REFRA-SOS project

(Realtime Flood Risk Assessment in developing countries using Social media, Optical and SAR satellite data, IGCP734)

Sponsored by

UNESCO International Geological Correlation Programme (IGCP)

and Space Generation Advisory Council (SGAC)

IGCP 734 Annual Workshop 2022

Small satellite constellation, Artificial intelligence and Internet of Things (IOT) for flood assessment using open access data and tools

Flood risk assessment in Cameroon: The present

WORKSHOP REPORT

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December 2022

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List of Abbreviations

EUMETSAT: European Meteorological Satellite

FRIEND: Flow regimes from international experimental and network data

GRAPHIC: Groundwater Assessment Under Human Pressure and Climate Change

G-WADI: Global Information Network on Water and Development in Drylands

HELP: Hydrology for the Environment, Life and Politics

IGCP: International Geological Correlation Programme

IIQW: International Initiative on the Quality of the Water

ISI: International Sedimentation Initiative

ISRAM: Management of the resources of shared aquifers at the international level

MINEPDED: Ministry of Environment, Protection of Nature and Sustainable Development

REFRA-SOS: Realtime Flood Risk Assessment in developing countries using Social media, Optical and SAR satellite data

SGAC: Space Generation Advisory Council

STEA: Space Technology for Earth Applications

UNESCO: United Nation's Education Science and Culture Organization

UWMP: Urban water management

W4L: Water For Life Cameroon

WHYMAP: World hydrogeological map

WWAP: World Water Assessment Program

1. Introduction

In the era of the rapidly changing climate, flood events are becoming more intense and more frequent posing losses of invaluable lives and properties worldwide, especially in the developing countries. Preventing floods or planning emergency or long-term response is mandatory of existence of useful and reliable information about flood expansion, affected zones, livelihoods, and services as well as up to date information about the situation. REFRA-SOS project (Realtime Flood Risk Assessment in developing countries using Social media, Optical and SAR satellite data, IGCP734), sponsored by UNESCO International Geological Correlation Programme (IGCP) and Space Generation Advisory Council (SGAC), aims to address these challenges by developing sustainable and effective management plans/tools driven by Earth Observations, social media crowdsourcing, and hydrological models. The project is about advancing international cooperation, knowledge transfer, and technological development. It brings together expertise from all continents and focus on coastal floods with Douala as a case study in Cameroon. Its objectives are to: (1) To inform policymakers and the local population on the dataset available online for flooding risk assessment and management, (2) *engage with local communities and youths for supporting behaviours change towards flood risk reduction*, and (3) propose technically feasible and economically viable solutions for *flood risk reduction*.

This second workshop falls under the third objective of the project and is a contribution to the 2022 global disaster reduction international celebration under the theme " ***Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030***". It focuses on the open datasets and tools to develop discussion on their real contribution to risk assessment and response strategies using Douala estuary in Cameroon as a case study. The second workshop in the series will focus on flood conditioning factors and methods/technologies and the needs for improvement, using Cameroon as a case study. The potential and future outlooks for using Small satellite constellation, Artificial intelligence and Internet of Things (IOT) for flood assessment in flood risk assessment will also be discussed. This workshop links several fields and is opened to city managers, scientists, engineers and people interested in citizen science. The aim of this workshop was to introduce young scientists and professionals to flood risk assessment using hydrology, AI and remote sensing tools as well as open-source data as a contribution to flood risk mitigation efforts. It is a strategic activity towards engaging with local communities and youths for supporting flood risk reduction through knowledge sharing and behavior/perception change.

The workshop gathered several participants around fruitful discussions on zoom platform which are highlighted within this report. The report has six sections: participant's demographics, opening ceremony, plenary sessions, panel discussions, break-out room discussions, and feedbacks from participants.

2. Participant's demographics

69 participants out of 423 registered attended the workshop with 52 participants who took the online evaluation of the workshop at the end.

It is worth mentioning that those who registered, expressing their interest in the workshop theme and content, where coming from 54 countries (Algeria, Australia, Austria, Bangladesh, Bolivia, Brazil, Burkina Faso, Cameroon, Canada, China, Colombia, Costa Rica, Ethiopia, France, Germany, Ghana, Greece, Haïti, Hungary, India, Indonesia, Ivory Coast, Japan, Jordan, Kazakhstan, Korea, Laos, Liberia, Luxembourg, Mauritius, Malaysia, Mexico, Morocco, Nepal, Nigeria, Pakistan Panama, Philippines, Romania, Rwanda, Senegal, South Africa, Spain, Sri Lanka, Taiwan, Tanzania, Togo, Tunisia, Turkey, United Arab Emirates, United Kingdom, United States of America, Zambia and Zimbabwe) over all Continent. This clearly indicate flood is a shared concern globally and discussion going on within this project would be of great interest to a large number of people in the world.

Of those who finally attended the workshop 71.1% where under 35 and most came from Africa (63.5%), Asia-Pacific (25%) and Europe '11,5%) as shown on figure 1. The first two regions are the most susceptible to floods in the world. They are also those who have the lowest coping capacities and higher exposure. This situation is predicted to be worse with future climate change trends. 26.9% of the attendees were female, 52% students and 75% from university and research sphere, while 11.5% were from Governmental institutions, 9.6% from private institutions and 3.8% from Nongovernmental organizations.

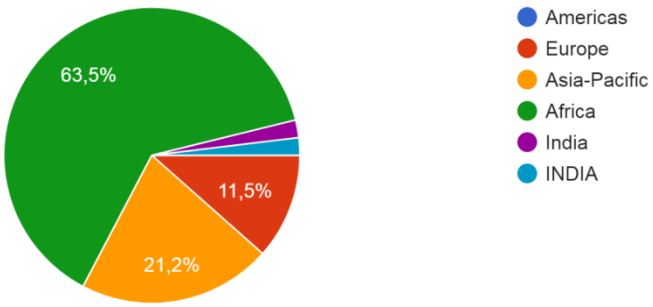


Figure 1 : Figure: Geographical origin of participants to the workshop

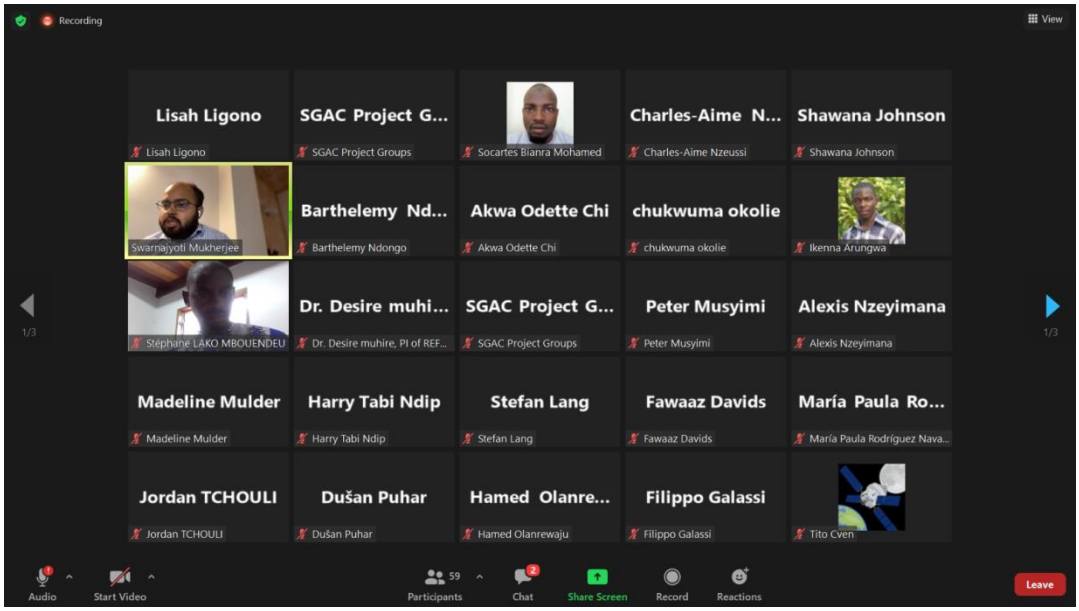
Attendees were coming from different backgrounds including: engineers, government institutions, researchers, graduate and undergraduate students, lecturers, researchers and corporate (see Figure 2). The participants were mainly from the following institutions:

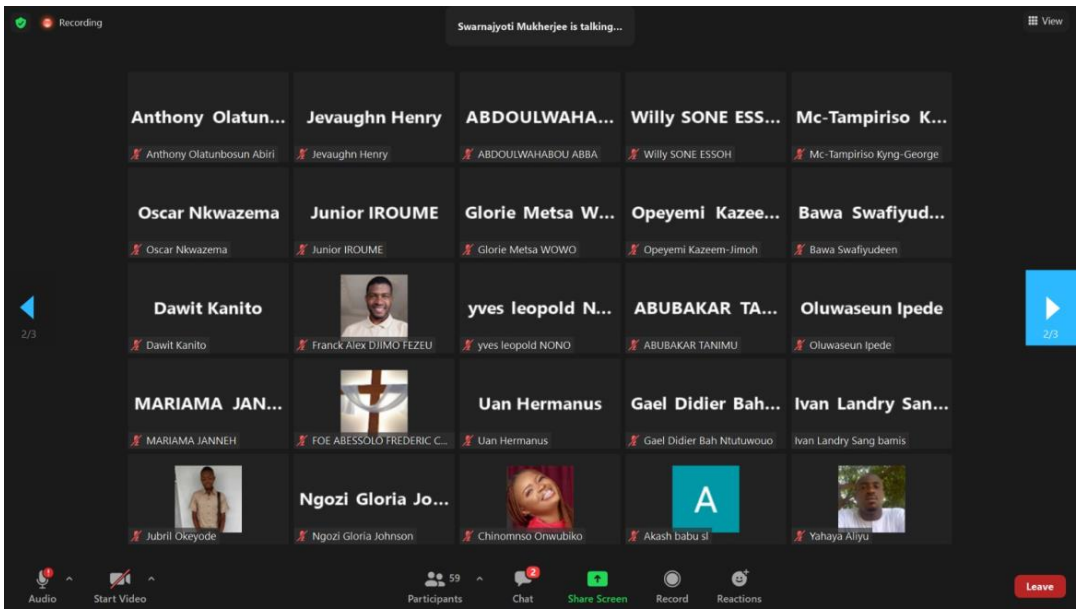
- Governmental institutions (Department of National Meteorology, Ministry of Transport Cameroon, Institute of Geological and mining Research Cameroon, Ministry of Environment, Nature Protection and Sustainable Development Cameroon),
- High schools (Federal School of Surveying, Oyo, Hassan Usman Katsina Polytechnic Katsina, ATBU, Institute of Forestry),

- Universities (University of Dschang, Kathmandu university, University of Chouaib Doukkali, University of Lagos, Ahmadu Bello University Zaria, Bangladesh University of Engineering and Technology),
- Non-Governmental Organizations (Clean Water and Sanitation Africa, Water For Life Cameroon, SGAC), Private companies (Satellogic, Cloud Data Technology, Mahoñol SARL)
- and UNESCO (Central Africa Regional Bureau).

All sectors showed interest for this workshop, and they brought insightful contribution to discussion. This is also a sign that collaboration to foster projects is possible.

From the monitoring of participation duration it is clear more than 75% participants attended to the workshop till the end for 04 hours while breakout room discussion drove 64% of the participants. Most of the participants got interest about flood risk assessment practices. Other sessions got almost the same interest for participants.





