UENR University of Energy and Natural Resources

Applications of Remote Sensing in Small-scale Mining Management

By: Dr. Abdul-Wadood Moomen

Senior Lecturer, School of Mines & Built Environment

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KNOWLEDGE INTEGRITY IMPACT

Some Key questions:

Can ASM be carried out safely and in environmentally acceptable manner?

How can the subsector be self-sustaining and contribute to national economic growth?

What technical and regulatory measures are required to achieve this, going forward?

Challenges: ASM is constrained by numerous factors, including;

Both the informal ASM practitioners and Governments are caught in negative circles of cause and effect constraints;

Lack of adequate and appropriate exploration technologies leads to low recovery and productivity, sporadic operations, environmental degradation, and low income and savings.

Lack of adequate operational resources for monitoring and regulation leads to illicit operations, poor environmental standards, and loss of revenues to support agencies.

To transform informal ASM into a self-sustaining activity, these individual issues MUST be addressed.

- Fostering sustainable mining practices through:
- **Enriching the potential of the ASM and;**
- The strengthening of the mining authorities with appropriate monitoring and mineral exploration technological know-hows;
- Thus, this presentation discusses the use of Remote Sensing technologies for mapping, monitoring, and evaluation of ASM activities as well as mineral exploration towards…….
- Enhancing the sustainability portfolio of ASM

Remote Sensing Overview

What is Remote Sensing (RS)?

- Any information acquired from an object without touching it, is RS.
- RS is the science of acquiring information about the earth using instruments which are remote to the earth's surface, usually from aircraft or satellites.
- Instruments use EMS; visible light, infrared or microwave to obtain data.
- RS offers the ability to observe and collect data for large areas relatively quickly, and is an important source of data for monitoring and management of ASM's environmental stewardship.
- Critical vehicle for achieving the UN Agenda 2030 SDGs, and AU 2063 mineral resource-based industrialization agenda

Remote Sensing Overview

What are the Components in Remote Sensing?

Platform: The vehicle which carries a sensor: satellite, aircraft, balloon, etc...

Sensors: Device that receives electromagnetic radiation and converts it into a signal that can be recorded and displayed as either numerical data or an image.

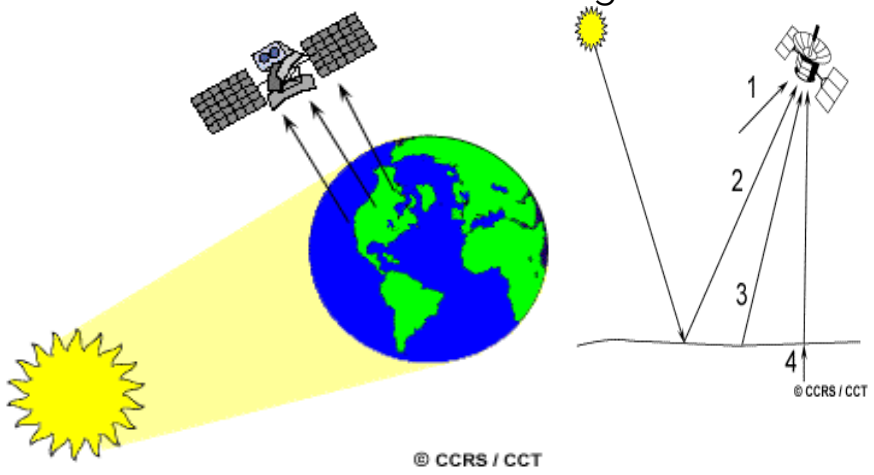
- Are there different types of Remote Sensing?..... Yes!! Passive and Active.

Passive Remote Sensing: Remote sensing of energy naturally reflected or radiated from the terrain.

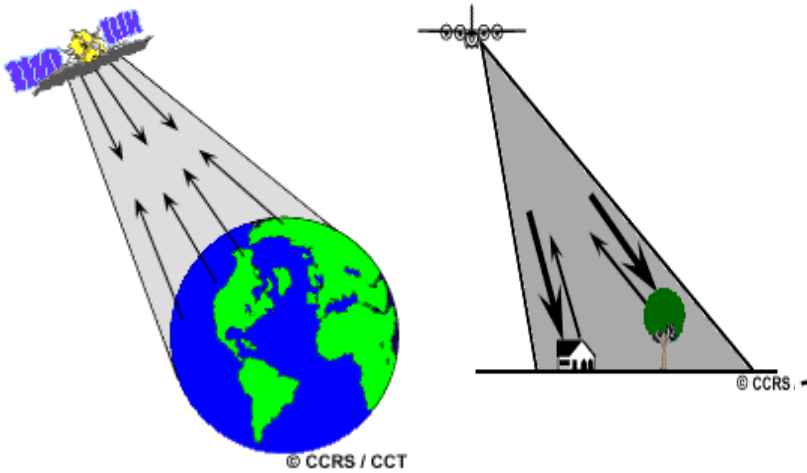
Active Remote Sensing: Remote sensing methods that provide their own source of electromagnetic radiation to illuminate the terrain. Radar is example.

