

02 – 04 May 2018

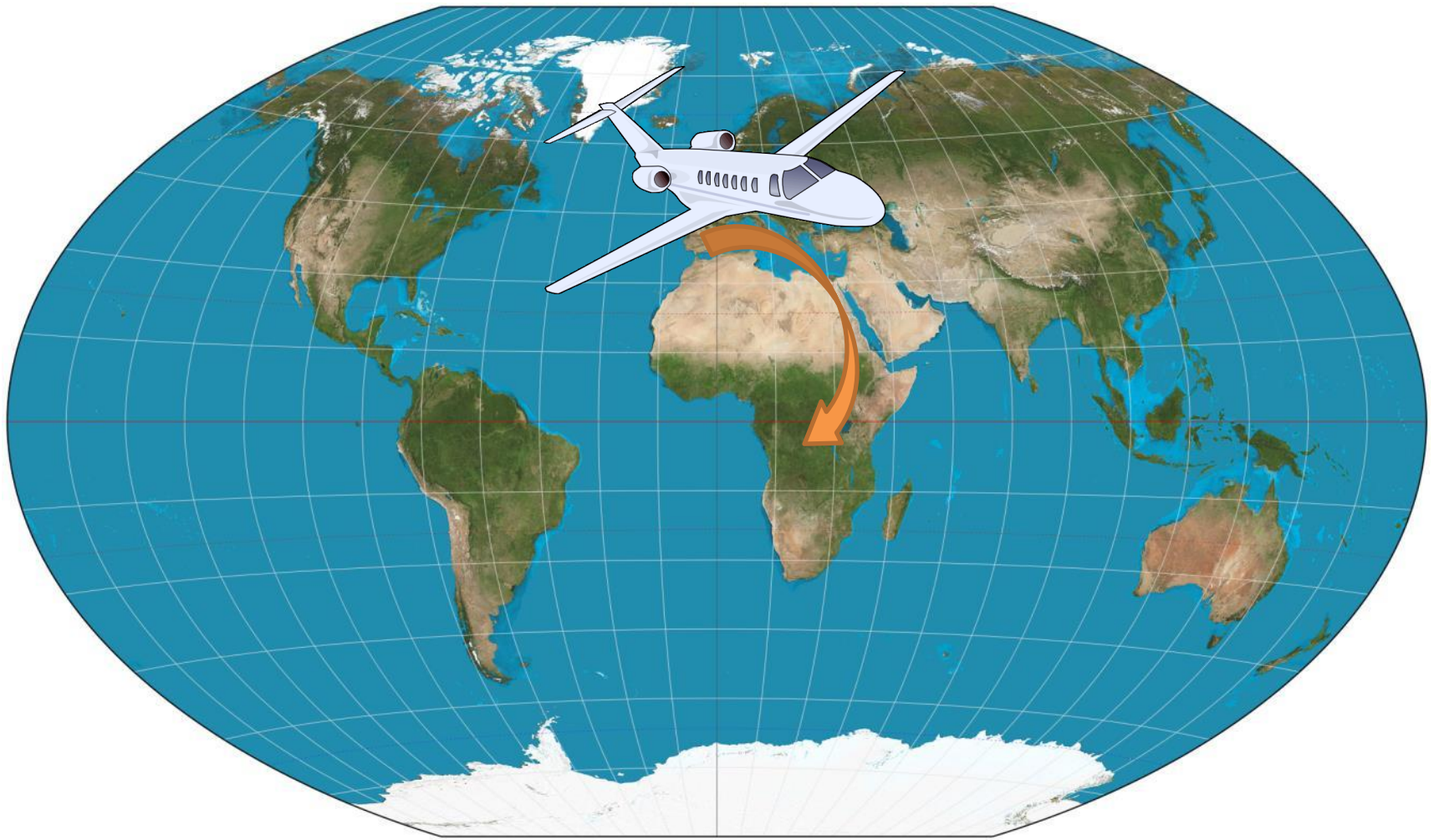


**Quarries alive**

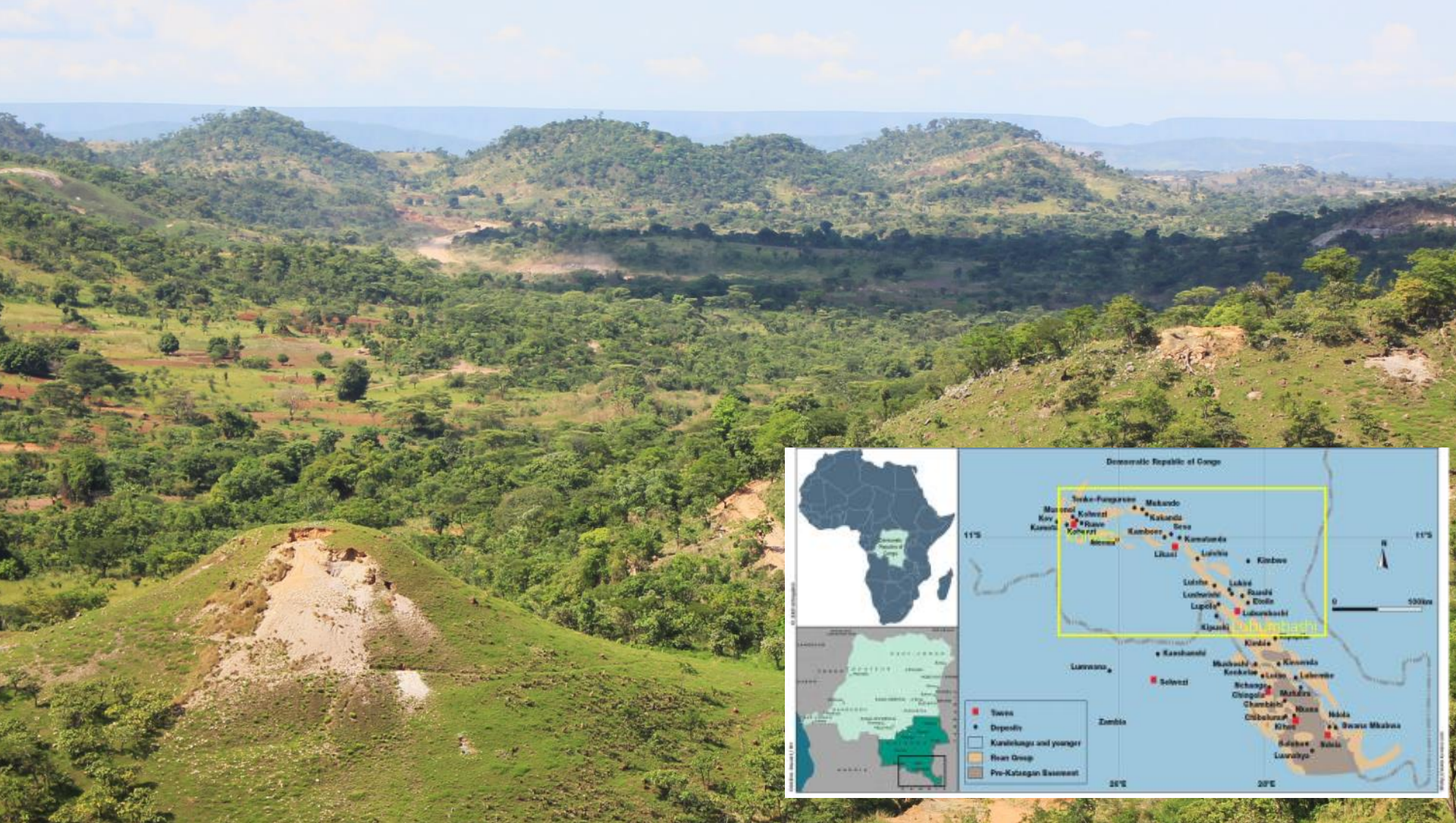


Mining and biodiversity: Exploring the conservation strategy of a  
metallicolous vegetation in the Katangan Copperbelt (D.R.C.)  
*Focus on integrated actions combining biodiversity and reclamation*