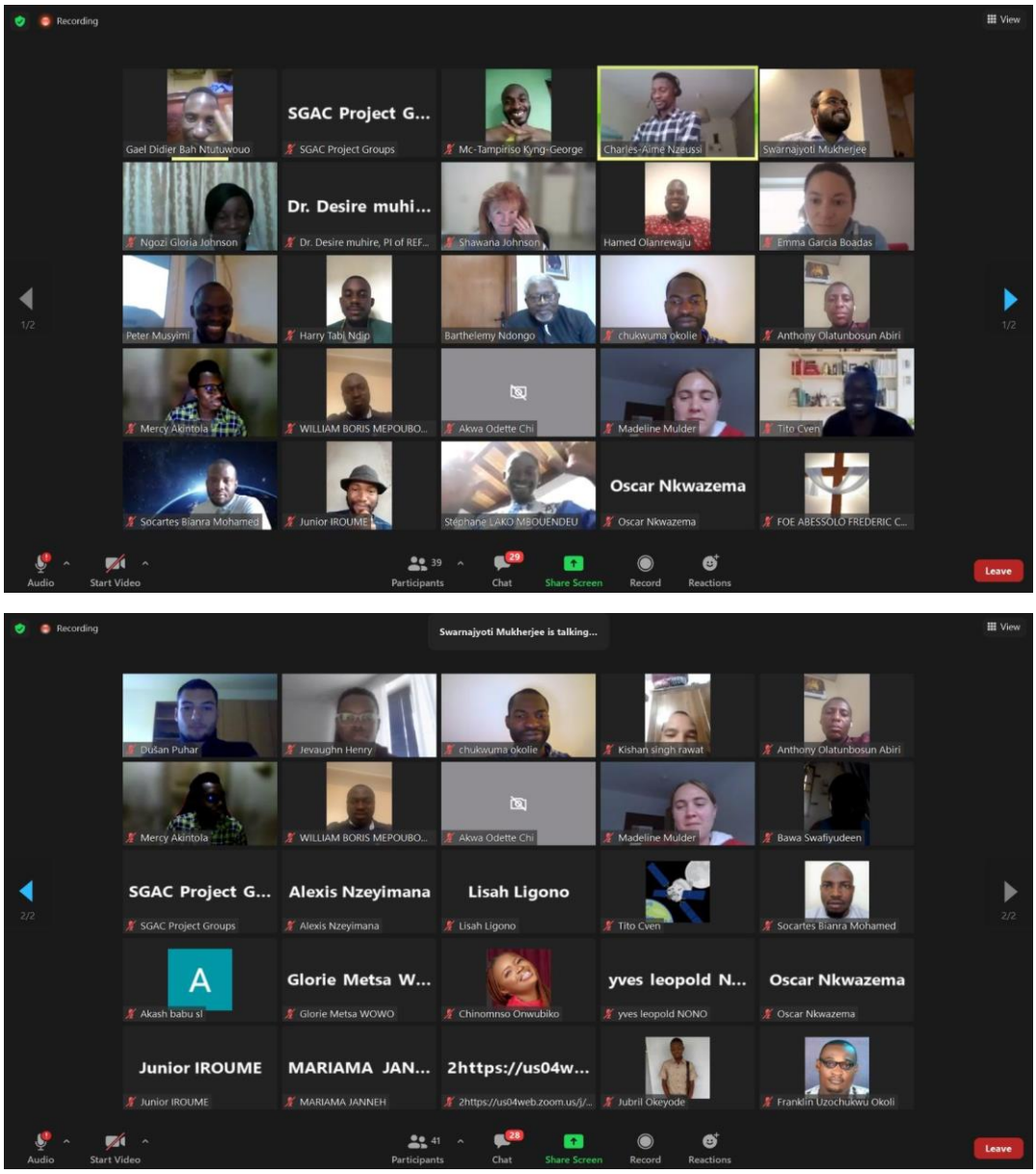


Figure 2 : ZOOM Photo of participants

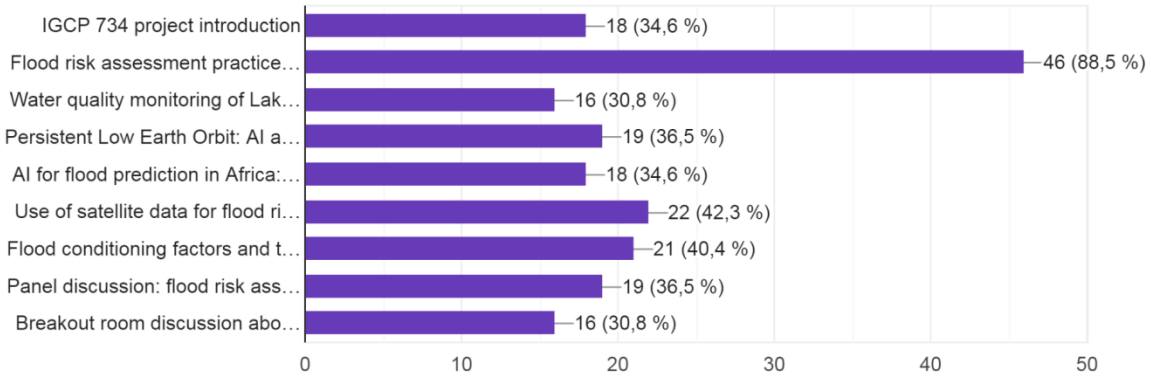


Figure 3 : *Sessions of the workshop which cached attention from participants*

3. Opening ceremony

The opening ceremony was punctuated by a presentation of the workshop facilitator, agenda, a recall of rules for the smooth running of the workshop. The principal investigators introduced the goals and status of the IGCP 734 project, followed by introductions of the project Lead institution, the Space Technology for Earth Applications (STEA) project group of the Space Generation Advisory Council (SGAC).

SGAC is a network of 364 members from 74 countries mainly from science, engineering fields recruited both in private, education and government institutions. Most of SGAC members are under 30 with 41.6% female members. As one of the key project of the STEA working group the REFRA SOS project draws several scientists from the group and envision future development in disaster risk reduction using satellite and earth observation Specifically plans for future include: earth observation and satellite technology for flood in developing countries, possible applications of satellite technology for communication, alert, disaster study, monitoring and response.

Water For Life Cameroon is a local organization mobilizing young talented people from science, engineering, social and law field around the vision of "water, healthy environment and decent life for all". They are engaged in promoting youths in water management with hydroclimatic risks, sanitation, drinking water, hygiene and water resources as their main focus.

4. Plenary sessions

Presentation 1: Earth observation for natural disaster risk reduction By: Luciano Giesso **Company**: Satellogic
Satellogic contributes to the space industry by building Earth Observation satellites for the purpose of geospatial mapping. The company aims to explore the Earth's surfaces and provide contribution toward improving life and preventing natural disasters using satellite data. The company was founded in Argentina. Their fleets of satellites are equipped with multispectral and hyperspectral cameras, and they cost less than other conventional satellites. The names of the satellites are chosen to honour women in STEM. Currently, there are 22 commercial satellites and an additional of 3 prototype satellites that are currently being tested. Satellogic assists in natural disaster risk reduction through emergency responses by providing near real-time satellite imagery of events such as floods and hurricanes. Some recent examples include flooding of Rhine river in Bohn, Germany, an Uttarakhand Hydro Plant flooding incident in India, and the recent blockade of the Suez canal by the Ever Given cargo ship, mudslide in Atami, Japan, monitoring of Pacaya volcano in Guatemala, the Beirut explosion, and wildfires in Sichuan, China. Satellogic's fleet of satellites can take images of the same location for up to 4 times per day.

Presentation 2: **Flood risk assessment: how artificial intelligence could be an issue for developing countries**

By: Rollis Ernest Jiofack **Institution**: Water Youth network

A flood is a temporary submersion, natural or artificial of space by water. There are three different types of floods: flash floods, fluvial foods, and urban floods. Flash flood is the most dangerous. Flood risks are assessed using a combination of hazards, vulnerability, and exposure. The risk mitigation measures are based on the intensity of the flood and the speed of water rise, the exposure of human activity to the flood, and the vulnerability of the exposed elements. There are five steps of integrated flood risk management: reduce flood hazard, protect against floods, regulate land use, raise awareness and preparedness, and mitigate residual risk. Artificial intelligence could help us with mapping floods in developing countries using for example forecasting flow require to integrate meteorological data, soil condition data and flow monitoring data. The more the data collected the more artificial intelligence could help develop efficient models or adjust existing predefined models like MPE-EUMETSAT, RFE2-NOOA, and FLOOD MAPS-UNED-GAR. We use those data to assess and anticipate the flood events prior to the start of the events.

Presentation 3: UNESCO contribution to global water security

By: Dr. Annie-Claude Nsom Zamo epse PIAL **Institution**: UNESCO regional office for Central Africa

UNESCO seeks to build peace through international cooperation in Education, Sciences, and Culture. The science sector focuses on ecological science, technology, and innovation as well as hydrological sciences. One of the major programs is the Intergovernmental Hydrological Program (IHP), which was launched in 1945. This program is undergoing its ninth cycle focusing on Water Security: Responses to Local, Regional, and Global Challenges. There are many institutions working with UNESCO such as 36 centres around the world, 60 chairs, 169 national committees, and World Water Assessment Programme (WWAP). Additionally, there are many programs working with UNESCO related to water security. Through their support to central Africa Water security and youth engagement UNESCO supported two projects in recent years: (1) EYD2R (Enhancing youth participation to flood and drought risk management) with training of 26 youths in Hydroclimatic risk management and project writing and (2) CAY T Dakar (Preparation of Central Africa Youths to 9th World Water Forum in Dakar) with support and showcase of 03 projects out of 186 screened as well as the sponsoring of the participation of 02 Youths.

Presentation 4: Floods prevention and management tools in the Logone transboundary watershed Cameroon.

By: Dr.NdongoBarthelémy**Institution**: University of Dschang-Cameroon.

The hydrological system of the Logone basin is very complex. Logone basin located at the boundary between Cameroon and Chad is prone to frequent flood submersion mainly caused by torrential rains. Response to flood generally include five key stages: prevention, mitigation, preparedness, response, and recovery. Their activation and mechanisms depend on the vulnerability state of the affected system (land, people, services, assets, resources). As far as the Logone basin is concerned, major sources of vulnerability include absence of an effective early warning system, absence of strategic local response plans, and lack of critical skills. These vulnerabilities specific to disaster risk management are exacerbated by major structural vulnerabilities including poor access to basic social serves, booming demography, low revenue households, severe degradation of natural resources and low coping capacity. Flood management in terms of prevention and tools remains to be consolidated in the Logone basin in particular and in Cameroon in general. The developed methodology and proposed tools such as social media, optical, and SAR satellite data are needed in this environment for relevant floods mitigation.

