

## Final Project Report (to be submitted by 30<sup>th</sup> September 2016)

### Instructions:

- Document length: maximum 10 pages, excluding this cover page and the last page on project tags.
- Start with an abstract (max 1 page).
- Final report text: Do not forget to mention your methodology; the people involved (who, how many, what organization they are from – if applicable); and the expected added value for biodiversity, society and the company. Finally, state whether the results of your project can be implemented at a later stage, and please mention the ideal timing and estimated costs of implementation.
- Annexes are allowed but will not be taken into account by the jury and must be sent separately.
- Word/PDF Final Report files must be less than 10 MB.
- If you choose to submit your final report in your local language, you are required to also upload your final report in English if you wish to take part in the international competition.
- To be validated, your file must be uploaded to the [Quarry Life Award website](#) before **30<sup>th</sup> September 2016** (midnight, Central European Time). To do so, please log in, click on 'My account'/ 'My Final report'.
- In case of questions, please liaise with your national coordinator.

### 1. Contestant profile

▪ Contestant name:	Kevin Mankununu Mutombo
▪ Contestant occupation:	Student
▪ University / Organisation	Université Chrétienne d'Afrique Centrale
▪ E-mail:	
▪ Phone (incl. country code):	
▪ Number of people in your team:	Two (2)

### 2. Project overview

Title:	Reforestation of the areas around Lukala and Cataractes with Leucaena.
Contest:	3 <sup>rd</sup> Edition (2016)
Quarry name:	Lukala quarry C-45 (Cilu)
Prize category: (select all appropriate)	<input type="checkbox"/> Education and Raising Awareness <input checked="" type="checkbox"/> Habitat and Species Research <input checked="" type="checkbox"/> Biodiversity Management <input checked="" type="checkbox"/> Student Project

	<input checked="" type="checkbox"/> Beyond Quarry Borders
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## Abstract (max 1 page)

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### Reforestation of the areas around Lukala and Cataractes with Leucaena.

The district of Cataractes is located in Kongo-Central province, in the Democratic Republic of Congo. A trend of desertification due to a strong leaching of stripped soil has been noticed in this district. It is admitted to be the consequence of extravagant deforestation for culinary needs and fertilizing the soil with the ash. In the quarry C-45, the growth of Leucaena intrigued, it is better to create the same conditions in the areas around in order to master the soil erosions, to fertilize the soil and secondary to sequester the carbon dioxide that contributes to the global warming and to solve needs of wood fuels. Leucaena stabilize the soil and struggle against the leaching and erosions. The implantation of Leucaena in the everyday life of Cataractes is a support to the development of fallow land agriculture. It is a protein feeding for cattles.

In DRC , the Latitude 4 to 5° south , from West to East seems to be similar. The vegetation found is a steppique forest where trees is scarce. All this space benefit of a tropical climate , with around 800 mm of precipitation height. If these elements are favourable for leucaena , the altitude and the soil components are not everywhere good for the Leucaena growth.

Kongo Central province altitude varies between 0 to 500 m . And Lukala is at 300 m of altitude. Soil at Lukala is the clay. Around Lukala and in Cataractes the conditions are gathered for the growth of leucaena. It is question to amend soil .

## Final Report

### Introduction

Leucaena is a genus of trees and shrubs native to Central America and belongs to the Fabaceae family (subfamily Mimosoidées).

Leucaena growing in the C45 quarry is the leucocephala Leucaena. It is considered sometimes like an invasive plant. In this quarry , Leucaena began to grow spontaneously . It is possible that birds or others animal brought their seed in the quarry from the residential city of Lukala. It is also possible that Leucaena reached the quarry from the residential Quarter by wind along a corridor conducive to their growth . (See the map below). In the residential area, the leucaena were introduced by a former site for rearing goats in 2003.