**Sylvain Boisson** | Guylain Handjila | Mylor Ngoy Shutcha | Grégory Mahy

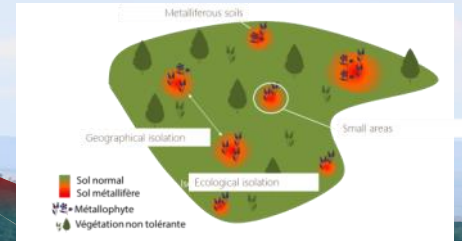


# The tropical metallicolous grasslands of South DRC Cu-Co outcrops and the plant diversity



# The tropical metallicolous grasslands of South DRC Cu-Co outcrops and the plant diversity

Copper and cobalt outcrops  
(High soil toxicity and High  
plant diversity) – Cu-Co Hills



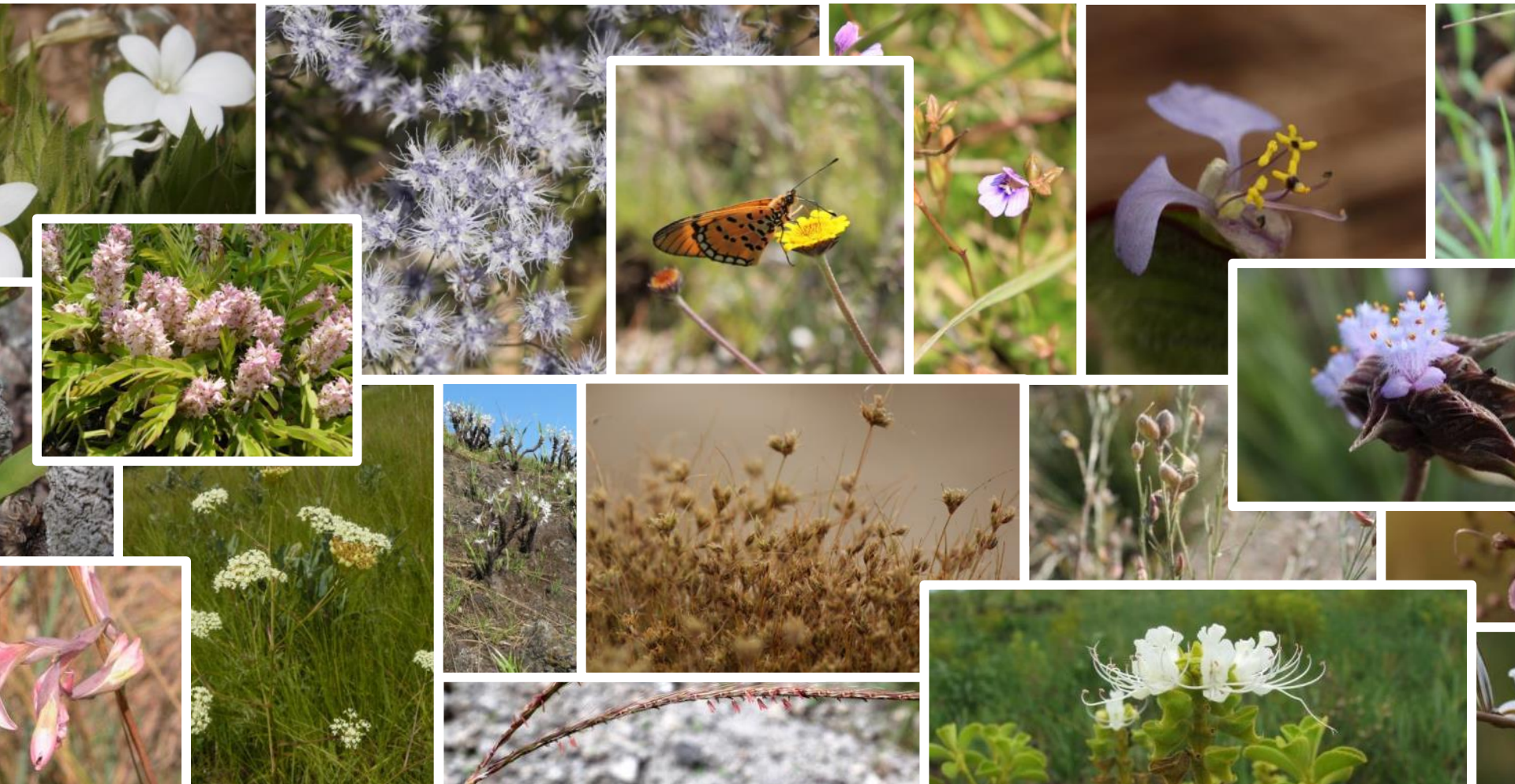
Cu (ppm)	100	10 000
Co (ppm)	1	1000

*Duvigneaud and Denayer-De Smet 1963, Leteinturier 2002, Cailteux et al. 2005, Faucon et al. 2010*

