Innovative method of greenhouse gas emission assessment for peatlands based on remote sensing data and GEST analysis

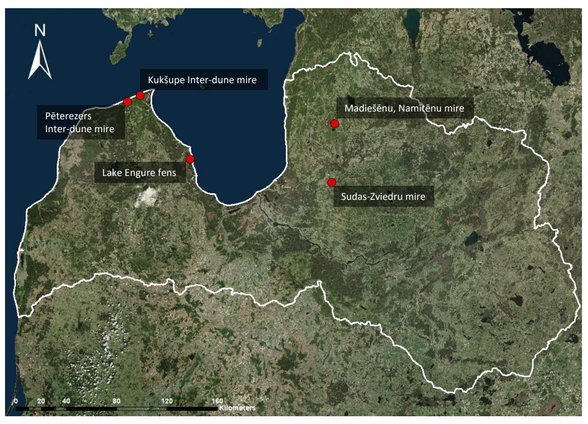
Rūta Abaja [1],*, Jevgēnijs Fiļipovs[1], Līga Strazdiņa[2], Māra Pakalne[2], Dainis Jakovels[1]

[1] *Institute for Environmental Solutions, "Lidlauks", Priekuļi parish, Priekuļi county, LV-4101, Latvia*
[2] *University of Latvia, Kandavas Street 2, Riga, LV-1083, Latvia*
* E-mail address: ruta.abaja@videsinstituts.lv

ABSTRACT

Direct greenhouse gas (GHG) emission assessment methods are expensive and time consuming, especially for peatlands. Soft and wet soil conditions burden carriage of the expensive GHG assessment equipment in peatlands. The commonly used direct GHG assessment methods are complicated to use for large and complex peatland ecosystems where are various processes and habitat types. It is approved that GHG emissions are related to particular vegetation type on peatlands that indicates also the natural or human caused environmental processes like water level, nutrient availability, etc. Remote sensing (airborne and satellite) techniques provide large area coverage in short time and possibility of automatic data processing. High resolution remote sensing data has demonstrated their potential to assess various vegetation types, habitats, their structure and even quality for different ecosystems.

The study aim was to combine high resolution spectral and LIDAR data with GEST analysis approach of peatland vegetation to develop new method for GHG assessment as an alternative and potentially less resource consuming GHG assessment method.

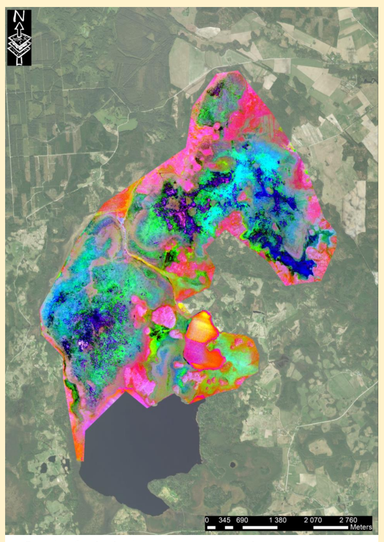


The study included four different peatland areas in Latvia:

1) Pēterezera Inter-dune Mire and Kukšupes Inter-dune Mire in Slītere National Park (include habitats: fens; 7140 Transition mires and quaking bogs; 7110* Active raised bogs);
2) Lake Engure Nature Park (7210* Calcareous fens with Cladium mariscus and species of the Caricion davallianae; 7230 Alkaline fens);
3) Sudas-Zviedru Mire in Gauja National Park (7110*, 7120 Degraded raised bogs still capable of natural regeneration; 7140);
4) Madiešēnu Mire and Namītēnu Mire in Augstroze Nature Reserve (7110*; 7120; 7140).

Remote sensing data of the project areas was collected in 03.06.2018. with airborne surveillance and environmental monitoring system (ARSENAL) that includes aircraft equipped with hyperspectral data sensors, LIDAR and high resolution visual camera. From the hyperspectral data, 27 most informative spectral bands of visible and near infrared spectral region were obtained for vegetation analysis. LIDAR point cloud was used to estimate vegetation structure differences and visual high resolution images were acquired for validation purposes. During summer period two peatland habitat and restoration specialists collected field data in project areas of GEST vegetation classes as a refence data for further remote sensing data analysis. Final process was to reclassify GEST maps as CO_2, CH_4 and global warming potential (GWP) maps according to previous GEST analysis that defined GHG values for each GEST class.

