The impact of flooding on greenhouse gas emissions from river-floodplains

Inland waters naturally emit large amounts of greenhouse gases (GHG) such as carbon dioxide (CO_2) and methane (CH_4) what makes them very important elements of the global carbon cycle. However, we still have a lot of uncertainty in the global carbon (C) budget, because the amounts of GHG added into the atmosphere by some of the aquatic systems are not well quantified. One of them are river-floodplains, especially European, temperate systems. River-floodplains are truly unique systems, they possess many particular features, including high ecological productivity and provide numerous recreational, scenic and cultural services to humans. They are also hot-spots for carbon processing, by transforming C and releasing CO_2 and CH_4. One of the most important characteristics of river-floodplains is the occurrence of periodic flooding, when large amounts of these GHGs may be emitted (Fig 1). Yet, we have very limited information, if and when it happens and how much of CO_2 and CH_4 in relation to flood extent can be liberated, especially in European, temperate systems. Lack of flood-related C emissions excludes river-floodplains from current C budgets. However, considering climate change and the rapid rise of atmospheric GHGs we need to constrain global and regional C budgets. When we have reliable assessments of GHG emissions, we can undertake actions to combat climate change.

Aim

This research aims to assess flood-associated pulse emissions of CO_2 and CH_4 from temperate, European floodplains and specify hot-moments and hot-spots of CO_2 and CH_4 release.

The goal is to include the flood-related floodplain CO_2 and CH_4 emission data into C budget of river-floodplains, helping to refine C flux estimates from inland waters. We also plan to create a solid basis for future projections of C emissions from temperate river-floodplains under ongoing climate change with raising flood frequency.

Approach

The study will be conducted in three European river-floodplains with a wide range of aquatic habitats and different levels of modification, including: two natural systems in Poland (Biebrza and Rospuda) and heavily modified, but also partially restored Danube river-floodplain (Austria). The project combines field, experimental and modelling approaches. We will use novel technique—automated flux chambers, equipped with CO_2 and CH_4 sensors —to quantify (with high spatio-temporal resolution) flood-associated CO_2 and CH_4 emissions. With the experiment we will determine the response of CO_2 and CH_4 to flooding frequency. Finally, we will apply statistical models to evaluate current and make predictions of future GHG emissions from river-floodplains.

Expected output

This research fills gaps in our understanding of flood-related C emissions and explains the interconnection of hydrology and biogeochemistry under climate change. The study will substantially enhance our understanding of if, when and where river-floodplains are significant sources of GHGs in relation to flooding frequency and magnitude. The broad coverage of various hydrological phases, application of novel methodology allowing for high spatio-temporal measurements of CO2 and CH4 fluxes together with a laboratory approach will allow us to quantify and determine variability and hot-moments of GHG emissions from such systems. The study will provide comprehensive data on emissions of GHG during flooding events with different intensities. It will also deliver information on largely unexplored, flood-related groundwater-surface water interlink and its impact on C emissions from temperate river-floodplains. Consequently, this project will create a solid basis to include the flood-related floodplain GHG emission data into the C budget for temperate river-floodplains, helping to refine C flux estimates from inland waters. This research will contribute to future projections of C emissions from temperate river-floodplain systems under climate change with raising flood frequency.

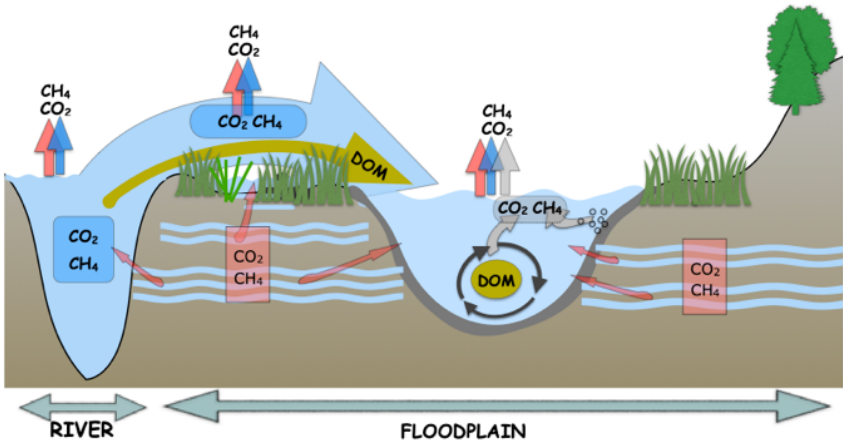

Fig. 1 Main pools, processes and interactions related to methane (CH_4), carbon dioxide (CO_2) in river-floodplain system which are addressed in the proposed research project.