# More than 550 plant taxa (The Copper Flora)

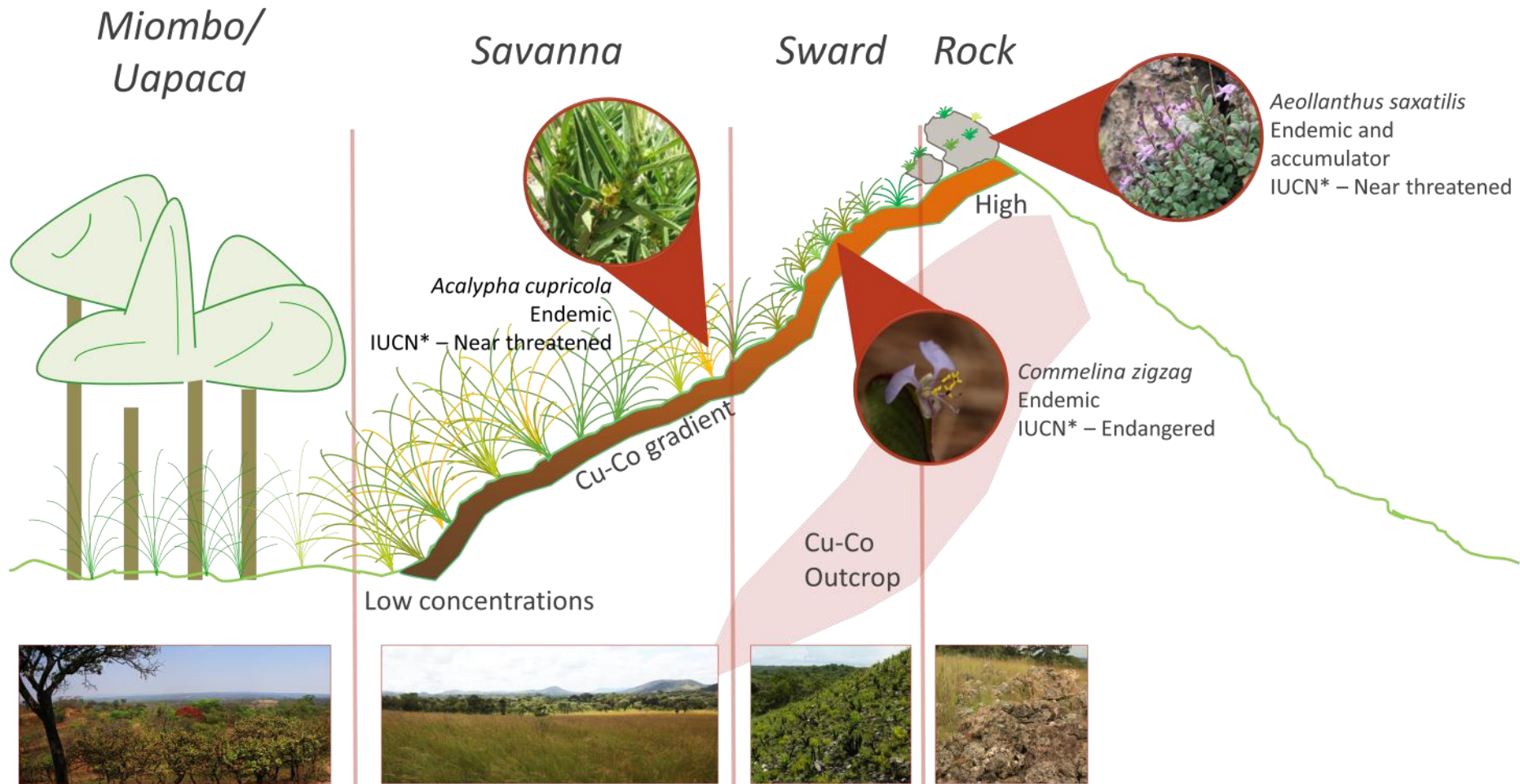
10 % endemic of Southeastern DRC

5 % restricted to Cu-Co soils (Specialized)



# A diversity of habitats (from Forest to Rocks)

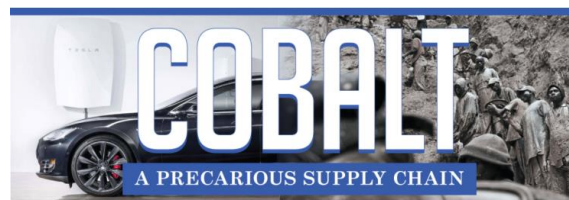
## A diversity of life forms





Apr 23, 2018

**eMining's eDumper is the world's largest electric truck**



Battery



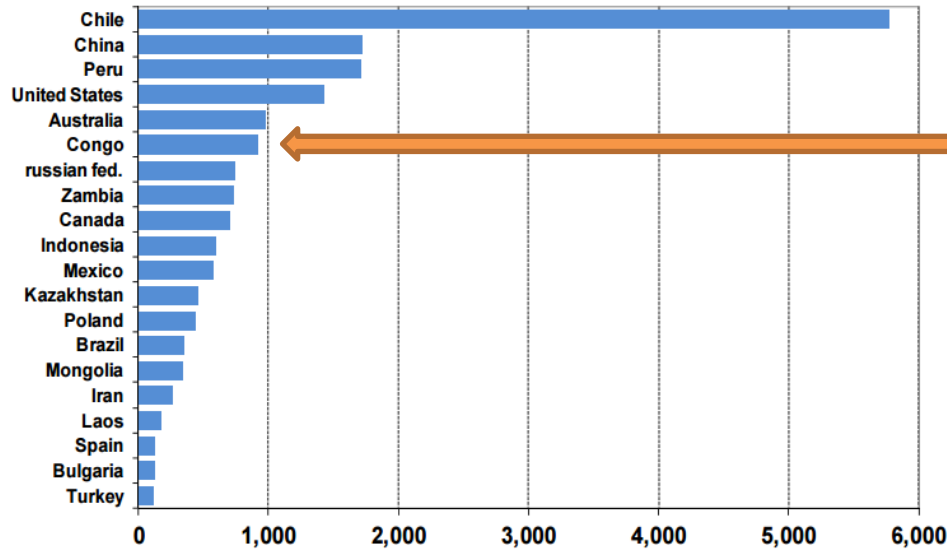
How does your mobile phone last for 12 hours on just one charge?

It's the power of cobalt, along with several other battery metals, that keeps your lithium-ion battery running.

The only problem?

Getting cobalt from the source to your electronics is not an easy feat - which makes for an extremely precarious and questionable supply chain.

**Copper Mine Production by Country: Top 20 Countries in 2015**  
(Thousand metric tonnes)  
Source: ICSG

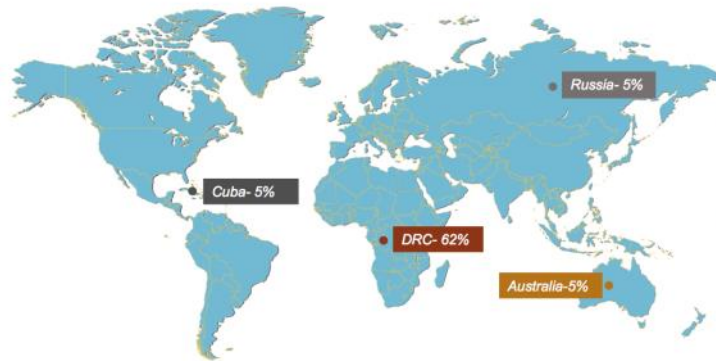


6th



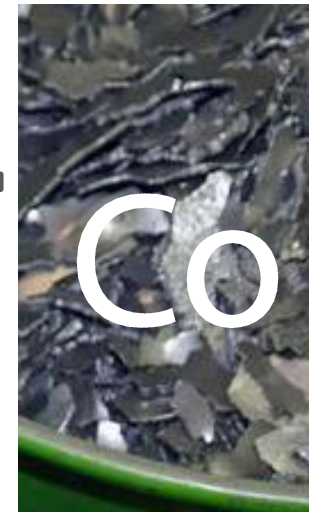
Chile accounted for almost one-third of world copper mine production in 2015 with mine output of 5.76 million t copper.

**2016 Global Production**



DRC	62.0%
Russia	5.0%
Australia	5.0%
Cuba	5.0%
Philippines	4.0%
Madagascar	3.0%
New Caledonia	3.0%
Canada	2.8%
Other Countries	8.0%

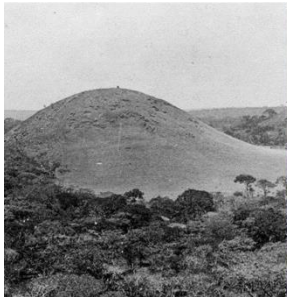
1st



Source: CRU



# Environmental impact (from mining exploration to metal extraction)



Plants

Impact on biodiversity



CR 67 %  
Proposed by Faucon et al (2010)

