Smart strategies for the transition in coal intensive regions

Project No: 836819

TRACER
TRANSITION IN COAL INTENSIVE REGIONS

Restoration of Post-mining Sites online Summer School

Photo by Ing. Markéta Hendrychová, Ph.D.

WP 7 – Task 7.3 / D 7.3

July 2021

CHARLES UNIVERSITY
Environment Centre

Author: Ing. Agáta Kotábová

Editor: Prof. Mgr. Ing. Jan Frouz, CSc.

Contact: Charles University Environment Center
Prof. Mgr. Ing. Jan Frouz, CSc.
Email: jan.frouz@czp.cuni.cz, tel.: +420 220 199 472
José Martího 407/2
Prague. 160 00
Czech Republic
www.czp.cuni.cz

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 836819. The sole responsibility for the content of this report lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the INEA nor the European Commission are responsible for any use that may be made of the information contained therein.

TRACER website: www.tracer-h2020.eu

Contents

1 Introduction

The Restoration of post-mining sites Summer School was held between on 8-11th June 2021, online in Prague, the Czech Republic, led by Charles University Environment Centre. The Summer School was organised alongside international conference "Forest and landscape restoration of post-mining sites". The four-day block of the Summer school thus concluded a two-week concentration on the restoration of post-mining sites.

The main topic of the summer school was the restoration of post-mining sites. The effort was to achieve comprehensive information with a focus on ecosystem restoration, natural processes and their usage on non-habitat and forest post-mining sites, post-mining lakes with their aquatic habitats, storage of soil C, rare species on post-mining sites etc.

2 Course and agenda

2.1 Course

The Summer School was held online due to COVID-19 pandemic. It allowed access for listeners from around the world. Out of 88 registrations 44 participants were attending the event. Participants were from the Czech Republic and neighbouring countries like Poland and the Federal Republic of Germany. There were representatives also from India, Greece, Colombia, the Philippines, Zambia and Ireland.

2.2 Agenda

The program was created with regard to the continuity of thematic units.

2.2.1 Tuesday 8th June

In the beginning, an informative introduction about the TRACER project was provided by Director of Projects at WIP Dr Rainer Janssen.

Figure 1: Dr Janssen´s TRACE project welcome.

Mr Frouz gave the introductory lecture on ecological principles for ecosystem restoration. Mr Frouz mainly spoke about ecosystems functions, different methods of developing ecosystems

and how and why to restore them. Ecosystem services were linked with socioeconomical, sociocultural aspects as moral obligation to nature conservation.

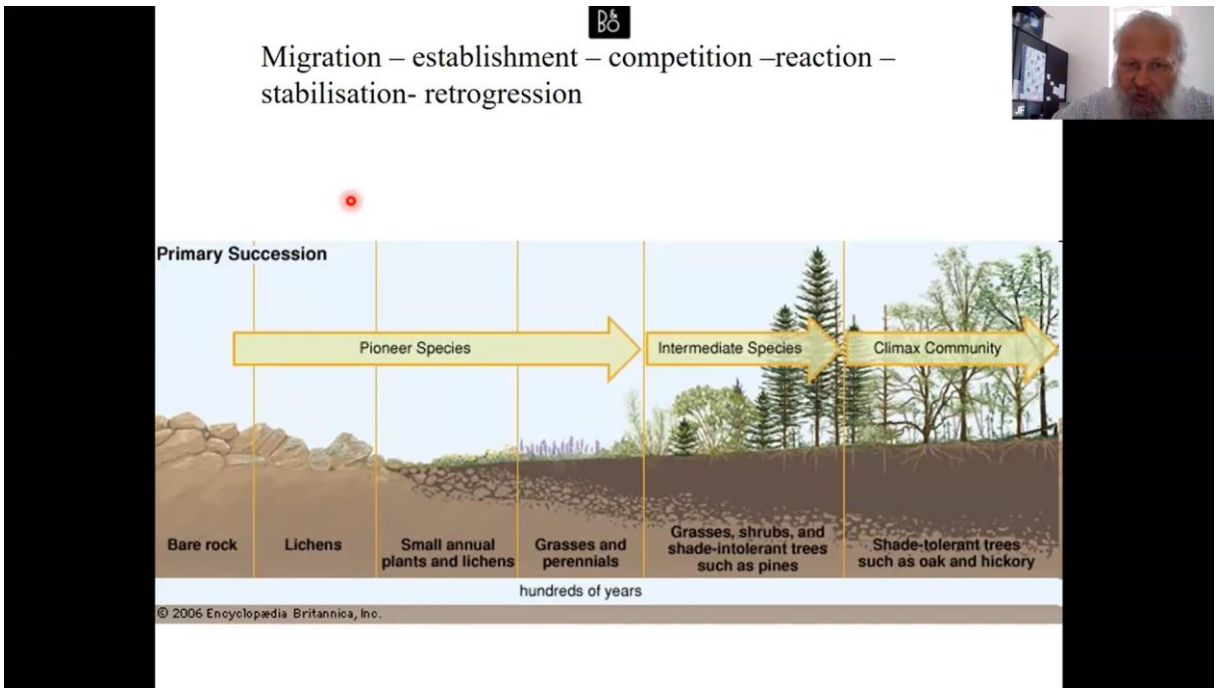


Figure 2: Primary Succession by Prof Frouz.

Mr Frouz also talked about the importance of biota modification. Amount of biota could show difference between functional and non-functional ecosystems, but mainly there was a reflection over balance stage (how far we want to push the whole ecosystem?). Community perception is very important here. If we want to disturb habitat, what will be the next step? It could be habitats converted for production thanks to reclamation.