In the quarry the expansion of these leucaena is full. It creates a small forest where live species. And around the quarry some directions are covered with these plants. Everybody can notice the contrast of vegetation between the quarry and immediate environment.

This contrast suggests answers to many of our questions: how to fight against the scarcity of forests ; how to provide charcoal to people in maintaining forest existence; how to promote agriculture without depleting soil , how to solve alimentary problems. Leucaena appears to be the solution for Kongo Central through the Quarry C45. Through Biodiversity preservation it is possible to solve economics, social, habitat and species question.

### Leucaena requirements and presentation

#### Soil requirements

In the native range, grows in deep, free-draining soils of mildly acid reaction (pH 5.5-6.5).

#### Moisture

Native to 1,500-3,500 mm annual rainfall, high altitude regions with very short dry seasons (0-3 months).

#### Temperature

Grows at 30-1,500 m asl in frost-free climates with average annual temperatures from 18-22°C. Young seedlings can be killed by moderate frosts.

#### Light

Native to regions with constant cloud cover and is therefore likely to possess some shade tolerance.

#### Reproductive development

Flowers predominantly over early summer (May to June in Mexico) but flowering can occur year-round, with the exception of mid-winter. Fruits predominantly over autumn and winter (August to February in Mexico) but fruiting can occur year-round.

#### Defoliation

Most accessions were tolerant of regular cutting in forage production trials in Hawaii, Florida, Australia and southeast Asia. *L. diversifolia* CPI 33820 was tolerant of regular grazing by cattle in northern Queensland, Australia.

#### Fire

Mature plants are tolerant of moderate intensity fires, regrowing readily from burnt stumps or branches

### The objectives

- The struggle against erosions that threat the district of Cataractes in the province of Kongo- Central by the soil studies inside the quarry and around;
- The soil fertilization at the quarry C-45 neighborhood by the soil comparative studies;
- Quick forest creation by the *Leucaena* specie that lives together with others species by a cultural technical approach study;
- Creation of other pits for CO<sub>2</sub> sequestration, and if possible to assess the absorption capacity of carbon dioxide by the *Leucaena* specie;
- The animal production increase by the assessment of the cattle feeding;
- The creation of diverse habitats;
- Reorientation of firewood seeking.

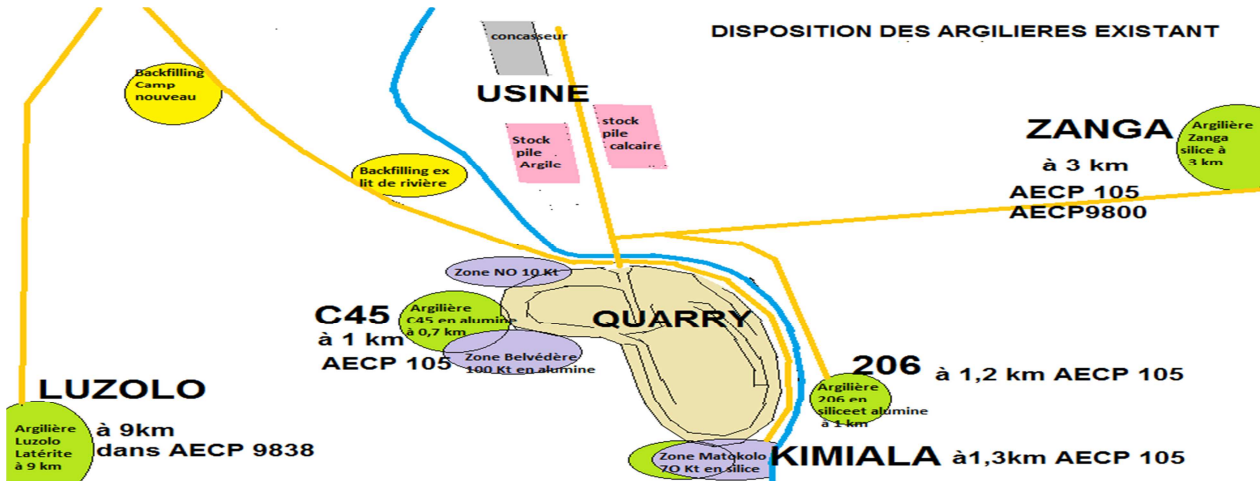
If in the quarry *leucaena* grows easily, why not everywhere in Cataractes? In the Province? In the Country?