EN 3 %

VU 9 %

EX 9 %



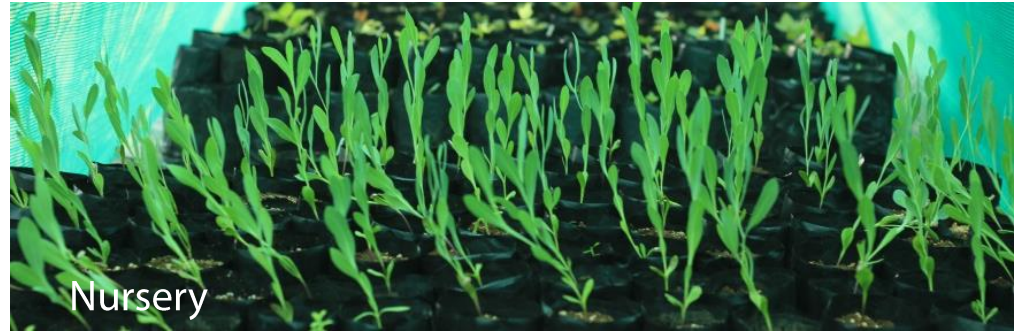
Soils

Human health exposure to metals



Drinking water

# Conservation actions for preserving endemic species



Since 2007 conservation actions are implemented for plant diversity



Plant communities translocation

# Innovative actions



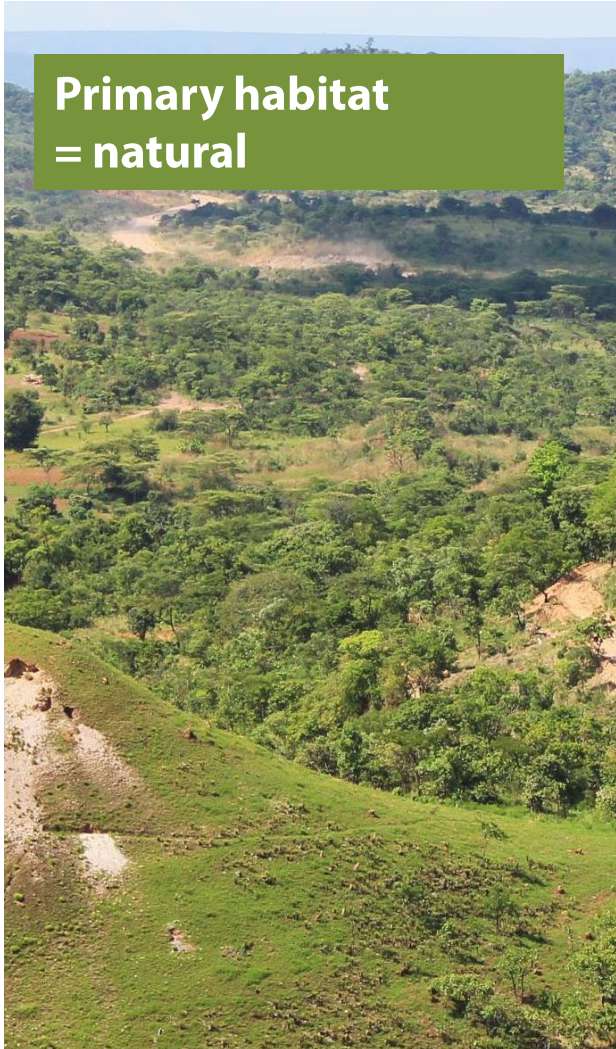
For preserving the biodiversity : Copper Flora (endemics and specialized species)



For decreasing the impact of mining operations on environment

# In ecological point of view

**Primary habitat  
= natural**



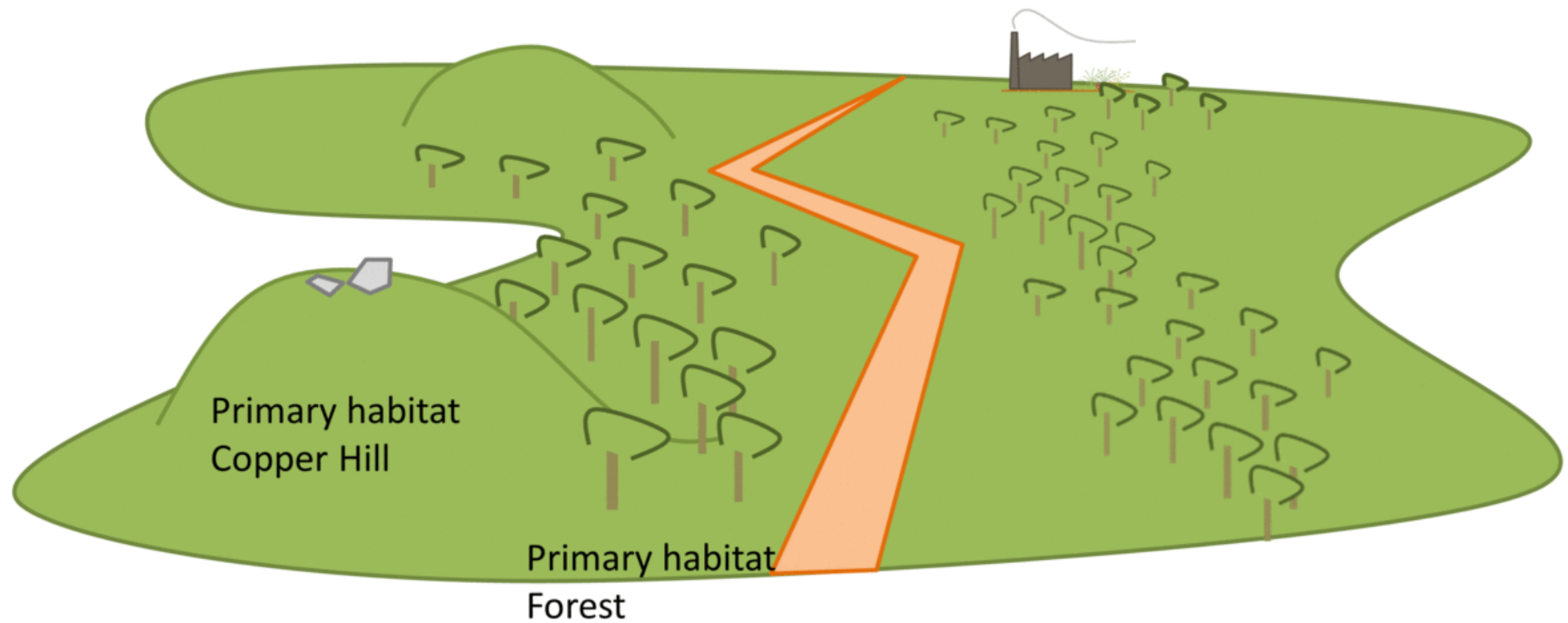
**Secondary habitat  
= Disturbed by human activities**