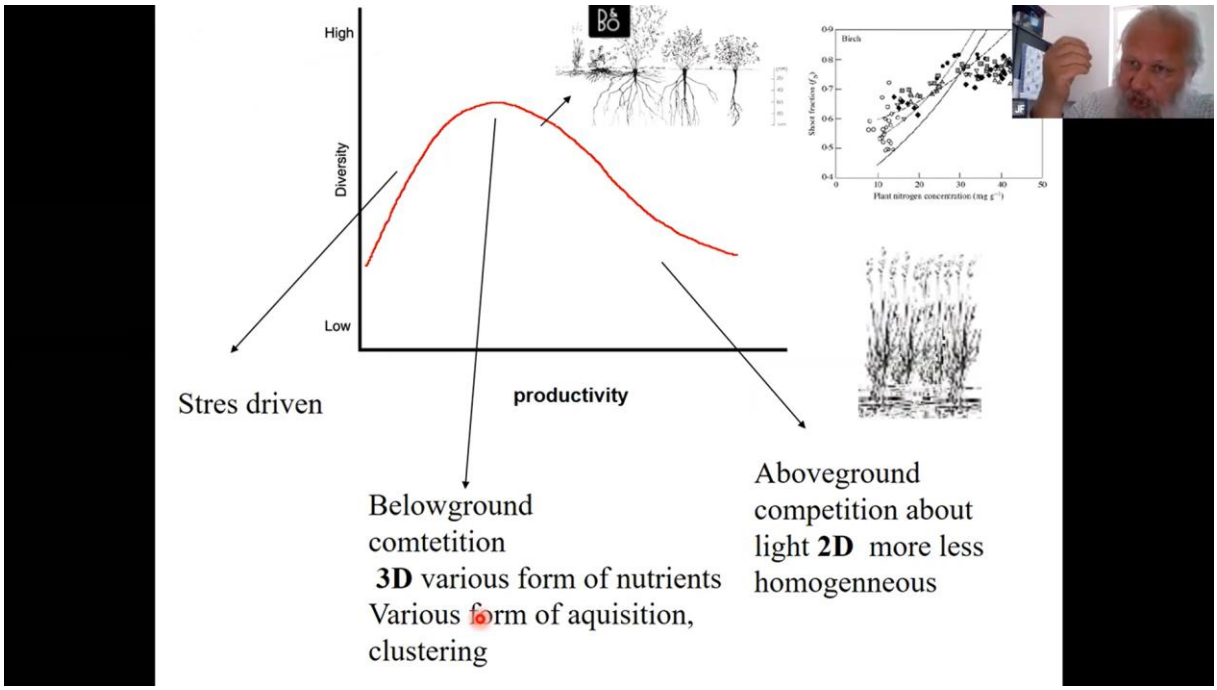


Figure 3: Community perception by Prof Frouz

Succession development leads to questions about disturbance vs degradation. Frequency of disturbance could be periodical and natural. Nature has own systems of dealing with

disturbance. On the other hand, we used to talk about degradation in connection with mining and changing whole ecosystems and habitats. Along with degraded habitats, is very important to mention migration of species and connectivity with terrain. Improvement of species establishing in microhabitats is of course dependent also on topsoil microstructure.

Development of plant community is covered by two clusters. One is ruderal cluster from pioneer´s species. Second cluster from more demanding species with hummus layer.

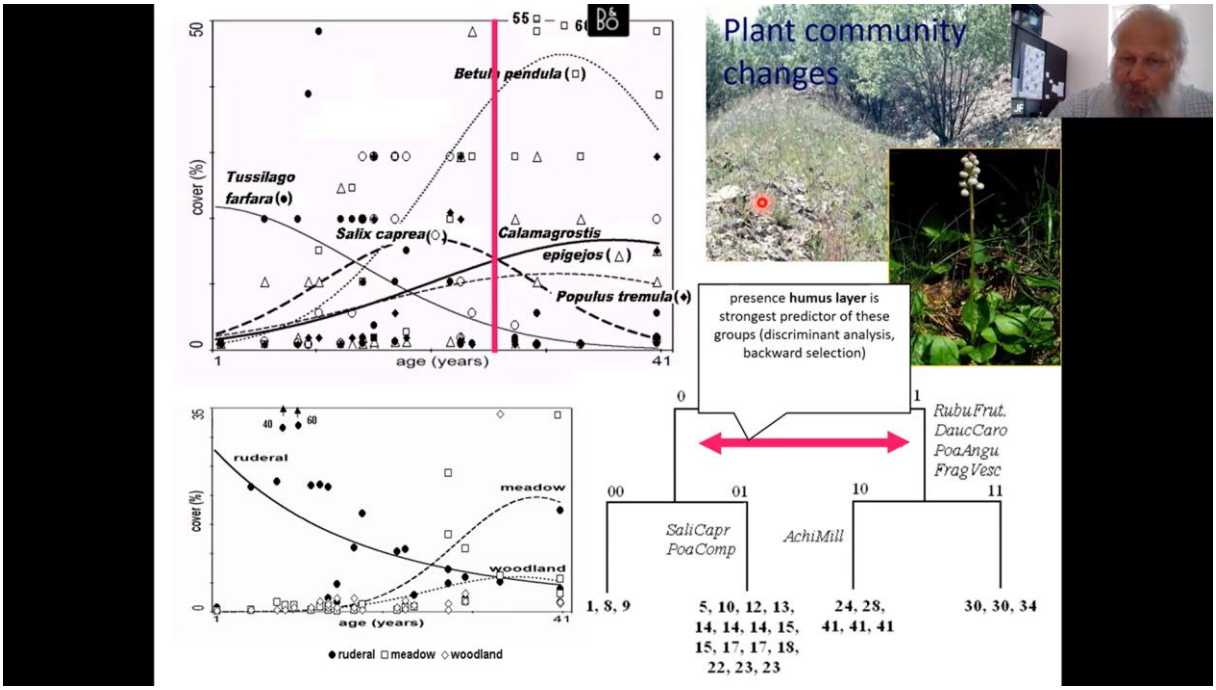


Figure 4: Plant community changes by Prof Frouz.

Last part of Mr Frouz´s lecture was dedicated to problems and opportunities of mining, overburden heaps and nutrient content.

Mr Masto continued on Tuesday´s lecture with examples of good practice in India, mostly from Dhanbad region.