Presentation 5: Progress from IGCP 734 project, REFRA-SOS

By: Dr. Desire Muhire **Institution**: University of Chouaib Doukkali, Morocco

The presentation describes the progress of the project in its first year with focus on flood risk research in Cameroon, knowledge transfer through academic internship and the presentation at the International Astronautical Congress. The study area is the economic capital city of Cameroon, Douala, which is frequently affected by floods. From the research it was found that optical images are obscured by clouds and hence are not very useful in mapping floods. A better alternative is the use of radar imagery. This project aims to mitigate flood risks in Cameroon by using the latest technology available along with inputs from the community through social media crowdsourcing. The use of social media is driven by its ability to indicate challenges faced by citizens, track alert and give information about affected zones. Flood analysis method used in this project is based on the change detection approach process which is divided into three steps: standard process, map refining, and damage assessment. The goal is to develop a solution that combines SAR remote sensing data, social media, and artificial intelligence to provide the flood maps (risks or occurrence). For now, the project focused on understanding past flood events and their causes. In conclusion, we want to achieve of understanding the past and causes of floods in Douala.

Presentation 6:Using Artificial Intelligence to assess flood risk on a watershed	
By: Mr. Njila Roger	**Institution**: University of Dschang, Cameroon
A flood is an overflow of water that submerges land. Flood has three parameters: hazard, vulnerability, and exposure. Existing approaches include statistical analysis, multi-criteria analysis, scenario-based inundation analysis, and analysis based on geographical information system (GIS) and remote sensing techniques. To create a risk map, you can use vector or raster information. Raster information is a combination of matrices whether vector information consists of a set of reasoning rules and provide qualitative analysis. Artificial intelligence offers the opportunity to manipulate and process high volume of data using complex physical models. It also provides means to integrate data from different sources and develop near real-time scenarios for emergency decision making. There are several opportunities to utilize artificial intelligence in flood assessments such as integration of social media, science-based decision making in town planning, hazards response or investments. Though, there are some challenges associated with use of artificial intelligence: the poor or non-existent system for data gathering and archiving, absence of skilled specialists, absence of artificial intelligence support infrastructure, and poor network coverage for performing data transfer and real time analysis.	

5. Panel discussions

The panel discussions focused on the potential of using synthetic aperture radar (SAR), social media crowdsourcing, and artificial intelligence (AI) in flood risk assessment.

Historically, science is based on hypothesis testing. Scientists make observations and conduct experiments trying to confirm or falsify the hypothesis. In recent years, science is shifting from hypothesis-driven to data-driven. There are so much available data and scientists often start with looking at patterns in the data rather than forming a hypothesis about some phenomenon. There is a growing interest in science-informed decision making and access to internet provide access the multiple data and information which sometimes only need to be revealed and better exploited.

One of the data types that could be more exploited is the social media data. Social media provides a platform for communication between scientists and the communities and can be utilized for public education and awareness. A psychological effects on individuals need to be carefully considered when developing social media-based solutions.

The biggest challenge for Africa is limited internet access and hence cloud-computing resources. In rural and remote areas where access to networks and internet are a challenge, innovative solutions have to be designed, such as community radio towers, social structures, posters as well as broadcasting instruments. In recent years, technological advancements reach unprecedented levels. 20 years ago, there was no access to internet or small laptop computers. Today, we have smartphones that can perform complicated calculations. In the

present, internet in rural area is mostly cable-based. This might change in the years to come with the increasing number of satellites and therefore satellite-based internet maybe available anywhere on Earth.

Despite expected technological breakthrough, collaboration with multi-stakeholder analysis is still at the heart of all flood assessment or response intervention. In the context of increasing flood or disaster, multi-stakeholder approaches are then to be used with community, technical science, decision makers, coming together and addressing the hazards. It's also important to involve elders who are witnesses of changes; they can help in tracking driving factors. It may also be important to plan wisely, and act as planned to prevent and increase flood resilience. Experience sharing from flood resilient areas is also an interesting option.

6. Break-out room discussions

6.1. Constraints of using emerging technologies for flood assessment in developing countries

The discussion focused on the constraints to access and use earth observation and artificial intelligence to address flood risk assessment. Some of the issues raised include:

- Data availability, especially hydrological data, and the fact high resolution DEM are commercialized at inaccessible costs for developing countries
- Proper mapping and delineation of flood risk zone in terms of the spatial extent, using earth observation satellite, community involvement and local knowledge
- Available open data set gives DMN of low resolution (greater than 20 m) which make modelling not accurate
- Access to meteorological and hydrological data access
- Low performance or lack of hardware facilities to take advantage of existing technology
- Few academic training programs in developing countries

It was suggested as possible ways out bridging and more collaboration and networking between agencies scientific institutions, governments and experts as well as more education opportunities for young scientists from developing countries in the areas of implementation of Artificial intelligence, remote sensing and machine learning. A good example being the Water quality monitoring around lake Chad by CBLT and UNESCO

It was also indicated that High resolution are commercial products and can only be made available either by purchasing (expensive cost) or convention between institutions

Discussion was done on the constraint of handling flood risk assessment in sahelian zones which are not much linked with distance from flows but which mainly depends on geology and flow speed. Participants suggested adjusting the conditioning factors and diversifying data source for models development or quest for collaboration with earth observation

agencies. But also use data fusion to fuse data from different image source to take advantage of each of them.
Somme interesting links to useful resources were shared within the group and are listed below:

Review of digital model (DEM) fusion methods
https://www.sciencedirect.com/science/article/pii/S0924271622000892
Global surface hourly wind speed and direction data from the National Climate Data Centre (NCDC) of the United States National Oceanographic and Atmospheric Administration https://www7.ncdc.noaa.gov/CDO/cdo
PERSIANN (Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks) system developed by the Center for Hydrometeorology and Remote Sensing (CHRS) https://chrsdata.eng.uci.edu/
Some hydrological datasets:
https://climateknowledgeportal.worldbank.org/download-data
https://cds.climate.copernicus.eu/cdsapp#!/dataset/insitu-observations-gruan-reference-network?tab=overview
https://gpm.nasa.gov/data
https://cds.climate.copernicus.eu/cdsapp#!/dataset/insitu-observations-gruan-reference-network?tab=overview
https://catalogue.ceda.ac.uk/uuid/251474c7b09449d8b9e7aeaf1461858f
https://climatedataguide.ucar.edu/climate-data/advanced_search
https://www.worldclim.org/data/index.html
https://www.ncdc.noaa.gov/cdo-web/
https://psl.noaa.gov/data/gridded/

6.2. Utility of Current flood risk assessment tools in developing countries

The discussion on the usefulness of current flood risk assessment tools in developing countries. Key conclusions from discussion are

- There is No identifiable flood risk tool for developing countries
- It is difficult to assess flood in developing countries, because of poor delineation of boundaries. Besides DMN were not initially made for flood risk assessment
- Existing flood risk tools are depended to access to internet which is a major obstacle in developing countries .
- There is No centralised pool for data and tools. This leads to multiplicity of armature tools, and duplication of efforts.
- There are Issues of data integrity, data accessibility and datum harmonization for spatial data due to diverse methods and platforms to collect ground or factual data.

