

Project Design Matrix (PDM-ver1)

Project Name: The Project on Magmatic Fluid Supply into Lakes Nyos and Monoun, and Mitigation of Natural Disasters through Capacity Building in Cameroon

Area: Cameroon

Period: April 2011 – March 2016

Counterparts: institution / organization

IRGM

Date: 21 October 2013

| Narrative Summary | Objectively Verifiable Indicators | Means of Verification | Important Assumptions |
|---|---|---|-----------------------|
| Overall Goal | | | |
| None | | | |
| Project Purpose | | | |
| <p>A framework is established where Cameroonian scientists can independently accomplish their own research on the issues related to the gas disasters at Lakes Nyos and Monoun, and utilize its outcomes for disaster management through scientific cooperation between Japan and Cameroon.</p> | <p>A) An operational direction in IRGM including the following contents.</p> <ol style="list-style-type: none"> 1. Lake observation <ol style="list-style-type: none"> 1-1. Automatic buoy 1-2. Climatic station 1-3. CTD observation 1-4. YY method 1-5. CO2 flux on water surface 1-6. Multi-beam sonar 1-7. CO2 flux around the lakes 1-8. Boats including engine 2. Lake, spring, well, rain and river water sampling <ol style="list-style-type: none"> 2-1. Niskin sampler 2-2. MK method 2-3. Dissolved gas sampling 2-4. Treatment at the sampling site 2-5. Preparation of pure water (milli-Q) | <p>A-1) Hard copy and electric file on web site</p> <p>A-2) Necessary reagents, standards, sampling tools, disposable materials (cleaning paper etc) and carrier gases etc in the lab</p> | None |

3. Water analysis

3-A physical parameters

3-A1. Temperature

3-A2. Conductivity

3-A3. pH

3-A4. Discharge rate (if possible)

3-B Chemical parameters

3-B1. Dissolved CO₂3-B2. Dissolved O₂

3-B3. Alkalinity

3-B4. Anions (major)

3-B5. Cations (major)

3-B6. Trace elements (relevant per sample)

3-C Isotope analyses

3-C1. D/H and ¹⁸O/¹⁶O ratios

4. Gas analysis

4-1. ¹³C/¹²C ratio of CO₂

B) Proper use of each analytical and observational instrument

C) Systematic storage of water and rock samples

B) Notebooks for the record of use, showing dates, name of analyzer, supplier of sample + sample ID, amount paid for each parameter analyzed in the sample, the condition of instruments etc

C) Shelves in the building of laboratory at Nkolbison for storing well cataloged (GIS ref) water & rock samples

| | | | |
|--|--|---|------|
| | <p>D) Communication among the project team members</p> <p>E) Funds-raised for the maintenance of analytical equipment.</p> | <p>D) Use of a groupware through internet</p> <p>E-1) Stand-by funds to be managed by the laboratory head for buying lab supplies as soon as need arises</p> <p>E-2) Acceptance of analytical request with charge</p> | |
| <p>Outputs</p> <p>1. The mechanism of limnic eruption is understood.</p> <p>2. The CO₂recharge system beneath Lakes Nyos and Monoun is understood.</p> <p>3. The hydrological regime around Lakes Nyos and Monoun is understood.</p> <p>4. The interaction between rock and CO₂-rich fluid is understood.</p> <p>5. Lakes Nyos and Monoun are monitored.</p> <p>6. The experimental system for removing CO₂-rich deep water to prevent gas rebuilding at Lake Monoun is set up.</p> <p>7. Magmatism of Oku volcanic zone is understood.</p> <p>8. Geochemical parameters of lakes along CVL other than Nyos and Monoun are understood.</p> <p>9. The results of scientific monitoring are systematically shared with the Department of Civil Protection (DPC).</p> | <p>1. A) A scientific journal paper B) Report for local people C) Information on Web site</p> <p>2. A) A scientific journal paper B) Information on Web site C) Awareness workshop for local people</p> <p>3. A) A scientific journal paper B) Outreach activities for local people</p> <p>4. A scientific journal paper</p> <p>5. A scientific journal paper</p> <p>6. A technical paper on the CO₂ removal system</p> <p>7. (a) PhD thesis (b) Scientific journal papers</p> <p>8. A scientific journal paper</p> <p>9. A) Seminar with DPC B) Special session in CVL-9</p> | | None |

