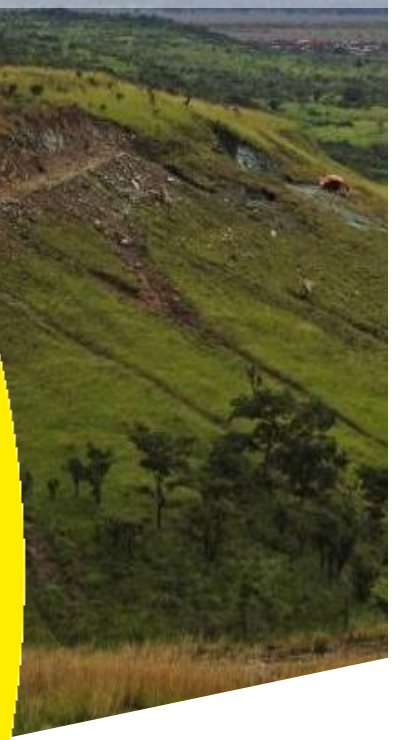
Intraspecific variation of copper tolerance of four endemic plant species from the katangan Copperbelt (D. R. Congo)

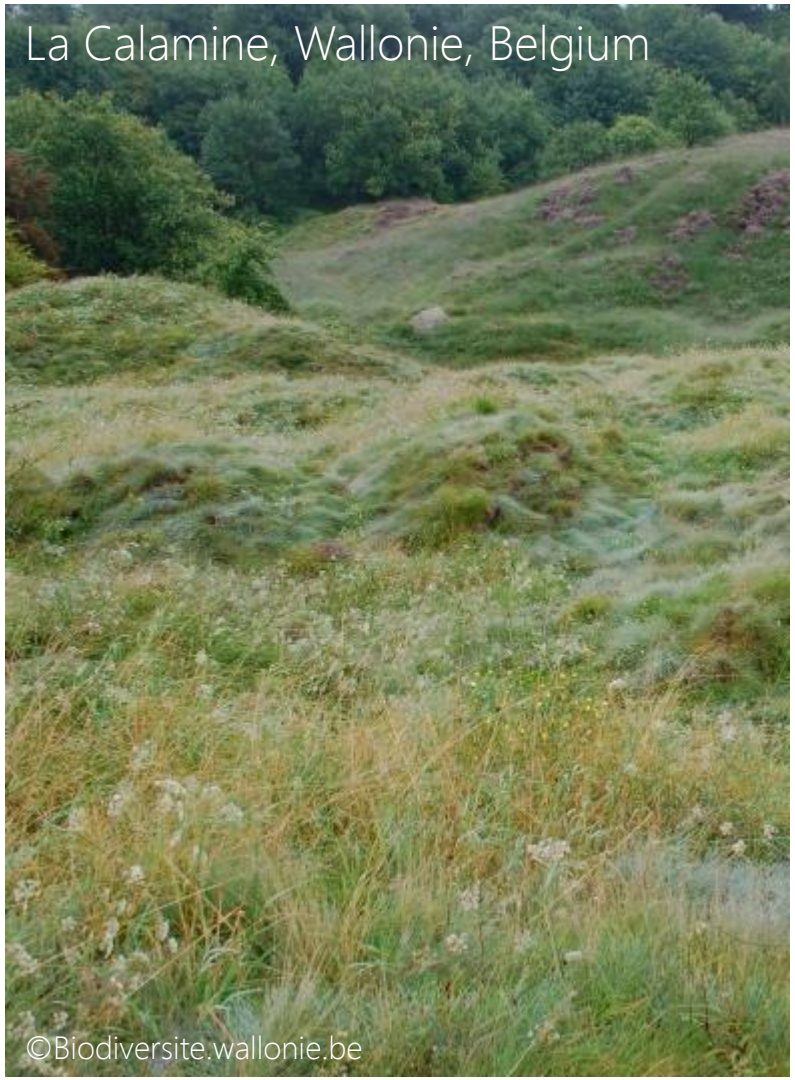
Sylvain Boisson, Olivier Garin, Maxime Séleck, Soizig Le Stradic, Grégory Mahy

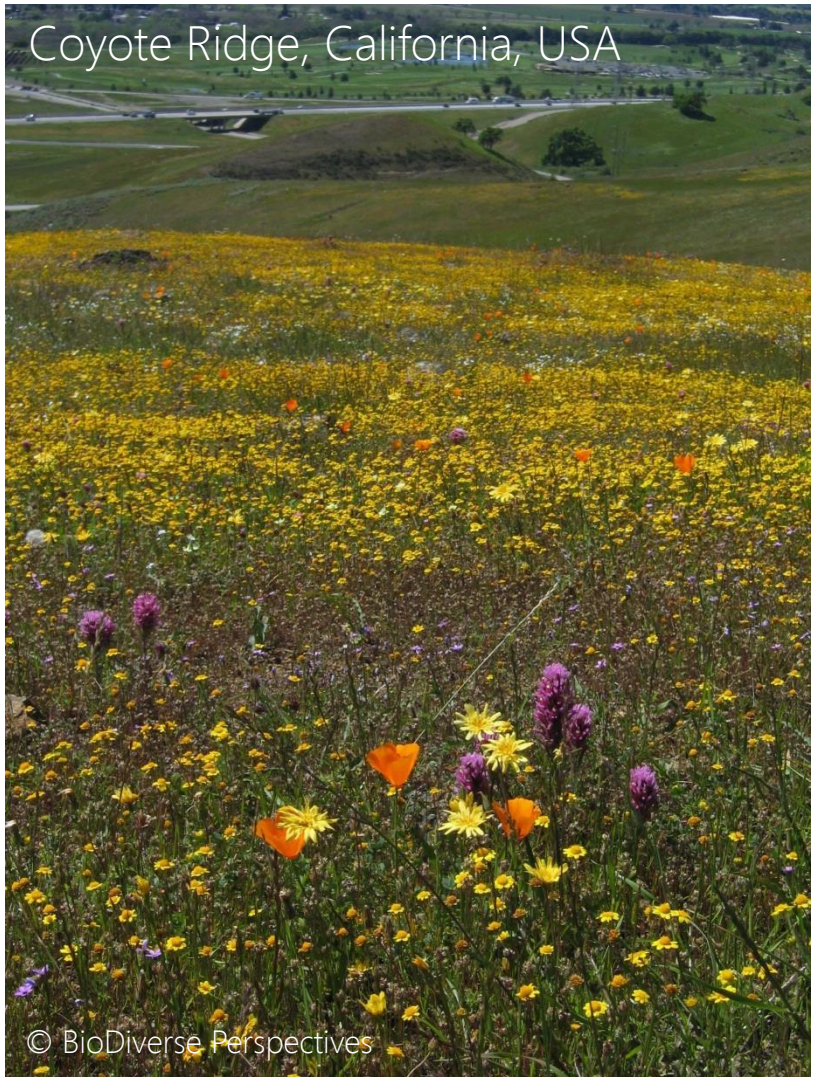


9th European Conference on Ecological Restoration | August 3-8, 2014, Oulu (Finland)

