Sustainable exploitation of biomass for bioenergy from marginal lands (MagL) in Europe

SEEMLA WP 5

Application of Soil Quality Rating (SQR) for evaluating land marginality

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seemla.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691874

Selection of marginal lands – SEEMLA case study sites

abandoned arable land	UA Lviv	UA Volyn	UA Poltava
mountainous land	GR Pelagia	GR Drosia	GR Sarakini
anthropo-genically degraded land	UA Vinnitsa	DE Welzow	DE Cottbus

What are “marginal lands”?

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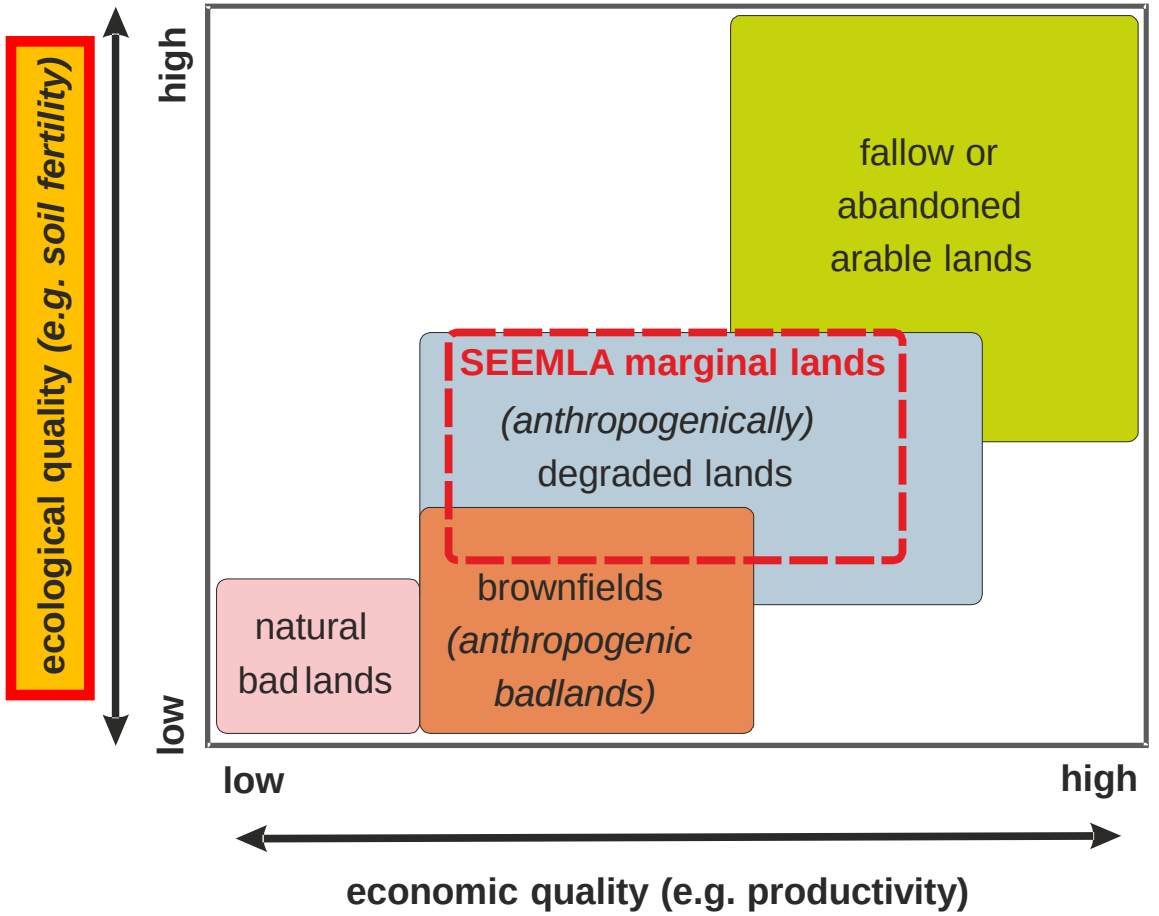
SEEMLA definition of marginal lands



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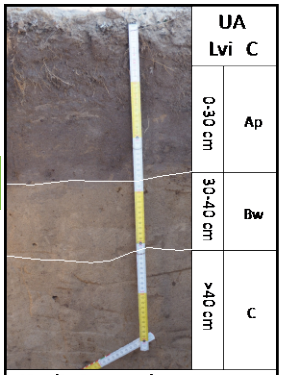
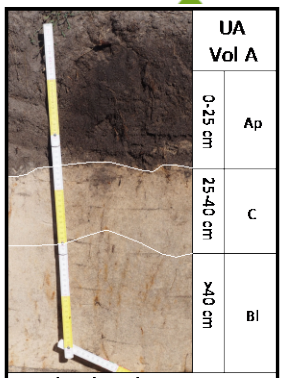
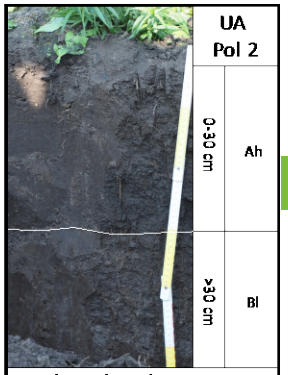
SEEMLA case study sites



