Measurements of tree height using lidar and gas fluxes by chamber methods

Scientific Report

Short Term Scientific Mission (STSM): COST Action FP1301

18th to 25th March 2017

Abhishek Mani Tripathi

manicfre@gmail.com

Global Change Research Institute, AV CR, v.v.i., Brno, Czech Republic

Host Institute

Latvian State Forest Research Institute Silava, Latvia

BACKGROUND

From 18th to 25th March 2017, I visited Latvian State Forest Research Institute Silava, Latvia to explore the medium in which practical knowledge and experience were transferred within the short rotation coppice (SRC) mainly poplars and willows. The main goal of STSM was to learn the precise and indirect method for tree height measurement and greenhouse gas sampling for measurements of ecosystem respiration (gas fluxes in coppice forest on peat lands using closed-chamber method) in off season, thus collaborate, and exchange knowledge in cultivation and management of SRC at different locations in Europe. During my research stay, I have travelled to many research places within Latvia where I have learned about tree height measurements (using Lidar), gas fluxes on peat lands with and without natural regeneration, coppice forest cultivation, management and harvesting.

FIELD WORK AND DATA PROCESSING

Date 18th to 19th March 2017: I visited research stations Olaines and Virsi (Figure 1) which are situated near the capital (5-6 km far from Riga) of Latvia. In Olaines, I have learned about nursery management and productivity of different clones (Tora, Torhild and Sven) from willows which are suitable for Swedish climate. This plantation was established at the end of March in 2004 with total number (14040) of planted cuttings per hectare including clones Tora (4800 cuttings), Sven (4320 cuttings) and Torhild 4800 (3840) and treated with wastewater sludge fertilizer (detail in Lazdina 2009).

Figure 1. An aerial view of research sites Olaines (nursery) and Virsi (several tree species were planted on extracted peat lands and treated with wastewater sludge and phosphorous (P) & potassium (K) for checking the performance of trees).

In Virsi, experimental plantation was established on a cut-away or extracted peat land with thick residual peat layer. This area was separated by ditches into narrow rectangles. Willow clone Sven was planted 10 m far from the ditches to reduce their impact on plantations. This experimental plot was partially in controlled conditions due to model the impact of doses of wastewater sludge compost and wood ash on chemical properties of peat, including leaching of heavy metals and strength of root development under maximal load of compost and wood ash. In this plantation impact of fertilizer treatments are quite visible on plant growth in different tree species (Scot pine, Silver birch and black alder) which are shown in figure 2.

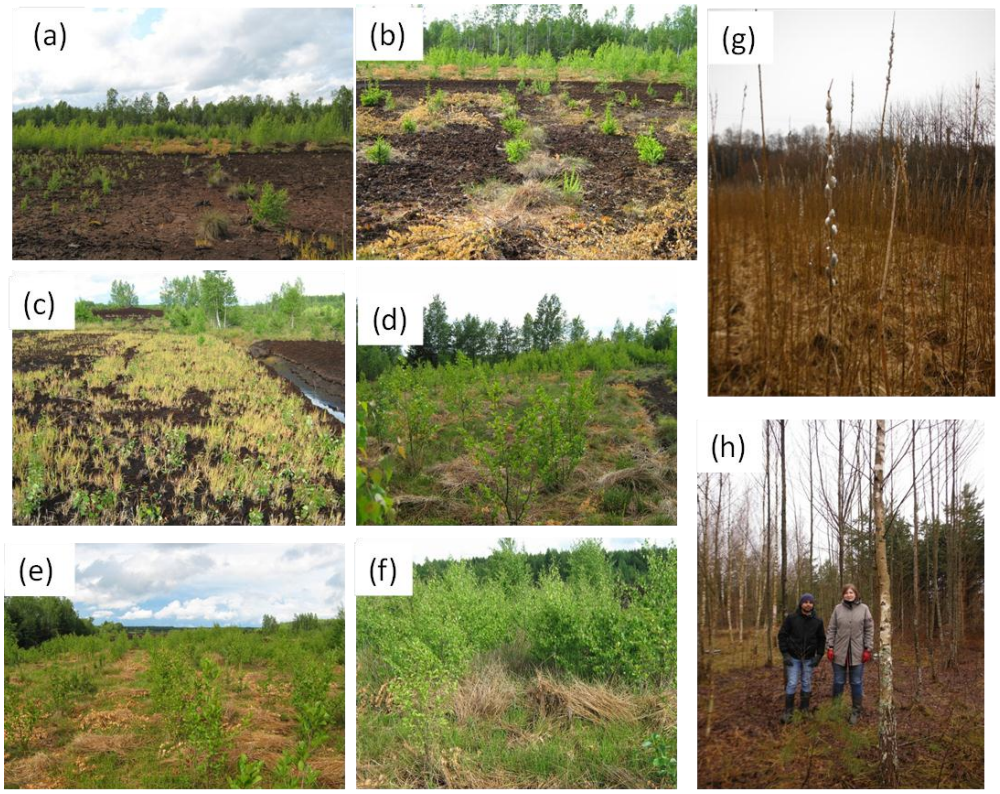

Figure 2. Management of land and cultivation of different tree species on fertilized and control lands (a) mineral fertilizer plots 1 year after planting (b) pine fertilized with mineral fertilization PK (c) reed canary grass sowing and natural regeneration with birches, (d) Black alders-6 year after cleaning; (e) silver birch - 6 year after cleaning (f) birches - 8 years after planting (g) willow clone Sven in Olaines nursery (h) planted and naturally ingrown fertilized with waste water sludge birch plots after 12 years of growth. Pictures were taken by Dagnija Lazdina.