- There is no deployable tool due to low artificial intelligence and machine learning tools penetration.
- Difficult mainstreaming of real-time data for purposes of forecast.

It was highlighted the necessity to create apps to collect data and report on flood risk (e;g; experienced in italy) and work towards the harmonization of approaches to not redesign existing solutions.

6.3. Opportunities for scientific development in flood science and engineering for developing countries

The focus of this group was the identification of opportunities for scientific development in flood science for developing countries. Three major areas were identified:

- Need for funding and specific policies considering flooding as a humanitarian issue.
- More interest and funding needs to be allocated in flood preparedness.
- Community should be involved with the help of mobile technology, IOT and online platform

In fact, in less developed countries the key challenge is finance. Decision makers don't feel like investing on disaster risk prevention is not the prime priority and invest less in EO and AI

7. Feedbacks from participants

7.1. Most valuable concept taken from the workshop

Artificial intelligence

Artificial intelligence (AI) plays a key role in flood risk assessment and even represent the future in real time flood hazard assessment models through the "Internet of Things" (IOT). Using AI would then help in flood prediction in several part of the world and specifically in Africa which is less advanced in flood risk technology. This may bring a shift in preparation and response approached of African countries and other countries show same exposure and coping capacity.

Remote sensing

Remote sensing can be intensively used in remote flood monitoring Flood and prediction models beyond the commonly accepted natural resources monitoring. The modern techniques/ used in assessing deforestation via Remote sensing could be adapted for Remotely monitor floods..

Satellite and earth observation

This workshop highlighted the importance of Satellites and Earth Observation in monitoring water resources and pointed out practical example of how satellite technology are used as a

valuable tool in tackling natural hazards such as floods. Besides using satellite position system and matching up with previous weather data and analysing water quality could hepl in the improvement of flood control techniques

Social media

Social media is a solution to flood preparedness and awareness raising. Sharing relevant information through social media could help improve resilience of dwellers of flood prone area but also inform decision makers about flood events and needs for emergency action. Integrating social media and remote sensing data for flood assessment in developing countries are realistically applicable methods. Despite their low access space technologies for EO, at least they have a considerable amount of social media users and access to some remote sensing data from satellites like the Landsat 8.

Flood risk factors and mitigation

Analysis of flood conditioning factors brings further innovations on flood risk assessments method. The methodology using disparate data sources and free access to satellite images/ data seemed original but this approach needs control measures with respect to time and distinction in flood assessment practices adapted to regional context. more needs to be done on creating state-of-the-art techniques in Flood assessment for developing countries, considering its peculiarities.

Response to flood risk needs prevention and we must all rise to curtail Flood effects on our environment. In fact, through prevention we could preserve the populations, assets, services and environment and reduce the negative impact of floods (poverty, famine, rural exodus and unemployment). This requires pro-activeness and a constant monitoring of key features dealing with the risk management. To counter act this Open data, experience and technology sharing across border collaboration is the key for collectively manage natural disasters and reduce their advert effects on lives, livelihood, services, assets and economies. It is also important to inspire future researcher through hackhaton like the one presented by Zindi.

7.2. Changes in flood risk perceptions for participants to the workshop

- Expansion of horizon on Climate change and mitigation
- flood management is about the proper planning and extensive agriculture and avoiding some irrelevant foundations which will lead to instability in a hilly or higher altitude regions leading to excess flow of water through the channels and various dams present over there .
- Due to increasing flood events in developing countries, effective strategies are needed to reduce loss and damages.

- Proper monitoring of flood will help countries in preparing well for future flood risks in prone areas and countries
- Other than weather reports that we get using various modes of broadcasting the news is also important to raise awareness of a larger public
- Getting to know the complexities and advancements of flood risk assessment can inspire someone to create more convenient way to prevent the hazards of flooding.
- There are professionals who are actively working to mitigate disaster like floods in Cameroon.
- It was from this workshop that I found out Cameroon's National observatory of climate is actively working on this too unlike before when I thought not much work on this topic is being done in Cameroon
- Flood risk assessment Countries primary obstacle for Development of flood risk assessment is access to data
- Artificial intelligence discovered as a tool for effective hazard protection.
- Ability to manage information over time and reports will go a long way to save life's and property.
- Small satellite constellation for remote sensing are accessible to developing countries,
- Crowsourcing method can be adopted in flood mitigation
- Discovered the innovative solutions being used in developing countries, which I used to thing are limited to more developed countries having more technology and financial capacity
- Floods in developing countries can be predicted by researching into the past flood occurrence. This would give us enough information (causes, social and economic impact, extent of damage etc), which can be modeled to provide accurate predictions so that better infrastructures are built to mitigate the effects and control risks.
- By using the appropriate methods and technologies flood risk can be assessed
- the different approaches flood is manage
- Reporting some successful or in progress cases that are run by young scientists. I was very inspired by their approaches and how enthusiastic they are about bringing a change in this sphere of scienc
- negative impact of flood risk is better prevented than management.
- There is a lot more ingenuity that I was previously aware of, I thought the lack of access to technology was going to be a bigger hindrance than it seems to be

- I now know that it is quite possible to avoid the worst thanks to coordination between the actors involved in flood risk management
- With the help of advanced technology and innovative minds any problem does have a solution
- There are many initiatives to understanding floods in Cameroon, but the related work needs to be more shared.
- We are now inform of the use or AI for flood Risk assessment
- I have learned new tools and innovative methods
- To be more enthusiastic about how to use GIS and RS to solve flood related issues.

7.3. Primary obstacles to flood risk assessment in developing countries

Primary obstacles to flood risk assessment in developing countries are associated to finance, access to adequate data, human resources, technology, knowledge and institution. Specifically these obstacles are:

Financial

i. Lack of resources to invest in well designed and efficient drainage systems and dams due to reduced income of the government.
ii. Limited resources invested in research and human resource development for flood risk assessment and management
iii. Limited resources invested in technological development for disaster monitoring, assessment and management

Data

i. Data availability and data acquisition
iv. Insufficient access to adequate data (real time Data, appropriate scale and resolution)
v. Lack of sufficient accurate data like of high spatial and temporal resolution data, hydrological data, soil data, meteorological data
vi. Limited access to flood risk information or maps to end users
vii. Insufficient data on land use plans

Human resources

i. Limited number of skilled researchers in the field of disaster risk management and specifically flood risks

Technology

i. Lack of early warning system using remote sensing and GIS.
ii. Limited access to adequate technology and tools for flood risk assessment and management like earth observation, internet of things or artificial intelligence for rapid assessment
iii. Limited technological capabilities or know how of existing institutions working on flood risk assessment
iv. Lack of surveying technology and equipment to assess and monitor flood risk
v. Lack of adequate advanced tools for flood prediction

Knowledge

i. Unawareness of population of the risk magnitude and potential future disaster effect
ii. Unused Research on flood risk and flood management
iii. Lack of information on previous events and control mechanisms
iv. Low and time bounded political exposure of flood risk issue
v. Limited awareness raising or communication mechanisms
vi. Unsuccessful research project that could have prevent flood risk
vii. Lack of communication between stakeholders in disaster risk management
viii. Reactive management policies
ix. Unawareness of existing technologies and response options available and accessible for flood risk assessment and management
x. Insufficient capacities to properly represent flood susceptibility
xi. Clear understanding of hydrological dynamics

Institution

i. Dedicated funded institutions for flood risk assessment and monitoring
ii. Efficient collaboration with affected or potentially exposed communities
iii. Data informed decision making in the field of flood risk management

7.4. Social media use in flood management

Frequently used social media platforms from participants to the workshop are: whatsap, facebook twitter, instagram, and tik tok. The first three could be used in flood science either to collect informations or to transmit information about flood events and flood risks.