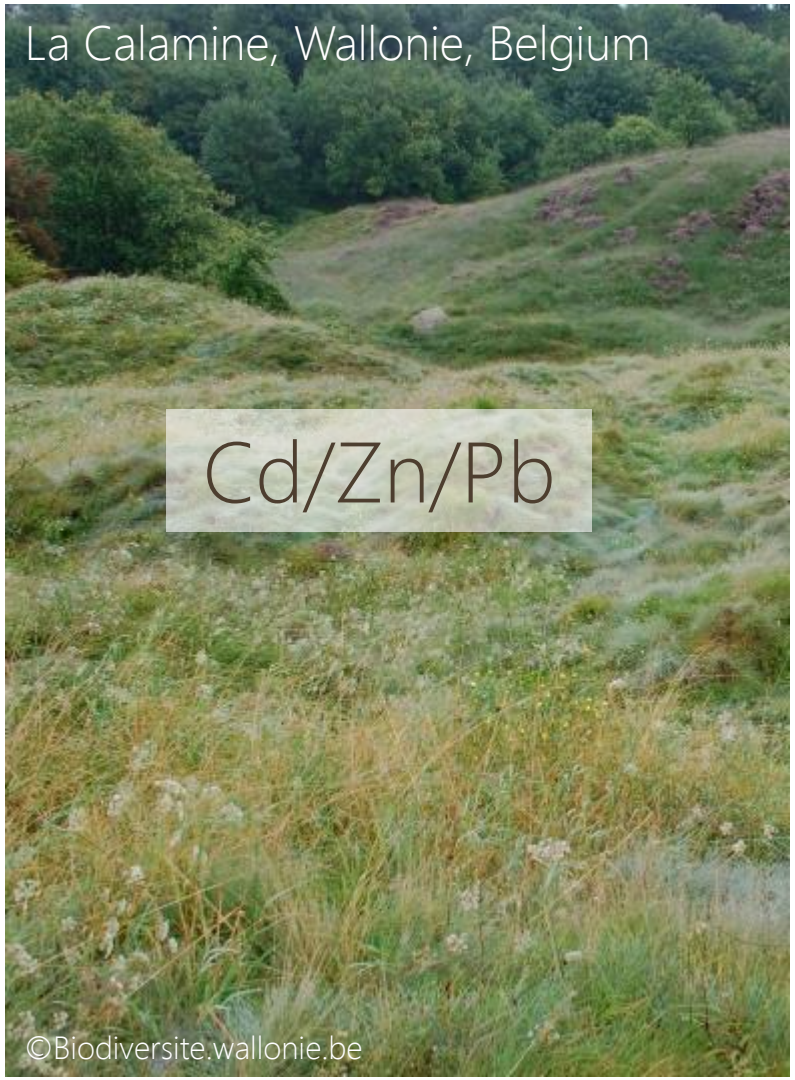
background

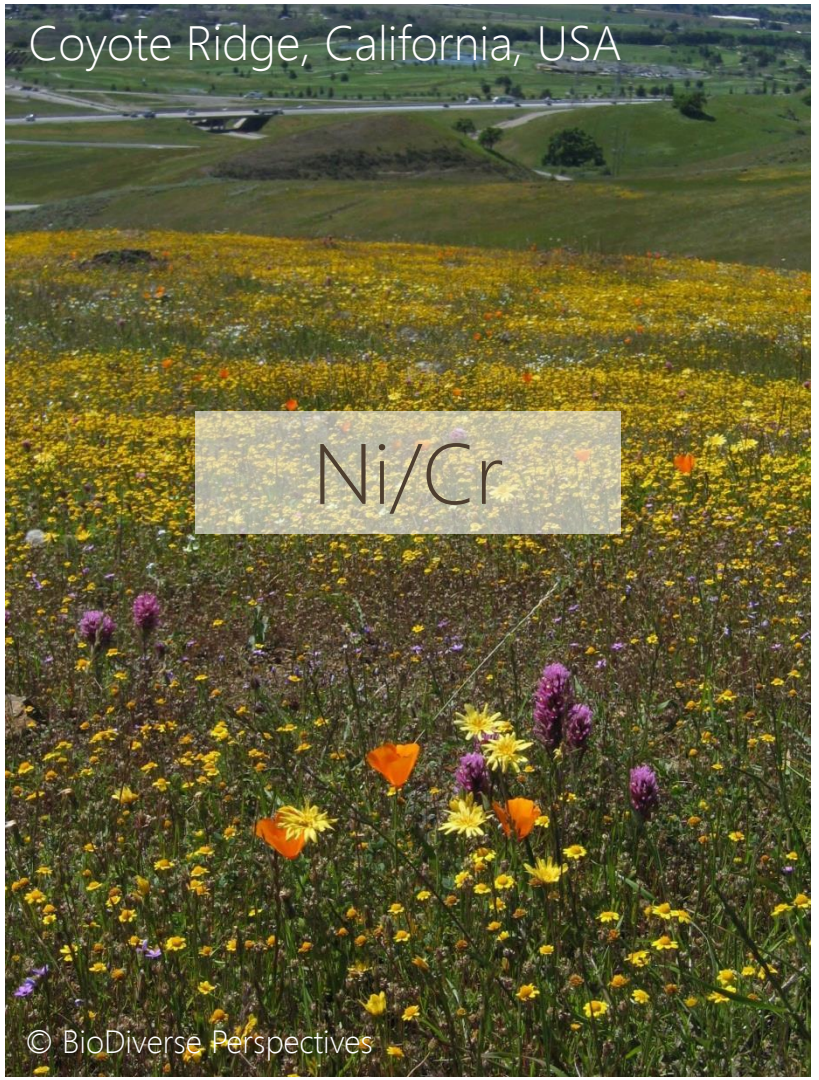
Natural metalliferous habitats





Natural metalliferous habitats





Natural metalliferous habitats

- Small size
- Extreme ecological conditions