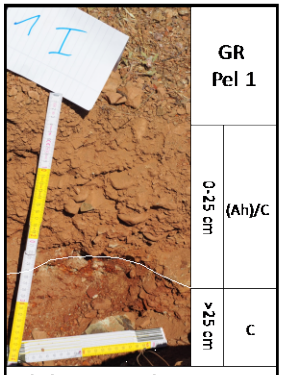
Haplic Arenosol
Final SQR: 29.5



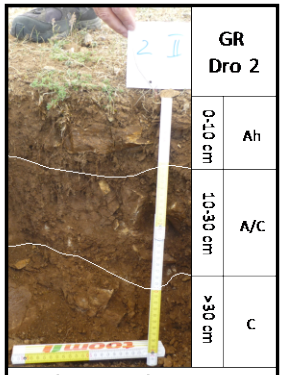
Haplic Gleysol
Final SQR: 37.1



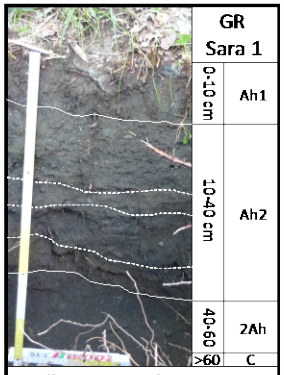
Umbric Gleysol
Final SQR: 1.7



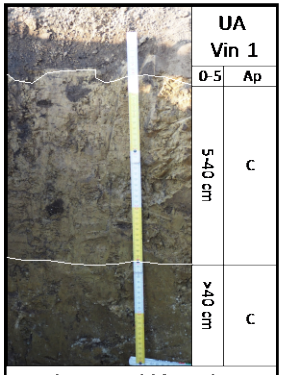
Skeletic Regosol
Final SQR: 7.6



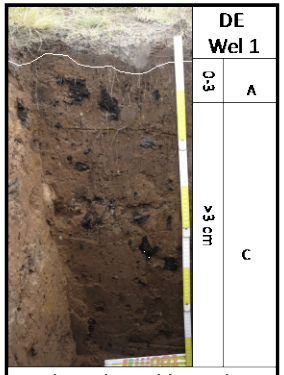
Haplic Leptosol
Final SQR: 8.8



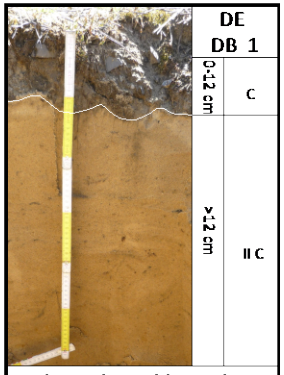
Colluvic Regosol
Final SQR: 19.3



Haplic Regosol (densic)
Final SQR: 29.0



Spolic Technosol (arenic)
Final SQR: 20.5



Urbic Technosol (arenic)
Final SQR: 9.1

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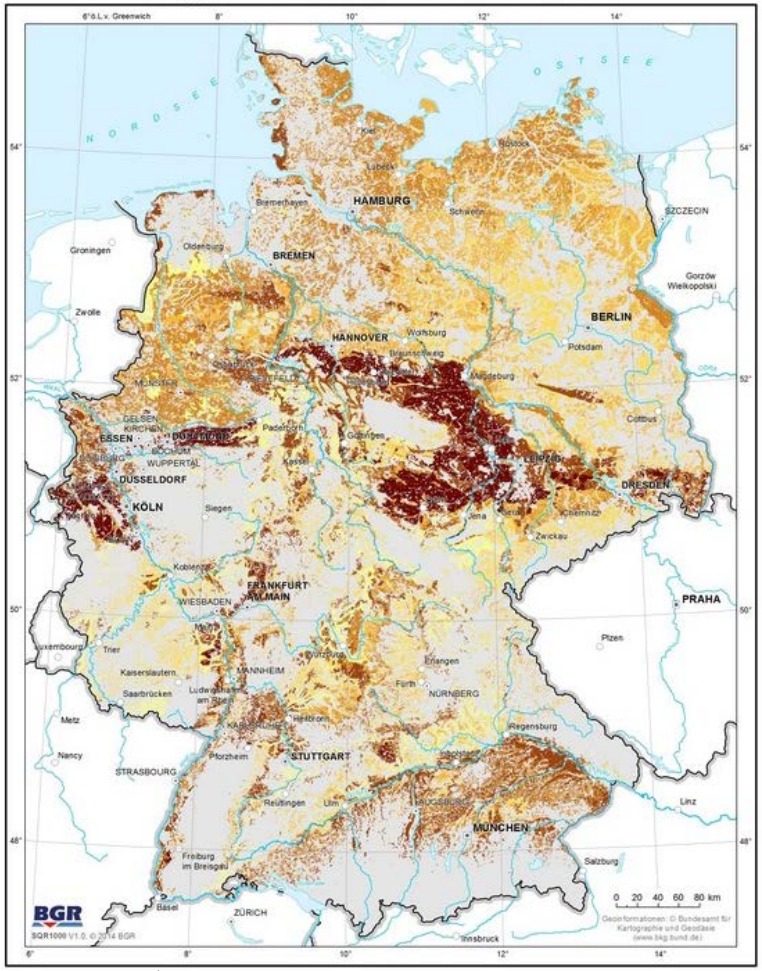
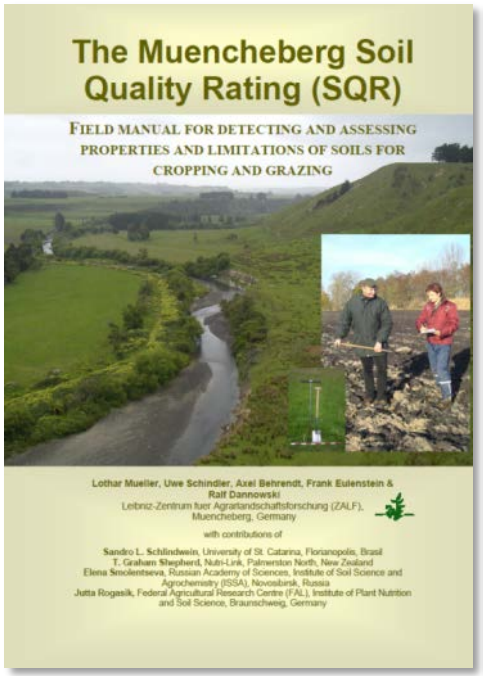
The Muencheberg Soil Quality Rating (SQR) system



