ANNUAL PROJECT PROGRESS REPORT

GLACIERS &STUDENTS- A SCIENTIFIC-BASED APPROACH TO MONITOR CLIMATE AND GLACIERS IN PAKISTAN'S MOUNTAIN REGION TO SUPPORT HYDROLOGICAL RISK PREVENTION

January- December 2023

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Project Summary Information	
Project Title	Glaciers &Students- A scientific-based approach to monitor climate and glaciers in Pakistan's mountain region to support hydrological risk prevention
Project ID	**00144462**
Project Duration	**24 months**
Location	**Gilgit Baltistan**
CPD/UNSDCF/RPD/SP Outputs	system generated
Gender marker	GEN 1
Digitalization marker	NA
Implementing Partner	Ev-K2-CNR
Total budget	1,100,000. Euro
Donors (funding sources)	Government of Italy
Project Manager name:	Maurizio Gallo, EvK2CNR Italy

1. Executive Summary

The Glaciers and Students Project made substantial progress in 2023, achieving significant milestones despite the project's short time frame. The focus remained on developing a comprehensive glacier inventory for Pakistan using data from the European Space Agency Sentinel-2 satellites. The methodology employed ensures homogenous coverage of northern Pakistan, with over 13,000 glaciers expected to be reported in the final inventory.

The project successfully concluded field surveys and installed five new Automatic Weather Stations (AWS) in Braldo (Askole), Boltoro, Biafo, and Rakaposhi (Minapin) regions, bringing the total AWS count to eight. Data from these stations have been downloaded and are currently being analyzed.

Recognizing the extensive post-field work requirements and the comprehensive nature of the glacier inventory, Ev-K2-CNR requested a six-month extension from UNDP. The reasons for extension include the need for additional time for compiling the two-volume glacier inventory, ongoing data analysis from the newly installed weather stations, increased glacier count, and the time-intensive process of publishing research papers.

To facilitate the extension request, Ev-K2-CNR submitted a comprehensive document outlining budget appropriation, cost breakdown, and the Annual Work Plan for the first six months of 2024.

The project team believes that the extension will enable the realization of the project's objectives and provide ample time to disseminate findings during the final event planned for Islamabad. The ongoing commitment to scientific rigor and the project's impact on understanding glacial dynamics in the region underscores the importance of this extension and further upscaling.

Overall, the Glaciers and Students Project remains dedicated to its goals and looks forward to the continued collaboration with UNDP to deliver meaningful and comprehensive outcomes.

Maurizio Gallo

Project Manager

2. Progress Review

a) Key results achieved

The annual reports cover the progress of the Glaciers and Students Project from January 2023 to December 2023. Key achievements during this period include:

- Installation of 05 AWS at Asokli, Biafo, Urdukus (Baltoro), Concordia (Baltoro), and Minapin.
- Conducted comprehensive training programs on GIS-RS (Geographic Information System, Remote Sensing), Geomatics, with 394 participants, including students, researchers, and government officials (171 females and 223 males) from Karakorum International University (KIU), University of Baltistan Skardu (UOBS), and EPA-GB for glaciological field activities and GIS.
- Presentation of the project at two international conferences.
- Submission of 01 research publication to an international journal for approval.
- Acquisition of data from AWS, various glacial inventory reports, and satellite images.
- Multitemporal and field analysis of 04 glaciers and glacial bodies.
- Updated Share Geonetwork Platform.
- GeoGB App has been updated
- Assessment of glacier changes
- MoUs with KIU, UoBs and GB-EPA signed

b) Output progress

Output statement	Baselines Value type	Indicators	Annual Targets	End of the project target	Status: On-track/ off-track / complete	Means of verifications and comment to substantiate the selected response
Output 1 Assessment and monitoring system of mountain glaciers and climate improved in Pakistan contributing to improved planning and management of water	03 number of AWS existing	1.1 Number of climate monitoring stations in glacier region established and maintained to provide data on changing climate patterns for use by MET Deptt. and	Total 08 AWS installed and improved	08 AWS installed (05 new installed and 03 improved/restored) Results will be communicated to relevant government departments to supplement knowledge for adoption in devising applicable strategies in	Complete	Field visits, monitoring and news reports, pictures Data retrieved from newly installed and improved/restored AWS.

