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GRASSES – A POTENTIAL SUSTAINABLE RESOURCE FOR BIOCRUDE PRODUCTION

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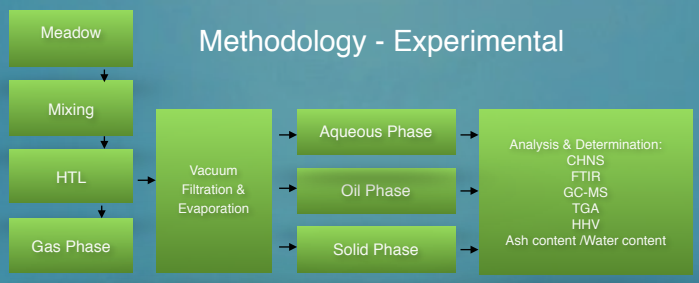
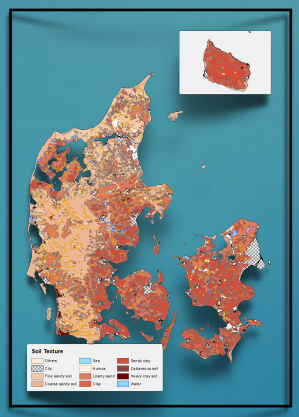
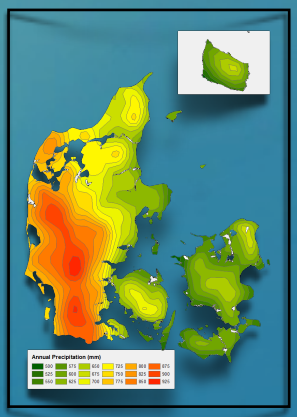
Abstract: This study aims to map the spatial distribution of different types of grasses available in Denmark using a GIS (Geographical Information System) based approach and to supplement these with biofuel potential maps based on HtL conversion. Biomass yields (t/ha) and biofuel energy equivalent (GJ/ha) are mapped as function of the type of grassland area (permanent, roadside, grass sown in crop rotation systems) using 2012 databases made available by Jordbrugs Analyser Portal and Danmarks Miljøportal. Grasses have become a promising lignocellulosic biomass for biofuels production due to the low cost factor and lack of competition with food crops. They can be used as whole input, or as a residue after protein extraction. In order to determine the production potential of biofuels based on HtL conversion and to establish at the same time the optimum conditions for the HtL process that could lead to a high bio-crude yield and a high quality of the bio-crude using grasses as feedstock a series of experiments with meadow grass have been carried out in a batch reactor. Biomass input and liquefaction products are characterized using proximate analysis, elemental analysis, heating values, FTIR, GC/MS. Data is subject to a multivariate analysis based on the different parameters used during the hydrothermal liquefaction process (temperature, heating rate, pressure, composition, bio-crude yield). Keywords: biomass resources, biomass potential, GIS, hydrothermal liquefaction, production potential of biofuels

Methodology - Experimental



Methodology - Modeling

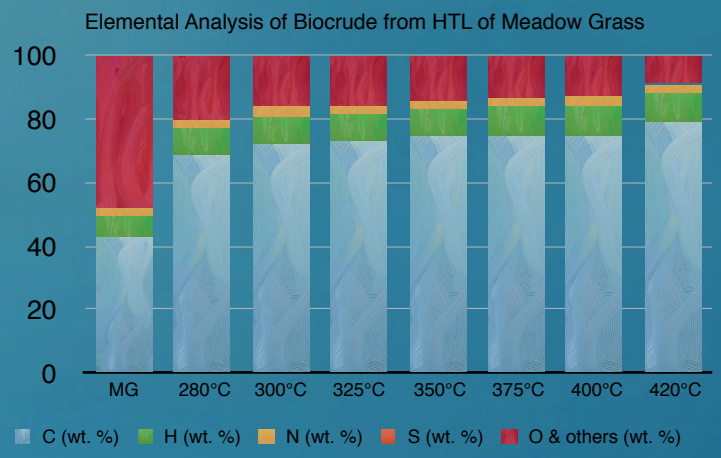


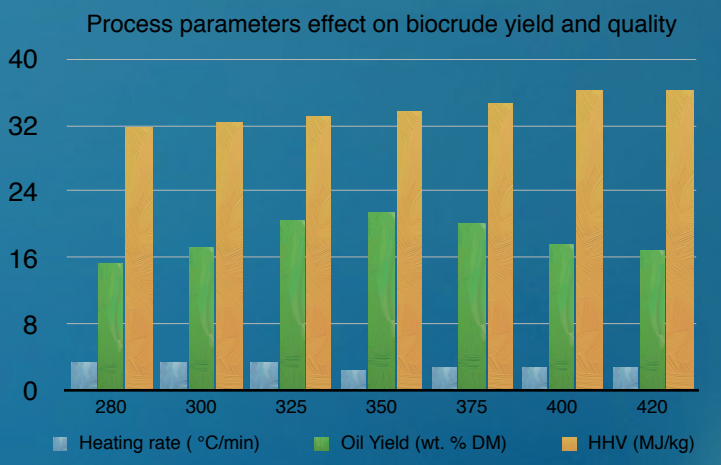


GIS modeling: Different data sets made available by Jordbrugs Analyser Portal and Danmarks Miljøportal were used to assess the production potential of biomass (grasses) and biofuels. Among these data sets, one can count: soil texture, land use, climate, slope, road network. Three types of grassland areas were included in this study: permanent grasslands, roadside vegetation and grass sown in crop rotation systems. Various geostatistical tools are used to estimate the biomass yield (t/ha) and biofuel energy equivalent (GJ/ha) as function of the type of grassland area in GIS.

Hydrothermal Liquefaction (HtL): Meadow grass mixed with water and catalyst (Potassium Carbonate) was used as biomass feedstock for the HtL process. The experiments are carried out under subcritical and supercritical conditions, a reaction time of 15 minutes being used at all conditions. HtL conversion of meadow grasses produced four different streams: the bio-crude (or oil phase), a water stream (water soluble organics), solids and gases. After each HtL experiment, at room temperature, the gases were vented out. In general the gas phase that results from the HtL process contains mainly CO_2, H_2, CO and CH_4. The other streams were subject of different analysis methods: elemental analysis, proximate analysis, heating value determination, water and ash content determination, FTIR, GC-MS, TGA.

Results





Conclusions: Process parameters (temperature, pressure, heating rate) have an effect on the bio-crude yield, as well as on the bio-crude quality. The experimental work showed that supercritical conditions are more advantageous compared to subcritical conditions in hydrothermal liquefaction of meadow grass.

An increase in the bio-crude yield until a maximum of 21.50 % at 350 deg. C in the case of meadow grass was observed, after which the yield started to decrease at supercritical conditions down to 17 wt. %, but the energy content increased from 31.67 MJ/kg at 280 deg. C up to 36.30 MJ/kg at 420 deg. C.

Moreover, this effect can also be observed in the elemental analysis of the biocrude. Comparing the different fractions obtained at the selected temperatures, the carbon content increases, as well as the hydrogen content. Oxygen is another important element in the bio-crude quality, decreasing from a content of 48.165 wt. % in meadow grass until 8.98 wt. % at 420 deg. C.

Even though the bio-crude yield is lower at supercritical conditions, the quality of bio-crude is much better, highlighting that there is no need of severe upgrading.

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