| Activities | | Inputs | | None |
|---|--|--|---|------|
| | <Indicators> | <u>Japan</u> | <u>Cameroon</u> | |
| 1-1 The conditions under which limnic eruption can occur are constrained through computer-simulation. | 1-1 Computer simulation code | Personnel - Chief Advisor | Personnel - Project Supervisor | |
| 1-2 Acoustic survey of the detailed topography of the bottom in Lakes Nyos and Monoun is made to locate the recharging point of CO2 enriched fluid. | 1-2 A) Bathymetric map of Lakes Nyos B) Bathymetric map of Lake Monoun | - Project Coordinator - Geochemistry - Volcanology | - Project Manager - Counterpart personnel | |
| 1-3 The conditions under which limnic eruption can occur are estimated, and utilized to judge the safety of the lakes. | 1-3 Recommendation to concerned authorities highlighting safety conditions | - Petrology - Geology - Geography - Hydrology - Other fields that are mutually agreed upon as necessary | Facility - Office space, furniture, facilities for communication and public utilities, and meeting rooms necessary for JICA Experts to undertake project activities - Space and appropriate facilities for the installation and storage of equipment with antitheft security at IRGM, Lake Nyos and Lake Monoun | |
| 2-1 3D distribution of CO2 in the lakes is investigated, which can be used to locate the recharging point of CO2 enriched fluids. | 2-1. A) 3D distribution map of CO2 in Lake Nyos B) 3D distribution map of CO2 in Lake Monoun | Equipment - Water and gas analysis - Monitoring equipment | - Other facilities mutually agreed upon as necessary | |
| 2-2 The CO2 flux from soil and the surface of Lakes Nyos and Monoun. | 2-2. A) CO2 flux map on the surface of Lake Nyos B) CO2 flux map on the surface of Lake Monoun C) CO2 flux map around the Lake Nyos D) CO2 flux map around the Lake Monoun | - sampling and observation - removing CO2-rich bottom water - Others mutually agreed upon as necessary for the implementation of the Project | Local Cost | |
| 3-1 The flow path of groundwater around Lakes Nyos and Monoun is established | 3-1. A) A detailed topographic map around Lake Nyos B) Ground water flow map around Lake Nyos C) Ground water flow map around Lake Monoun | Training in Japan Activities in Cameroon | | |

| | | |
|---|--|----------------|
| 3-2 The interaction between surface water and groundwater is understood. | 3-2 A) A water quality map around Lake Nyos B) A water quality map around Lake Monoun | |
| 3-3 The water balance in Nyos basin is estimated. | 3-3 A Data base for climate and hydrological data for Lake Nyos | |
| 4-1 Natural experiments on the interaction between rock and CO ₂ -rich fluid are carried out to understand geochemical and mineralogical processes in a sub-lacustrine CO ₂ -supply system. | 4-1 A) Photographs on mineral precipitation and dissolution B) Specimens of experiments | |
| 5-1 Automatic observation systems to monitor the lake water and climatic parameters are installed in Lakes Nyos and Monoun and the data are transmitted to IRGM via satellite. | 5-1 A) Climatic station B) Automatic observation buoy | |
| 5-2 Work rafts to collect water and gas samples are set up at Lakes Nyos and Monoun. | 5-2 A) Work rafts on Lake Nyos B) A Work raft on Lake Monoun | |
| 5-3 The amount of CO ₂ remaining in the lakes will be measured through physical and chemical methods on a regular basis, at least, once a year. | 5-3 A) A data base on the components in Lake Nyos B) A data base on the components in Lake Monoun | |
| 6-1 An apparatus to pump CO ₂ -rich deep water is designed and tested at Lake Monoun to evaluate its capability, cost-performance and easiness of maintenance. | 6-1 A test system for the removal of deep lake water in Lake Monoun | |
| | | |
| | | Pre-Conditions |
| | | None |

| | | | |
|--|---|--|--|
| 7-1 Geological and petrochemical survey of rocks from Oku volcanic zone. | 7-1 A petro-chemical data base for rocks of the Oku Volcanic Group | | |
| 7-2 Geological maps of the Nyos and Monoun areas are produced. | 7-2 A) 1/25000 scale geological map of Lake Nyos area (B) Explanatory note for the 1/25000 scale geological map of Lake Nyos area (C) 1/25000 scale Geological map around Lake Monoun area (D) Explanatory note for the 1/25000 scale geological map of Lake Monoun area | | |
| 8-1 The CO2 flux around the lakes other than Nyos and Monoun along the CVL. | 8-1 CO2 flux maps at lakes other than Lakes Nyos and Monoun | | |
| 8-2 Basic survey are carried out at other lakes along the CVL. | 8-2 A geochemical data base on the lakes other than Nyos and Monoun along the CVL | | |
| 8-3 deleted | | | |
| 9-1 The results of scientific monitoring are sent to DPC | 9-1 Annual report including data and interpretation. | | |
| 9-2 Recommendations for disaster management are proposed based on scientific findings. | 9-2 Final project report | | |