Output statement	Baselines Value type	Indicators	Annual Targets	End of the project target	Status: On-track/ off-track / complete	Means of verifications and comment to substantiate the selected response
resources and natural resources including the sustenance of biological diversity.		other concerned		agriculture and livelihood sector.		
	0	1.2 Number of glacial bodies measured, monitored and documented to monitor changes over time that can provide early warning for natural hazards and contribute in reducing risks faced by mountain communities, particularly women and marginalized groups, in downstream valleys	04 glacier bodies monitored and studied	04 glacier bodies monitored and studied Results will be communicated to relevant government departments to supplement knowledge for adoption in devising applicable strategies in agriculture and livelihood sector.	Complete	Field visits, surveys and assessments reports

Output statement	Baselines Value type	Indicators	Annual Targets	End of the project target	Status: On-track/ off-track / complete	Means of verifications and comment to substantiate the selected response
	Partial inventory of CKNP Glaciers exist	1.3 Update the Pakistan Glacier Inventory	Update (01) Pakistan glacier inventory and (03) other scientific research articles published	01 Pakistan glacier inventory and 03 scientific research publications	On track	Field visits and expert reviews Draft of Pakistan glacier inventory (draft volume1) (E20) 01 research publication submitted in international journal for approval

Description of Output level results achieved in 2023:

In activity 1.1.3, A team from Ev-K2-CNR, comprising three members, including two technical experts and monitoring personnel, visited the Askole and Urdukas sites as part of the Glaciers and Students project. The main objective of the visit was to evaluate the condition of the Automatic Weather Stations (AWS) installed at these locations and, if possible, to restore them. The technical team assessed the Askole AWS during the visit and observed that the steel fence surrounding the AWS was intact, suggesting a certain level of protection. Additionally, they installed a new memory card, provided and installed a new battery, and installed a new solar panel to ensure the proper functioning of the station. (**E1**)

Under activity 1.1.4 in June 2023, a successful data download captured information from March to June for the Borith and Passu Automatic Weather Stations (AWSs). Both AWSs are in optimal condition, with no signs of damage. Analysis of meteorological data indicates a temperature rise from March to June, with cold conditions persisting into early May, followed by a rapid temperature increase. Passu AWS recorded considerably stronger wind speeds compared to Borith Lake, highlighting its importance in capturing local conditions. High correlation among air temperature, atmospheric pressure, and relative humidity supports using one station for reconstruction in case of malfunction.

Additionally, in collaboration with GB-EPA, the University of Baltistan, and Karakoram International University, the Ev-K2-CNR team completed a 22-day field mission to install and upgrade Automatic Weather Stations (AWS) at various locations, including Asokli, Biafo, Urdukus, Concordia glacier, and Minapin. Four new AWS systems were installed, and one at Askole was upgraded, bringing the total AWS installations to eight. All AWS units are fully operational, transmitting accurate weather data. The additional installations, strategically placed in Upper Hunza, Nagar, Baltoro, and Biafo areas, provide

comprehensive coverage of the central Karakoram region, crucial for monitoring the majority of Pakistan's glaciers.

We are pleased to report that all AWS (08) installations are fully operational, efficiently transmitting weather data with a high degree of accuracy. This accomplishment marks a significant milestone in our ongoing efforts to enhance meteorological data collection and monitoring in Gilgit Baltistan region. **(E2)**

In 1.1.5 activity the data from the AWSs located in Hunza Valley and Braldu valley were retrieved and the weather stations checked for maintenance. AWSs were found to be operational, and the data from the Hunza Valley have been analysed, ready to be shared with project partners. For the AWSs on Baltoro glacier, MATLAB routines were developed to check for the acquired data and process them into hourly values ready to be analysed and shared.