- Ecologically isolated

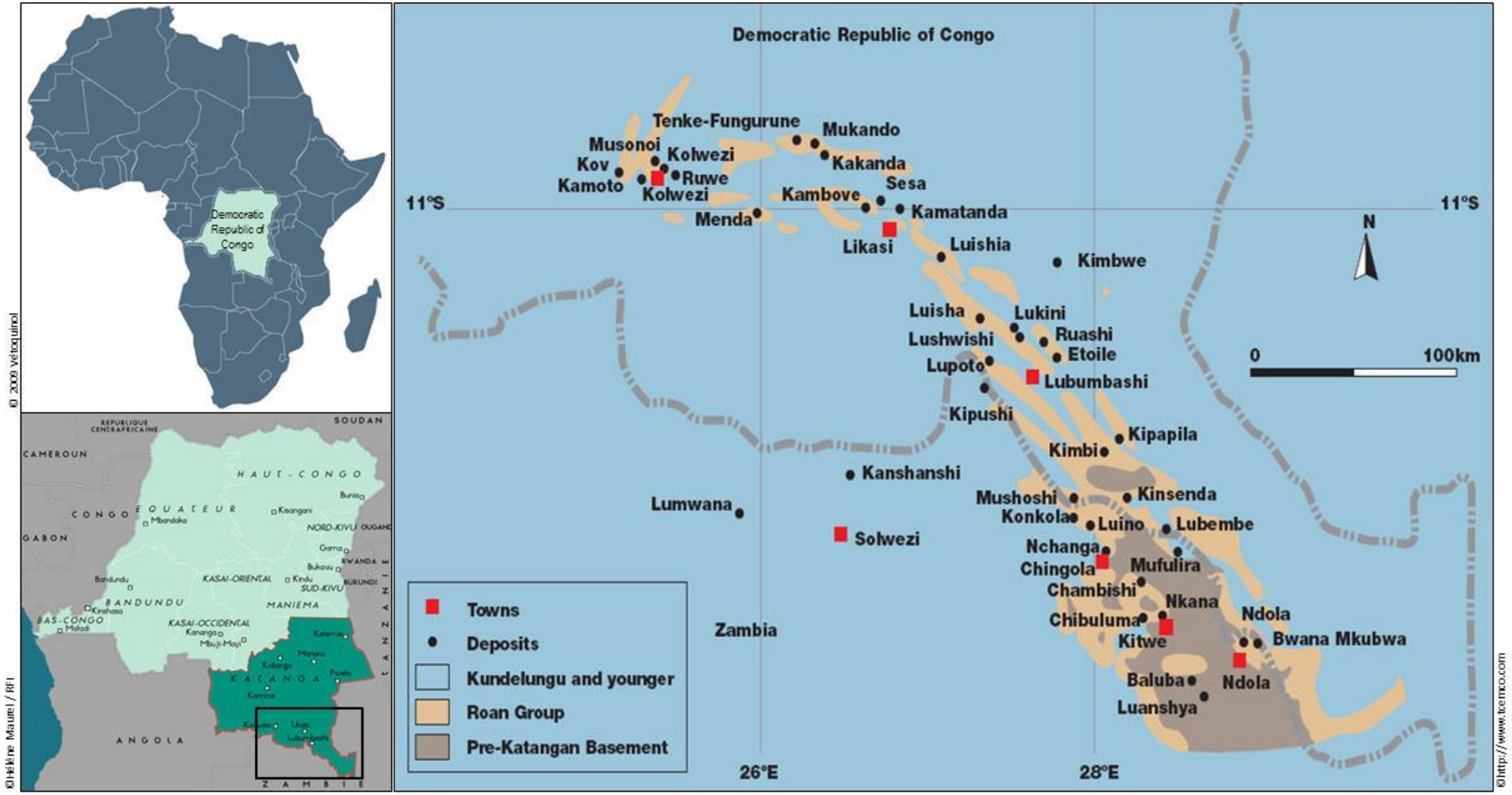
→ Island nature

- Speciation processes

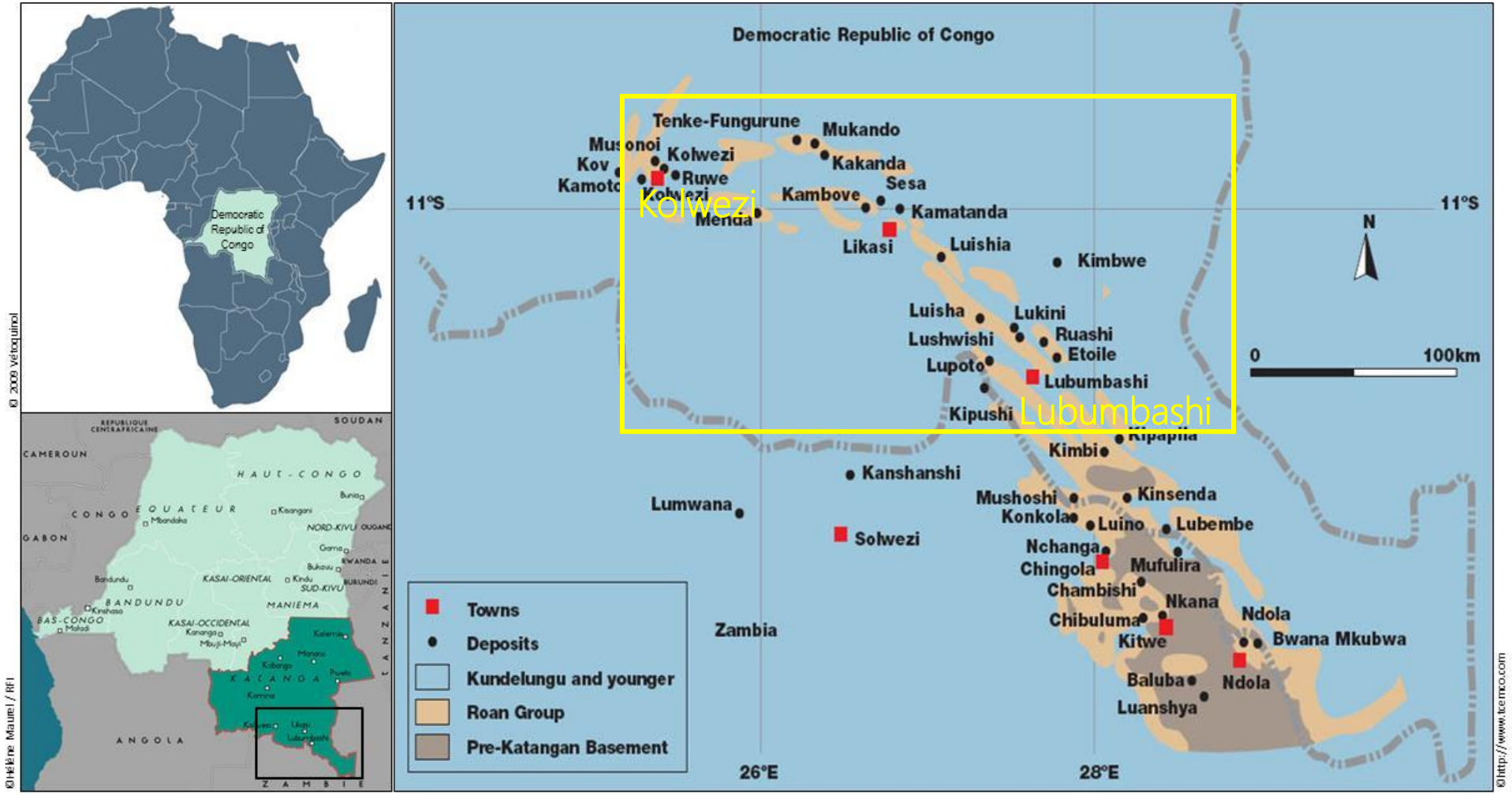
→Endemic species

→Specialized species

Katangan Copperbelt (D.R.Congo)