### Detail of the problematic

#### C-45 quarry coordinates :

- altitude 350 m,
- 14°29'35" East Longitude
- 5°31'27" South Latitude.
- Quarry Area 25 ha

*Leucaena* is growing to much at the North of quarry and are scarce at the South. The difference of these 2 areas is the quality of their clays. In the South the clay has high content of alumina and the north this content is less



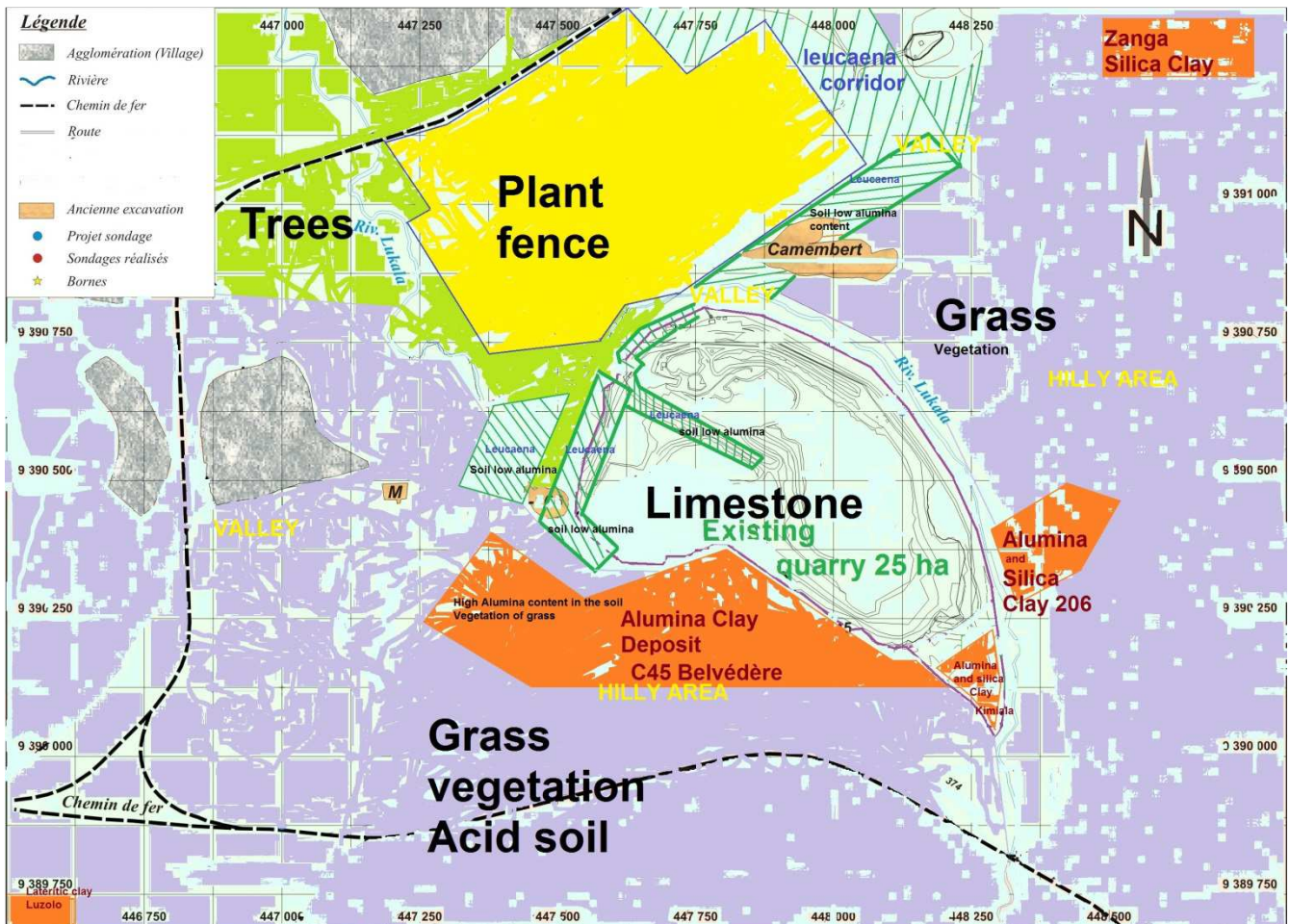
Around C-45 Quarry exists sites where are extracted different clays.