In Ocotber 2023, the Automatic Weather Stations installed in Hunza Valley (e.g. Borith Lake, Passu glacier, Shispar glacier and Minapin glacier) were visited by a team of the Environment Protection Agency of Gilgit-Baltistan (EPA-GB) to carry out the necessary maintenance activities and data download. The stations were found to be operational, and data were correctly retrieved.

For the AWSs located on Baltoro glacier, a different procedure was necessary for data elaboration compare to those in Hunza valley, as they originate from a different manufacturer (CAE systems). For AWSs in Hunza valley, the data are recorded every minute and statistics are calculated and available for every hour. Data cleaning and checking is then carried out with a routine created in Matlab language for validation of these hourly meteorological data. **(E3)**

Activity 1.2.3a, to assess the glacier changes, the glaciers of Skinmang basin and Hispar basin were assessed. The glaciers in both basins underscore the stability of glacier areas in the Karakoram region, emphasizing the importance of focusing on glacier tongues for meaningful analysis. The utilization of advanced technologies, such as semi-automatic segmentation and higher spatial resolution imagery, enhances the precision of inventory creation. The results depict a nuanced picture of glacier dynamics, with minimal changes in total area but some variations in specific glaciers due to factors like surging and debris cover. Overall, the findings contribute to a better understanding of the glacier landscape in the Karakoram region, supporting the broader discourse on glacier responses to environmental shifts. (**E4)**

Under activity 1.2.4a, data collection of ablation stakes on Passu and Ghulkin glaciers allowed to quantify the melt rates of these glaciers over the summer 2023; this was found to be higher at Passu glacier compared to Ghulkin, reaching up to 11 cm day^{-1}, and more than 7 m during the summer period.

On the glacier inventory, validation checks were performed to ensure the database can easily be interpreted for change assessment. All glacier topographic parameters, including slope and aspect and elevation ranges, were calculated. These can be used to investigate the relationship with area changes.

On 13 October 2023, scientific officers from the EPA-GB team visited Ghulkin and Passu glacier to carry out measurements of ablation on the two glaciers, by measuring the emergence of ablation stakes installed in August of this year on at representative locations on the glacier tongues. The team were able to find all 6 stakes located on Ghulkin and all 6 on Passu glacier.

The measurements were then compared to the previous emergence of the stakes recorded in August 2023 to find out the glacier ablation. They are reported here for Ghulkin and Passu glacier, separately. **(E5)**

Under the activity 1.2.5b of validation of acquired field data, the data acquired by the AWS at Borith lake, Shispar glacier and Passu glacier was retrieved through dedicated field expeditions by the EvK2-CNR and EPA-GB teams. A mat lab script was set up for validation of the acquired data through dedicated checks for the presence of missing data and the percentage of data acquired by the data logger every hour. The AWSs are functional and the data appear to be correctly acquired at all stations. The script will be used to validate further data as it keeps being acquired. **(E6)**

Activity 1.2.6b, the validated data acquired from 03 installed AWSs (2022) in Borith, Passu and Shispar were further processed to investigate local meteorological patterns, useful to describe the conditions influencing glacier melt. Air temperature follows very similar patterns at the stations, with high correlation and expected differences owing to elevation; the same is observed for atmospheric pressure. Larger differences are seen for relative humidity between Shispar and Borith lake AWSs, which are located in different valleys, while more consistent patterns are seen in the comparison between Borith and Passu AWSs. The largest differences are observed between Borith and Passu AWSs for wind speed, owing to the katabatic wind effect of the glacier influencing wind speed at Passu AWS, and rainfall, which is affected by the rugged topography of the area.