Remote Sensing Overview

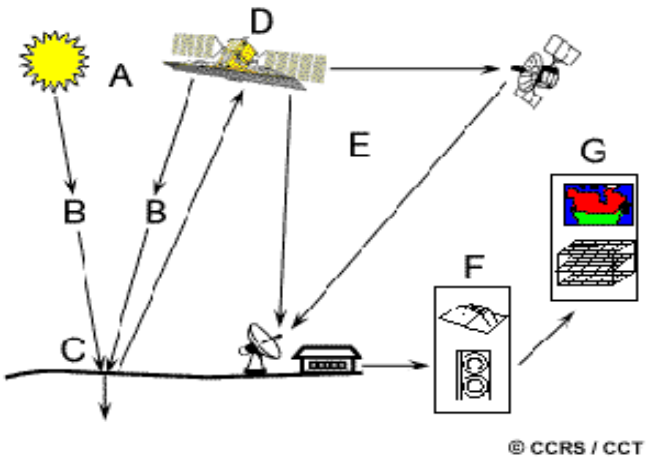
1. Passive Sensing



2. Active Sensing



Data Acquisition Processes



- The process involves an interaction between incident radiation and the targets of interest.
  - Energy Source or Illumination **(A)**; Radiation and the Atmosphere **(B)**; Interaction with the Target **(C)**; Recording of Energy by a Sensor **(D)**; Transmission, Reception, and Processing **(E)**; Interpretation and Analysis **(F)**; Application **(G)** - reveal some new information or assist in solving a particular problem. i.e., ASM Monitoring, Management, and Mineral Exploration

ASM Operations Monitoring

Bisie in North Kivu, DRC. VHR true colour satellite images showing the development of illicit ASM sites from April 2010 to March 2015 (Moomen et al., 2022).

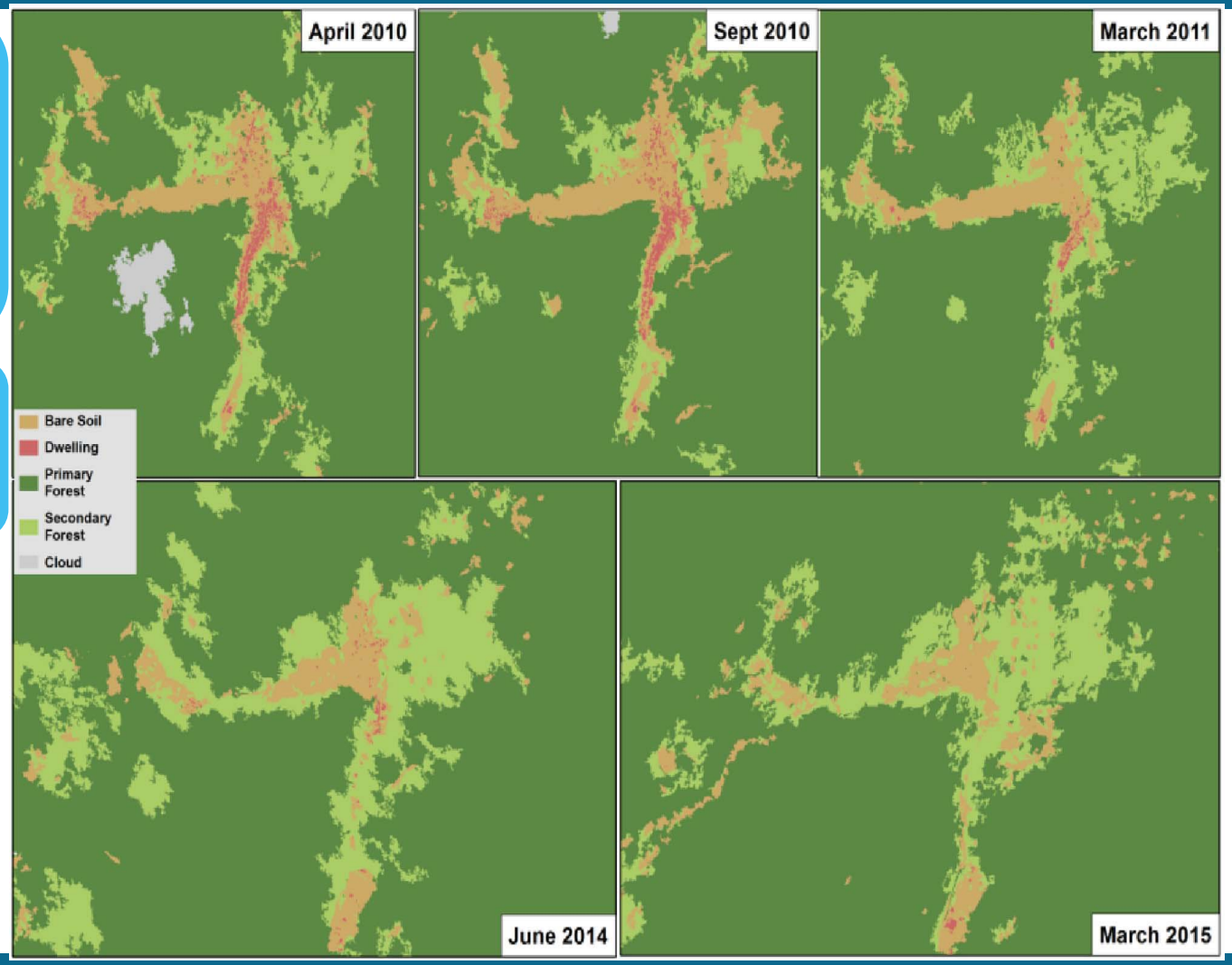
Images from multispectral sensors record the different stages of ASM activities in the area: 2010, 2011, 2014, & 2015 DigitalGlobe, Inc.