**Tertiary habitat  
= Polluted areas**



# Mining activities



# Mining activities

**Primary habitat**  
= Cu-Co hill

Cu Co  


**Tertiary habitat**  
= Cu-Co Polluted areas

Cu Co  


Cu Co  


**Secondary habitat**  
= Tailings

Cu Co  


# Opportunity for testing integrated actions

**Primary habitat**  
= Cu-Co hill

**Tertiary habitat**  
= Cu-Co Polluted areas



**Secondary habitat**  
= Tailings





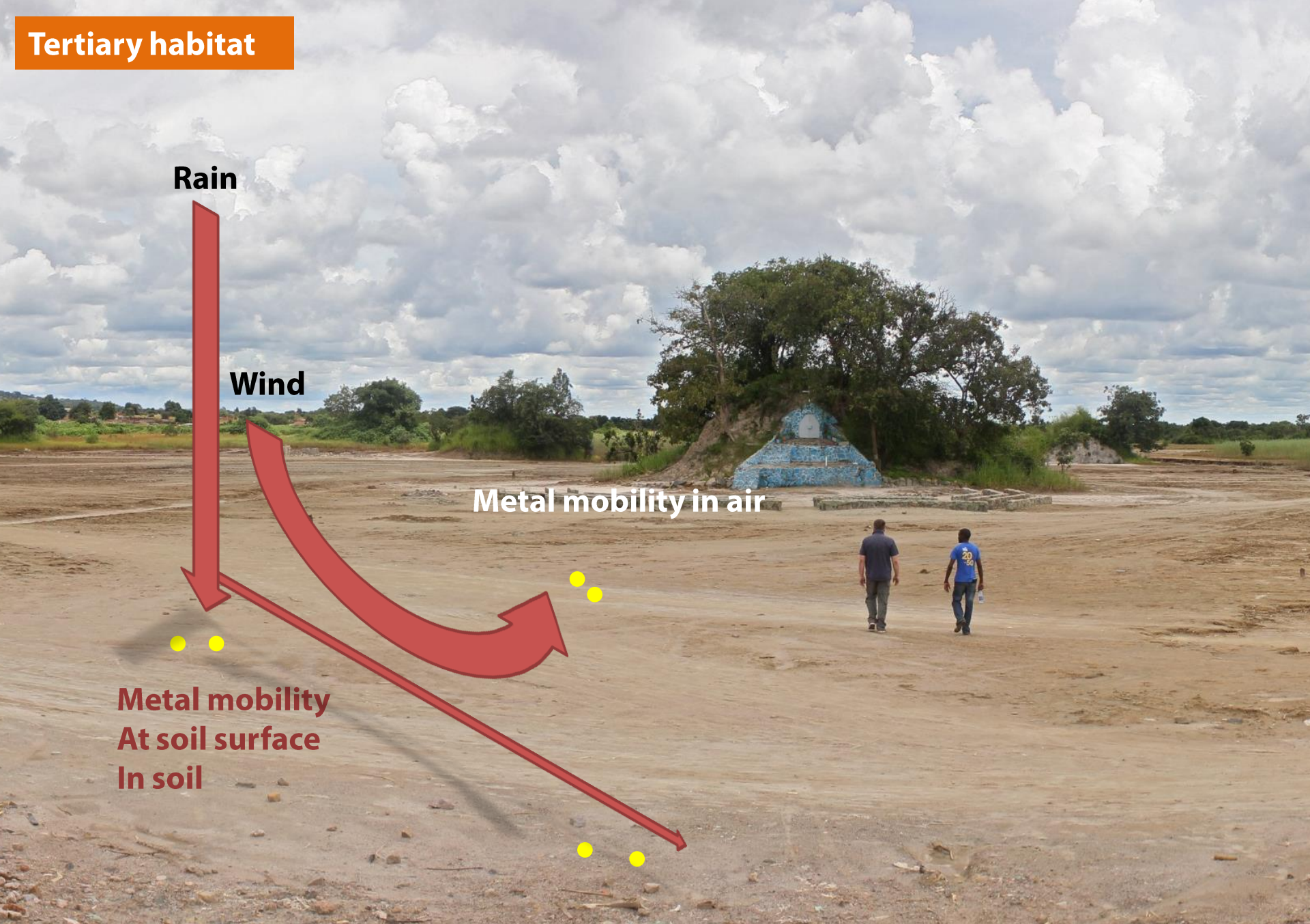
# Tertiary habitat

Rain

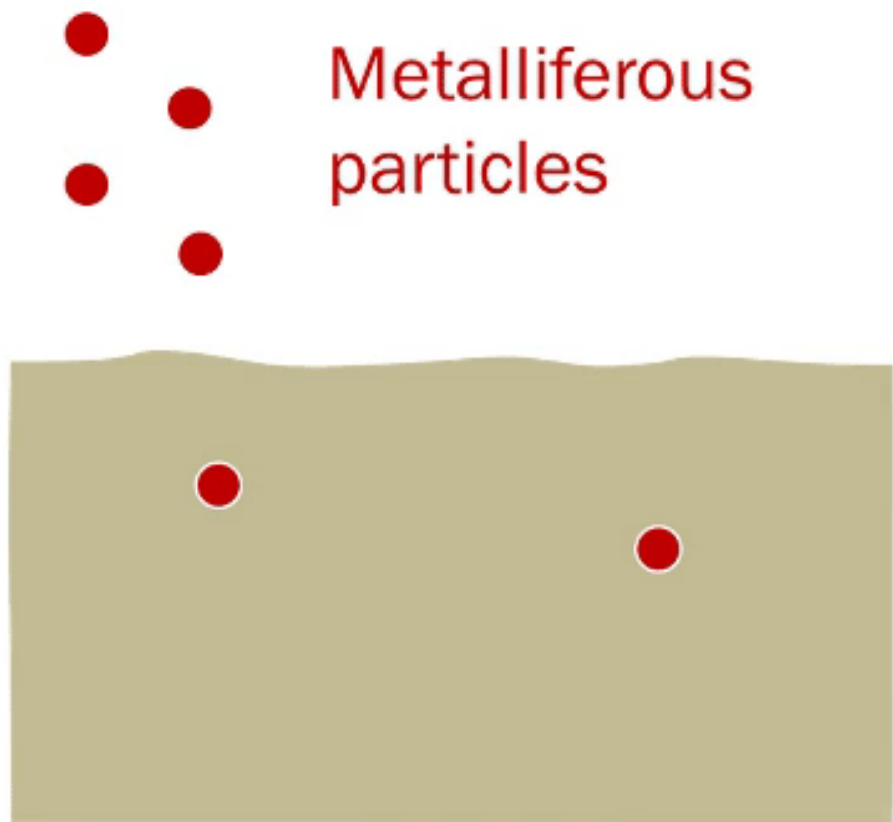
Wind

Metal mobility in air

Metal mobility  
At soil surface  
In soil



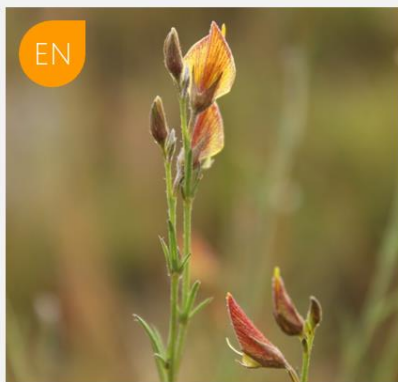
# Phytostabilization



# 1. Selecting the candidates

*Crotalaria cobalticola*

Fabaceae  
Annual  
Habitat : Steppes  
Strict endemic

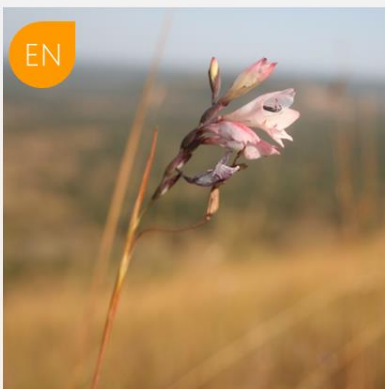


*Diplolophium marthozianum*



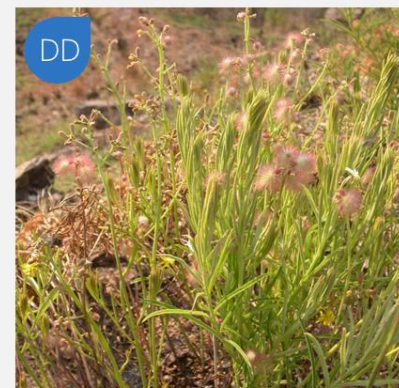
Apiaceae  
Perennial  
Habitat : Steppes/Steppic  
savanna  
Broad endemic