The analysis of microplastics collected on Ghulkin, Passu and Batura allowed us to identify 154 likely microplastics, 144 of which were fibres (93.5%). The average concentration on the glacierised was 100 ± 40 MPs/kg dried debris, and the size of microplastics suggests that the primary source is mid- to long range atmospheric transport. (**E7)**

under the activity 1.2.7b, the programming of glacier research activities for summer 2023 was discussed through several meetings with researchers, who will both continue the work started in summer 2022 and lead new activities according to the planning of the next quarters. It was decided to split the activities in two field missions, which are consequential to one another and involve different researchers, allowing coverage of the whole summer period. (**E8)**

Activity 1.2.8b, During June 2023, field activities were carried out on Passu, Ghulkin and Shispar glaciers for weather station maintenance and to search for the ablation stakes installed in September 2022. The Weather stations installed at Passu, Shisper and lake Borith were perfectly functional. The search for the ablation stakes allowed us to identify the stakes on the Ghulkin glacier which indicated a melt of more than 7 m since September 2022 at some locations and a movement of the ice of about 100 m**. (E9)**

In activity 1.2.9b, on August 5th and 6th, 2023, the EvK2CNR team conducted the installation of 12-meter-long ablation stakes on Passu and Ghulkin glaciers. The decision to use longer stakes was influenced by high melt rates observed on clean ice surfaces, ensuring greater likelihood of retrieval after a year. Six stakes were placed on each glacier. For Ghulkin glacier, stakes were strategically installed in locations with varying debris thickness to explore its impact on glacier melt. The team successfully retrieved four stakes from the previous year, revealing the influence of debris cover on melt rates, with clean ice stakes exhibiting higher rates compared to debris-covered ice stakes. This

prompted the installation of new stakes in locations with varying debris cover for further investigation. **(E10)**

Under the activity 1.2.10b, upon successful data retrieval from the AWSs situated at Borith Lake, Shispar, and Passu Glacier Moraine, our subsequent step involved processing this data to discern patterns in the meteorological variables of interest. For Borith Lake and Shispar, to the team accessed nearly a complete years' worth of weather station data, spanning from August 2022 to August 2023.

Initial task was to validate the data, ensuring its accuracy and completeness, technical team scrutinized the recorded valid data field, as maintained by the data logger and extracted the average measurements for each hour of the day. It's important to mention that the AWS conducts observations at 5-minute intervals, and subsequently, statistical summaries are generated for each hour based on these observations. **(E11)**

The activity 1.3.5 under first classified map, maps were generating a glacier inventory of North Pakistan using Sentinel-2 imagery and segmentation. The project methodology included several steps, beginning with the mosaicking of low or no-cloud cover Sentinel-2 imagery from the Copernicus website. The processed data were exported in TIFF format. The next step was image segmentation using QGIS software. The segmentation algorithm was used to segment the Sentinel-2 imagery into different glacier regions. The study also utilizes the classification method of assigning values to the glacier areas and merging polygons to delineate glacier boundaries. **(E12)**

Activity 1.3.6, After the creation of the glacier outlines by merging the glacier segments, some small errors can still remain, as a result of artefacts of the merging process, inaccurate classification of the segmentation process itself and errors by the analyst. To correct these errors, different procedures are carried out: an automatic removal of small holes in the polygons and manual corrections of the outlines based on high resolution satellite images. These are particularly helpful in case of debris covered glaciers, as they can help identify the terminus more clearly. **(E13)**

Activity 1.3.7, the final classified maps were generated through a meticulous manual correction process using high-resolution satellite imagery from sources like Google Satellite, Bing Maps, and Google EarthTM. Special attention was given to larger glaciers, which, after manual correction, could indicate surging behavior, posing potential hazards to the local population.

Italian and Pakistani students collaborated with experts from the universities of Milan and Cagliari. The project's organization involved weekly online meetings for discussing progress, displaying work through screen sharing, and ensuring consistent interpretation. Verification occurred in phases, including boundary checks, glacier attribution, and topological analysis. Additionally, efforts were dedicated to searching for glacier names using available digital maps.