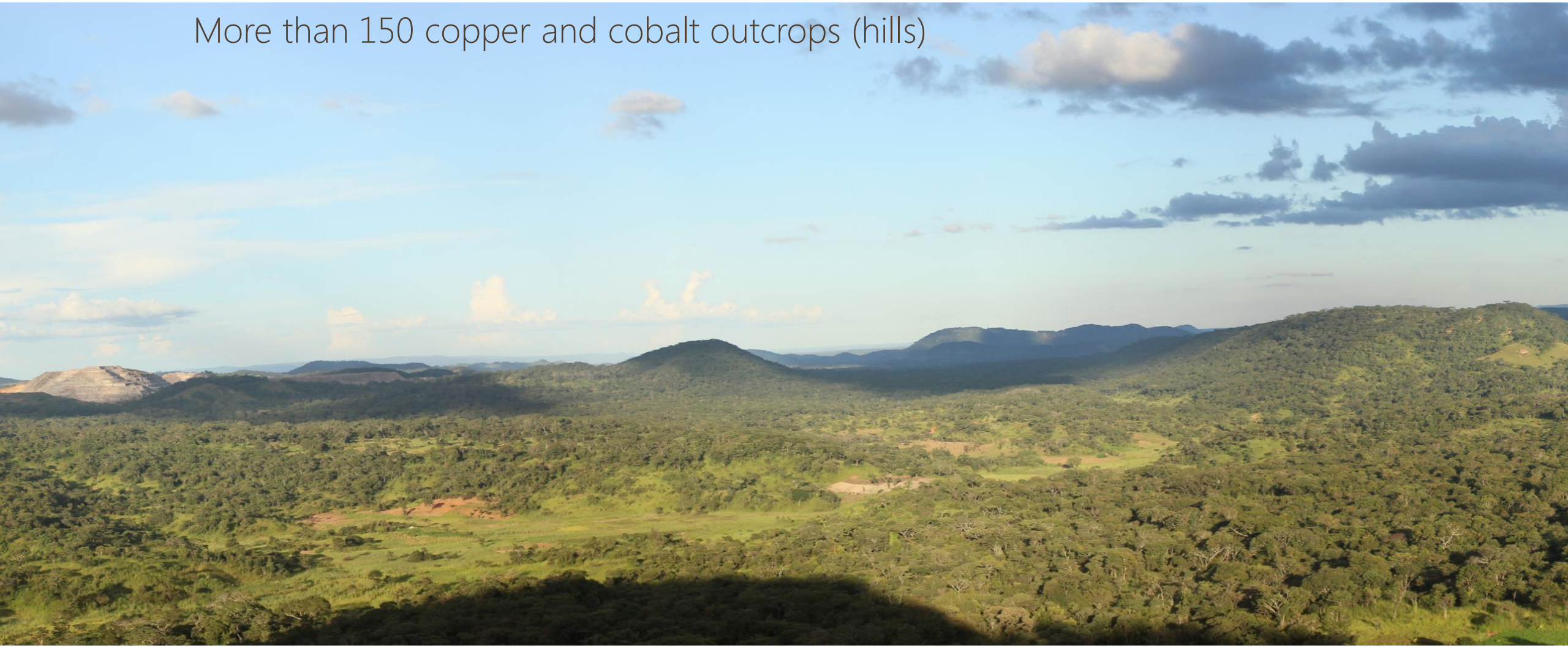


Katangan Copperbelt (D.R.Congo)



Katangan Copperbelt (D.R.Congo)

More than 150 copper and cobalt outcrops (hills)



Katangan Copperbelt (D.R.Congo)

- 600 plant species
- 10 % endemics

Barleria lobelioides

Basananthe kisimbae

Triumfetta likasiensis

Tinnea coerulea var. *obovata*

Lopholaena deltombei

Euphorbia cupricola

Sopubia neptunii

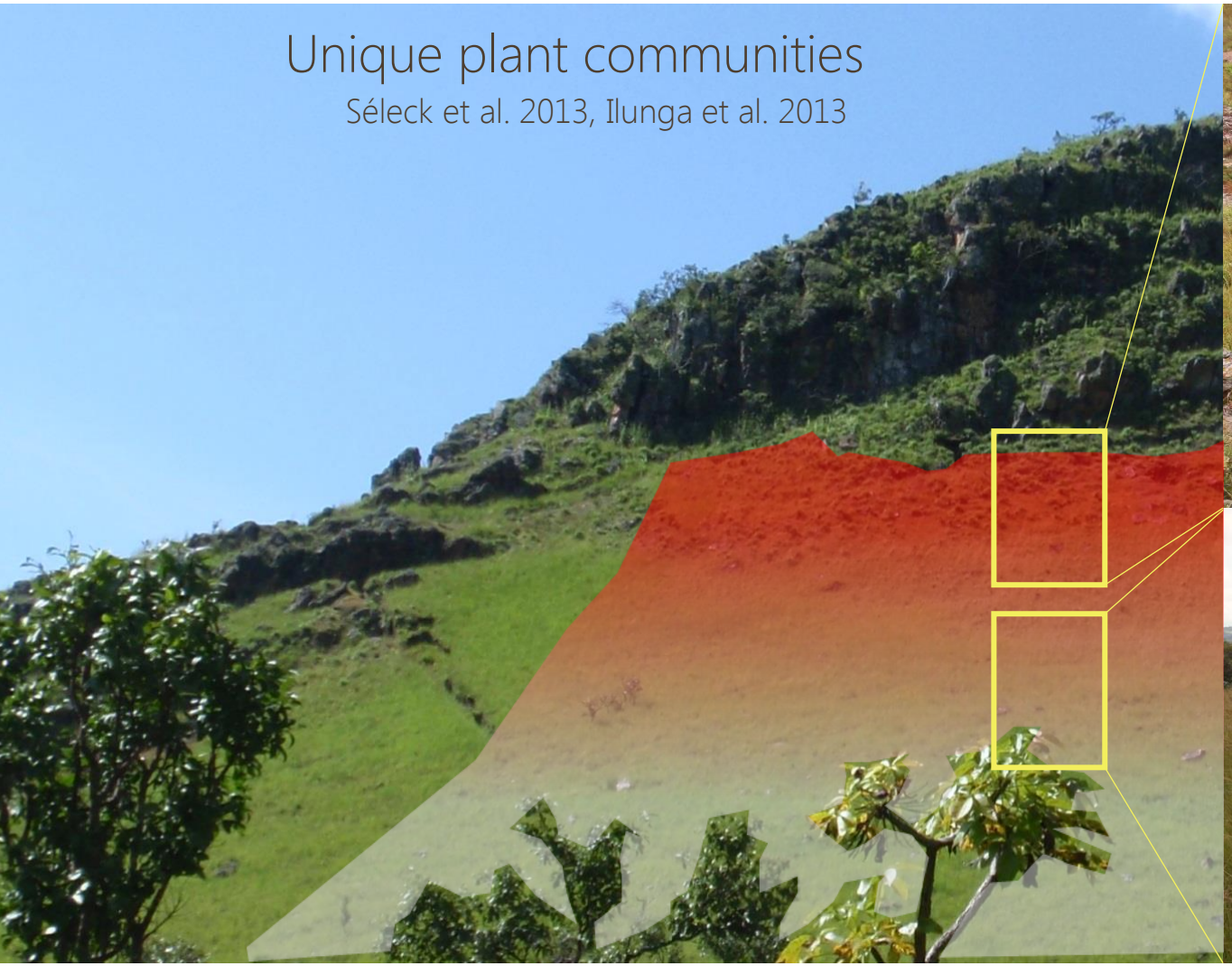
Commelina zigzag

Katangan Copperbelt (D.R.Congo)

Katangan Copperbelt (D.R.Congo)

Unique plant communities

Séleck et al. 2013, Ilunga et al. 2013



Mining activities

Impact on the katangan ecosystem

IUCN revision of copper endemics (Faucon, 2010)

CR 67 % EN 3 % VU 9 % EX 9 %

Potential in rehabilitation strategies

600 species (55 endemics)

Metal tolerance capacities

(Hyper)accumulators

= phytogenetic resources

Potential in rehabilitation strategies

600 species (55 endemics)

Metal tolerance capacities

(Hyper)accumulators

= phytogenetic resources

(Whiting et al. 2004)

Potential in rehabilitation strategies

600 species (55 endemics)

Metal tolerance capacities

(Hyper)accumulators

= phytogenetic resources

To conserve and use these species, we have to improve the knowledge about their ecology and their biology

This study aims to…

Identify intraspecific copper tolerance of **4 endemic** plant species from **3 sites** of the katangan copperbelt in native conditions