Aerial RGB colour image collected for Madiešēnu Mire and Namītēnu Mire areas

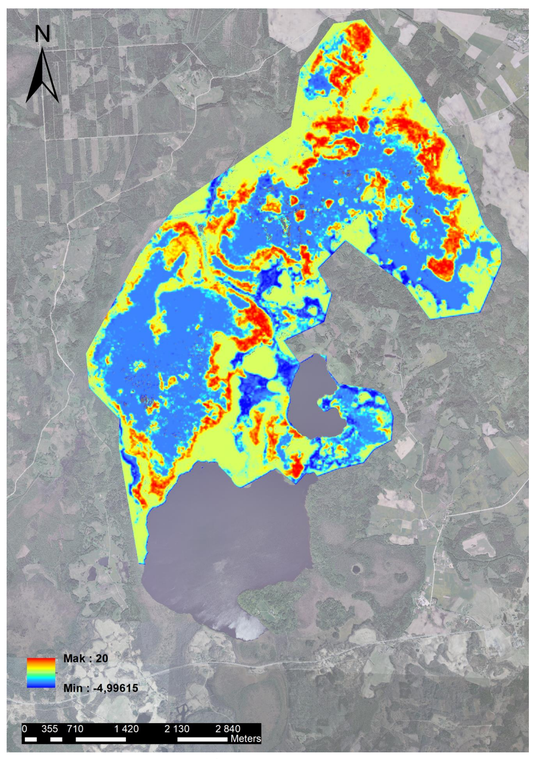


Result of principal component analysis that represents combination of three the most informative spectral bands. The map was used for field data collection.

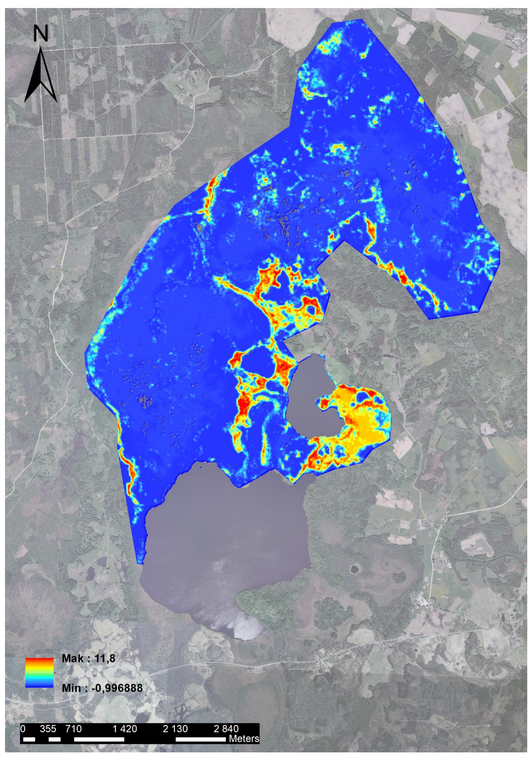
Classification of GEST types based on specific combination of vegetation associations and soil type. Each GEST type has refering values of green house gas emission measures: Water level (expert based rate); CO_2 (t/ha per year); CH_4 (t/h per year); GWP – global warming potential (t/ha per year).

GEST types	Water level	CO_2 emission	CH_4 emission	GWP estimation
Wet peat moss hollows resp. flooded peat moss lawn	5+	-4,6	11,8	7
Wet peat moss lawn	5+	-0,5	0,3	-0,3
Very moist Meadows, forbs and small sedges reeds	4+	-0,5	2,3	1,9
Mesotrophic and eutrophic peatlands - Very moist Forests and shrubberies	4+	-0,5	2,1	1,6
Wet tall sedges reeds	5+	-0,1	8,5	8,4
Wet calcareous Meadows, forbs,..	4+/5+	0,2	0,5	0,7
Very moist Forests and shrubberies	4+	1,7	3	4,7
Oligotrophic peatlands - Moist Forests and shrubberies	3+	9,4	0	9,4
Oligotrophic peatland - Moderately moist Forest and shrubberies	2+	20	0	20
Mesotrophic and eutrophic peatlands - Moderately moist Forests and shrubberies	2+	20	0	20