Manual corrections were conducted in QGIS, enhancing accuracy compared to the semi-automatic approach. Challenges arose when high-resolution satellite images were snow-covered, requiring alternative sources like Bing Maps. Figure 26 illustrates the manual correction process, highlighting the refinement achieved through comparison with high-resolution imagery.

In the absence of usable high-resolution images, reliance on Sentinel-2 multispectral images was necessary. Hole filling and manual corrections were applied to delineate glacier boundaries, as depicted in Figure 28 for basin L8 128, including Chogo Lungma glacier. Comparisons with previous

inventories, such as the GAMDAM glacier inventory, were conducted to validate outlines, emphasizing cases where increased size indicated potential surging behavior.

A crucial final step involved calculating glacier area using QGIS's "Field Calculator" tool, ensuring precise delineation and area measurement in square kilometers. This meticulous process contributes to a comprehensive understanding of glacier dynamics, particularly identifying glaciers with surging potential and their implications for local communities, including the risk of Glacial Lake Outburst Floods (GLOFs) and associated hazards. **(E14)**

Activity 1.3.8, the morphometric analysis aims to extract key parameters from glacier maps, following international standards. The ongoing activity involves analyzing glacier boundaries to determine essential information for understanding glacier dynamics and evolution.

The basin delineation process heavily relied on a suitable digital elevation model (DEM) to automatically define basins containing glaciers within Pakistan.

To achieve this, the r.watershed tool within the GRASS software via QGIS was employed. This tool employs advanced algorithms to deduce flow direction and accumulate flow across the DEM. Subsequently, it identifies river networks and topographic ridges, effectively defining river basins based on specified area thresholds.

The analysis primarily targeted the Central Karakorum National Park (CKNP) region, leveraging high-resolution Sentinel-2 satellite data and the ALOS AW3D30 global DEM. The extracted basins, while initially small, were aggregated, guided by the HydroSheds database's definitions, aligning mostly with level 7 of the Pfafstetter coding system.

These basins were then thoroughly assessed for morphometric properties and elevation characteristics. Naming conventions were established, often referencing main rivers or distinctive landscape features.

The results displayed a wide elevation range within these basins, with limited areas surpassing 6000 meters above sea level. The average basin elevation ranged from 4000 to 4300 meters above sea level. This analysis forms a crucial foundation for a broader study of glacier morphometry and behavior in the CKNP region. **(E15)**

Output statement	**Baselines** **Value type**	**Indicators**	**Annual Targets**	**End of the project target**	**Status: On-track/ off-track / complete**	**Means of verifications and comment to substantiate the selected response**
Output 2 Collaboration and sharing	0 number of systematic web-based GIS data	2.1. Web based GIS climate and glaciers data archiving and sharing	1 number of systematic web-based GIS data	systematic web-based GIS data archiving and sharing	On track	Quarterly report.

Output statement	Baselines Value type	Indicators	Annual Targets	End of the project target	Status: On-track/ off-track / complete	Means of verifications and comment to substantiate the selected response
mechanism among Pakistani and international institutions and students strengthened to build capacities for longer term glaciers monitoring through innovative approaches and technologies.	arching and sharing mechanism exist	system developed and maintained to enable knowledge and data sharing among the authorities responsible e.g. Met Deptt, Disaster Management Authorities, Agriculture Deptt, Water Mgt. Deptt & EPA at GB and national level.	archiving and sharing mechanism exist.	mechanism developed		Data, georeferenced maps, trend and scenarios are being processed to be available through the information system.
	0	2.2: Number of students and faculty members of the local universities in Gilgit-Baltistan trained in glacier inventory and monitoring	100 students and faculty members with 40% female participation	100 (End target with 40% female student's participation)	On track	Quarterly reports Training reports

Description of Output level results achieved in Third Quarter of 2023:

Activity 2.1.2 focuses on enhancing the GB GeoApp, and this report outlines the improvements made to the application. The updated version now includes a new feature for collecting Points of Interest (POI). Users can input the POI's name, capture specific pictures, add notes, and relevant information for each existing topic. The app functions in both online and offline modes, enabling users to gather

data even in areas with poor or no network connectivity. In offline mode, users can collect data as guests, without the need for authentication. However, when online, users have the option to authenticate either through the app itself or via Facebook.