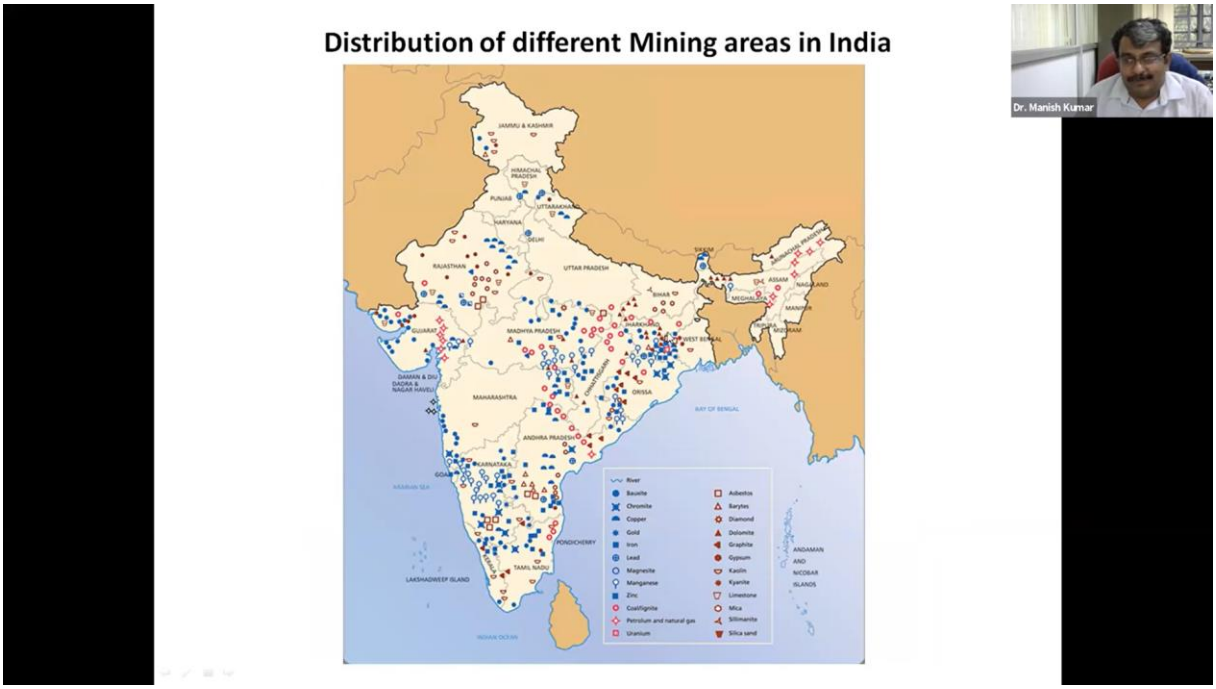


Figure 5: Distribution of different mining areas in India by Mr Masto

Mr Masto introduced several examples of reclamations in India. He started with reclamation of OB dumps and after that he mentioned reclamation of sponge iron waste dump and continued with lignite mine reclamation.

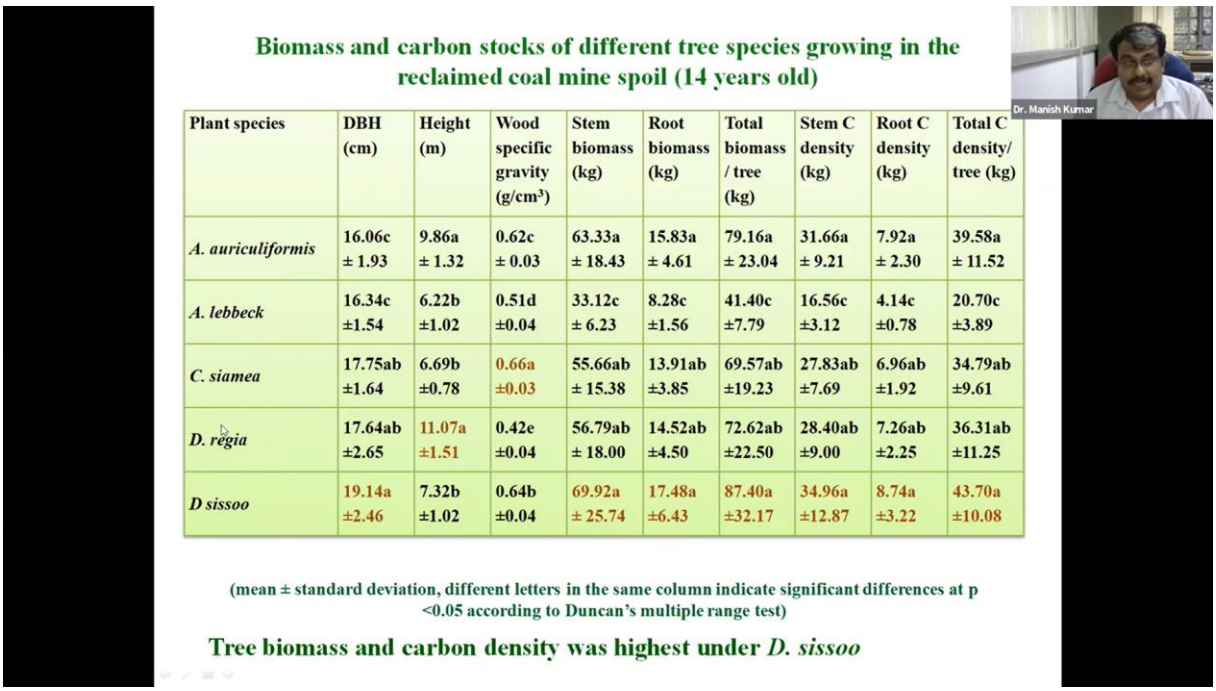
India is very active for lignite mining. Reclamation in lignite mining areas is established with mixture of red soil, cattle manure, coir pitch, fly ash and biofertilizers as Azospirillum, Phosphobacteria, mycorrhizaa, humic acid, neem cake, DAP and planting with trees, weeds etc.

Figure 6: Inhabitance of lignite mine after reclamation by Mr Masto

Reclamation for growing agricultural crops was made by levelling, ploughing, sow dust (25t/ha), lignite dust (10t/ha), gypsum, urea, cattle manure and press mud. Locality of reclamation mine was ploughed two times, sowing of green manure seeds and puddling and transplantation of paddy seedlings.

Another important aspect in India´s reclamation practice is the use of geotextiles. There exist multiple reasons why to use them. They absorb water, they can control temperature, prevents rain splash an are favourable for micro climate and erosion control.

Carbon sequestration and soil quality in a reclaimed coal mine in Jharia coalfield depend also on tree species growing there. Highest carbon density and tree biomass was higher under Dalbergia sissoo species.



Plant species	DBH (cm)	Height (m)	Wood specific gravity (g/cm³)	Stem biomass (kg)	Root biomass (kg)	Total biomass / tree (kg)	Stem C density (kg)	Root C density (kg)	Total C density/ tree (kg)
A. auriculiformis	16.06c ± 1.93	9.86a ± 1.32	0.62c ± 0.03	63.33a ± 18.43	15.83a ± 4.61	79.16a ± 23.04	31.66a ± 9.21	7.92a ± 2.30	39.58a ± 11.52
A. lebbeck	16.34c ±1.54	6.22b ±1.02	0.51d ±0.04	33.12c ± 6.23	8.28c ±1.56	41.40c ±7.79	16.56c ±3.12	4.14c ±0.78	20.70c ±3.89
C. siamea	17.75ab ±1.64	6.69b ±0.78	0.66a ±0.03	55.66ab ± 15.38	13.91ab ±3.85	69.57ab ±19.23	27.83ab ±7.69	6.96ab ±1.92	34.79ab ±9.61
D. regia	17.64ab ±2.65	11.07a ±1.51	0.42e ±0.04	56.79ab ± 18.00	14.52ab ±4.50	72.62ab ±22.50	28.40ab ±9.00	7.26ab ±2.25	36.31ab ±11.25
D sissoo	19.14a ±2.46	7.32b ±1.02	0.64b ±0.04	69.92a ± 25.74	17.48a ±6.43	87.40a ±32.17	34.96a ±12.87	8.74a ±3.22	43.70a ±10.08

Figure 7: Biomass and carbon stocks of different tree species growing in the reclaimed coal mine spoil (14 years old) by Mr Masto

Another measure used in India is fly ash back filling. It is advantageous in multiple ways in mine reclamation. For example, improve bulk density, porosity, water holding capacity, infiltration rate, hydraulic conductivity, erodibility, pH, nutrient content and much more. One of the most interesting finding is that fly ash could gradually increase soil organic C due to the increase in plant growth and root biomass.