Map of Agricultural Yield Potentials in Germany

- extremely low (< 35)
- very low (35 - < 50
- low (50 - < 60)
- medium (60 - < 70)
- high (70 - < 85)
- very high (> 85)
- not evaluated



https://www.bgr.bund.de/DE/Themen/Boden/Ressourcenbewertung/Ertragspotential/Ertragspotential_node.html

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The Muencheberg Soil Quality Rating (SQR) system

Basic soil indicators

1. Substrate (3)
2. A horizon depth (1)
3. Topsoil structure (1)
4. Subsoil compaction (1)
5. Rooting depth (3)
6. Profile available water (3)
7. Wetness and ponding (3)
8. Slope and relief (2)

Soil hazard indicators

1. Contamination
2. Salinisation
3. Sodification
4. Acidification
5. Low total nutrient status
6. Soil depth above hard rock
7. Drought
8. Flooding and extreme waterlogging
9. Steep slope
10. Rock at the surface
11. High percentage of coarse soil texture fragments
12. Unsuitable soil thermal regime
13. Miscellaneous hazards

Basic soil score
(between 0 and 34)

Hazard multipliers
(between 0.1 and 3)

Soil score (SQR score)
(between 0 and 100)

< 20	very poor	**marginal lands**
20 – 40	poor	
40 – 60	moderate	
60 – 80	good	
> 80	very good	

Mueller et al., 2007

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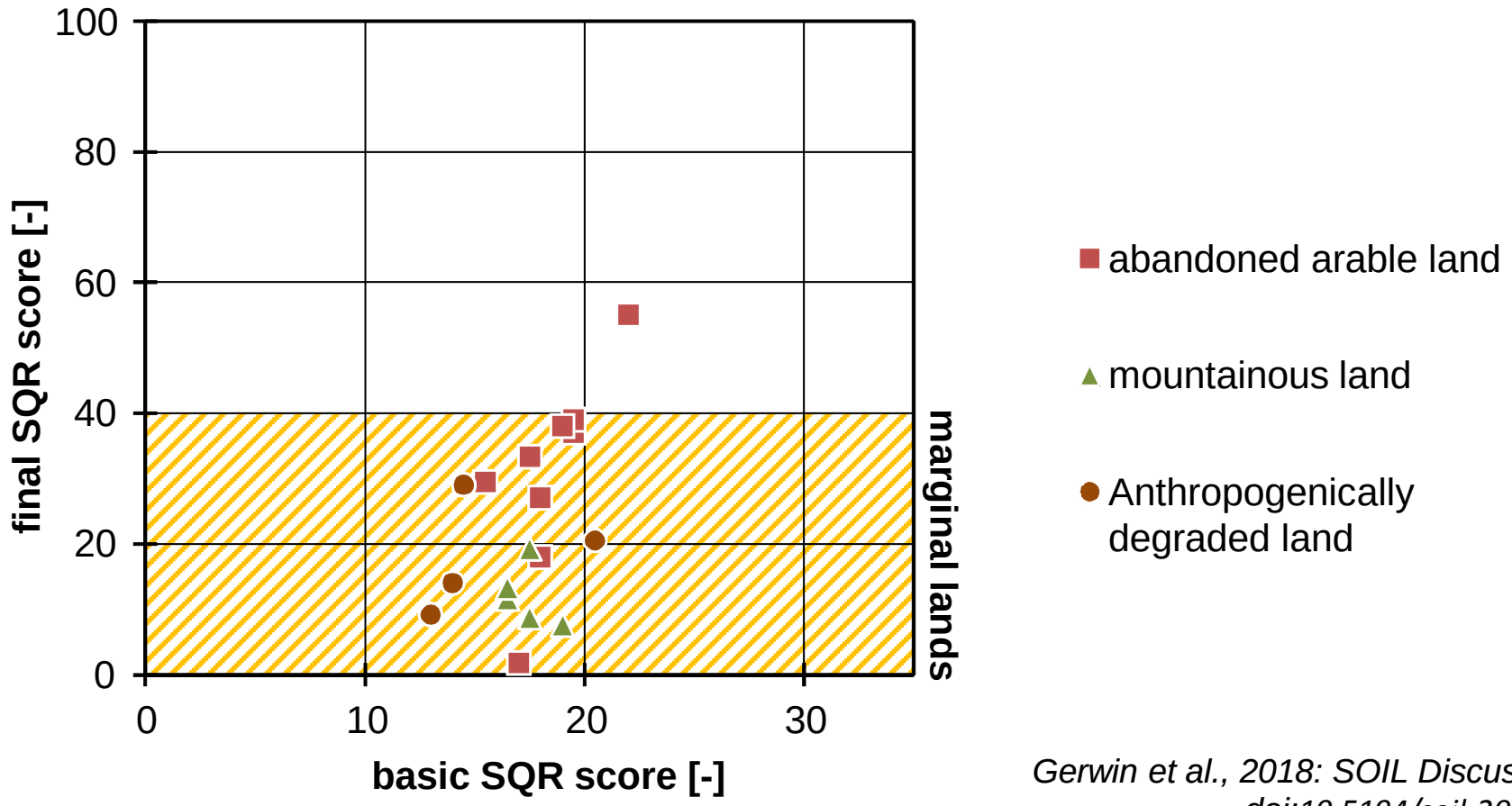
Results – SQR scores for SEEMLA case study sites