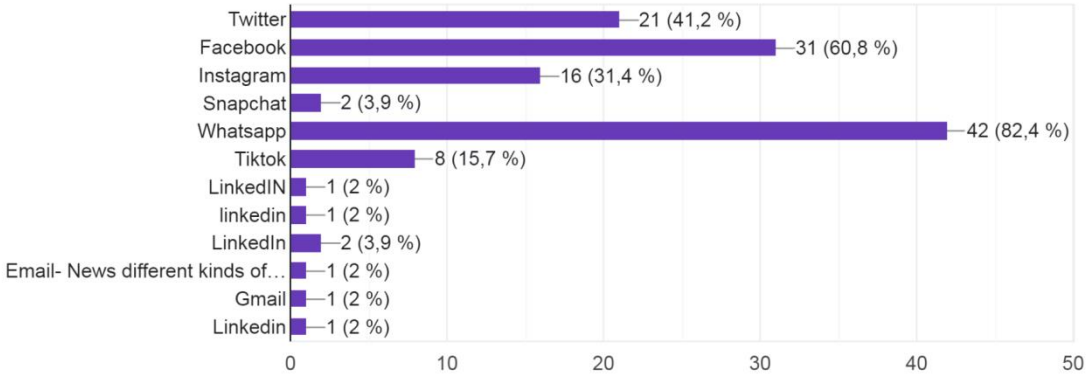


Figure: social media platforms used by participants to the workshop

Detailed analysis of the participant's perception indicates that social media could be used for:

- Flood risk awareness campaign
- Flood alert dissemination
- Communication among stakeholder about flood issues like coordination of response, dissemination of early warning, updates about measures taken, flood predictions, flood impacts,…
- Advocacy for appropriate flood preventive or response measures to be taken
- Timely reporting of flood events, flood field data, hazard consequences and impact perceived
- Develop survey tools with large audience
- Geolocalization of flood hotspots via tweets for example
- Collect spatialized data during a disaster for model calibration or validation
- Share meteorological alerts
- Inform about people reaction and vulnerability
- Data exchange
- Best practices dissemination to improve preparedness, response and resilience
- Discussion platform among organizations and actors
- Share knowledge about flood science
- Large public reach out for fundraising campaigns

7.5. Outcomes wished from REFRA SOS project

The outcomes suggested for the REFRA SOS project were about products, new research fields, project team membership and future project orientations.

Products

i. well-curated information that could help in flood prediction and risk management.
ii. Flood prediction models and solutions to flooding using geospatial technologies.
iii. develop early warning tools/system that will permit people to be informed at least 24 hours before about a potential flood so they can depart before it occurred
iv. Development of viable flood risk assessment tools adapted to developing countries .
v. Practical training modules on the use of Remote Sensing Data and AI for flood Risk evaluation

New research fields

i. Erosion and landslide in high rainfall and complex topography areas Western region of Cameroon.
ii. Test the methodology with more diverse open softwares in near future. T

Project team membership

i. Reaching out to interested or potential likeminded persons who cares about the our environmental welfare.
ii. More involvement of people from outside the region to give an automatic edge for an outsider to influence people and get a different perspective

Future Project orientation

i. Development of multicultural teams or data platforms that are focused on making data and technology available and accessible to everyone
ii. Mobilize different countries to work towards flood risk assessment, prevention and management
iii. Exchange experience with decision makers from developing countries
iv. Assess and support flood risk assessment methods improvement in developing countries,
v. Encourage more young people to pursue careers in related fields (flood science, artificial intelligence, remote sensing, applied statistics), given the potential of it
vi. Impact today's young generation so that they take this very serious problem into consideration and work effectively to make changes that could be mobilized to prevent floods.

vii. Continue to collaborate with various educational institutions to develop scientific techniques/tools to help mitigate flooding in other affected countries like Accra

viii. Transfer knowledge, technology and methodology to other developing countries once it is proven to be efficient.

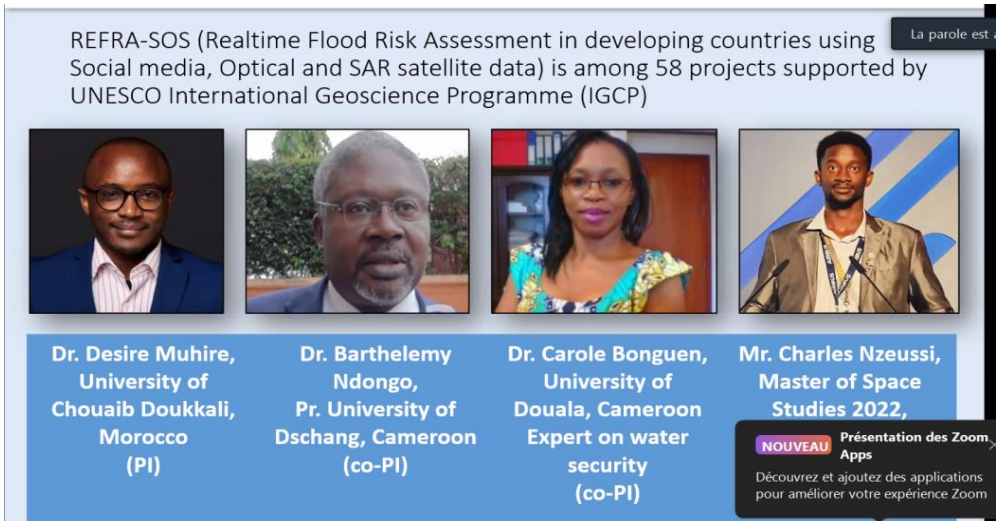
ix. Invite previous participants to future workshops and involve medias in future workshops to government interest to the issue and solutions developed

x. Apply the methodology to different areas in real cases in collaboration with flood risk prevention institutions including coastal, sahelian and hilly areas

xi. Bridging the communication gap between researchers, administrations and decision makers in charge of risk management in Cameroon

xii. Implementation of workshop's recommendations and develop policies related to flood risk in developing countries

Annex 0 : Project Core team



Annex 1 : Term of Reference of the Workshop

Theme:
Small satellite constellation, Artificial intelligence and Internet of Things (IOT) for flood assessment.

The STEA IGCP734 project organizes an **IGCG734 Annual Workshop 2022** with the topic "**Flood Risk Assessment in Cameroon: The Present**." The workshop is co-organized by STEA and our partner WaterForLife Cameroon with sponsorship from the UNESCO International Geological Correlation Programme (IGCP).

The workshop will be on **October 15, 2022, from 1 pm – 4.00 pm Cameroon time (UTC+1)** and will be hosted on zoom. The language for this workshop is English. The theme of this year's workshop is "small satellite constellation, Artificial Intelligence, and Internet of Things (IoT) for flood assessment."