*Gladiolus ledoctei*



Iridaceae  
Perennial  
Habitat : Steppes  
Broad endemic

*Triumfetta welwitschii*



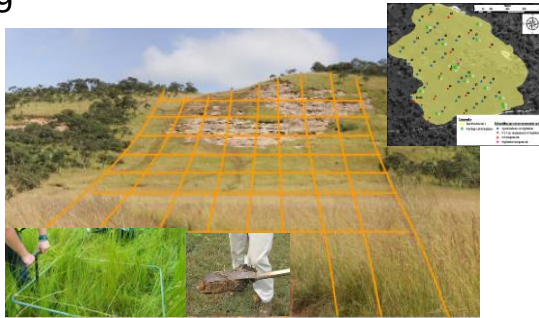
Malvaceae  
Perennial  
Habitat: Steppic savanna  
Strict endemic

Proposed IUCN status by Faucon 2010

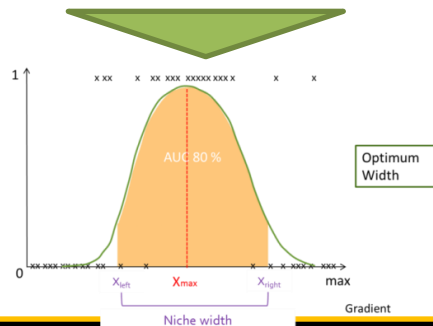
# 1. Selecting the candidates

Characterization of the natural conditions where the endemic species occurs – Along copper gradient

Monitoring

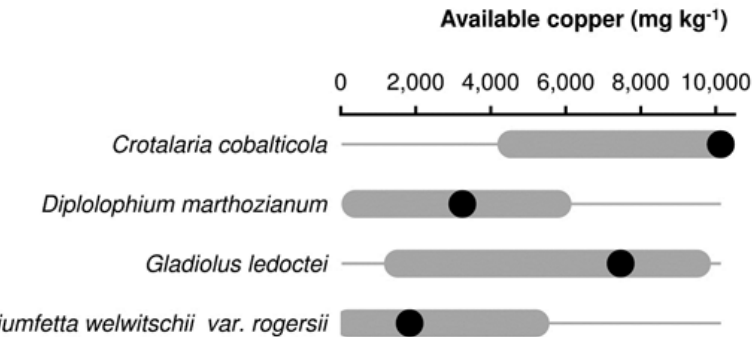


Modeling the probability of presence according to copper concentrations



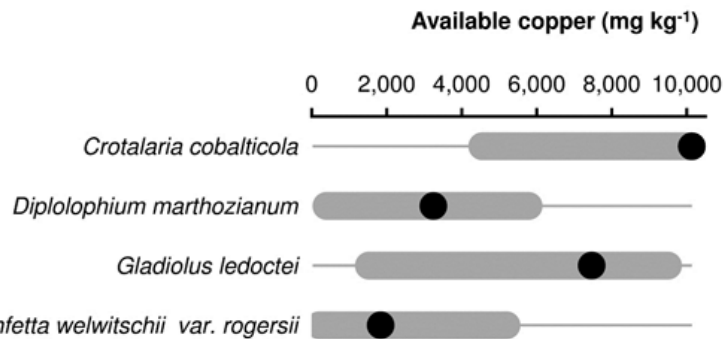
# 1. Selecting the candidates

Characterization of the natural conditions where the endemic species occurs – Along copper gradient



# 1. Selecting the candidates

Characterization of the natural conditions where the endemic species occurs – Along copper gradient



Plant shoot response in artificial polluted soil with copper

BY SPECIES

3 POPULATIONS

X

3 COPPER CONCENTRATIONS IN SOIL

0 ppm

100 ppm

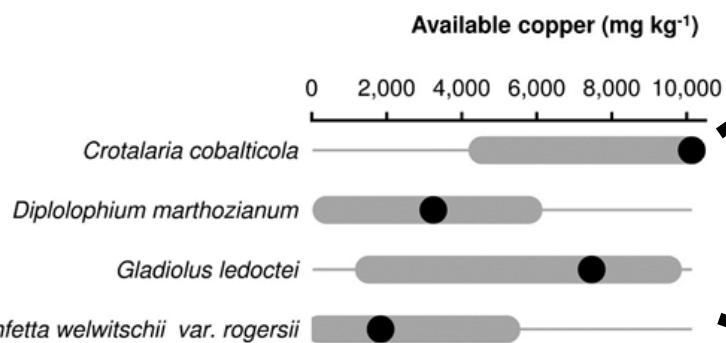
1000 ppm

Contaminated with  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  + 0.2 % compost

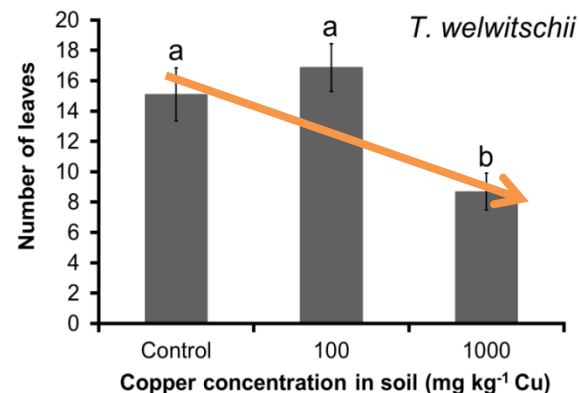
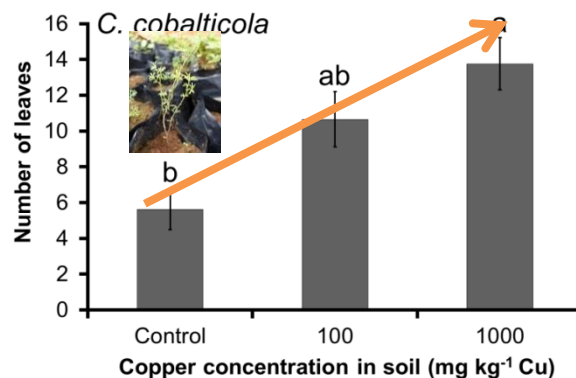
X 10 replicates

# 1. Selecting the candidates

Characterization of the natural conditions where the endemic species occurs – Along copper gradient