Studied species

Crotalaria cobalticola

Fabaceae
Annual
Habitat : Steppes
Strict endemic

Diplolophium marthozianum

Apiaceae
Perennial
Habitat : Steppes/Steppic savanna
Broad endemic

Gladiolus ledoctei

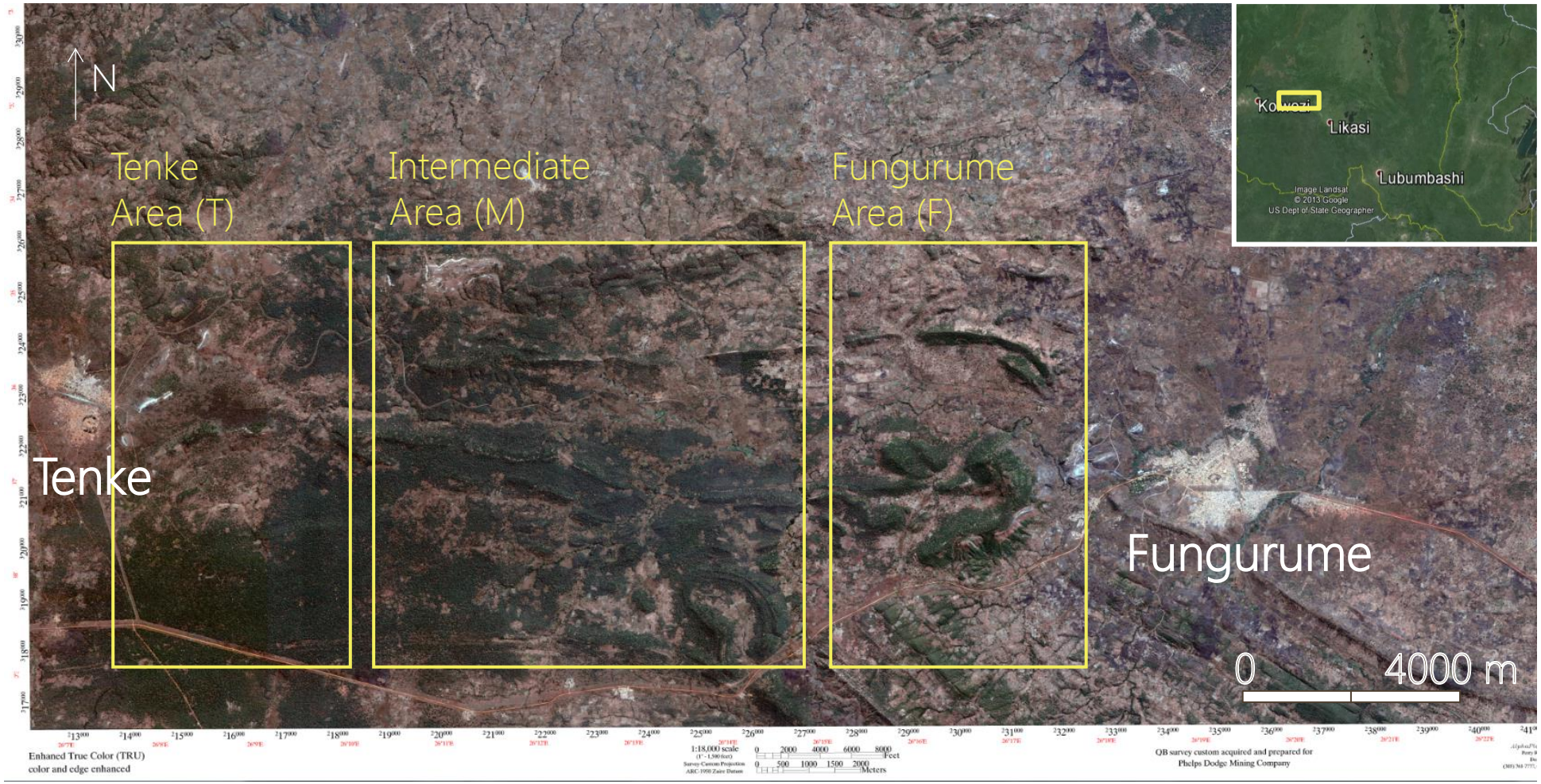
Iridaceae
Perennial
Habitat : Steppes
Broad endemic

Triumfetta welwitschii

Malavaceae
Perennial
Habitat: Steppic savanna
Strict endemic

Proposed IUCN status by Faucon 2010

Seeds collection



Species populations :

3 populations between Tenke and Fungurume

One population/area

At the same year

Random sampling

Experimental design

BY SPECIES

Experimental design

BY SPECIES

3 POPULATIONS
T-M-F

Experimental design

BY SPECIES

3 POPULATIONS
T-M-F

X

3 COPPER CONCENTRATIONS IN SOIL	0 ppm
	100 ppm
	1000 ppm

Contaminated with $CuSO_4.5H_2O$ + 0.2 % compost

Experimental design

BY SPECIES

3 POPULATIONS
T-M-F

X

3 COPPER CONCENTRATIONS IN SOIL	0 ppm
	100 ppm
	1000 ppm

Contaminated with $CuSO_4.5H_2O$ + 0.2 % compost

X

10 repetitions with 5 seeds/bag

Measures, monitoring and analyses

- November 2013 – May 2014
- Before sowing, **seedlots** were **weighed**
- After February, 20 → 1 plant/bag

Measures, monitoring and analyses

- November 2013 – May 2014
- Before sowing, **seedlots** were **weighted**
- After February, 20 → 1 plant/bag

- Perennial species
  - Germination
  - Nb of leaves, height (cm)

- Annual species (*C. cobalticola*)
  - Germination
  - Nb of branches, height, root system length (cm
  - Dry weight/modality (g)

Measures, monitoring and analyses

- November 2013 – May 2014
- Before sowing, **seedlots** were **weighted**
- After February, 20 → 1 plant/bag

- Perennial species
  - Germination
  - Nb of leaves, height (cm)

- Annual species (*C. cobalticola*)
  - Germination
  - Nb of branches, height, root system length (cm
  - Dry weight/modality (g)

- Analyses: AV2 (R software)

Seed weight and germination

- No significant differences of seedlots weight between populations
- Mean germination rate

C. cobalticola	44.1±4.8 %
D. marthozianum	12.0±2.6 %
G. ledoctei	49.3±28.3 %
T. welwitschii	13.3±2.6 %

Seed weight and germination

- No significant differences of seedlots weight between populations
- Mean germination rate

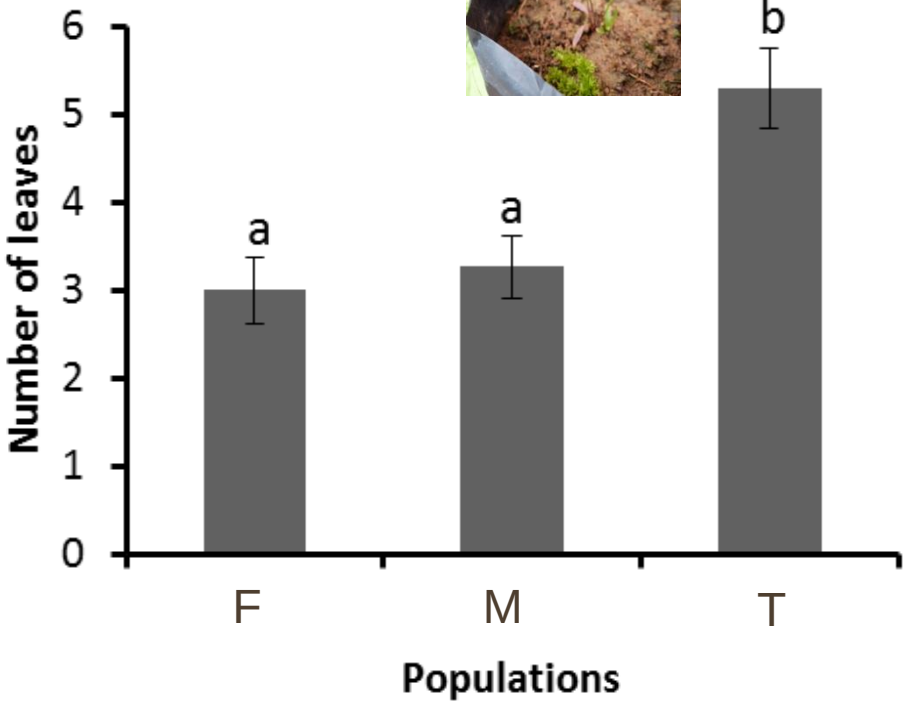
C. cobalticola	44.1±4.8 %
D. marthozianum	12.0±2.6 %
G. ledoctei	49.3±28.3 %
T. welwitschii	13.3±2.6 %