Gerwin et al., 2018: SOIL Discussion, doi:10.5194/soil-2018-14

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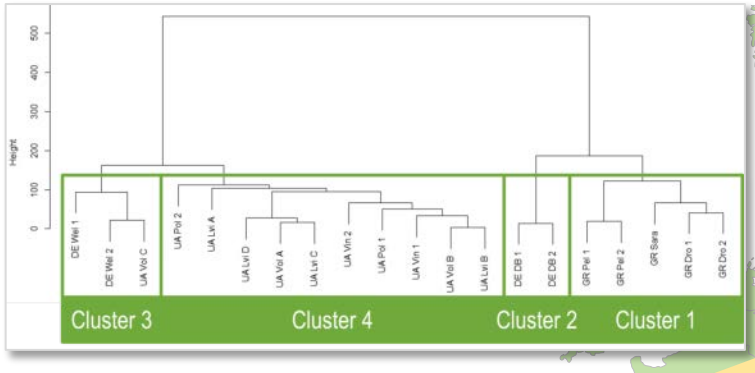
Results – main constraints of marginal lands



Abandoned agricultural land *(cluster 4)*

- low soil nutrient status
- frequently endangered by flooding/waterlogging

Reclaimed land *(cluster 3)*

- acidic soils
- higher salt content
- low soil nutrient status

Post-industrial sites *(cluster 2)*

- stones at the surface
- high amount of coarse fragments

Mountainous land *(cluster 1)*

- low soil nutrient status
- very shallow soils
- high amounts of coarse fragments at the surface and in the soil
- higher heavy metal contents (geology)
- drought risk (Mediterranean climate)

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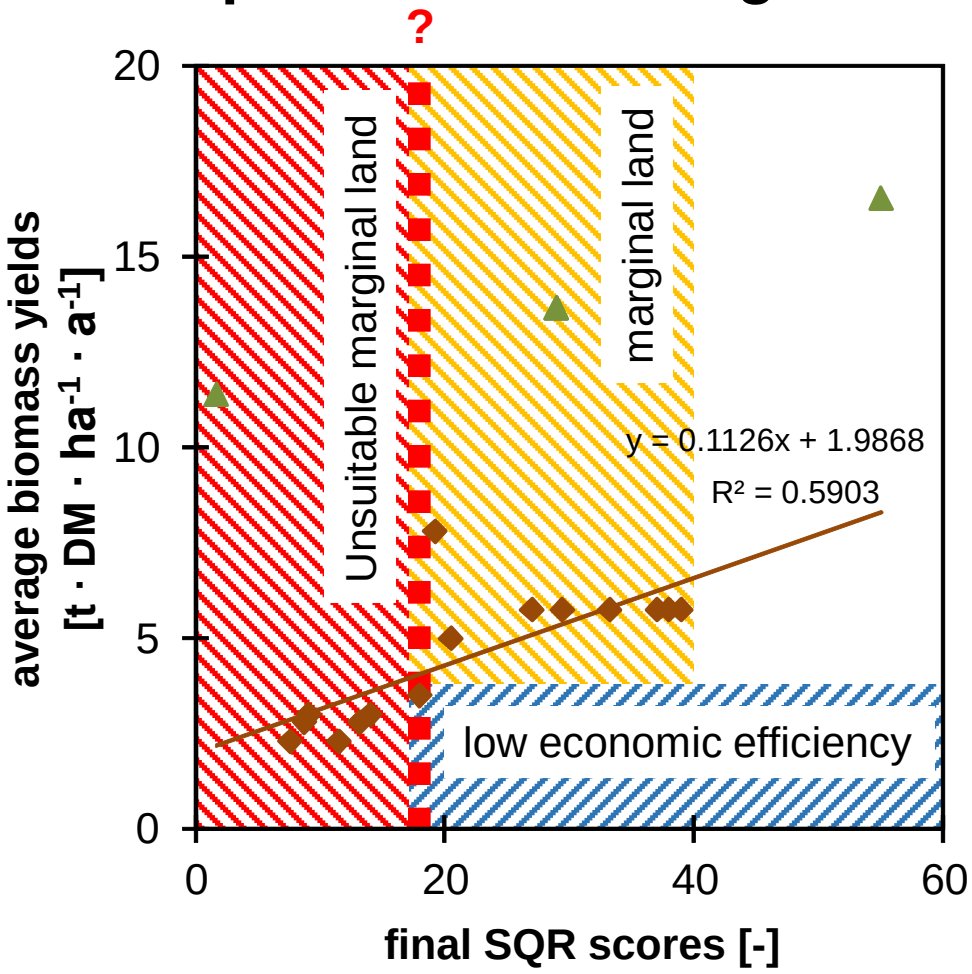
Results – potentials of marginal lands



- woody bioenergy crops
- grass like biomass crops

Gerwin et al., 2018: SOIL Discussion, doi:10.5194/soil-2018-14

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Lessons learned

- “Marginal” sites vary substantially with regard to their soil properties and soil related constrains **=> terms and definitions need to be harmonized**
- SQR is easy to apply and SQR scores turn out to be a reliable criteria for differentiating between fertile and marginal sites
- SQR scores clearly correspond to potential biomass yields of bioenergy crops **=> adapted soil quality rating needed for bioenergy crops**
- Yield data reflect reduced productivity of marginal lands
- Very poor marginal lands offer low economic efficiency for bioenergy production **=> need for defining the lower boundary of suitable marginal lands**