Plant shoot response in artificial polluted soil with copper



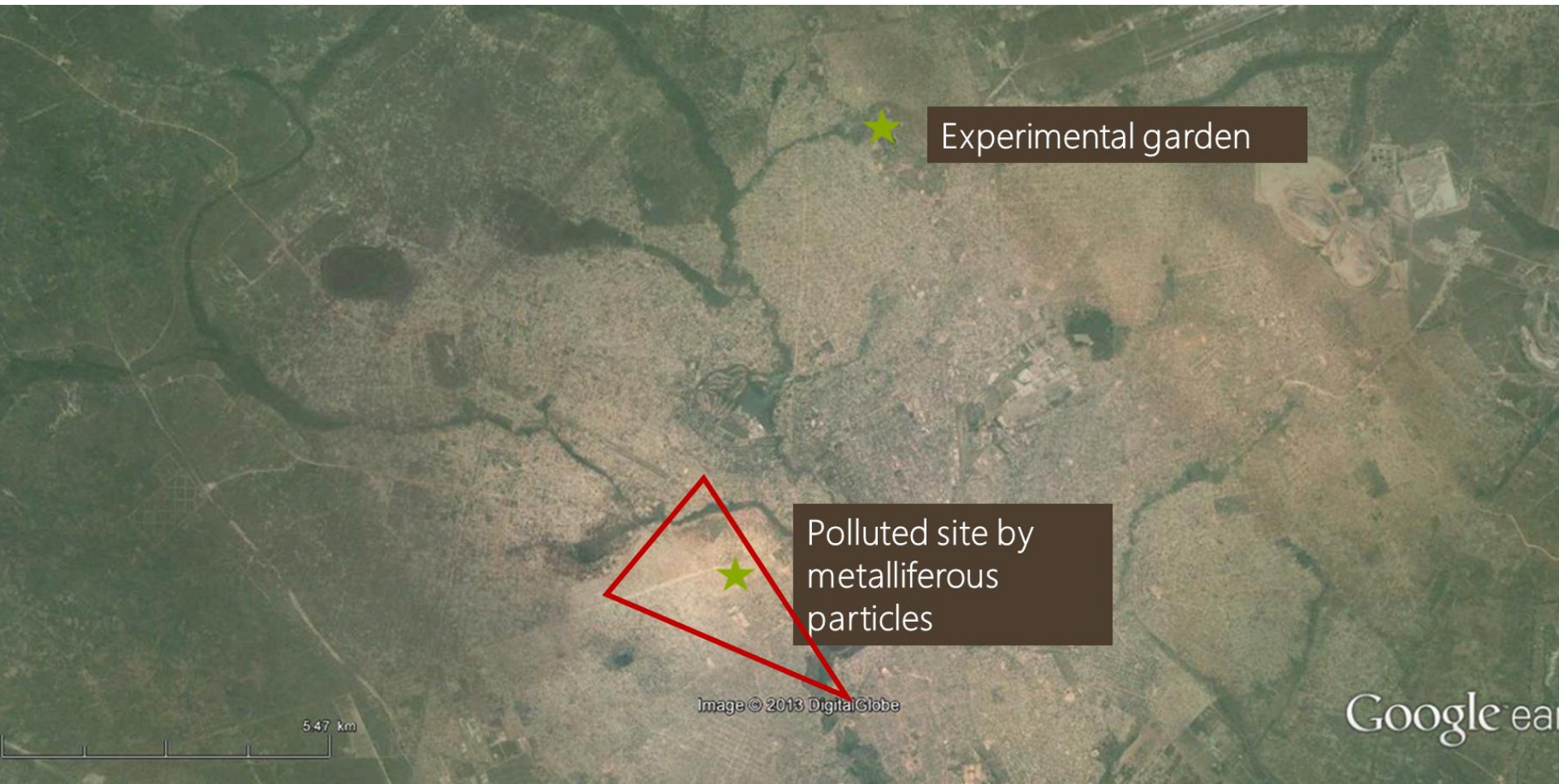
Plant Soil  
DOI 10.1007/s11104-016-3095-7

REGULAR ARTICLE

**Specialized edaphic niches of threatened copper endemic plant species in the D.R. Congo: implications for ex situ conservation**

Sylvain Boisson · Michel-Pierre Faucon · Soizig Le Stradic · Bastien Lange · Nathalie Verbruggen · Olivier Garin · Axel Tshomba Wetshy · Maxime Säck · Wilfried Masengo Kalengo · Mylor Ngoy Shutchu · Grégory Mahy

## 2. Sowing the species in phytostabilized area





## 2. Sowing the species in phytostabilized area



Sylvain Boisson · Maxime Séeck · Soizig Le Stradic  
Julien Collignon · Olivier Garin · François Malaisse  
Mylor Ngoy Shutchu · Grégory Mahy**Using phytostabilisation to conserve threatened endemic species  
in southeastern Democratic Republic of the Congo**

# Results

## Germination

	With vegetation cover	Without cover	<i>F</i>	<i>p</i> -value
<i>A. davyi</i>	16.1 ± 4.9 <sup>a</sup>	5.0 ± 2.8 <sup>b</sup>	19.0	< 0.01
<i>C. cobalticola</i>	49.4 ± 19.6 <sup>a</sup>	28.8 ± 11.9 <sup>b</sup>	7.09	< 0.05
<i>C. peschiana</i>	11.1 ± 8.3 <sup>b</sup>	26.7 ± 10.5 <sup>a</sup>	4.89	0.07
<i>T. welwitschii</i>	8.3 ± 3.5	6.1 ± 6.8	1.28	0.30

## Survival

	With vegetation cover	Without cover	<i>F</i>	<i>p</i> -value
<i>A. davyi</i>	0	0	-	-
<i>C. cobalticola</i>	37.8 ± 20.0	23.9 ± 26.4	2.27	0.18
<i>C. peschiana</i>	91.7 ± 20.4	73.1 ± 29.6	3.86	0.09
<i>T. welwitschii</i>	100 ± 0	80.6 ± 40.0	1.32	0.29

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# Discussion

Distinct response of species to environment



Interspecific interaction (competition, facilitation)

For germination : Competition was not highlighted

For growth : Competition for the light

Selecting species according to hosted sites

Phenology (= Presence of individuals)

Metal – Concentration in soil

Esthetics (Color of shoot, leaves, flowers)

## PERSPECTIVES :

To create new species association (Grasses-Legumes)

To adapt phytostabilization technics at large scale (hay transfer, etc...)

To test other species

Ecol Res  
DOI 10.1007/s11284-018-1604-2

CrossMark

**SPECIAL FEATURE** Ultramafic Ecosystems: Proceedings of the 9th International Conference on Serpentine Ecology

Sylvain Boisson · Maxime Séleck · Soizig Le Stradic  
Julien Collignon · Olivier Garin · François Malaisse  
Mylor Ngoy Shutcha · Grégory Mahy

**Using phytostabilisation to conserve threatened endemic species in southeastern Democratic Republic of the Congo**

**Potential of copper-tolerant grasses to implement phytostabilisation strategies on polluted soils in South D. R. Congo**

Poaceae candidates for phytostabilisation

Sylvain Boisson<sup>1</sup> · Soizig Le Stradic<sup>1</sup> · Julien Collignon<sup>1</sup> · Maxime Séleck<sup>1</sup> · François Malaisse<sup>1</sup> · Mylor Ngoy Shutcha<sup>2</sup> · Michel-Pierre Faucon<sup>3</sup> · Grégory Mahy<sup>1</sup>