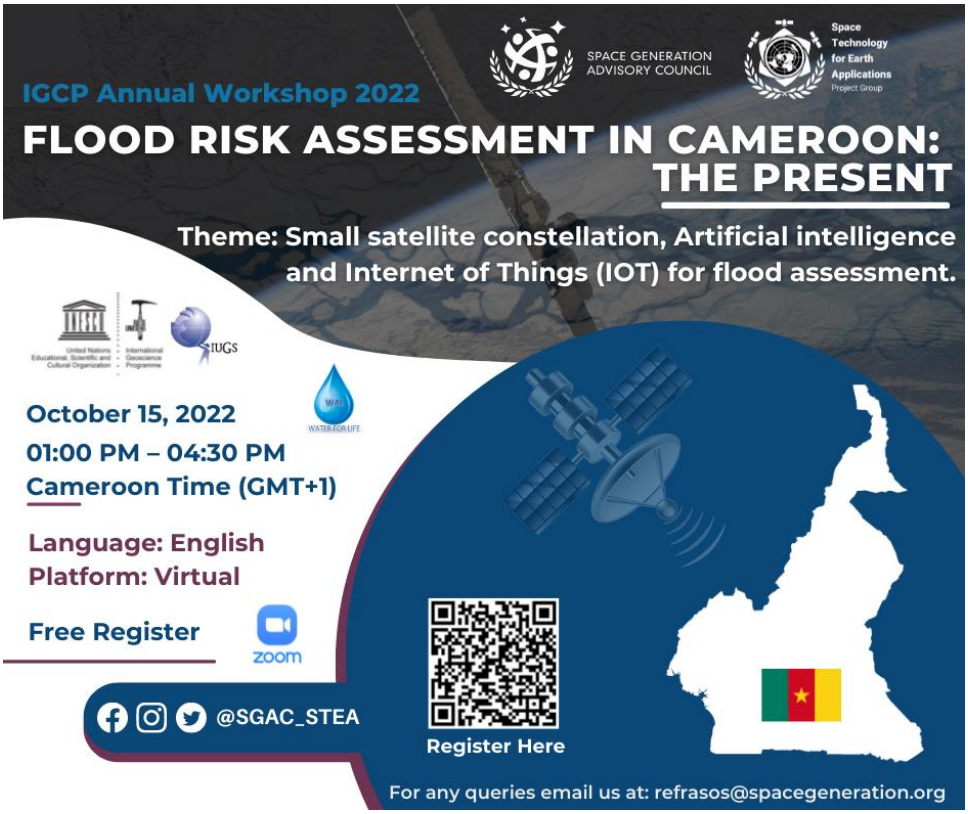
To register for the workshop, please follow this link:
https://spacegeneration-org.zoom.us/meeting/register/tZMvd-GhrDouEtHuK44Ku2w8jSOSWyaFw4ne

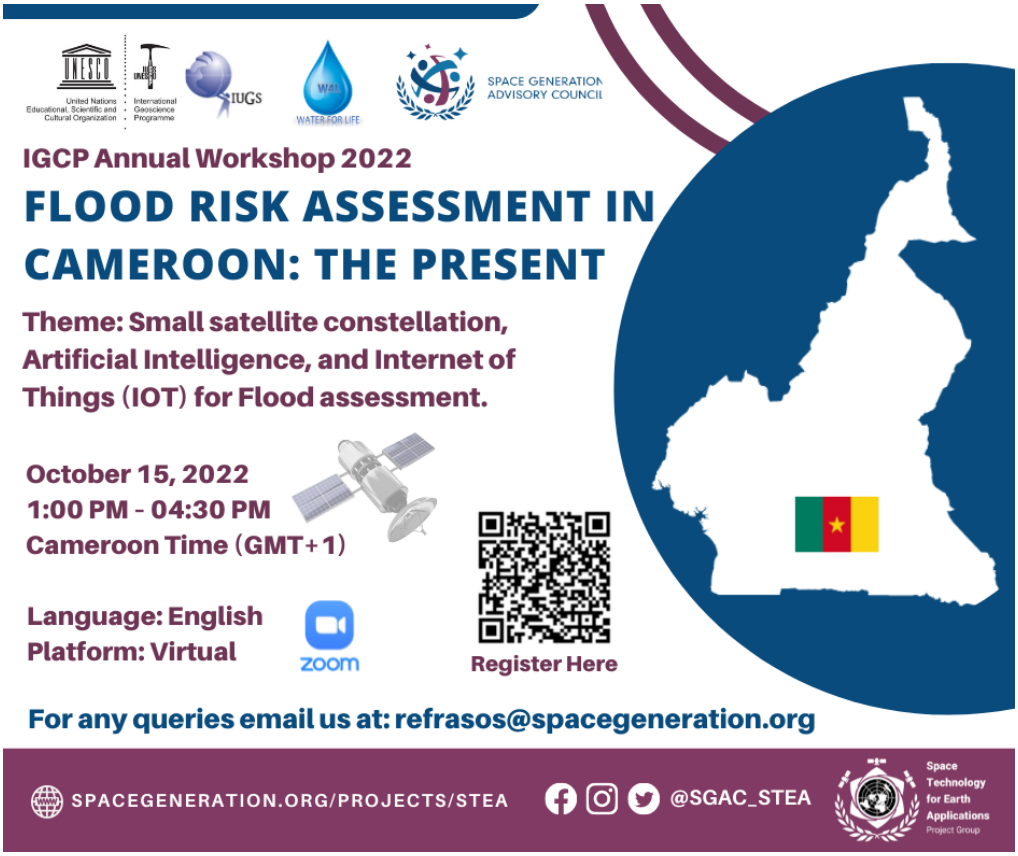
To learn more about our project IGCP 734 (Realtime Flood Risk Assessment in Developing Countries using Social Media, Optical and SAR Satellite Data, or in short REFRA-SOS), please visit our website:
https://en.unesco.org/international-geoscience-programme/projects/734
You can also check the website: https://sites.google.com/view/refra-sos/

Last year's workshop is available online through the SGAC YouTube account:
https://www.youtube.com/playlist?list=PLz0tdbacLdIHbvtt1G9WIdWebDwWwAhwR

Any questions can be directed to the REFRA-SOS team at refrasos@spacegeneration.org