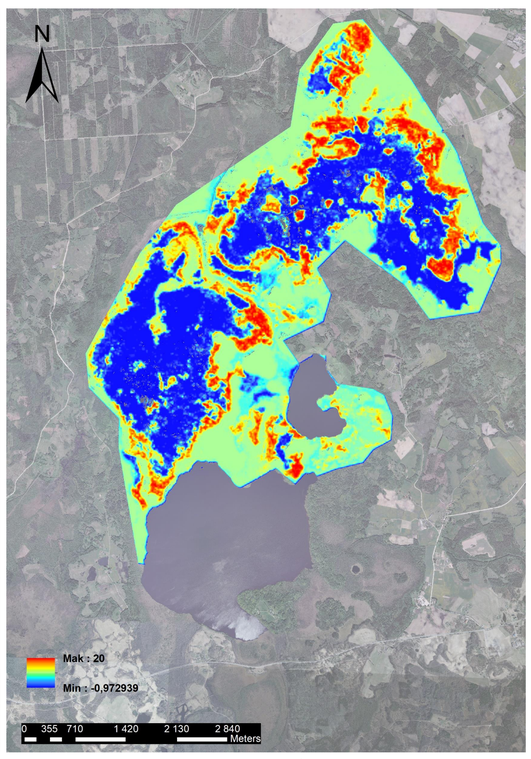
RESULT EXAMPLE OF GREENHOUSE GAS ASSESSMENT USING GEST METHOD COMINED WITH REMOTE SENSING DATA FOR AUSTROZE NATURE RESERVE



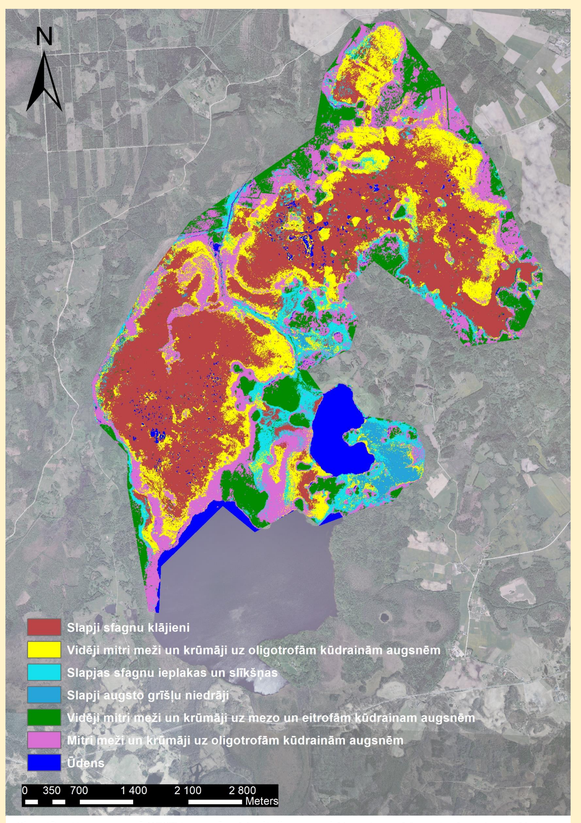
Map of **CO_2 emissions** (t/ha per year) for Madiešēnu Mire and Namītēnu Mire.



Map of **CH_4 emissions** (t/ha per year) for Madiešēnu Mire and Namītēnu Mire.



Map of **global warming potential** (t/ha per year) for Madiešēnu Mire and Namītēnu Mire.



Classification map of GEST types for Madiešēnu and Namītēnu Mires in Augstroze Nature Reserve. Classes and their colour identification is analogue to the GEST type table above the image. The dark blue colour – water.

CONCLUSIONS

During the study developed GHG emission assessment method of combination between GEST and remote sensing data analysis demonstrated promising results which can be applied for further GHG emission studies in peatlands especially for complex and large areas with high peatland habitat diversity and mixture. The method is appropriate for GHG emission modelling and assessment before and after peatland restoration actions. Advantage of the method is visually attractive GHG emission maps that can help in communication with various audience to raise awareness and increase understanding and knowledge of peatland importance on global climate stability.

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