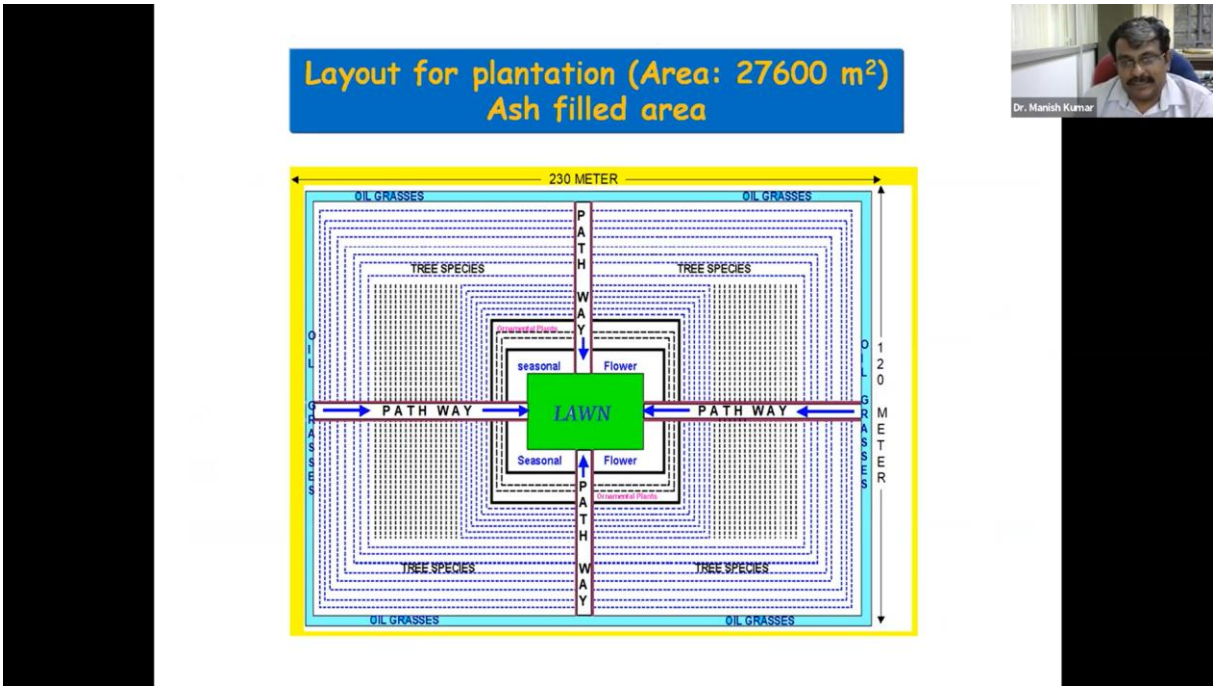


Figure 8: Fly ash usage by Mr Masto

In addition, fly ash is a new material for reclamation. It is also an innovative approach for mitigation of global climate change.

At the end of lecture, Mr Masto thought over biggest challenges for reclamation as stone substrate with steep slopes, accelerated erosion, fire due to the carbonaceous shale substrate, toxic chemicals, adverse climatic conditions, grazing and improper planning.

2.2.2 Wednesday 9th June

Wednesday's cycle began with a Mr Frouz´s lecture on the use of natural processes and their role in the restoration of forest and non-habitat post-mining sites and continued with the presentation about post-mining lakes and other aquatic habitats led by Mr Frouz and Mr Peterka.

Mr Frouz started with common practice reclamation as heaping, dumping and levelling with heterogenity of surface intact of last layer followed by forest planting. Long term impacts are very important.

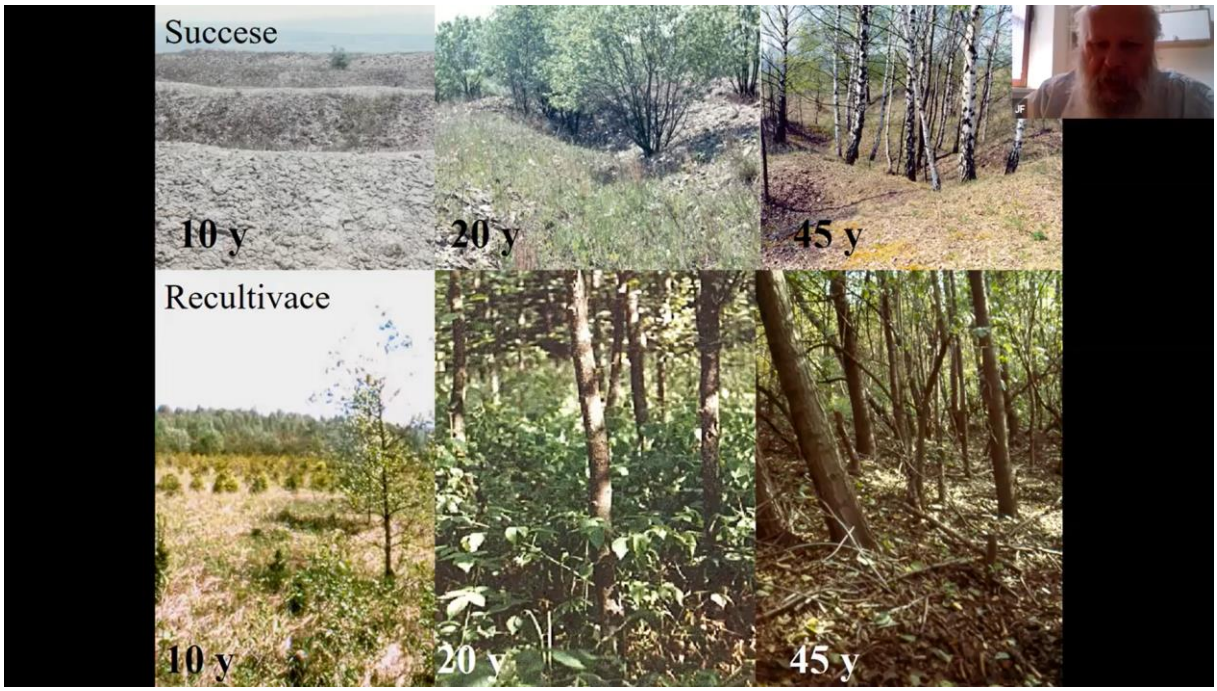


Figure 9: Comparison between natural succession and reclamation in Sokolov by Mr Frouz

He mentioned a number of reclamations and field trials with comparison of ungraded overburden sites and topsoils supplied sites. Generally, after 40 years the trees planted in ungraded overburden sites grow better. After that he continued with establishment of late succession species.

Reclamation often needs to fill pool of nutrients, mostly with minerals and organic matter. One of the best fertilizers is rock dust. It is highly unlikely to overdose soil and nutrients are released slowly and gradually. You also need to think about availability of nutrient, best in pH slightly under 4.