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WP 5

Pilot cases Germany

SeeLa

Final Conference

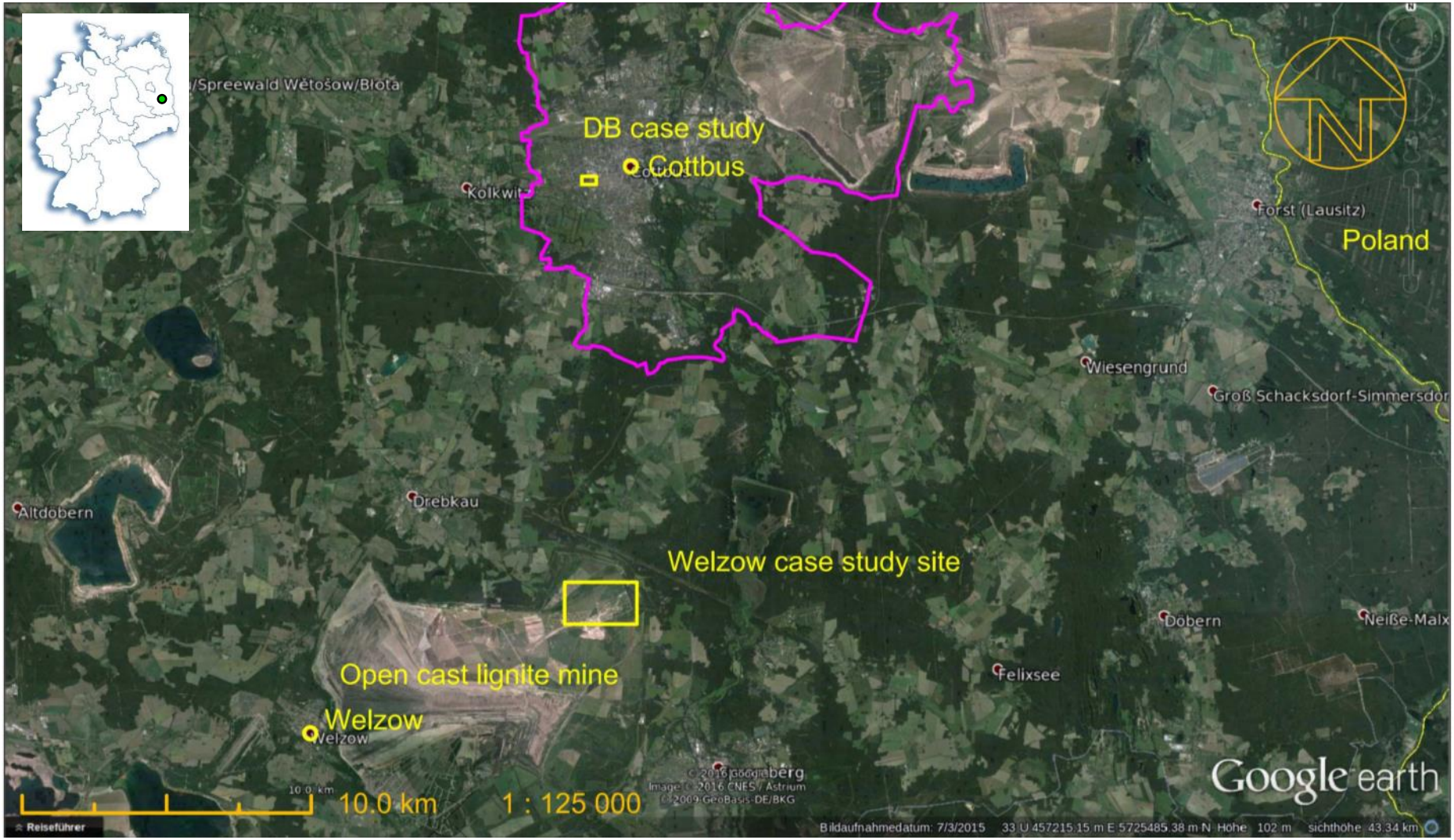
Brussels, Belgium

November 20 2018

Sustainable exploitation of biomass for bioenergy from marginal lands (MagL) in Europe