It exists five zones where are extracted clays; and many of them are confronted to the leaching action of climate

- At East ZANGA zone where it is extracted Silica clay
- At South West of quarry LUZOLO where it is extracted Lateritic clays
- At South KIMIALA zone where it is extracted Alumina and silica clay
- At Immediat South West C45 zone where it is extracted Alumina clay.
- At South East 206 zone where it is extracted alumina and silica clay



Leucaena Leucocephala in North West side of Cilu Quarry C-45



It is noticed Leucaena Leucocephala presence in valley area , and far from Alumina Clay deposits. In places where grow leucaena, the content of alumina in soil is low (in North and North West of the quarry) . And the limestone presence is high.

The same situation is noticed at the corridor from the residential Quarter to the Quarry . In this corridor before installing the filter back, the decarbonized limestone dust rejected by the Kiln, fell on it. This dust had CaO, and was widespread everywhere in this area since 1973 to 2014.

But over a large area, it only grows grass. This is due to leaching phenomenon and also to soil acidity. This is the situation in all Cataractes Area.

#### Methods

How to do Leucaena Forest in the large acid soil where grass is growing?

- Analysis of soil where leucaena is growing easily
- Analysis of soil where grass is growing
- Determine the difference between the 2 types of soil
- Contribution of missing components
- Planting Leucaena

A soil analysis was carried out for getting a prior specific reference. That specificity helped for comparison to every soil found where the Leucaena must be planted

#### Analysis

We found soil analysis done by Cilu in 2010 through his exploration program.. Two analysis Luk 11 and Luk 18 were done in the area where leucaena is growing easily . The others analyses that we considered; were done in

the large area of grass. These analyses were done to evaluate limestone reserve and to define clay components.

In grass area ( Hilly area and some space in valley)

Zone à absence de concentration leucaena												
	P.F	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	CaO	MgO	N.D	Titre	Total			
Zan 32	11,18	58,34	15,02	8,8	0,95	0,32	5,39	1,69	94,61			
Zan 31	8,02	56,52	19,23	10,05	0,45	0,22	5,51	0,8	94,49			
Zan 17	7,04	53,16	14,44	9,6	0,96	0,88	13,92	1,71	86,08	Au delà de péage et déviation		
Zan 14	8,89	36,12	19,02	30,25	0,4	0,12	5,2	0,71	94,8			
Zan 11	10,02	51,96	19,85	12,56	1,02	0,69	3,9	1,82	96,1			
Zan 10	7,77	61,12	14,99	12,5	2,9	0,65	0,07	5,17	99,93			
Zan 9	9,72	60,38	17,7	9,23	1,06	0,3	1,61	1,89	98,39			
Luk 64	8,76	60,34	19,64	10,59	0,44	0,17	0,06	0,78	99,94			
Zan 5	9,34	53,70	16,43	8,81	6,35	0,80	4,57	11,32	95,43			
Zan 4	5,75	65,66	15,81	6,02	0,45	0,16	6,15	0,80	93,85			
Luk 69	15,01	34,02	19,08	28,26	2,62	0,70	0,31	4,67	99,69			
Luk 54 bis	3,09	76,18	4,44	7,85	2,34	1,35	4,75	4,17	95,25			
Luk 46	7,37	57,78	20,06	8,74	0,74	0,18	5,13	1,32	94,87			
Luk 45	10,20	42,96	22,65	19,03	1,46	0,52	3,18	2,60	96,82			
Luk 01	6,50	68,98	13,30	8,81	0,46	0,66	1,29	0,82	98,71			
Moyenne	8,58	55,81	16,78	12,74	1,51	0,51	4,07	2,69	95,93			