Date 20th and 23rd March 2017: I have learned about height measurements using Lidar (metadata) and drone flying for capturing the pictures on the top of canopy in short rotation coppice willow plantations in Madona (industrial scale willow plantation). In 2016, data collections were done in willow plantation in Skriveri by drones flying. I focused on metadata and learnt how to process them. Data were processed by using Global Mapper v 16.0 and QGIS 2.18.4, respectively. First in Global Mapper data were converted into digital elevation and second in QGIS results were obtain using raster calculation. Final average heights were estimated to be between 2-4 meters in coppice willows (figure 3). This result was validated with ground measurement during the data collection period. My main task was to learn how to analyses images and process the data.

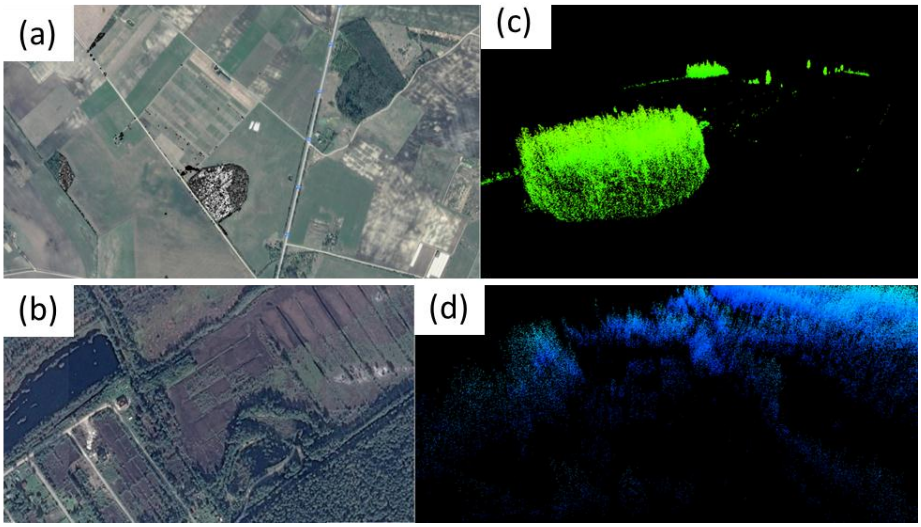

Figure 3. An aerial view of established experimental sites in (a) & (b) and 3D view of trees are shown in (c) & (d), respectively.

Date 21st to 22nd: I have traveled with colleagues (Ieva and Toms) to Western part of Latvia which is about 150 km far from Riga (capital of Latvia). This part of Latvia is poor with peat lands but most of the experimental plots are located in central Latvia and south east-central east of Latvia. In this part Latvian State Forest Research Institute Silava has established an experimental plots to measure emission of greenhouse gases in birch forest (natural regeneration on extracted peat lands) and on natural peat lands, respectively. For measurement of greenhouse gases emission closed-chamber method was used (Hutchinson & Livingston, 1993). The closed chambers (gas samplers) was made by PVC (painted in white color to avoid heating during measurements), volume of the chamber is 65 L, height 40 cm, Ø 50 cm and on the soil surface water-filled rings were installed at five places figure 4 (same protocol is repeated at the selected sites at different places in Latvia). These five rings were randomly chosen with distance 3 to 5 m from each other. However, we have measurement on 21st and 22nd March 2017. Gas samples were drawn from the chamber headspace using tube and a syringe into previously evacuated (0.3 mbar) 100 mL bottles. Four samples from each chambers were collected within 1 h at 20 min intervals (at time points 0 (immediately after establishment of the chamber on ring), 20, 40 and 60 min) (Soosaar*et al.*, 2011; Mander*et al.*, 2012; Becker *et al.*, 2015).