No effect of copper concentrations on germination rates
Population effect on germination of *T. welwitschii*

Growth of perennial species

- Population effect on perennial species

D. marthozianum

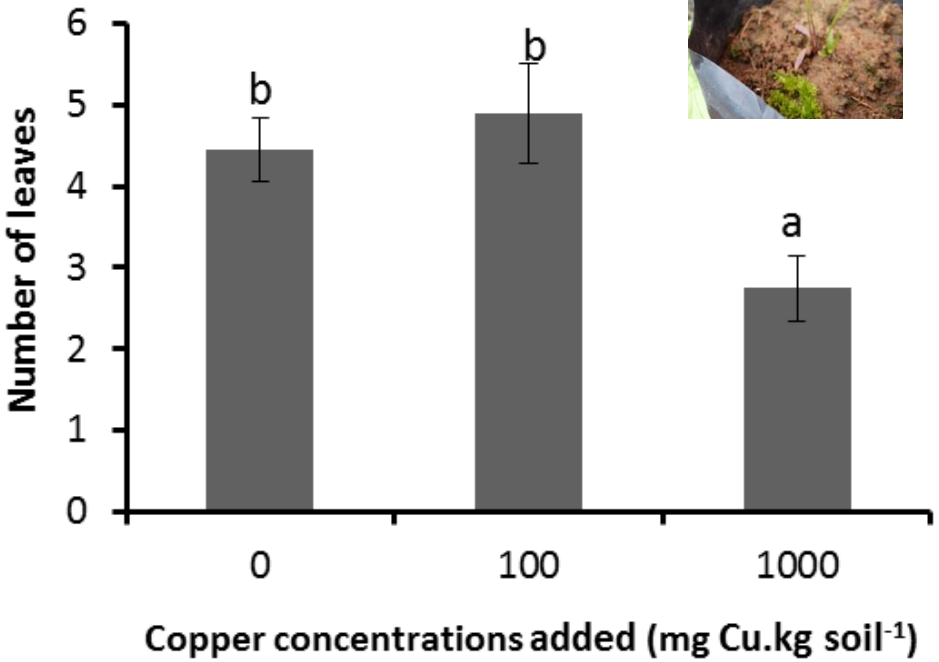


T. welwitschii

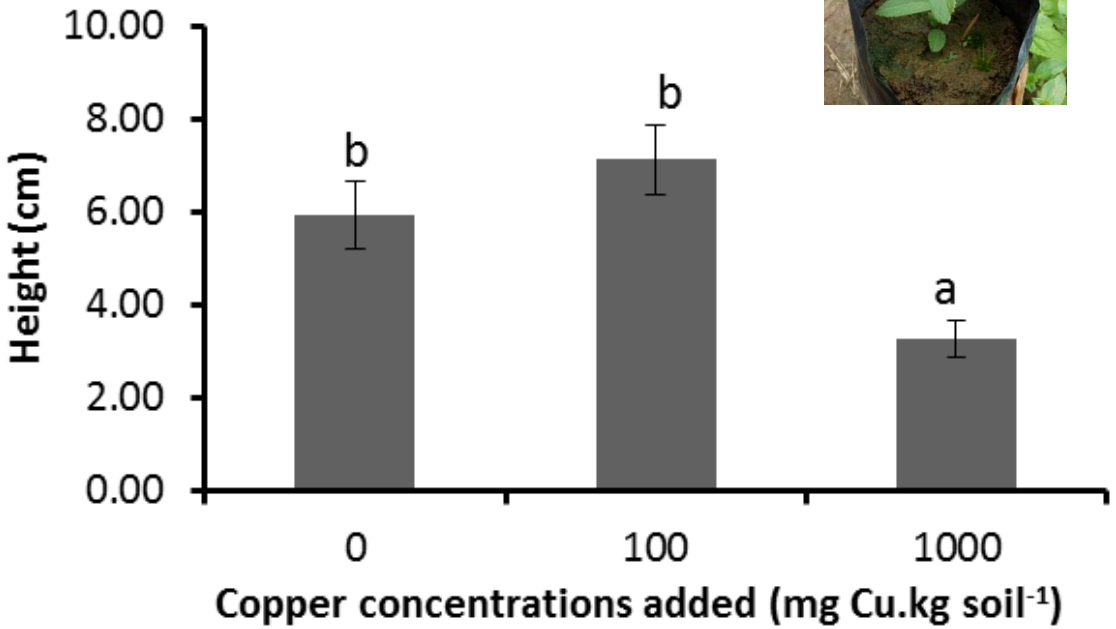
Growth of perennial species

- Copper concentration effect on perennial species

D. marthozianum



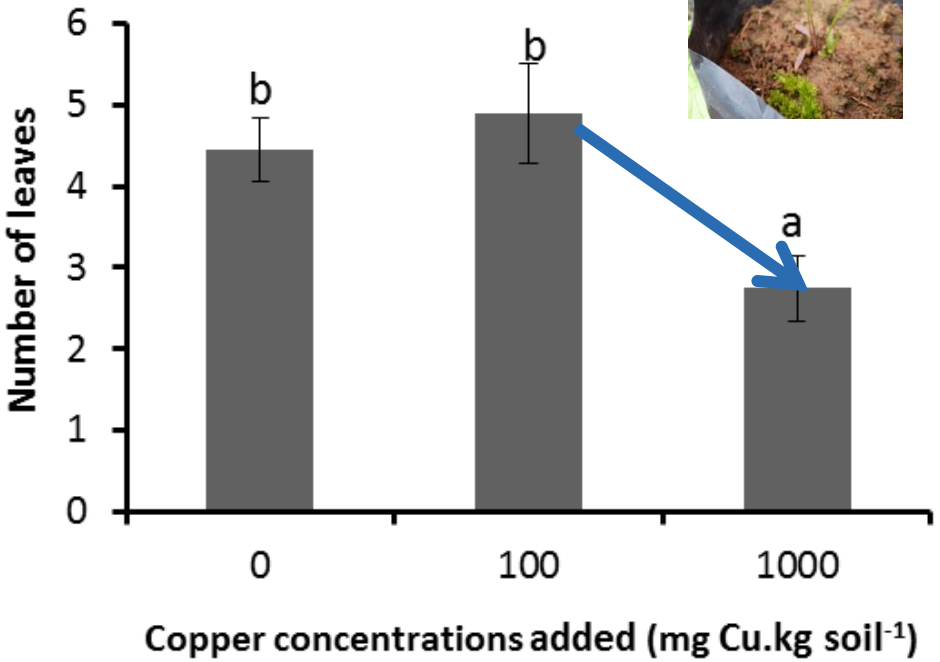
T. welwitschii



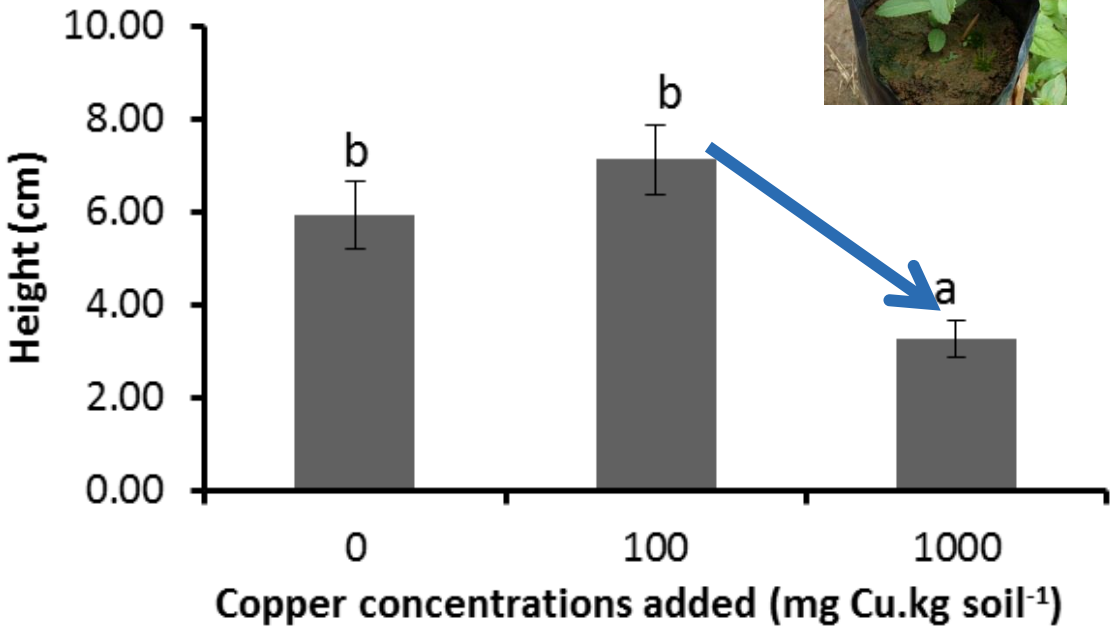
Growth of perennial species

- Copper concentration effect on perennial species

D. marthozianum

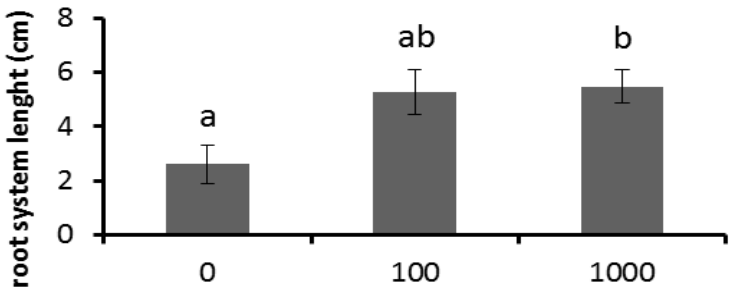


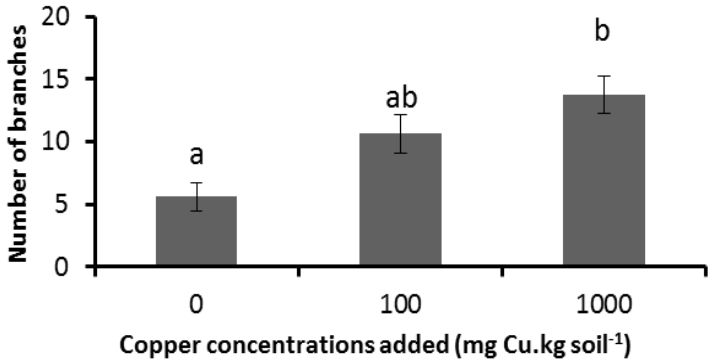
T. welwitschii



Growth of the annual species: *C. cobalticola*

- No population effect
- Copper concentration effect on perennial species



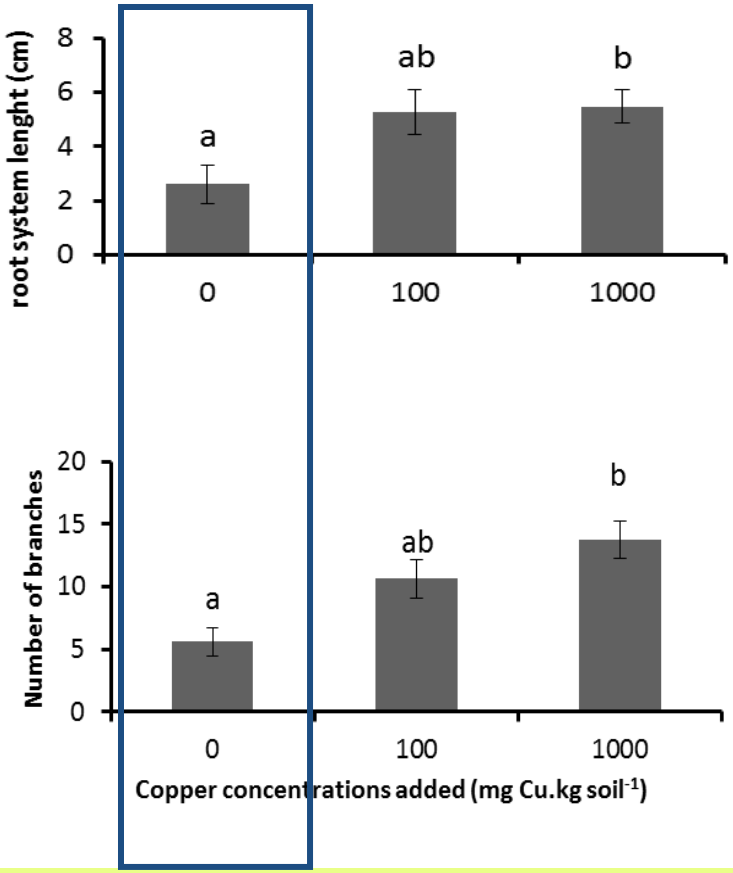


Growth of the annual species: *C. cobalticola*

- No population effect
- Copper concentration effect on perennial species

Lowest concentrations

Dry weight: 0.89± 0.16 g

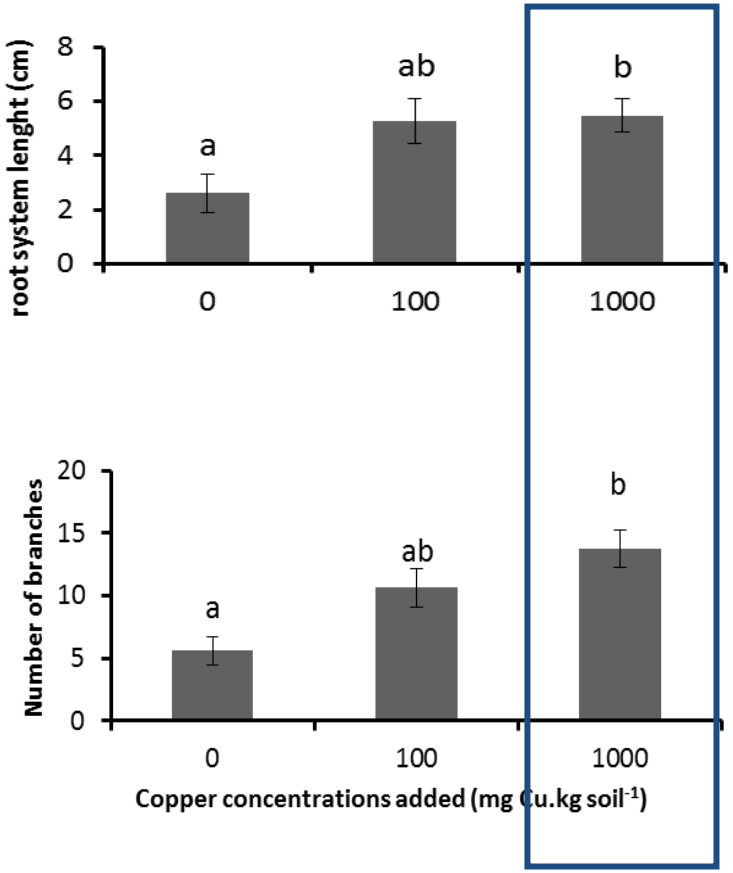


Growth of the annual species: *C. cobalticola*