In Leucaena area

Zone à concentration leucaena												
	P.F	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	CaO	MgO	N.D	Titre	Total			
Luk 11	6,50	70,50	13,45	6,44	0,94	0,17	2,00	1,68	98,00	vers poudrière vers l'usine		
Luk 18	5,79	76,46	10,07	4,47	1,48	0,82	0,91	2,64	99,09			
Moyenne	6,15	73,48	11,76	5,46	1,21	0,50	1,46	2,16	98,55			

It is noticed in Leucaena area in comparaison with the Grass area a high rate of SiO<sub>2</sub> and a low rate of Al<sub>2</sub>O<sub>3</sub> and Fe<sub>2</sub>O<sub>3</sub> . The CaO and MgO rates remaining the same.

If to create the good conditions for growing Leucaena Leucocephala , it is needed this following clay component :

- 1,21% of CaO
- 0,50% of MgO
- 11,76% of Al<sub>2</sub>O<sub>3</sub>
- 5,46 % of Fe<sub>2</sub>O<sub>3</sub>

Than in grass area where the clay composition is :

- 1,51% of CaO
- 0,51% of MgO
- 16,78% of Al<sub>2</sub>O<sub>3</sub>
- 12,74% of Fe<sub>2</sub>O<sub>3</sub>

A readjustment of clay components rate is desirable.

So by the rule of three , we can say :

- Soil with 11,76 % of Al<sub>2</sub>O<sub>3</sub> needs CaO content equals 1,21% to facilitate the growth of Leucaena
- Than soil with 16,78 % of Al<sub>2</sub>O<sub>3</sub> , CaO content will equal 1,73 %

With the same reasoning: The grass area needs 0,71% of MgO to be to be favorable to the growth of leucaena. The soil with grass is more acid than the one where leucaena is growing. To correct this soil an addition of CaO and MgO is recommended.

- CaO Addition is 1,73% - 1,51 % or 0,22% of CaO
- MgO addition is 0,71 % - 0,51 % or 0,20 % of MgO

In 1 Ton of this soil, it must be added

- 2,2 kg of CaO
- 2 kg de MgO

So 1 Ton of this high alumina content will comprise:

- 995,8 kg of identified soil.
- 2,2 kg of CaO to add
- 2 kg of MgO to add.

Otherwise:

In 1 Ton of this soil occupies 1 m<sup>3</sup> of volume if it is considered:

- 1,2 T/m<sup>3</sup> of specific weight
- 1,2 of expansion coefficient

- 0,2 m of depth

This Cubic meter of volume is than equivalent to 5 m<sup>2</sup> of surface

So in 1 ha of area to be amend with CaO and MgO addition , the quantities to add are:

- CaO :  $((1\text{ha})/5\text{m}^2) \times 2,2 \text{ kg} = 4,4 \text{ T}$
- MgO :  $((1\text{ha})/5\text{m}^2) \times 2 \text{ kg} = 4 \text{ T}$

But it is known that in a soil 70% of Ca<sup>2+</sup> and 10% of Mg<sup>2+</sup> provide a balanced cation exchange capacity.

If the total of CaO in 1 Ton of soil is 1,73 % or 17,3 kg, considered like 70% in the CEC , than the need of MgO will be 2,5 kg .