Registration on GBGeoAPP is accessible through the SIGN UP button, and registered users can change or reset their passwords as needed. If a password reset is initiated, a new password will be generated and sent to the user's email. Authenticated users can geolocate their positions, categorize points of interest by defining attributes via a data input form, and attach images taken using the device's camera. Additionally, users have the flexibility to choose the base map for their background. To ensure uninterrupted functionality in areas with limited connectivity, users can download available maps in advance through the "Download maps" section. **(E16)**

Activity 2.1.3, during reporting period primary focus was on two key aspects: defining a new database and associated services, and determining how to integrate these with the existing or new Mountain Genius web platform. A significant portion of efforts during this period was dedicated to gathering and organizing the latest information that needed to be uploaded onto the web service, specifically the data and metadata from the new AWS (Automatic Weather Station) station. To accomplish this, IP's work primarily revolved around enhancing the existing metadata database. The goal was to adapt it in a way that would seamlessly accommodate the inclusion of the new data, adhering to the established schema of the Geonetwork platform for subsequent publication.

Within this report, a comprehensive listing of the metadata associated with these stations, providing a detailed overview of the information gathered and processed during this phase of the project. **(E17)**

Activity 2.1.4 focused on enhancing the project's portal, especially in terms of data and map publication. The project implemented an updated Geonetwork system, providing a new platform for sharing geographic data and maps. This involved adding tools to the Geoportal dedicated to AWS (Automatic Weather Station) data and introducing a system to support GIS web functionality.

The project aimed to publish various geographic datasets, including a glacier inventory created as part of the project. Users could access these datasets online or download maps in the shape format from the platform after going through an authentication process. The GeoPortal underwent a graphical redesign to improve clarity and responsiveness, with ongoing template and layout testing.

One significant change in the project was a shift toward an easy-to-use interface, making data sharing accessible to non-specialized users. To achieve this, the project adopted the GeoNode system, which is a geospatial content management platform. GeoNode offered data management tools, integrated data and metadata creation, and map visualization. Users could share datasets, and social features promoted user engagement and data quality control. GeoNode accommodated various resource types, with datasets being the primary focus. Users could easily share their datasets, ensuring data integrity checks during the upload process. This platform provided a flexible and user-friendly environment for sharing, managing, and visualizing geospatial information. (**E18)**

Activity 2.1.5: The primary objective of this activity is to facilitate the publication of a new web service containing the data collected from the AWS (Automatic Weather Station). Specifically, the raw data obtained from the stations located at Shispar, Passu, and Borith have been organized into three separate folders, each containing data files in TXT format. Additionally, the data that have undergone

validation and quality checks have been formatted and stored in XLS (Microsoft Excel) format. These validated data sets are now prepared for seamless integration into the web-sharing system, making them readily accessible to users. This process ensures that the data collected from the AWS stations is not only well-organized but also available for easy retrieval and utilization through the web service. The new SHARE GeoNetwork portal is now available at https://geoportal.mountaingenius.org/portal/ . The Mountain Genius Geoportal is the main access point to the data provided by EvK2CNR. The Geoportal allows; monitoring the availability of datasets, discovering suitable datasets based on their descriptions (metadata), and accessing the selected datasets through their view or download services. **(E19)**

2.2.6 Training for GEOMATICS: On August 10th and 11th, 2023, EvK2CNR conducted an extensive training session covering topics related to GIS (Geographic Information Systems), remote sensing, and glacier mapping. This comprehensive training took place within the well-equipped computer laboratories at the Karakoram International University (KIU). The participants in attendance numbered 40, representing both KIU and the University of Baltistan (UoB). These participants came from diverse academic backgrounds, including environmental sciences and earth sciences (at KIU) and tourism, archaeology, and computer science (at UoB). Notably, the training attracted members from various organizations, such as the Environmental Protection Agency of Gilgit-Baltistan (EPA-GB), the GLOF II project, and the Pakistan Meteorological Department (PMD).