Mr Frouz wrapped the topic up to a few most important recommendations. Planting trees is faster than succession, but not better in long term. Initial stages need nitrogen fixers to produce nice soil development and establishment, but again, it is not good in the long run. For grassland and arable land we need topsoil reconstructions.

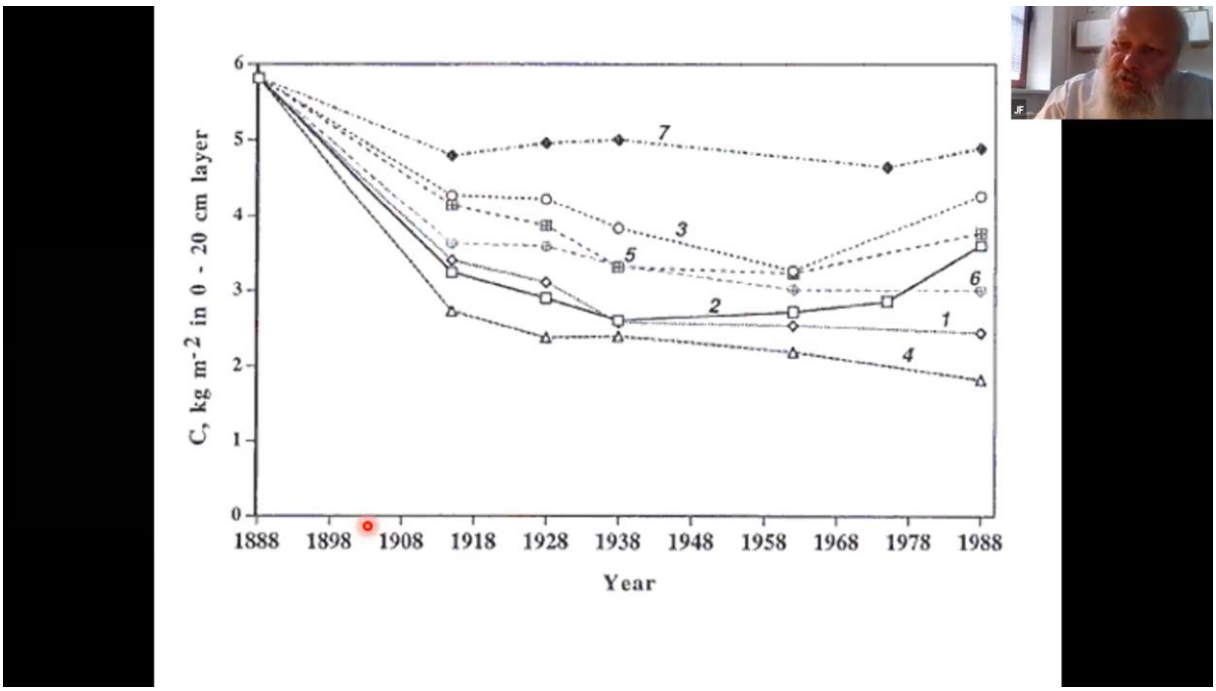


Figure 10: Development of carbon stock in tall grass prairie.

Mr Frouz continued with a lecture about water in post mining sites presented by Mr Přikryl. Mining strongly affect water regime. It might drain out surrounding landscape.

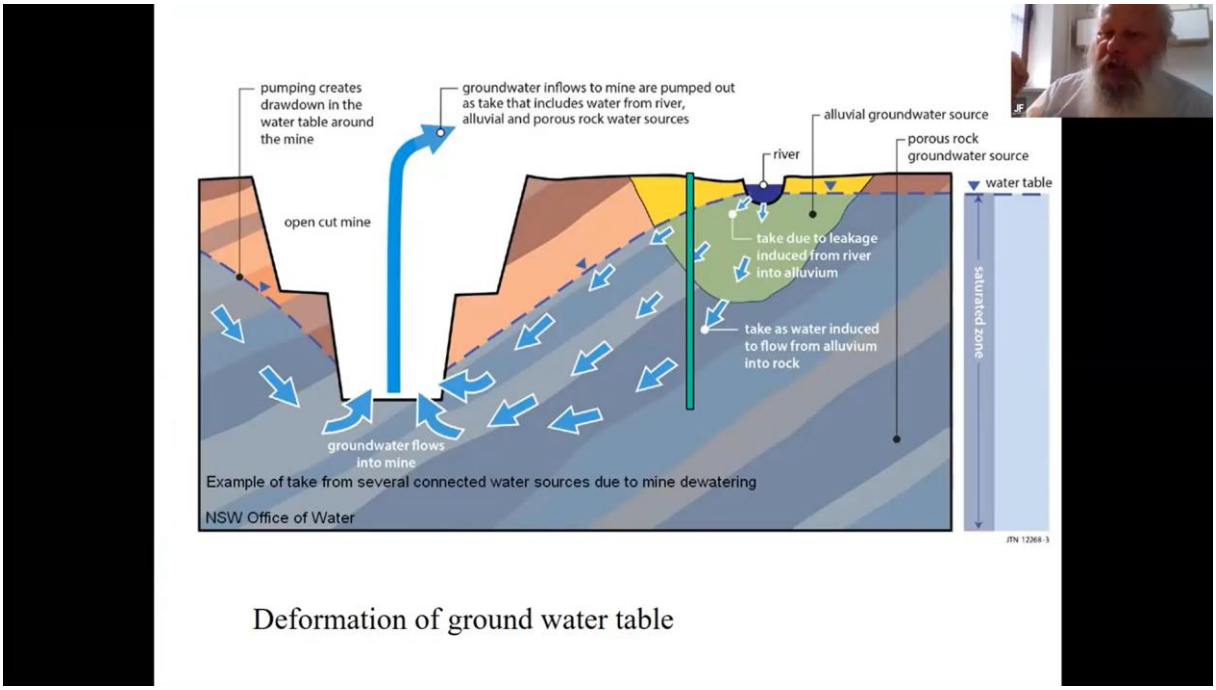


Figure 11: Scheme of ground water table deformation.

Postmining heaps offer a high amount of pyritic material. The starting point of dealing with those high pyritic heaps is to build postmining lakes. Their littoral zones can reduce abrasion and provide many ecosystems services and economic opportunities. They can be prepared during mining for a little cost.