The existent 0, 51% of MgO , represent 5,1 kg . This shows no need to add MgO.

To increase the PH<sup>+</sup> of acid soil around the quarry , 4,4 T of CaO must be mixed with the soil in each ha . When leucaena will own the ground , it will create his Organic Material to maintain his CEC. Micro organisms diversities will grow to help leucaena roots to act. Capture and pumping nitrogen into the soil will be effective.

### Liming Operation

To maintain the cation exchange capacity balanced, it will be done a liming operation. Every year 300 kg/ha of lime will be spread to increase bioavailability of phosphorus and promote nitrification and symbiotic nitrogen fixation.

Notice: It is known that the interspecific crosses between *L. leucocephala* and *Leucaena diversifolia* to obtain hybrids tolerant to acid soils is a good solution instead the acid soil amendment. This will be the subject of another study. It will discuss control of the adaptability of *Leucaena diversifolia* in the country.

### Soil Amendment cost

The first action intended :

- Soil amendment for 10 ha.
  - o CaO need : 44 T
  - o CaO provenance : the cleaning plant waste
  - o Distance Plant to the first area to restore: 3 km . Transport cost : 3,3 \$/T or 145,2 \$ Total
- Operation
  - o Plowing on grass : 200 \$/ha or a total of 2000 \$
  - o Seed collection : By workers from existing leucaena trees
  - o Planting: Direct seeding along furrows by workers
  - o Weeding : 8 times by village comminutes : 500 \$/time
  - o Quantity of needed young plants :
    - Space 3 m
    - Line Interval 3 m
    - Number of seeds (10890 X2) + 20% of lost
    - These distances between leucaena are preferred because the spaces will be filled by young plants in second generation and every time in each 3 m , 2 seeds must be place in the same place, to maximize germination chance. After germination , they will grow together.
- Planning
  - o Collecting seed : December 2016
  - o Seed preparation : January 2017
  - o Planting ; January 2017 to take profit of rainy season
  - o Weeding : Every 2 weeks since January till end of April
- Total Cost :
  - o Soil amendment : 145 \$
  - o Plowing : 2000 \$
  - o Weeding : 4000 \$
  - o Unplanned : 5% of precedent items : 310 \$
  - o Total : 6455 \$
- Cilu Profit:
  - o The success of this first experience, will convince stakeholders of its extension in the province and in DR Congo
  - o This would enhance the reputation of the Cilu
  - o This would improve the sales of limestone powder and lime.

- This activity to reforest DR Congo will create employees
- In the DR Congo communities
  - Stopping desertification process
  - Stopping erosion
  - Protection of road
  - Improve and diversify livestock foods and improve profitability farms
  - Solving charcoal problem
  - Protection of species
  - Creating new habitats and protection of animal species
  - Improving agriculture by corridor system
  - Improving CO2 capture

### Conclusion

The soil leaching in the tropical climate mixed with bad agriculture practice and charcoal production, are leading some area in DR Congo to a desertification. Reforestation through *leucaena leucocephala*, which is growing easily and very quickly can give response to :

Agriculture

Famine

Energy problem (cooking)