# Integrated actions

**Primary habitat**  
= Cu-Co hill

Cu Co  

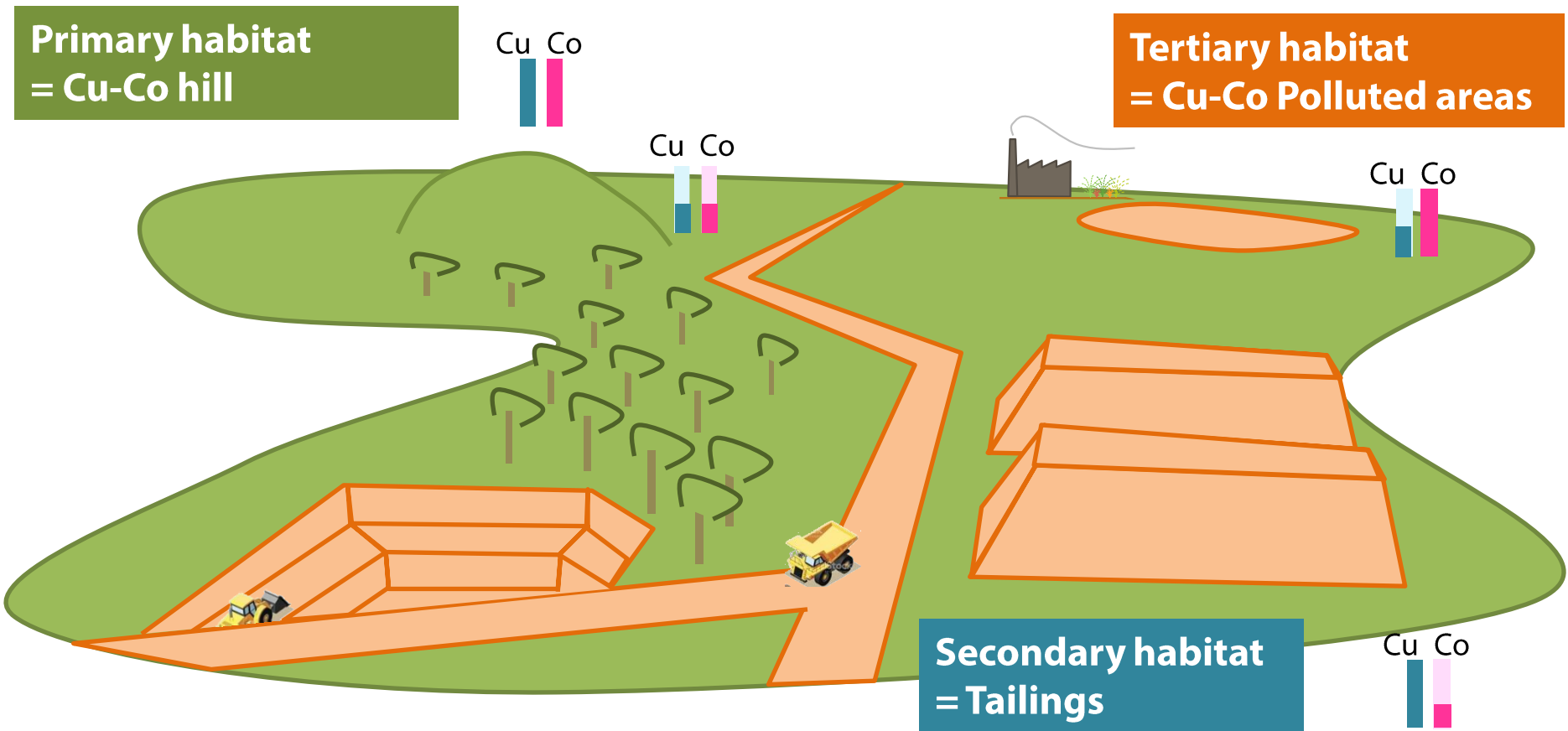

**Tertiary habitat**  
= Cu-Co Polluted areas

Cu Co  


Cu Co  


**Secondary habitat**  
= Tailings

Cu Co  

# Integrated actions

Conservation – Operations – Services (rehabilitation)

Nursery



Natural sites



Cu Co



Community translocation



Cu Co



Phytostabilized area

Cu Co



Protected areas

Cu Co



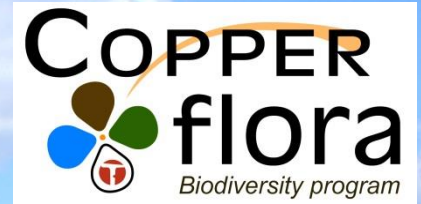
Operated area



Revegetation of backfill

Cu Co





# Obrigado

More information

[Copperflora.org](http://Copperflora.org)

ResearchGate: #SylvainBoisson

Our partners

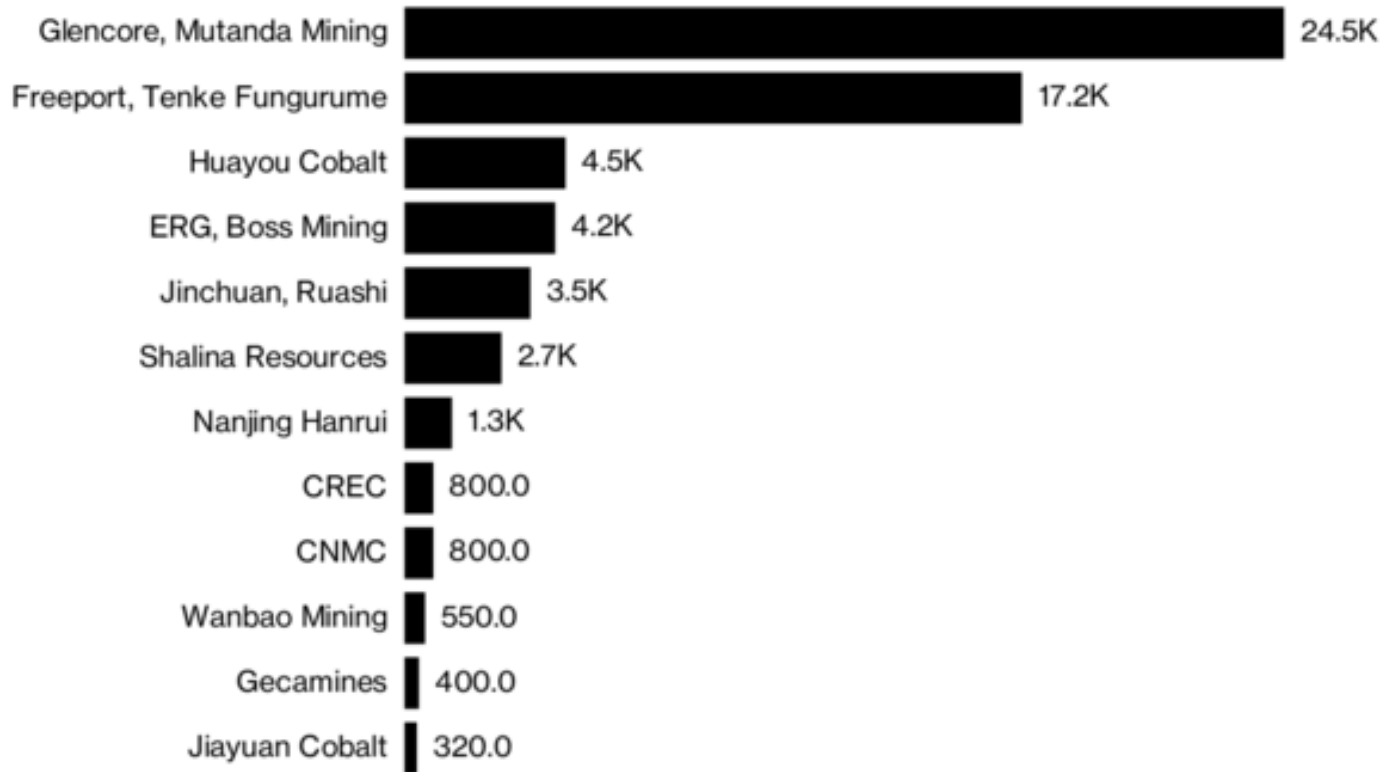






## Congo's Cobalt

Tons produced at mines in the Democratic Republic of Congo in 2016



Source: Darton Commodities Ltd.

**Bloomberg**