- No population effect
- Copper concentration effect on perennial species

Lowest concentrations

Dry weight: 0.89± 0.16 g



Highest concentrations

Dry weight: 1.72± 0.09 g

To conclude

- According to species
  - Populations have an effect on growth AND/OR
  - Copper concentrations have an effect on growth

To conclude

- According to species
  - Populations have an effect on growth AND/OR
  - Copper concentrations have an effect on growth
- For *C. cobalticola*
  - Performance seems to be higher at 1000 ppm than 0 ppm Cu added → specialist
  - Few individuals had flowers and fruits → no statistical analyses

To conclude

- According to species
  - Populations have an effect on growth AND/OR
  - Copper concentrations have an effect on growth
- For *C. cobalticola*
  - Performance seems to be higher at 1000 ppm than 0 ppm Cu added → specialist
  - Few individuals had flowers and fruits → no statistical analyses
- For *G. ledoctei*
  - No significant effect of population and copper concentration

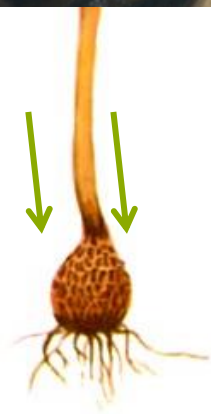
To conclude

- According to species
  - Populations have an effect on growth AND/OR
