Dye Tracer Techniques in hydrogeology studies: Tham Luang-Khun Nam Nang Non karst Aquifer, Chiang Rai Province, Thailand

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Between 2018 and 2023, the Department of Groundwater Resources, in collaboration with the Department of Mineral Resources and the Department of National Parks, Wildlife and Plant Conservation, conducted dye tracer studies to delineate the recharge area of the Tham Luang cave system and its associated aquifer. These studies aim to facilitate systematic future management of these water resources. The preliminary findings are contributing to a more detailed understanding of the Tham Luang-Khun Nam Nang Non karst aquifer.

Fluorescein and rhodamine WT (20%) were selected as tracers for their distinct green and red colors, water solubility, high sensitivity of detection, and safety for humans, wildlife, and plants. Injection points were chosen based on field investigations: fluorescein was injected in a swallet along the Huai Nam Dan Valley, north of Tham Luang Cave, and rhodamine WT was injected in Huai Pak Tin Fai to the south. Monitoring was conducted at nine stations using C3 submersible (in situ) and 10-AU-005-CE Turner Design fluorometers, supplemented by water samples and charcoal bags. The stations included Tham Luang Cave, Tham Luang Cave Well, Ban Chong Reservoir, Emerald Resurgence (Morakot Pool), Tham Pla Cave, Khun Nam Pong Spring, Huai Khrai Reservoir, San Sai Noi School Well, and downstream Huai Pak Tin Fai.

On November 7, 2023, 3.8 kg of fluorescein was injected into the swallet along Huai Nam Dan Valley, followed by a second injection of 15.5 lbs. (approximately 7 kg in weight) of liquid rhodamine WT on November 8, 2023, into a swallet midway along Huai Pak Tin Fai. The discharge rates were 39 m^3/hr and 283 m^3/hr, respectively. Fluorescein was visibly detected at Tham Luang Cave 17 hours later and at the Morakot Pool 48 hours later. Rhodamine WT was detected in water samples and charcoal bags 3.5 days later at Tham Pla Cave.

These results indicate that the swallet along Huai Nam Dan Valley is directly connected to the Tham Luang Cave System and the Emerald Resurgence (Morakot Pool), while the downstream section of Huai Pak Tin Fai Valley is linked to Tham Pla Cave/Spring. Consequently, upstream activities involving large water usage, fertilizers, pesticides, detergents, or waste disposal can significantly impact the quantity and quality of groundwater for downstream communities and the Tham Luang and Tham Pla Cave Systems.

Keywords: dye tracer techniques, groundwater flow, karst aquifer