Brandenburg University of Technology Cottbus - Senftenberg

Frank Repmann, Werner Gerwin & Dirk Freese



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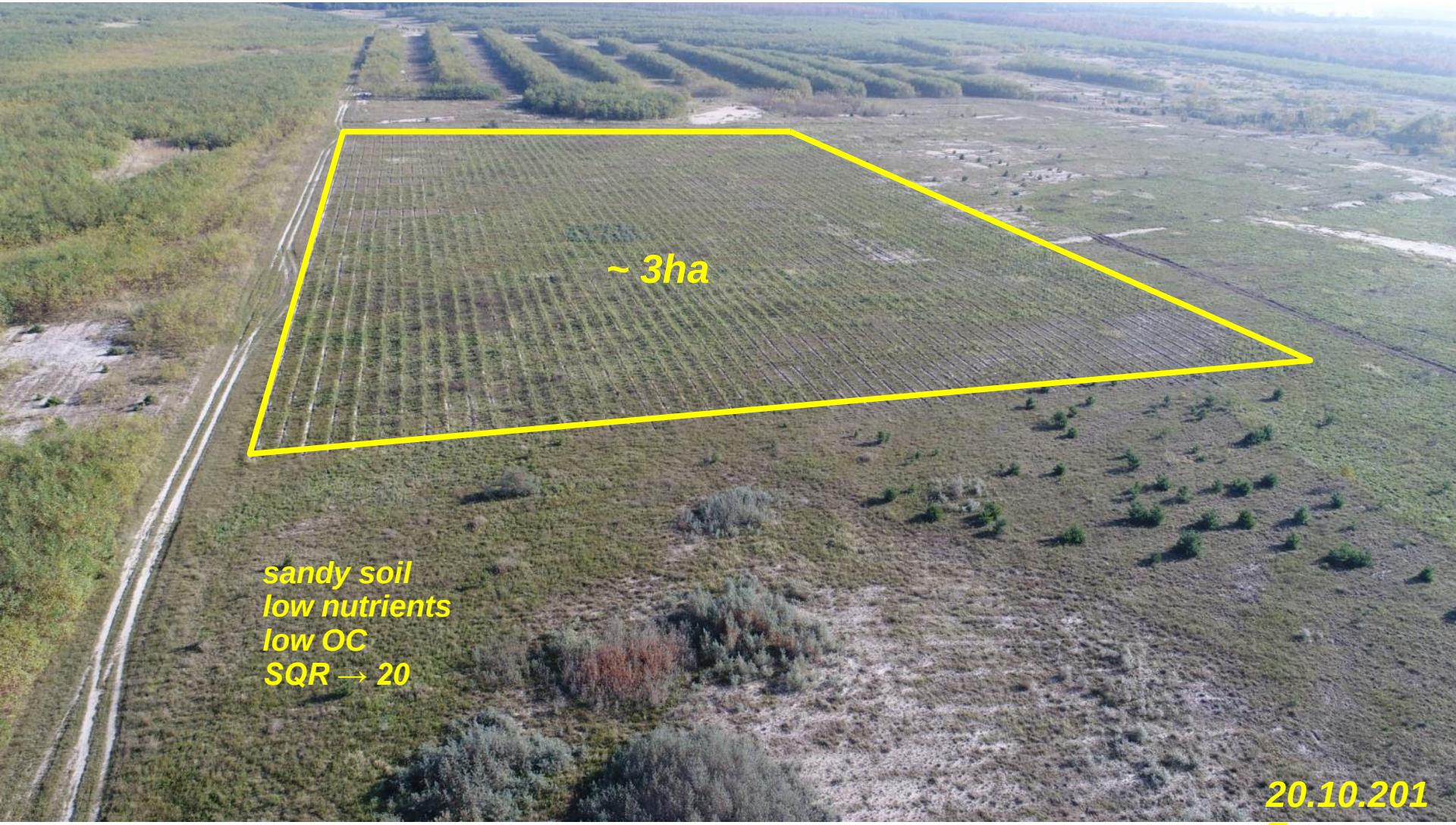

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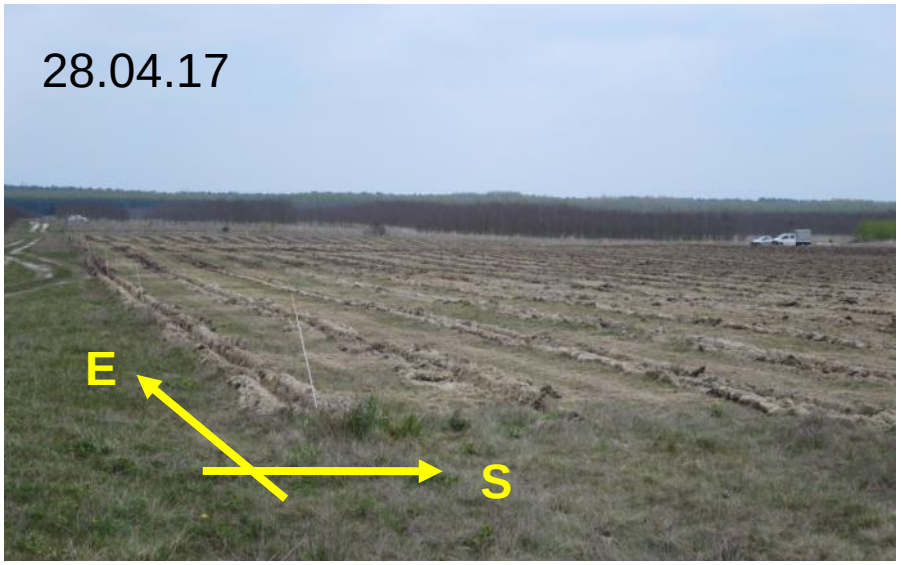

