1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan)

Project title: Late Weichselian glacial megafloods in Poland and Lithuania: geomorphic records and palaeogeographic implications

1.1. **Project goals:** The principal aims of research project are (1) to identify landforms which prove the sudden discharges of large quantities of meltwaters in Poland and Lithuania during the last glaciation, (2) to determine the impact that glacial megafloods had on the formation of Europe's valley system during the last glaciation and (3) to identify the source of meltwaters and magnitude glacial floods.

1.2. **Outline:** Geological processes with catastrophic environmental consequences are often initiated by climate changes. They caused glacial processes to intensify and often to become extreme. Such phenomena undoubtedly include cataclysmic glacial megafloods. These processes may have caused a significant transformation in the morphology and geological structure of the proglacial area and may have been one of the main causes of the formation of the European valley system, which transferred significant quantities of meltwaters to the Atlantic ocean. For this reason also, flood-related landforms are indicators of a sudden changes in climate conditions. The research hypothesis for the project is that systems of landforms exist in the proximal part of the outwash plains would indicate attest to glacial megafloods in Poland and in Lithuania. The main cognitive importance of the doctoral project lies in identification of landforms, which unambiguously indicate catastrophic megafloods. Such Pleistocene landforms have been identified along the flow pathways of meltwaters in North America and in Altai, which makes this project's anticipated research results of global significance. Research methodology includes analysis of landforms morphology using GIS tools, building of geomorphological and geological digital databases, geomorphological research to identify the morphology and geological structure of landforms created by sub- and proglacial floods, interpretation of field-study and laboratory results, paleohydraulic estimations, building semi-quantitative models of extreme processes in the marginal zone of the Scandinavian Ice Sheet.

1.3. **Work plan: Phase 1**: review of the literature relating to the geology and geomorphology of the study area and the processes associated with Pleistocene and contemporary glacial megafloods, collecting geological and geomorphological maps of test fields, developing high-resolution elevation models (DEM) and maps of the geomorphometric variability of landforms based on LIDAR data and building a digital model of the ice margin topography. **Phase 2**: identifying the morphological and genetic types of landforms and their morphometric characteristics and parameters which typify the individual genetic types of indicator landforms for glacial megafloods and publishing research results. **Phase 3**: sedimentological and geomorphological investigations at key sites - identifying the geological structure of subglacial landforms (at key sites) developed as a result of glacial megafloods, collecting deposit samples for further laboratory analysis, creating a database which includes the lithofacial characteristics of glaciofluvial sediments, lab analysis results, geomorphometric parameters of megaflood-related landforms. **Phase 4**: drawing up digital geomorphological and palaeogeographical maps showing the impact of megafloods on European valley system evolution; developing a database of hydraulic, geomorphometric and lithological parameters and characteristics of their mutual relations and publishing research results; identification of the source of meltwaters and magnitude glacial floods.

1.4. **Literature:**

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Carling, P.A., 2013. Freshwater megaflood sedimentation: What can we learn about generic processes? Earth-Science Reviews, 125: 87–113.

Carling, P.A., Martini, P., Herget, J., Borodavko, P., Parnachov, S., 2009. In: Burr, D., Baker, V.R., Carling, P.A. (eds.), Megaflood sedimentary valley fill: Altai Mountains, Siberia. Megaflooding on Earth and Mars. Cambridge University Press: 243–264.

Carling, P.A., Perillo, M., Best, J., Garcia, M.H., 2017. The bubble bursts for cavitation in natural rivers: Laboratory experiments reveal minor role in bedrock erosion. Earth Surface Processes and Landforms, 42: 1308–1316.

Høgaas, F., Longva, O., 2016. Mega deposits and erosive features related to the glacial lake Nedre Glomsjø outburst flood, southeastern Norway. Quaternary Science Reviews, 151: 273–291.

Lang, J., Lauer, T., Winsemann, J., 2018. New age constraints for the Saalian glaciation in northern central Europe: implications for the extent of ice sheets and related proglacial lake systems. Quat. Sci. Rev., 180: 240–259.

Lang, J., Alho, P., Kasvi, E., Goseberg, N., Winsemann, J., 2019. Impact of Middle Pleistocene (Saalian)

glacial lake-outburst floods on the meltwater-drainage pathways in northern central Europe: Insights from 2D numerical flood simulation. Quaternary Science Reviews, 209: 82–99.
Maizels, J.K., 1989. Sedimentology and paleohydrology of Holocene flood deposits in front of a jökulhlaup glacier, south Iceland. (in:) Floods: Hydrological, Sedimentological and Geomorphological Implications, New York: John Wiley and Sons: 239–252.
Russell, A.J., Roberts, M.J., Fay, H., Marren, P.M., Cassidy, N.J., Tweed, F.S., Harris, T. 2006. Icelandic jökulhlaup impacts: implications for ice-sheet hydrology, sediment transfer and geomorphology. Geomorphology, 75: 33–64.
Russell, A.J., Tweed, F., Roberts, M., Harris, T., Gudmundsson, M., Knudsen, O., Marren, P., 2010. An unusual jökulhlaup resulting from subglacial volcanism, Sólheimajökull, Iceland. Quat. Sci. Rev., 29: 1363–1381.
Russell, A.J., Knudsen, Ó., 2002. The effects of glacier-outburst flood flow dynamics in ice-contact deposits: November 1996 jökulhlaup, Skeiðarársandur, Iceland. In: Martini, I.P., Baker, V.R., Garzón, G. (Eds.), Flood and Megaflood Processes and Deposits: Recent and Ancient Examples, Spec. Publ. Int. Assoc. Sedimentol., 32: 67–83.
Weckwerth, P., Wysota, W., Piotrowski, J.A., Adamczyk, A., Krawiec, A., Dąbrowski, M., 2019. Late Weichselian glacier outburst floods in North-Eastern Poland: Landform evidence and palaeohydraulic significance. Earth-Science Reviews, 194: 216–233.
Winsemann, J., Alho, P., Laamanen, L., Goseberg, N., Lang, J., Klostermann, J., 2016. Flow dynamics, sedimentation and erosion of glacial lake outburst floods along the Middle Pleistocene Scandinavian Ice Sheet (northern central Europe). Boreas, 45: 260–283.
Zieliński, T., 1989. Lithofacies and palaeoenvironmental characteristics of Suwałki outwash (Pleistocene, Northwest Poland). Annales Soc. Geol. Pol., 59: 249–270.

1.5. **Required initial knowledge and skills of the PhD candidate:** (1) knowledge about the processes associated with glacigenic landforms development; (2) understanding of fluvial and glacial processes, (3) understanding and knowledge about glacial and fluvial geomorphology and sedimentology; (4) experience of geomorphometry analysis of landforms using GIS tools and LIDAR data, and visualizations of research results; (5) a good command of the English language; (6) the ability to think analytically and overcoming obstacles to achieve an ambition or goal.

1.6. **Expected development of the PhD candidate's knowledge and skills:** (1) knowledge about the sedimentary processes and meltwater activity associated with glacial outburst floods and megadunes development; (2) knowledge about morphogenetic and morphometric types of megaflood-related landforms; (3) experience in geomorphometry analysis of landforms using LIDAR data; (4) experience in sedimentological research, especially in lithofacial analysis of fluvioglacial sediments; (5) knowledge and experience in

papaleohydraulical estimations; (6) experience in creating palaeographical reconstructions and megaflood discharge modelling.