The latter portion of the training program placed a special emphasis on the intricacies of geomorphological mapping of glaciers. Participants were exposed to various scenarios encountered in glacier mapping using satellite imagery, with a particular focus on providing detailed insights into the mapping of debris-covered glaciers and effective techniques for their identification and analysis. This training initiative aimed to equip attendees from diverse academic and professional backgrounds with valuable skills and knowledge in GIS, remote sensing, and glacier mapping, fostering interdisciplinary collaboration and enhancing their capabilities in these crucial fields. **(E20)**

Activity 2.2.7, the inventory of Pakistan's glaciers is being meticulously compiled through a highly sophisticated satellite image analysis, with invaluable contributions from international project partners, namely the University of Milan and the University of Cagliari in Italy. The expertise of specialists from these Italian universities, particularly the University of Milan, which has dedicated over 70 years to the study of Karakoram glaciers, and the University of Cagliari, known for developing thematic maps crucial for the management plans of the Central Karakoram National Park (CKNP) and Deosai, played a pivotal role in this endeavor.

To enhance future estimations of water availability for local communities, both for agricultural purposes and the broader Indus basin, the glaciers have been categorized according to their respective hydrological basins. Volume 1 of this inventory focuses on project overview, the methodological aspects and analyses of changes occurring over the past two decades, making it a significant contribution. Meanwhile, volume 2 presents the actual inventory through graphical representations and maps. A portion of volume 1 (still in draft form) is appended herewith.

It's important to note that 02 volumes of Pakistan glacier inventory book are currently in the development phase, with final publications expected in the next quarter. The scientific data obtained from satellite and ground-based sources are also in the final stages of the conclusion of their analysis.

This new inventory identifies approximately 13200 glaciers in the northern region of Pakistan, signifying a substantial achievement in glacier research and management**. (E21)**

Under the 2.2.8 activity, Ev-K2-CNR, in collaboration with AICS, UNDP, and Devcom-Pakistan, celebrated International Mountain Day on December 11, 2023, at the Pakistan National Council of the Arts. The event featured a two-day exhibition titled "The Colours of the ICE" at PNCA, showcasing 21 large-sized photos capturing the hues and textures of glaciers in northern Pakistan and 40 photos of the Boltoro cleanup. (**E22**)

3. Communications, visibility, and partnerships

Partnerships:

Glacier and Students project, since its inception has been executed adopting an inclusive approach. The partners have played a highly significant role in achieving results and will be doing so even after the closure of the project. The major initiatives such as AWSs, their maintenance, data collection and the dissemination of data on the request of any institution will be the mandate of EPA GB. Furthermore, partnerships have been made with the concerned government institutions of GB as well as with the academia of the region. This includes both universities including KIU and University of Baltistan.

To formally establish collaborations for several project interventions, MoUs have been inked with EPA GB, KIU, and University of Baltistan. The capacity building of students as well as the faculty of both universities and the personnel of the partner institutions are an integral part of the project activities.

Mainly, partnership has been made with the following institutions in executing the G&S project:

- GB-EPA
- KIU
- University of Baltistan
- GBDMA
- Forest, Wildlife and Environment GB
- Planning Department Gilgit Baltistan
- University of Milan
- University of Cagliari

Communication

The Glaciers and Students Project's interventions, since its commencement, has received a great deal of attention and coverage from national and provincial newspapers, national news channels and social media etc.