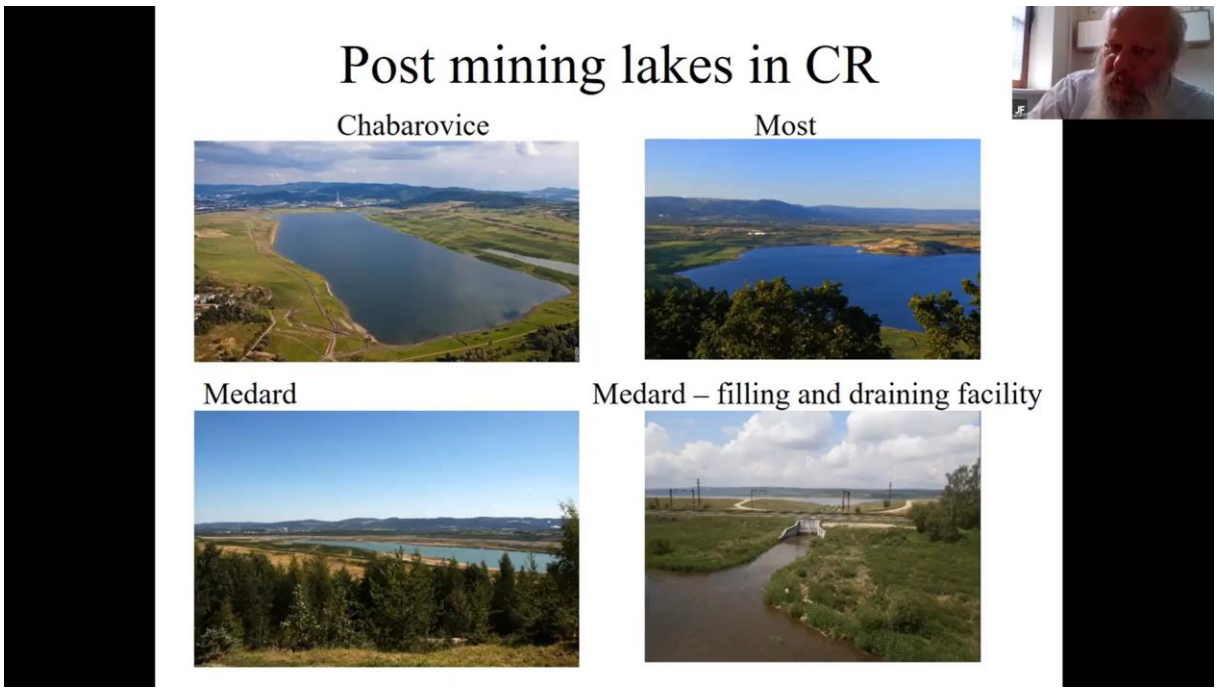
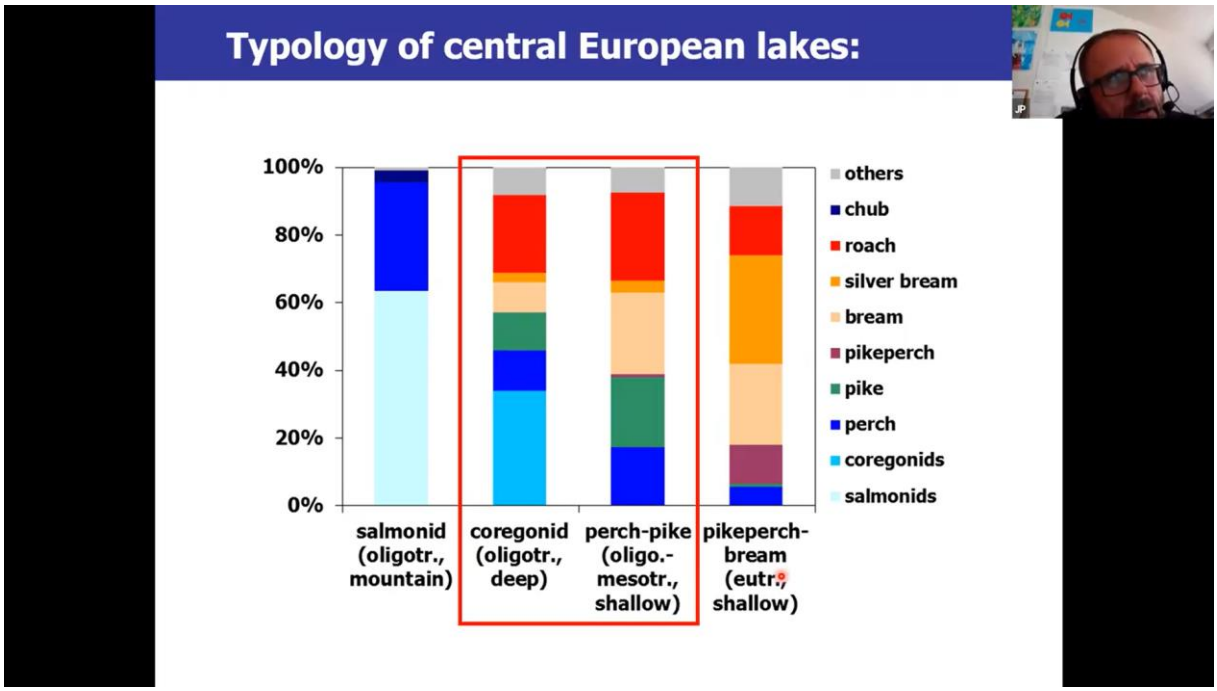


Figure 12: Comparison between three flooded postmining lakes in the Czech Republic by Mr Frouz

Mr Frouz discussed about nutrients in water, trophic state, phytoplankton, water plants, zooplankton and zoobenthos in post mining lakes after they have been flooded. He mentioned he mentioned eutrophication, water-pumping power station and increase of mineralization as possible future challenges.

Mr Peterka continued with his lecture about “Postmining lakes – the way towards exceptional landscape jewels”. He spoke about fish community, as an integral and essential component to post mining lakes.



Figures 13: Central European typology of lakes by Mr Peterka

Fish communities are highly valued for being a guard of long-term maintenance the high water quality. The problem could happen, when enormous pressure on the use of postmining lakes for fishing activities rises. It is needed to prohibit carp stocking for ecosystem conservation.

2.2.3 Thursday 10th June

The third day of the summer school started with Mr Bonkowski's and Mr Frouz's speech about soil C storage and ecosystem functions recovery.