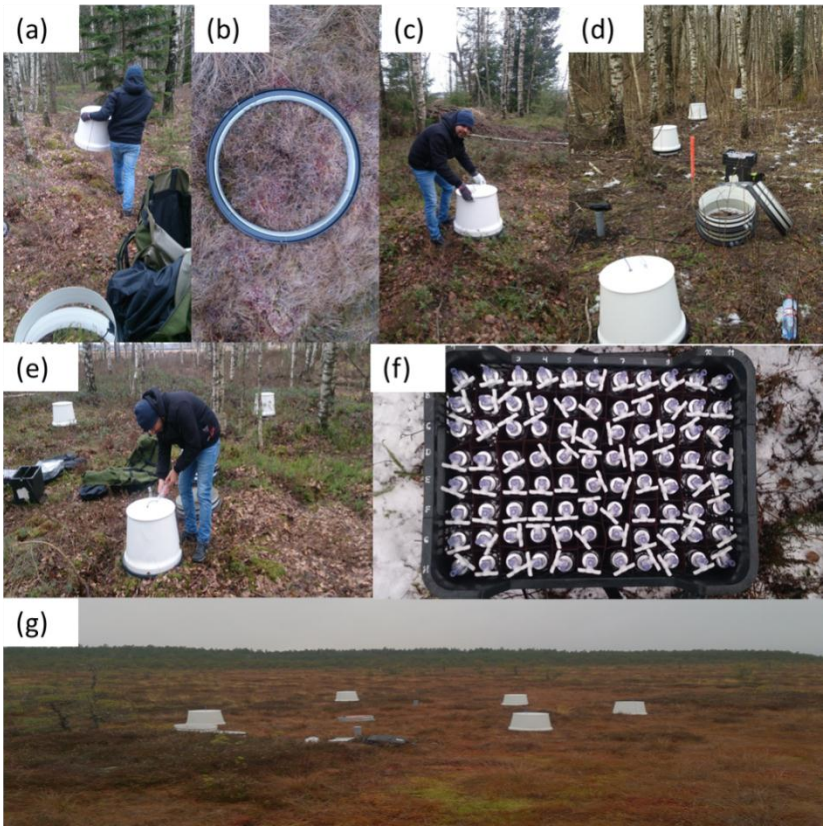

Figure 4. (a) carrying chamber (b) ring on the ground (c) covering ring by chamber (d) randomized sampling spots in natural forest on extracted peat lands (e) taking sample by using syringe (f) stored samples and (g) sampling spot on natural peat lands.

Date 24th to 25th: I prepared STSM report and travel back to home institute (Global Change research Institute, Brno, Czech Republic).

CONCLUSIONS

- STSM has given me an opportunity to make a comparison of coppice forest between Czech Republic and Latvia.
- I was explored to the new methods such as measuring greenhouse gas emissions using closed-chamber method and Lidar measurements with the experts.
- Getting STSM grant was a best opportunity for me as a researcher, to gain knowledge by interacting with experts and improved networking.

- STSM has empowered me to improve my insight about coppicing research mainly SRC with different tree species such as poplars, willows, alders and birches, thus enabling me to refine my knowledge and learn about new measurement techniques which might be used in future studies in Czech Republic.
- I found common research interest with host and we have decided for future collaboration and write projects.

ACKNOWLEDGEMENTS

I acknowledge the COST Action FP1301 EuroCoppice to giving me grant for eight days STSM stay in abroad. I am grateful to Dr. Dagnija Lazdina (senior researcher at Silava) and her group member Dr. Andis Lazdins (senior Researcher), Kristaps Makovskis and Ieva Bebre for giving me an opportunity (hosted) to utilize STSM. I am very thankful to Prof. Petr Horacek (Head of the Department of Water Balance and Biomass Production) and Prof. Michal V. Marek (Director of the Global Change Research Institute CAS, Belidla 986/4a, 60300 Brno, Czech Republic) for supporting me to stay at Latvian State Forest Research Institute Silava. I also thanks to Janis Ivanovs, Toms Sarkanabols and Guntis Saule for help and cooperation during field work at different research stations in Latvia.

REFERENCES

Becker, H., Uri, V., Aosaar, J., Varik, M., Mander, Ü., Soosaar, K., Hansen, R., Teemusk, A., Morozov, G., Kutti, S. & Lõhmus, K. (2015). The effects of clear-cut on net nitrogen mineralization and nitrogen losses in a grey alder stand. *Ecological Engineering*, 85, pp 237–246.

Hutchinson, G. L. & Livingston, G. P. (1993). Use of Chamber Systems to Measure Trace Gas Fluxes. *Agricultural Ecosystem Effects on Trace Gases and Global Climate Change*, asaspecialpubli(agriculturaleco), pp 63–78.

Lazdina, D. (2009) Using wastewater sewage sludge in short rotation rotation willow coppice, PhD dissertation, http://llufb.llu.lv/dissertation-summary/forest/Dagnija_Lazdina_promocijas-darba-kopsavilkums-2009-LLU-MF.pdf

Mander, Ü., Järveoja, J., Maddison, M., Soosaar, K., Aavola, R., Ostonen, I. & Salm, J.-O. (2012). Reed canary grass cultivation mitigates greenhouse gas emissions from abandoned peat extraction areas. *GCB Bioenergy*, 4(4), pp 462–474.

Soosaar, K., Mander, Ü., Maddison, M., Kanal, A., Kull, A., Lõhmus, K., Truu, J. & Augustin, J. (2011). Dynamics of gaseous nitrogen and carbon fluxes in riparian alder forests. *Ecological Engineering*, 37(1), pp 40–53 (Special Issue: Enhancing ecosystem services on the landscape with created, constructed and restored wetlands).