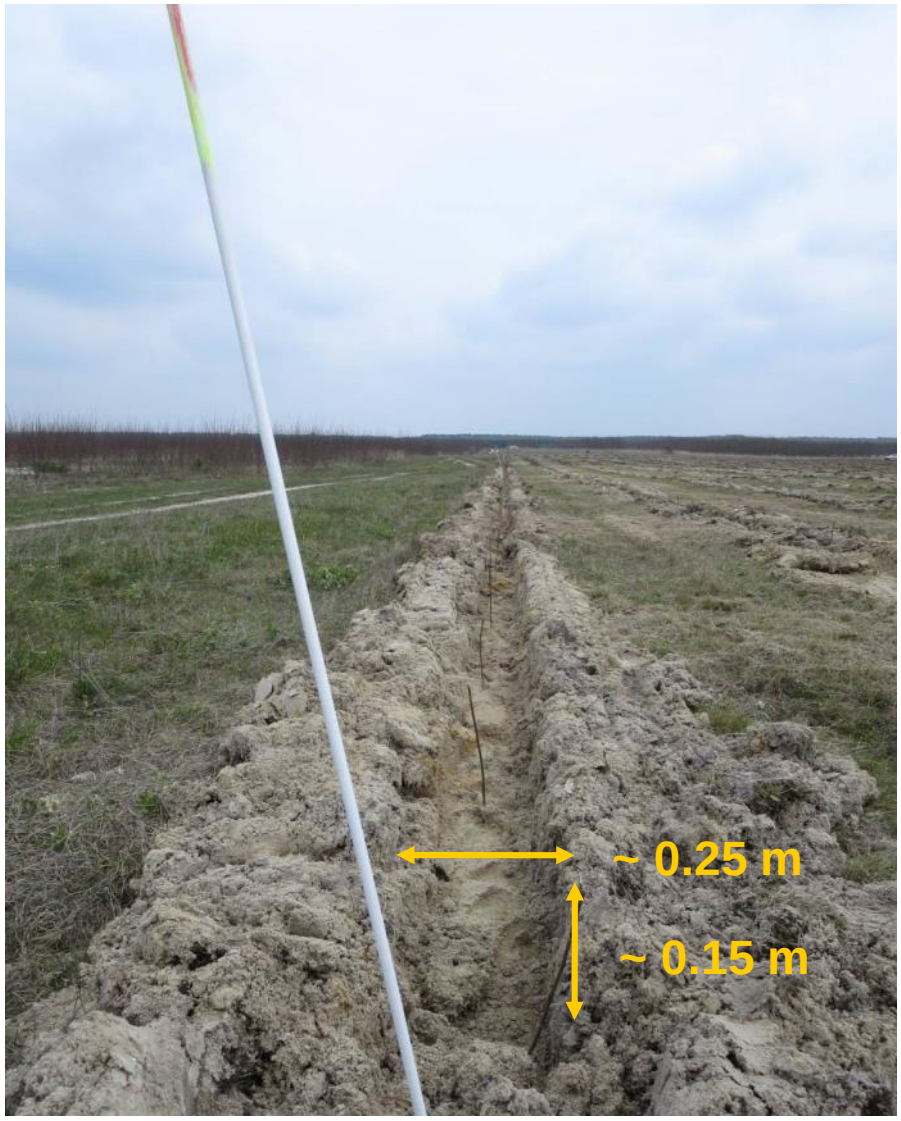

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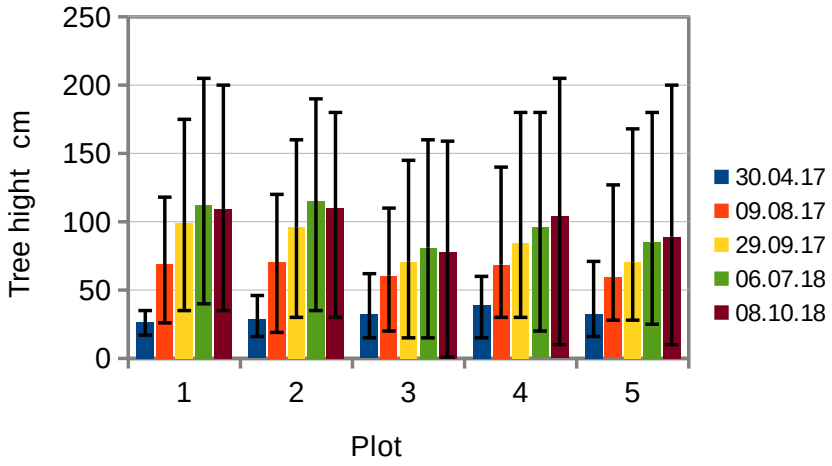
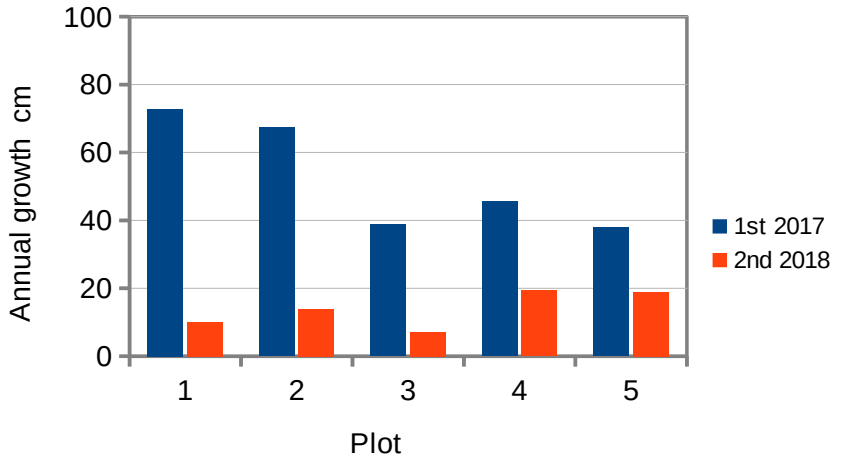
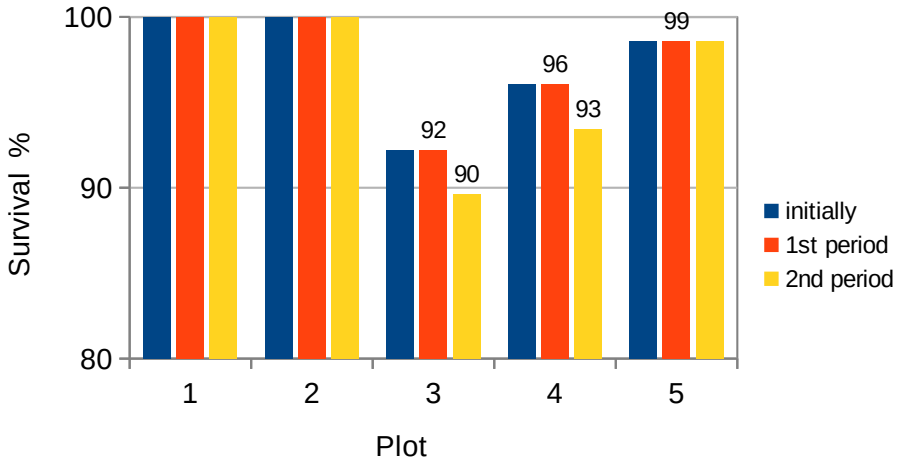
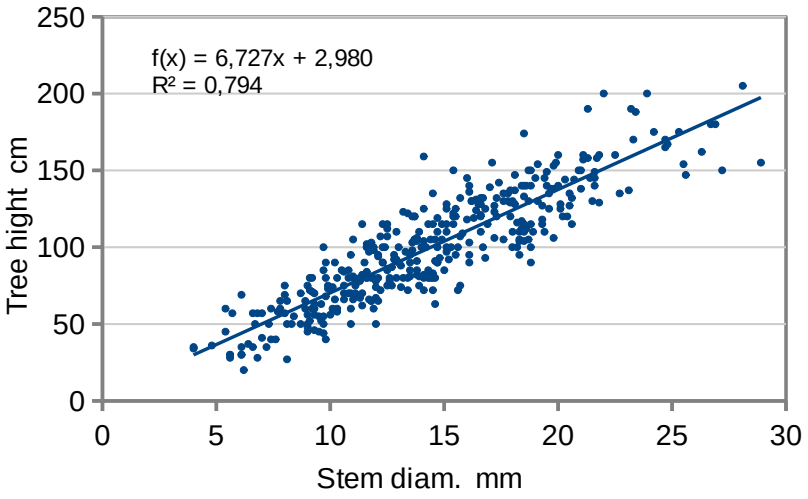
Growth performance









