

IPL Project Proposal Form 2017

(MAXIMUM: 3 PAGES IN LENGTH)

1. **Project Title:** Combination of radar and optical remote sensing for hazard assessment of the potentially river-damming landslides: the cases of the Vakhsh and the and Brakmaputra Rivers

2. Main Project Fields

(1) Technology Development

A. Monitoring and Early Warning, B. Hazard Mapping, Vulnerability and Risk Assessment

(2) Targeted Landslides: Mechanisms and Impacts

A. Catastrophic Landslides

(4) Mitigation, Preparedness and Recovery

A. Preparedness

3. Name of Project leader

Affiliation: Geodynamics Research Center – branch of JSC "Hydroproject Institute". Chief expert.

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Core members of the Project (Names/Affiliations): (4 individuals maximum)

- Prof. Andrea Manconi, ETH Zürich, Dept. of Earth Sciences
- Mr. Nurilo Abdulloev, JSC "Rogun Hydraulic Power Plant", Tajikistan, head of the engineering monitoring department.
- Prof. Yueping Yin, China Geological Survey

4. **Objectives:** To perform identification and some quantitative characterization of sites in the Vakhsh and Brakmaputra River basins, far upstream from the sites where high dams with large reservoirs are constructed or planned, where large-scale bedrock landslides could originate causing rivers damming and subsequent catastrophic outburst floods that would pose a significant threat to dams, population and infrastructure. (5 lines maximum; what you expect to accomplish?)

5. **Background Justification:** Large-scale landslides are one of the most threatening natural phenomena for hydraulic schemes in mountainous regions. Besides affecting slopes directly at the dams' abutments they can collapse in reservoirs causing tsunami-like waves as it occurred in 1963 at Vajont, highlighting the importance of the potentially unstable slopes identification not only directly at the dam sites but also in the reservoir areas. However, adverse consequences might result from river channel blockage upstream from the reservoir since catastrophic breach of such blockage could produce outburst flood which discharge would be far larger than the design values. Such potentially hazardous sites were identified in the Vakhsh and the Brakmaputra River basins, upstream of the dam sites which are constructed now or planned in future. All of them are located in high altitude hardly attainable areas and combination of various remote sensing methods is the most efficient way to get information about these sites allowing grounded decision on necessary prevention or mitigation measures.

6. **Study Area:** Vakhsh River basin in Northern Pamir mountains (Tajikistan) upstream from the Rogun dam site (Obi-Khingou, Surkhob and Muksu River valleys); Brakhmaputra (Siang, Tsangpo) River basin upstream from the proposed dam sites (Yigong River valley).
7. **Project Duration:** 3 years (2018-2020)
8. **Resources necessary for the Project and their mobilization:** Hydroproject Institute (ICL member) and ETH have qualified personnel with long-term experience in the analysis of optical and radar images. Necessary instruments and software for various types of the remote sensing data analyses, including INSAR are available. High quality modern optical data for the study regions are available at such resources as Google Earth, SAS Planet, ArcGIS Earth. Aerial photographs of 1956 and KFA-1000 space images made in late 70s for some parts of the Vakhsh River basin upstream from the Rogun dam site are available in Hydroproject Institute. Corona declassified space images obtained in 70s for the Barakhmaputra River basin will be purchased from the USGS. Project participants have software that will be used for data processing.

9. **Project Description:**

Project will start from comparative analysis of the georeferenced space and aerial images of the suspicious sites that have been preselected in both regions. Images obtained decades ago will be compared with modern that will provide preliminary, qualitative assessment of the activity of slope deformations at the sites in question. Maps of these sites showing various geomorphic indications of slope processes will be compiled.

Next step of the Project implementation will be the analysis of the available radar data by use of the INSAR technology. It will provide quantitative data on the rates of most recent deformations at these sites that will be compared with data revealed from the analysis of optical images.

Project participants will perform field reconnaissance of the sites demonstrating active slope deformations to collect structural and geotechnical information necessary for slope stability analysis.

Combined analysis of all data collected will be performed to estimate possibility of large-scale slope failures in both basins and to assess height, shape and stability of the blockages that might originate here. Volume of water that could accumulate upstream and be released after dams breach will be estimated and scenarios of possible outburst floods will be elaborated. Depending on the results of risk analysis recommendations on optimal protection/mitigation measures will be provided for local authorities (necessity of monitoring and selection of optimal combination of monitoring methods; development of the early warning system(s) and their structure; possible technical measures).

10. **Work Plan/Expected Results:**

2018.

- 1 - Search and selection of optical and radar images of the study regions suitable for carrying out planned investigations.
- 2 - Landslide mapping (search of past rockslides and of the evidence of the ongoing slope

deformations) in the pre-selected parts of Vakhsh and Brakhmaputra River basins based on the geomorphic and landscape identification criteria.

3 - INSAR analysis aimed to identify slopes with ongoing slope deformations.

4 - compilation of the landslide susceptibility maps based on joint analysis of optical and radar data.

2019.

5 - Selection of the most critical sites that of Vakhsh and Brakhmaputra River basins require more detailed analysis.

6 - Comprehensive study of the selected sites based on combination of various techniques of the analysis of the remote sensing data.

7 - Field visits of some sites that will be possible.

8 - Preparation of research paper(s).

2020.

9 - Analysis of possible adverse effects that might be caused by slope failures in river basins upstream of the dam sites.

10 - Elaboration of recommendations on protection/mitigation measures (necessity of monitoring and selection of optimal combination of monitoring methods; early warning system(s) and their structure; possible technical measures).

11. **Deliverables/Time Frame:**

After completion of the first stage of the Project implementation (end of 2018) maps of the potentially hazardous sites in the study river basins will be compiled based on the analysis of both optical images and INSAR;

After completion of the second stage (end of 2019) most hazardous sites or sites with potentially most adverse effects will be selected and described and quantitative data on their present day state (slopes motion rates) will be provided. We expect submission of one or two research papers at the end of this stage.

At the end of the project (2020) recommendations on possible protection/mitigation measures to avoid most adverse effects of slope instabilities in the study river basins will be elaborated and provided to local authorities. Research papers could be submitted at the end of Project.

12. **Project Beneficiaries:** Owners and designers of the hydraulic projects in the study river basins in Tajikistan, China and India; Emergency agencies responsible for peoples' safety at the local, regional and state levels; young researchers from Tajikistan and China that will participate in the Project and will be trained in modern techniques of the remote sensing data analyses.

13. **References:**

Strom, A.L. 2010. Landslide dams in Central Asia region. *Landslides – Journal of the Japan Landslide Society* 47(6), 309-324.

Strom, A. 2013. Geological Prerequisites for Landslide Dams' Disaster Assessment and Mitigation in Central Asia. In: Wang F, Miyajima M, Li T, Fathani TF (eds). *Progress of Geo-Disaster Mitigation Technology in Asia*, Springer-Verlag Berlin Heidelberg. (ISBN 978-3-642-29106-7),

17-53.

Strom, A., Zhirkevich, A. 2013. "Remote" landslide-related hazards and their consideration for the hydraulic schemes design. In: Genevois, R., Prestinzi, A, (eds). Proc. Int. conference on Vajont – 1963-2013. Italian Journal of Engineering Geology and Environment, Book series No 6. 295-303.