News and updates are posted on the official pages of EvK2CNR Pakistan, GB EPA, KIU, and University of Baltistan on social media. Furthermore, the official pages of the Chief Secretary GB, Information Department GB have also posted news on their pages expressing their appreciation for several initiatives under the project G&S.

It has been constantly strived to highlight the project activities, interventions, and achievements and to give credit to the Italian Agency for Development Cooperation (AICS) as the donor of the project, UNDP as executing agency and EvK2CNR as implementing partner.

One of the major occasions to highlight the role of the donor and the executing and implementing partners of G&S was the event held on International Mountains Day jointly organized by EvK2CNR and DevCom in Islamabad. The coverage of the event was made almost by all mainstream national newspapers of Pakistan**. (E 23)**

4. Project risks and mitigation measures

Project risk log **E24.**

5. Lessons Learned

- The project timeframe appears insufficient, especially considering the extensive task of mapping over 1300 glaciers. The sheer volume of work necessitates the involvement of students, adding an additional workload that puts everyone under time constraints.
- The validation process for the students' work is time-consuming, requiring the engagement of more individuals from Italian universities. This is further complicated by the challenges associated with the timing of payments.
- The preparation of the final document (volume) demands more time than initially allocated, and achieving this will only be possible with an extension of the project timeline.
- A significant decision has been made to include small glaciers and those covered with debris in the inventory, aspects that were not considered in previous inventories. This expanded scope adds complexity to the project but is deemed essential for a comprehensive mapping effort.
- Fundamental rescue and emergency training in high altitudinal areas, along with terrain knowledge, are crucial for preventing accidents resulting from unexpected snowfall, landslides, and flash floods. During this summer, one of our project participants encountered a high-velocity stream. Thanks to his experience and knowledge, he was able to safely navigate the situation.
- It is also essential to cross all streams in the morning since, in the afternoon, water levels tend to rise due to higher temperatures and glacial melt.

6. Way Forward

In 2024, the following actions have been planned under the following activities:

- In the **activity 1.3**. regarding Pakistan Glacier inventory, in the year 2024 classified map will be finalized. Glacier bodies will be monitored implying in-situ measurements and remote sensing techniques and the data generated over a period will be used to establish a link between climate variations and glacier changes. The information will be periodically processed and validated for the publication.

- **Activity 2.1:** For implementation of information system, in 2024 SHARE Geonetwork platform will be updated and publication of the new web-service with new high-altitude weather stations data will also be carried out.
- Under the capacity building **activity 2.2**, preparation and publication of the glacier inventory book will be finalized.

7. Annexures

E1= 1.1.3 Weather station restoration at Askole and Urdukas

E2=1.1.4 weather station checking and maintenance

E3= 1.1.5 Data provisioning and sharing

E4=1.2.3a glacier area change assessment

E5= 1.2.4a change assessment report

E6= 1.2.5b Validation of acquired field data

E7=1.2.6b Elaboration of field data for each glacier

E8= 1.2.7b Planning of field missions on selected glaciers

E9=1.2.8b Field activities on selected glaciers

E10= 1.2.9b Validation of acquired field data

E11= 1.2.10b Data elaboration and sharing

E12=1.3.5 First classified map

E13= 1.3.6 Validation of the first map

E14= 1.3.7 Final classified map

E15 = 1.3.8 Morphometric analysis

E16= 2.1.2 New release of the GB GeoApp

E17= 2.1.3 Requirement analysis for new climate data and metadata publication

E18= 2.1.4 Update SHARE Geonetwork Platfrom

E19= 2.1.5 Publication of the new web service with new high-altitude weather station data

E20= 2.2.6 Training for geomatics

E21= Preparation and publication of the book of the glacier inventory

E22= 2.2.8 Event

E23= Communication, visibility and partnerships

E24= Project Risk Log

E25= Quarterly monitoring Report