  - Copper concentrations have an effect on growth
- For *C. cobalticola*
  - Performance seems to be higher at 1000 ppm than 0 ppm Cu added
  → specialist
  - Few individuals had flowers and fruits → no statistical analyses
- For *G. ledoctei*
  - No significant effect of population and copper concentration

  BUT

  Resources allocated in bulbs ?

  !! plants stay until next year



In conservation and rehabilitation

- It is possible to regenerate endemic species from **steppic savanna** in **normal soils**
  - <> *C.cobalticola* (**steppe**)

- Population involve the growth of some perennial species
  - Prioritizing the conservation of performant populations in the first step
  - Then adding new populations to increase the diversity

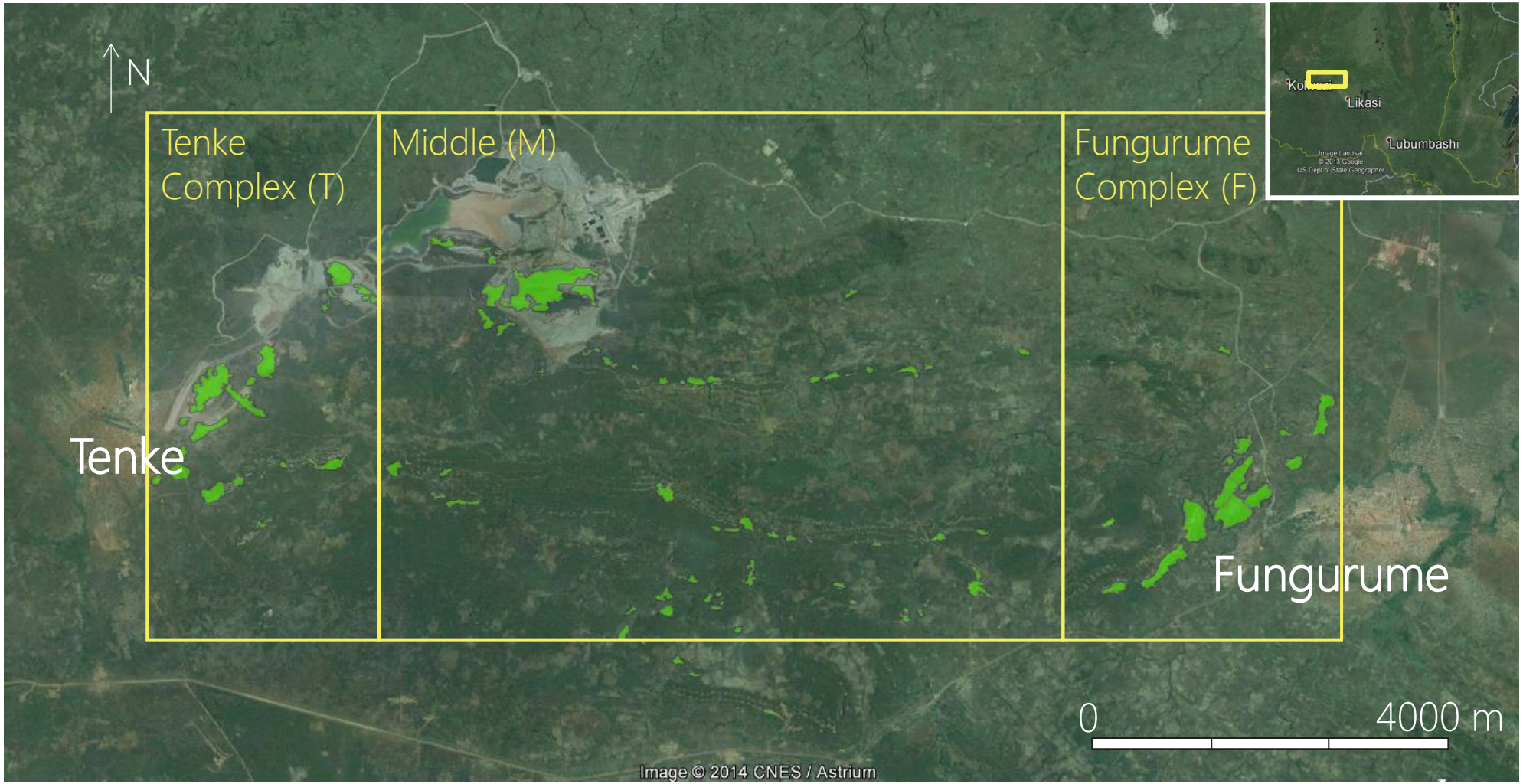
- *C. cobalticola* present the highest tolerance level to copper → use in rehabilitation

Thank you for your attention

Pictures: O. Garin, S. Boisson & copperflora.org

Copperflora.org
info@copperflora.org

Seeds collection



Species populations :

3 populations between Tenke and Fungurume

On each complex

At the same year

Random sampling