Mr Bonkowski described carbon saturation in agricultural soils. Microbial stoichiometric threshold at 1 % SOC is critical for CUE (qCO_2). Mining sites have a high ability to store C

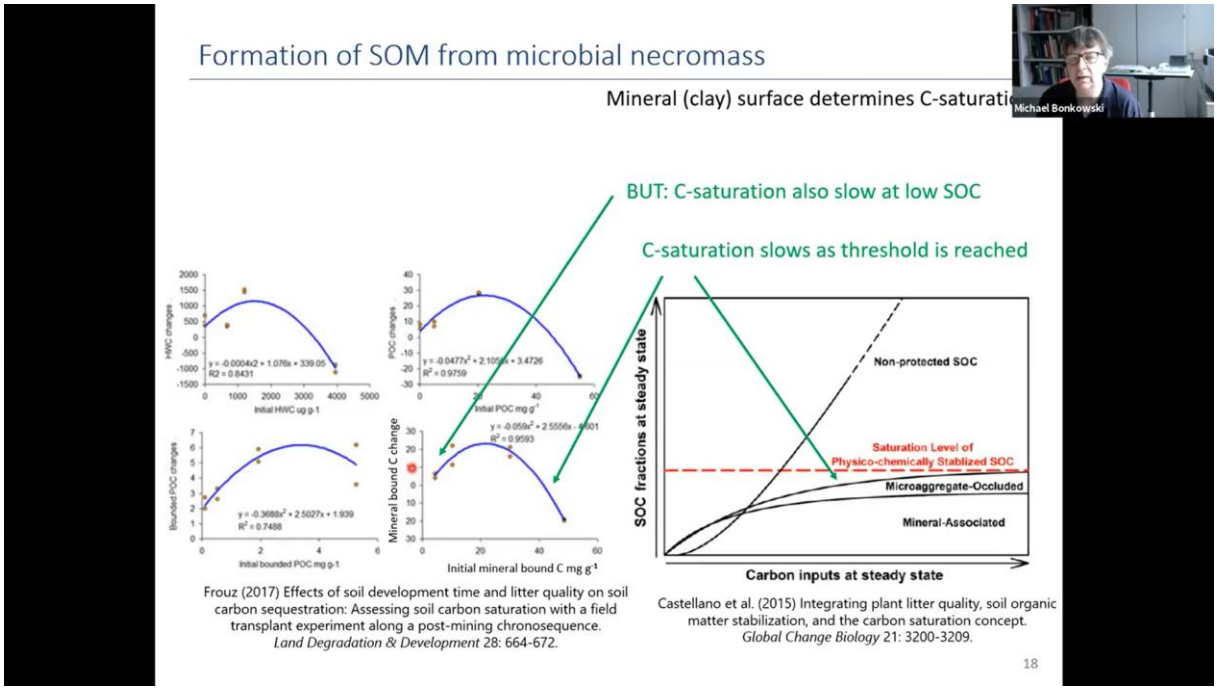


Figure 14 Carbon saturation formation by Mr Bonkowski

Mr Tropek continued with lecture about the value of post-mining sites for nature protection as a habitat of rare species. He used natural sand habitat as a “good” example of a disturbance fundamentally influencing numbers and kinds of species.

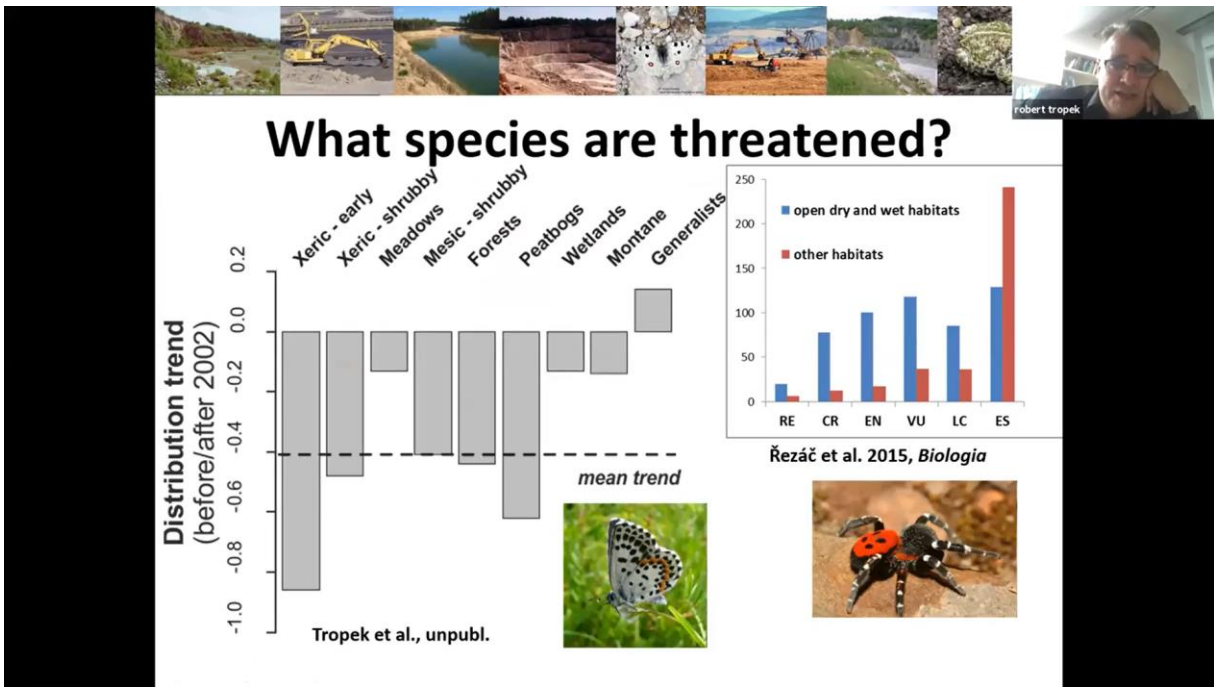


Figure 15: Threatened species in Czech Republic from special and common habitats by Mr Tropek

He linked this change to post-industrial and postmining sites, where habitats disappear very quickly. Majority of threatened species in Kladno region – region with heavy post-industrial load – do not occur anywhere else.