Environment preservation and improvement CO2 capture

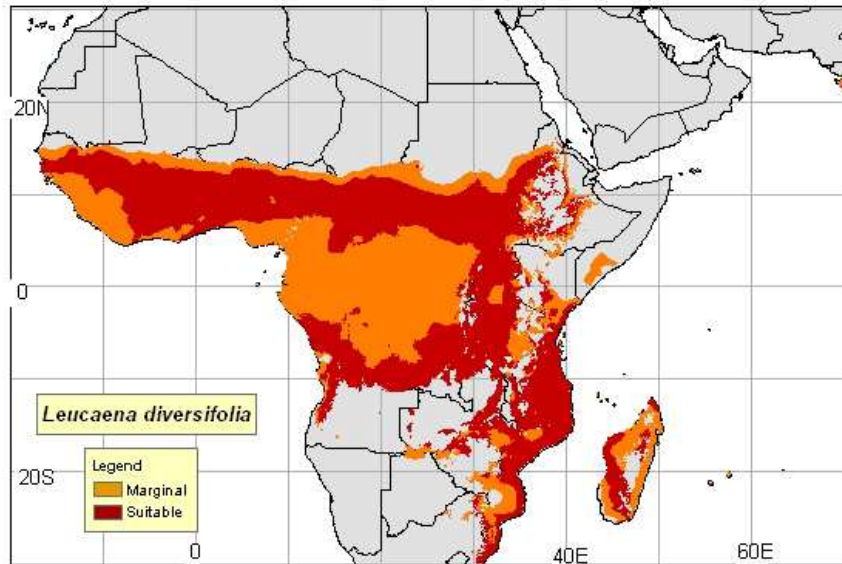
Landscape preservation

Biodiversity preservation

The *leucaena* can boost DR Congo economy

### 1. References

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Leucaena in C45 Quarry Lukala Democratic Republic of Congo ( Development opportunity)

To be kept and filled in at the end of your report

<b>Project tags (select all appropriate):</b> This will be use to classify your project in the project archive (that is also available online)	
<p><b>Project focus:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Biodiversity management</li> <li><input type="checkbox"/> Cooperation programs</li> <li><input type="checkbox"/> Education and Raising awareness</li> <li><input type="checkbox"/> Endangered and protected species</li> <li><input type="checkbox"/> Invasive species</li> <li><input checked="" type="checkbox"/> Landscape management - rehabilitation</li> <li><input checked="" type="checkbox"/> Rehabilitation</li> <li><input type="checkbox"/> Scientific research</li> <li><input checked="" type="checkbox"/> Soil management</li> <li><input type="checkbox"/> Urban ecology</li> <li><input type="checkbox"/> Water management</li> </ul> <p><b>Flora:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Conifers and cycads</li> <li><input type="checkbox"/> Ferns</li> <li><input type="checkbox"/> Flowering plants</li> <li><input type="checkbox"/> Fungi</li> <li><input type="checkbox"/> Mosses and liverworts</li> </ul> <p><b>Fauna:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Amphibians</li> <li><input checked="" type="checkbox"/> Birds</li> <li><input checked="" type="checkbox"/> Dragonflies &amp; Butterflies</li> <li><input type="checkbox"/> Fish</li> <li><input checked="" type="checkbox"/> Mammals</li> <li><input checked="" type="checkbox"/> Reptiles</li> <li><input type="checkbox"/> Spiders</li> <li><input type="checkbox"/> Other insects</li> <li><input type="checkbox"/> Other species</li> </ul>	<p><b>Habitat:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Cave</li> <li><input type="checkbox"/> Cliffs</li> <li><input type="checkbox"/> Fields - crops/culture</li> <li><input checked="" type="checkbox"/> Forest</li> <li><input type="checkbox"/> Grassland</li> <li><input type="checkbox"/> Human settlement</li> <li><input type="checkbox"/> Open areas of rocky grounds</li> <li><input type="checkbox"/> Recreational areas</li> <li><input type="checkbox"/> Screes</li> <li><input type="checkbox"/> Shrubs &amp; groves</li> <li><input checked="" type="checkbox"/> Soil</li> <li><input type="checkbox"/> Wander biotopes</li> <li><input type="checkbox"/> Water bodies (flowing, standing)</li> <li><input type="checkbox"/> Wetland</li> </ul> <p><b>Stakeholders:</b></p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Authorities</li> <li><input checked="" type="checkbox"/> Local community</li> <li><input checked="" type="checkbox"/> NGOs</li> <li><input checked="" type="checkbox"/> Schools</li> <li><input checked="" type="checkbox"/> Universities</li> </ul>