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Yield estimate

	Growth period	Tree height m	Stem diam. mm	Mass of tree (fresh) kg	Mass of tree (dry) kg	Yield (fresh) kg ha^{-1}	Yield (dry) kg ha^{-1}
Volumetric estimate using height, diameter and bulk density	projected 3rd	1.5	21.9	0.760	0.380	3,282	1,641
	~ 2nd	1.0	14.4	0.221	0.110	953	476
	~ 1st	0.85	10.7	0.102	0.051	442	221
Allometric function, Knoche et al. (2015)	projected 3rd	1.5	21.9		0.324	2,797	**1,399**
	~ 2nd	**1.0**	**14.4**		0.105	905	**453**
	~ 1st	0.85	10.7		0.046	398	**199**

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Railways facility

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Site preparation

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Survival of trees

Overall survival rate 64%

No growth during July, August and September

89	43	67	67					
43	78	41	87	74	72		67	52
41	78	67						

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Summary – Railway site

- Survival rate ~ 64% → **36% losses**
  - Some plots up to ~ 60 % losses
- Losses are clearly induced by **adverse climatic conditions however, soil quality also plays a major role**
- There was **nearly no additional biomass produced during 2018** – plant growth largely stopped between July and September 2018
- Due to unfavorable conditions during initial growth period, it is **not clear whether the plantation recovers** in the seasons to come up
- **High economic risk**:
  - crop failure in 2018
  - losses of approx 40% which presumably induce additional shortfall during next production periods

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Summary – Post-mining site I

- Despite SQR 20 **high survival rates between 90% and 100%** even after the extremely dry summer 2018
- **Plants do grow on marginal land!**
- The **gain in biomass in 2018 was clearly reduced** due to adverse climatic conditions → precipitation only ~ 200 mm between April and October 2018
- Tree heights vary in wide ranges highlighting the **distinct inhomogeneity of the site and soils**

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Summary – Post-Mining site II

- Biomass yields estimated for **2 growth periods amounted to only 450 kg** dry mass per ha
- The projection for the **3rd period** amounted to **~ 1,400 kg** dry mass per ha and **466 kg** dry mass per ha and year
- **Low actual yield** when compared to yields given for marginal sites which might range between 2.5 and 4.0 t per ha dry and year
- **High economic risk** → presumably low profit in the actual case study Welzow

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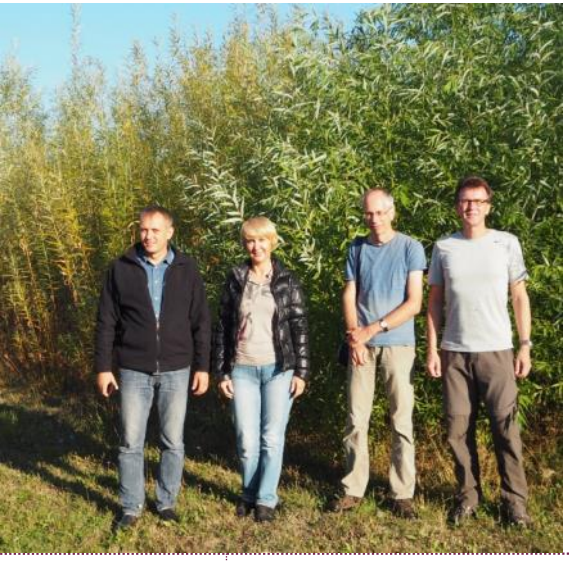
Thank you for your attention!



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