《來古冰川 GLOF 防災避險與氣候韌性手冊》

Laigu Glacier GLOF Safety & Climate Resilience Handbook (Youth Edition / 青少年版)

專案網域 Master Domain www.themooreblue.com	觀察團隊 Natural Observer Team 藍冰城堡小小自然觀察員 & 青年氣候倡議者	地理座標 Location & Alt 西藏波密縣來古與雅隆冰川 (29°17'N, 96°56'E | 4,200m)
氣候對接 Global Goals UN SDGs 13.1 / 13.3 / 11.5	隱私保護 Privacy & COPPA 100% 遵循 COPPA 兒童線上隱私保護規範	文件權威 Credibility 結合氣象與冰川專家核實之公眾安全導引

一、 冰川湖潰決（GLOF）的科學機制 / Science of GLOF Hazards

海洋性冰川速融與內部空洞化：

來古冰川群與雅隆冰川為藏東著名的海洋性冰川（Maritime Glaciers）。來自印度洋的暖濕氣流與表面融水滲入冰川裂隙，「就像在給冰洞撓癢癢一樣」，流水一邊侵蝕一邊掏空冰體內部，雕琢出巨大的藍冰洞。當氣溫持續升高，冰洞內部被嚴重空洞化、洞頂變薄時，便會發生劇烈的結構性坍塌。坍塌冰體堵塞河道或擠壓冰川湖，極易誘發冰川湖潰決（GLOF - Glacial Lake Outburst Flood），瞬間釋放出數百萬立方米的融水，形成強烈的山洪與泥石流危機。

Maritime Glacier Melting & Internal Cavity Formation:

Laigu and Yalong Glaciers are prominent maritime glaciers in eastern Tibet. Warm, humid monsoons and surface meltwater seep into ice crevasses—acting like 'tickling the ice cave'—carving out massive blue ice caverns from within. As global temperatures rise, internal cavities expand and cavern ceilings thin, leading to structural collapses. Falling ice masses block river channels or compress moraine lakes, triggering Glacial Lake Outburst Floods (GLOFs) that instantly release millions of cubic meters of meltwater, posing severe flash flood and debris flow hazards.

二、 GLOF 早期預警三大徵兆 / 3 Early Warning Signals

預警徵兆 Signal	現象說明 Description	應對行動 Action
1. 水色突變 Water Discoloration	溪流或冰川湖水色突然由清澈或深藍轉為劇烈渾濁的泥灰色，含沙量暴增。 Streams or lake water suddenly turn thick, muddy grey with surging sediment.	預示上游冰洞崩塌或泥沙沖刷，立即準備撤離！ Signals upstream collapse; prepare to evacuate immediately!
2. 流量異常 Abnormal Flow	下游溪流流量無預警突然斷流或暴漲，水位在短時間內劇烈波動。 Downstream river flow abruptly stops or surges without warning.	上游可能已發生冰塞或堰塞湖，切勿滯留河谷！ Ice damming or outburst forming upstream; leave riverbed immediately!
3. 山谷轟鳴 Mountain Roar	冰川深處或上游山谷傳來連續、沉悶的「隆隆」冰裂與山體巨響。 Continuous thunder-like crashing echoes from deep ice or upstream valleys.	冰洞崩塌或冰湖潰決在即，迅速向高處轉移！ Impending outburst or collapse; move rapidly to high ground!

三、 山區村落與青少年避險逃生 4 步走 / 4 Evacuation Steps for Youth & Communities

【第一步】聽警報，速避險 / Step 1: Listen for Roars & Act Immediately
聞聽預警警報或發現水色混濁、山谷轟鳴等異常徵兆時，切勿留戀財物，第一時間隨家人與同伴撤離！
Upon hearing warning signals or observing abnormal signs, abandon belongings and evacuate immediately with your family!

【第二步】垂直山谷向高處跑 / Step 2: Climb Perpendicularly to the Valley
逃生方向必須垂直於河谷與溝谷方向，向兩側高陡山坡快速攀登，切勿順著河谷下游方向奔跑！
Evacuation routes must run perpendicular to the river valley—climb rapidly up side slopes and NEVER run downstream!

【第三步】避開滑坡與崩塌區 / Step 3: Avoid Landslide & Collapse Hazards
保持遠離陡峭土坡、河岸崩塌體與鬆散泥石流堆積區，防止二次地質災害危害。
Stay far clear of steep earth slopes, collapsing riverbanks, and loose debris deposits to prevent secondary hazards.

【第四步】到達安全高地集結 / Step 4: Assemble at Safe High Ground
在高於歷史最高洪水位 30 米以上 的安全高地集結，等待官方氣象與救援隊伍指示。
Assemble at safe high ground at least 30 meters above historical high water levels and await official instructions.

四、 青少年氣候行動宣言 / Youth Climate Action Pledge

藍冰城堡小小氣候倡議者宣言：
「冰川並不是真的有腳會跑，而是因為全球氣候變暖（Global Warming），它融化得太快，正在迅速『消退』！保護冰川，需要我們每個人從隨手關燈、低碳出行的小事做起，留住地球的美麗藍冰！」

Young Climate Advocate Pledge:
"Glaciers don't actually run on hidden feet — global warming is forcing them to retreat far too fast! To save the blue ice, everyone can start with simple low-carbon habits like turning off unused lights and walking green."

五、 極地戶外安全守則與 LNT 原則 / Field Safety Rules & LNT Protocol

【青少年極地戶外安全提示】：
海洋性冰川內部冰洞結構極不穩定，隨時有坍塌與湧水風險。冰面極滑，野外考察時必須時刻佩戴頭盔、綁定專業防滑冰爪，並在具備高山救援資格的在地專業嚮導帶領下進行，嚴禁單人私自進入冰洞或湖岸低窪區。同時遵循 LNT（Leave No Trace 無痕山林）原則，愛護脆弱的高山生態。

[Youth Field Safety & LNT Protocol]:
Interior ice cave structures in maritime glaciers are highly unstable with severe collapse and flash flood risks. Glacial ice is extremely slick; field explorations must be conducted wearing helmets and professional crampons under the direct supervision of certified mountain guides. Solo entry into ice caves or low-lying lake margins is strictly prohibited. Always practice Leave No Trace (LNT) principles to protect fragile alpine environments.