Annex 2: Flyer of the workshop





Annex 3: Agenda of the workshop

	Speaker Name	Company / Organization	Role / Title	Topics
01.00 - 01.05 5 min	Mr. Charles-Aimé Nzeussi	SGAC/STEA member & REFRASOS Secretary	The moderator	Introduction of the event
01.05 - 01.15 10 min	Mr. Swarnajyoti Mukherjee	STEA Co lead, REFRASOS	Speaker 1Introduction: -SGAC-STEA projects -REFRASOS -Satellite Application	Satellite technology and earth observation for flood issues in developing countries
01.15 - 1.25 10 min	Dr. Barthelemy Ndongo	Inspector General at the Ministry in charge of environment & University of Dschang, Cameroon	Speaker 2 Principal Investigator of REFRASOS	Flood risk assessment practices in developing countries: case Cameroon
01.25 - 01.35 10 min	Mr. Bandiougou DIAWARA	UNESCO Regional Multisectorial Bureau for Central Africa	Speaker 3	Water quality monitoring of Lake Chad
01.35 - 01.40 5 min	Ms. Lisah Ligono SGAC/STEA member & REFRASOS The moderator			
01.40 - 01.50 10 min	Dr. Shawana P. Johnson,	Global Marketing Insights Inc.	Speaker 4	Persistent Low Earth Orbit: AI and Flood Management
01.50 - 02.00 10 min	Willy Soap	GEOSM open, collaborative and shared infrastructure composed of data	Speaker 5	XXXXXX
2.00-2.10 10 min	Paul Kennedi	Zindi startup (Chief of Staff)	Speaker 6	AI for flood prediction in Africa: developing community-driven solutions on Zindi
2.10-2.15 10min	CHINAZUM SGAC/STEA member & REFRASOS The moderator			
2.15-2.25 10min	Romain BATHA	National Observatory on Climate Change in Cameroon (ONACC)	Speaker 7	Use of satellite data for flood risk prevention in Cameroon: feedback of the National Observatory on Climate Change
2.25-2.35 10min	Rodrigues METALA	Global Water Partnership Cameroon (GWP Cmr)	Speaker 8	Flood and Drainage issues in the Wouri Estuary : case study over 03 drainage basins
2.35-2.45 10min	Chukwuma John Okolie	University of Lagos, Nigeria	Speaker 9 IGCP Project Lead	Flood conditioning factors and the methods/technologies for flood assessment
	Panel discussion (TBD): Lako Mbouendeu Stephane, Water for Life Cameroon			
2.50-3.10 20 min		Krittanon Sirorattanakul, California Institute of Technology, USA	Lako Mbouendeu Stéphane, Water For Life, Cameroon	Swarnajyoti Mukherjee, GP Advanced Projects, Italy
3.10-3.30	**Group discussion:** Mr. Charles-Aimé Nzeussi, Moderator			

	Speaker Name	Company / Organization	Role / Title	Topics
	Group 1: *Lead: Ngozi Johnson* *Secretary: Ugonna Nkwunonwo*	*Group 2:* *L: Ikenna Arungwa* *S: Hassan Musa*	*Group 3:* *L: Ayila Adandeh* *S: Tchameni Franck Eric*	
	·*Constraints of using emerging technologies for flood assessment in developing countries*	*Current flood risk assessment tools in developing countries: how useful?*	*How efficient? Opportunities for scientific development in flood science and engineering for developing countries.*	
3.30-3.40 10 min	Dr. Muhire Desire	Principal Investigator of REFRASOS		REFRA SOS next milestones
3.40-3.50 10 min	Krittanon Sirorattanakul, California Institute of Technology, USA	STEA Lead		Key messages and Closing remarks
	END			

Annex 4: Invitation letters and replies

UNESCO Regional Director *Grenoble, August 15th, 2022*

UNESCO, Central Africa Regional Bureau

Yaounde, Cameroon

Dear Sir,

With this letter we kindly inform you about our UNESCO IGCP project 734 supported project entitled "***Realtime Flood Risk Assessment in Developing Countries using Social Media, Optical and SAR Satellite Data*** (REFRA-SOS)" and the event we plan to organize by ***October 15th 2022*** as a contribution to global celebration of World Disaster Risk Reduction Day.

Our project is conducted within the framework of the Space Generation Advisory Council (SGAC) and its Space Technologies for Earth Applications (STEA) project group, which focuses on the application of space technologies for the improvement of life on Earth. It is composed of young professionals and researchers from all continents to address flood awareness in the region. We are working with a local association, ***Water For Life Cameroon***, and several researchers from Africa, Asia, Europe and America.

With the rise of climate change, community awareness and capacity building on the use of Artificial Intelligence, earth observation and satellite technology are essential to build resilience. Through the planned webinar (October 15th), we wish to raise awareness in developing countries and in this case Cameroon on the different open access tools and scientific methods for wise water and flood management.

Hence, on the behalf of the organizing committee and IGCP project 734, we would like to cordially invite you to be a guest speaker at our annual project workshop.

This year, the workshop will be held virtually via zoom on ***October 15, 2022 from 1- 4:30pm Cameroon time (GMT+1)***. The theme of this year's workshop is "***Small satellite constellation, Artificial intelligence and Internet of Things (IOT) for flood assessment using open access data and tools"***. We will also discuss Needs for improvements in flood risk assessment in developing countries.

You will have 15 minutes to present a topic of your choice related to the theme, followed by Q&A session followed by a panel discussion. We would highly appreciate your participation in that workshop and future collaboration on the project. We are looking forward to hearing back from you.

Best Regards,

IGCP734 Workshop Organizing Committee ***Dr Desire Muhire***

Director of the Research Institute for Development *Grenoble, August 15th, 2022*

Research Institute for Development ***(IRD)***

Attention to Principal Investigator of Douala Sustainable City project

Yaounde, Cameroon

Dear Sir,

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You will have 15 minutes to present your work on flood risk assessment in developing countries, followed by Q&A session followed by a panel discussion. We would highly appreciate your participation in that workshop and future collaboration on the project. We are looking forward to hearing back from you.

Best Regards,

IGCP734 Workshop Organizing Committee ***Dr Desire Muhire***

Director of Civil Protection Agency *Grenoble, August 15th, 2022*

Ministry of Territorial Administration

Yaounde, Cameroon

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Best Regards,

IGCP734 Workshop Organizing Committee ***Dr Desire Muhire***

Representant of OpenStreetMap Foundation *Grenoble, August 15th, 2022*

Yaounde, Cameroon

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Best Regards,

IGCP734 Workshop Organizing Committee ***Dr Desire Muhire***

Director of SOGEFI

Yaounde, Cameroon

Grenoble, August 15th, 2022

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Best Regards,

IGCP734 Workshop Organizing Committee

Dr Desire Muhire

Reply letter of UNESCO Multisectoral Central Africa Regional Bureau to the Workshop invitation

Multisectoral Regional Office of UNESCO for Central Africa
Bureau Régional Multisectoriel de l'UNESCO pour l'Afrique Centrale
Oficina Regional Multisectorial de la UNESCO para África Central

unesco
Organisation des Nations Unies pour l'éducation, la science et la culture

Dr Desire Muhire
IGCP734 Workshop Organizing Committee
Space Generation Advisory Council (SGAC)

Réf: CM-FU-YAO-2022-007822

Yaounde, 19th September 2022

Ref:

Subject: Invitation to the workshop on Small satellite constellation, Artificial intelligence and the Internet of Things (IOT) for flood assessment using open access data and tools

Dear Sir,

I have the honor to acknowledge the receipt of your correspondence of 16th August 2022 relating to the subject mentioned in the margin and I thank you for it.

Following this, I would particularly like to express the interest that UNESCO has in this workshop on **Small satellite constellation, Artificial intelligence, and the Internet of Things (IOT) for flood assessment using open access data and tools** virtually via zoom on the 15th of October.

I, therefore, have the honor to agree to participate in the 2022 online workshop through my collaborators with an intervention topic on "**water quality monitoring of Lake Chad**" which aims to support the Lake Chad Basin Commission (LCBC) on water quality monitoring and it's tributary Chari-Logone rivers through satellite Earth Observation, complemented by in-situ measurements.

My colleague Mr. Bandiougou Diawara (b.diawara@unesco.org), the head of the natural science sector is at your disposal for any other information.

In reiterating UNESCO's commitment to accompany Cameroon in addressing flood awareness in building a resilient society and for the improvement of life on Earth, please accept, Sir, the expression of my highest consideration.

Paul COUSTERE
Director and Representant

Organisation des Nations Unies pour l'éducation, la science et la culture
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Tel: + 237 222 508 318/ 696 29 05 49 – Email: yaounde@unesco.org - Site web: http://www.unesco.org/new/fr/office-in-yaounde