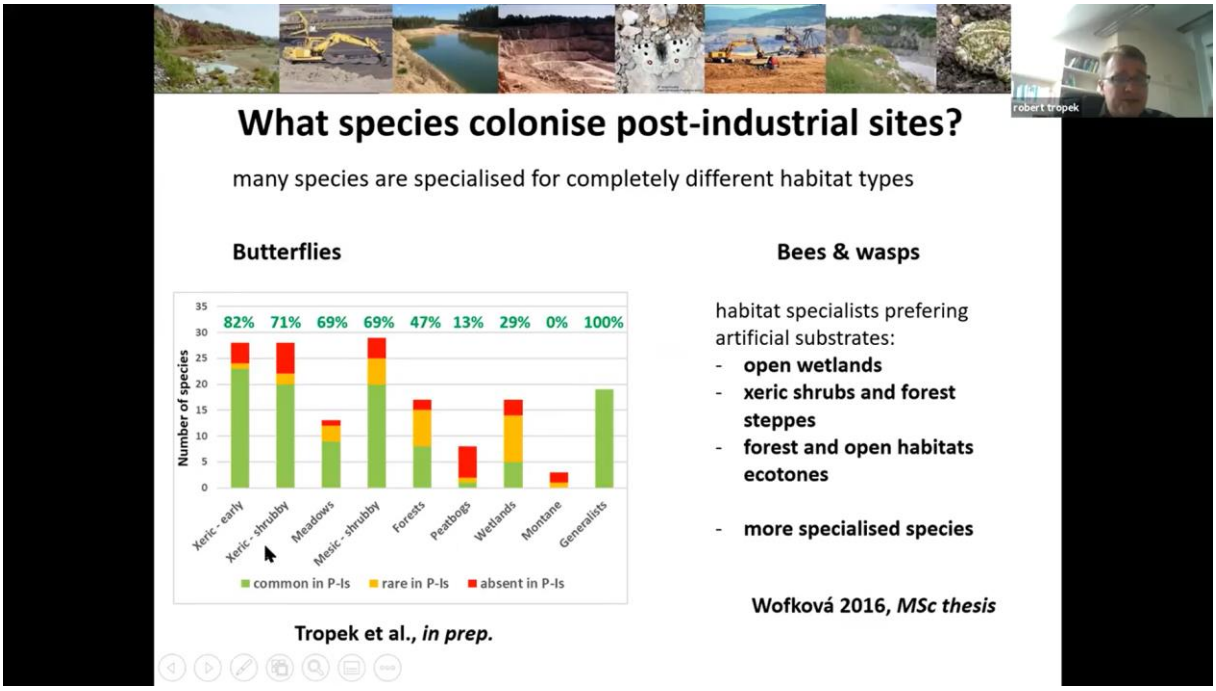


Figure 16: Species colonising post-industrial sites

Technical reclamations are not beneficial for biodiversity and for terrestrial habitats. Therefore, spontaneous succession is better than technical reclamations. For restoration of habitats in fresh water, we do not observe difference in species colonization habitats restored by technical way or by succession.

Mr Tropek ended his lecture with explanation, why we should not ignore post-industrial sites and closed Thursday's lectures with a plenary discussion.

2.2.4 Friday 11th June

The last day of the summer school was opened with a lecture by Ms Hendrychová about post-mining restoration in the context of landscape use. Ms Hendrychová started with reclamation history and it needs. As mining has long history of environmental impact, she outlined a multiple types of mining as open cut mining or underground mining.

Figure 17: The biggest modern mines in 21th century by Ms Hendrychová

Mining degradation could lead through restoration, or reclamation, to resocialization of whole locality. Goal of reclamation should be full integration of reclaimed area into surrounding landscapes.

Ms Hendrychová introduced landscape changes during the time.

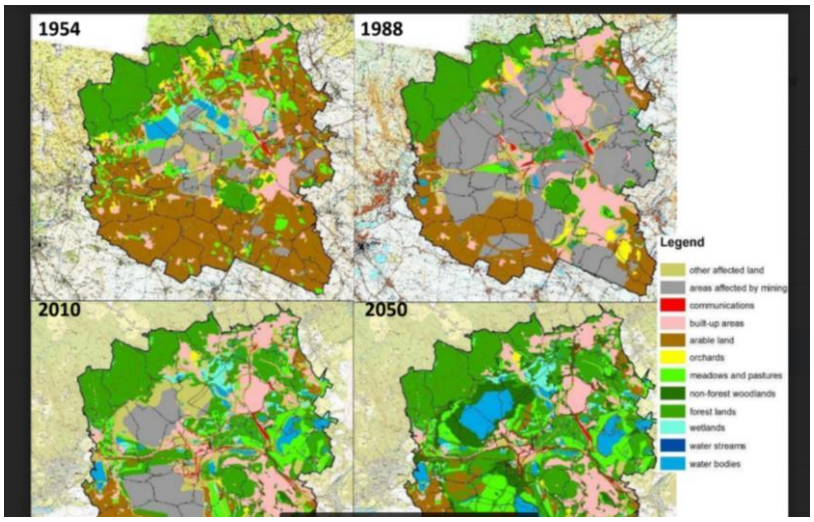


Figure 18: Landscape changes in Sokolov region by Ms Hendrychová.

Ms Henrdychová continued with fresh water habitat biota species, where she agreed with previous conclusions, that more reclaimed ponds did not differ significantly from spontaneous development, but more rare species were on non-reclaimed sites. Afterwards she spoke about bird biodiversity, sparsely vegetated areas and blocked succession.

Figure 19: Map of stakeholders in the reclamation process by Ms Hendrychová.

Next part of a lecture was devoted to general sanitation, reclamation plan and subsequent activities. Czech legislative process and discrepancy inside scientific sphere, where succession has not been fully respected creates a great barrier to ecological succession.

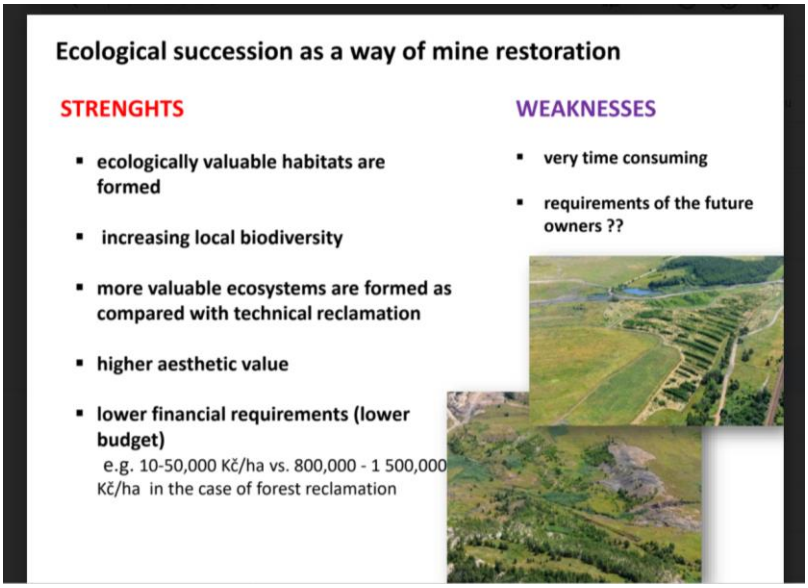


Figure 20: Strengths and weaknesses of ecological succession by Ms Hendrychová

At the end of lecture, Ms Hendrychová summarized best approaches of reclamation. Last lecture day was closed with a video summarizing the whole summer school.

3 Conclusion

The summer school lasted four days, and six expert lecturers provided insight into seven topics about the restoration of post-mining sites. 44 listeners from all over the world actively participated in the ongoing discussions after each block of lectures.

4 Annex

4.1 Agenda

	Morning block 11-12:30	Afternoon block 13-14:30
Tuesday 8th June	Introduction to restoration ecology and ecological principles that underline ecosystem restoration	Best practice examples from India
	J. Frouz	**R. Masto**
Wednesday 9th June	Restoration of forest and non-habitat in post mining sites role of natural processes and how to use them	Post mining lakes and other aquatic habitats
	J. Frouz	**J. Frouz, I. Přikryl, J. Peterka**
Thursday 10th June	Soil C storage and ecosystem functions recovery	The value of post mining sites for nature protection as a habitat of rare species
	J. Frouz & M. Bonkowski	**R. Tropek**
Friday 11th June	Post mining restoration in context of landscape use	Synthesis and closure
	M. Hendrychová	**J. Frouz**