceptability;
- score 3: moderate acceptability;
- score 1: bad acceptability.

With the final assessment both criteria are considered as equivalent and the overall acceptability is set up according to the standards of the criteria already mentioned.

3.3.3. Acceptability for the urban functions

1. Planned extension of enterprises

By means of several existing plans, it is possible to examine which facilities for economic activities have been considered. This leads to an indication on the accessibility of forest establishment for the economic sector.

Three scores are retained:

- score 5: no planned extension of enterprises and absence of a spatial claim by the industry;
- score 3: no extension of enterprises is planned for the next future, though there is a relative high pressure on the location by the industry;
- score 1: a big claim on the location by the planned extension from enterprises.

2. Planned recreational extension

The establishment of a relative large urban forest must also be tested against the plans of the recreational and tourist sector. This test can occur in collaboration with the tourist service.

- score 5: optimal acceptability; elaboration of a soft recreational belt;
- score 3: moderate acceptability;
- score 1: bad acceptability; locations are reserved for extensive nature recreation. The number of visitors must be limited to the "nature lovers".

3. Planned extension of residential areas

By means of plans it is examined whether extension of residential areas is scheduled or not. Three classes are accepted:

- score 5: no extension of residential areas is planned;
- score 3: the planned extension for residential areas puts a moderate claim on the space which comes into consideration for establishment of forest;
- score 1: the planned extension of residential area puts a big claim on the space which comes into consideration for establishment of forest.

With the final assessment of the acceptability of the establishment of an urban forest for the urban functions, the three criteria are considered as being equivalent. The overall acceptability is, such as for the other criteria, the result of the sum of the three individual criteria. The division into classes too occurs in the same way as with the other criteria. The locations with a percentage of more than 70% for the overall acceptability are classified into the class of the most acceptable locations, etc.

3.3.4. Global assesment of the feasibility phase

The overall assessment of the feasibility phase occurs on the basis of the importance of the three distinguished main functions: agriculture, nature and landscape, urban function. Different scenarios can be developed.

Taking into account the local situation, meaning that the agriculture is by far the most important land user, the highest weight in the basic scenario is attributed to the acceptability of the agricultural sector. But also the two other groups have a determining role in the elaboration of the multicriteria-analysis. Therefore the difference in weight, attributed to the three main criteria, may not be too large. So the basic scenario is determined as follows :

- two times more weight is attributed to the "acceptability for the agricultural sector"
- within each group the criteria are considered as equivalent.

The other scenarios are developed as follows:

- Scenario 1: the three groups of the main criteria have the same value.
- Scenario 3: three times more attention is paid to the acceptability of the agricultural sector than to the other two sectors.

On the basis of the above mentioned division, the acceptability is calculated for each location for each of the three functions. The result proves, that the differences between the different locations are not very significant.

As there is no significant differences between the (four) selected most suitable locations, the **final overall assessment of the acceptability is based on the acceptability of the three functions separately:**

- most acceptable locations: the locations belong for each of the three main functions to the most acceptable locations;
- more acceptable locations: absence of moderate acceptability for all functions (so, only the most and/or the more acceptable locations for each of the three functions);
- less acceptable locations: a bad acceptability appears for at least one of the three functions.

In this case study the results of the feasibility phase do not significantly differ from these of the classifying phase. It appears that the three locations, which were the most suitable according to the classifying phase, almost identically score in the feasibility phase.

3.4. Opportunity criteria

When it appears, that different locations almost score equally, the final choice for the location of an urban forest can be determined by so called opportunity criteria. This category of criteria is mainly directed to the degree of "immediate realization possibility" for the afforestation project. Herewith the local opportunities are examined on a detailed scale, by preference information on the level of the plots.

Moreover the application of these criteria leads to a better insight of the concrete realization of the urban forest in a well determined location, as it provides the manager with a lot of detailed data.

As main opportunity criteria for the establishment of new urban forests can be mentioned:

- presence of green destinations according to the regional plan;
- presence of already existing afforestation projects;
- possibility of the acquisition of land on short term:
 - presence of properties of public authorities;
 - presence of fallow land in the area;
- presence of non-professional agriculture;
- presence of farmers without direct succession.

A detailed opportunity study is very labour consuming, but nevertheless it must be considered as necessary, moreover it provides a lot of useful silvicultural data.

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