ASM Operations Monitoring

Land use / cover classification from April (Moomen et al., 2022).

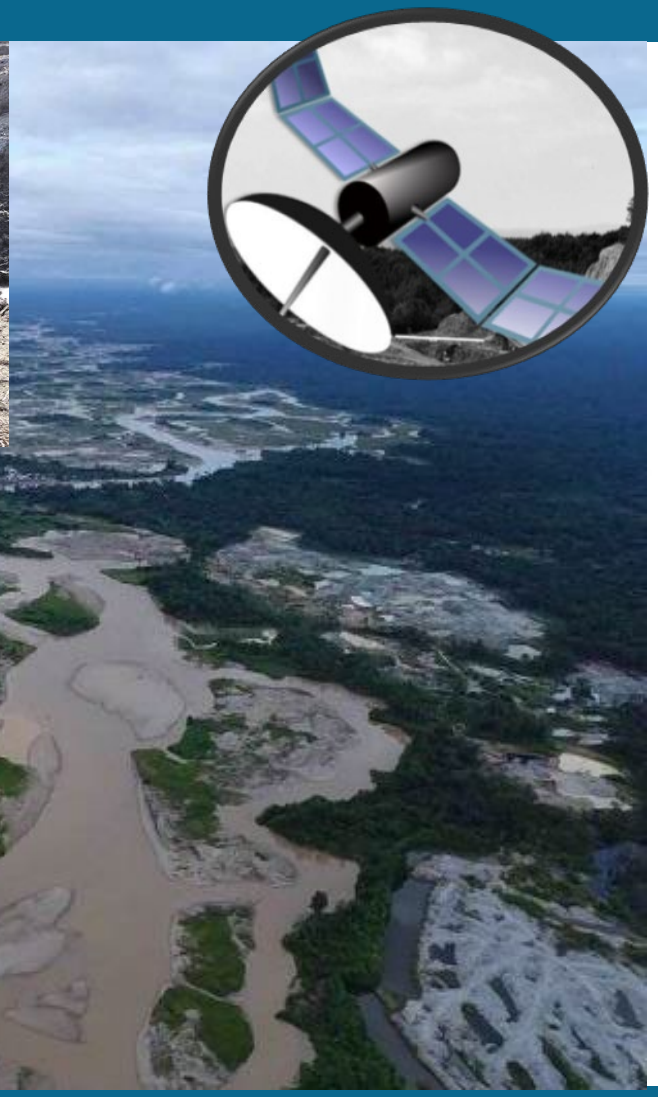
Results

- An increase of the class bare soil indicates an expansion of ASM and related activities.
- The monitoring results reveal an increasing number of dwellings



ASM Operations Monitoring

Establish Real-Time Satellite monitoring station and substations across ASM zones; to transmit 24/7 high resolution satellite data

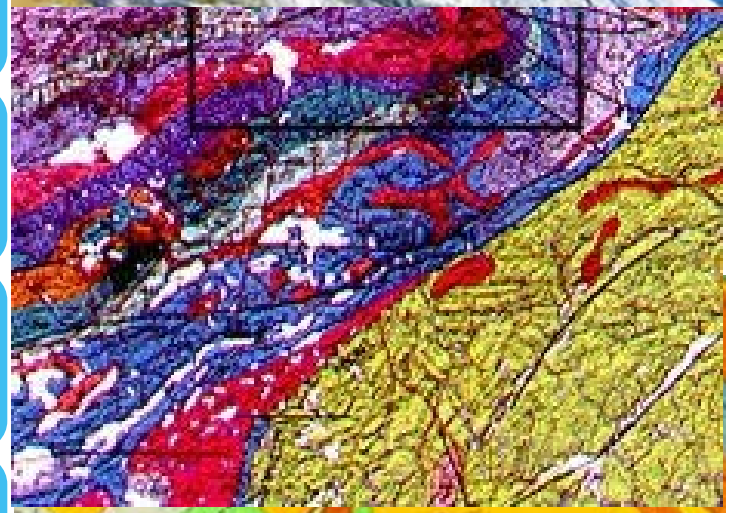


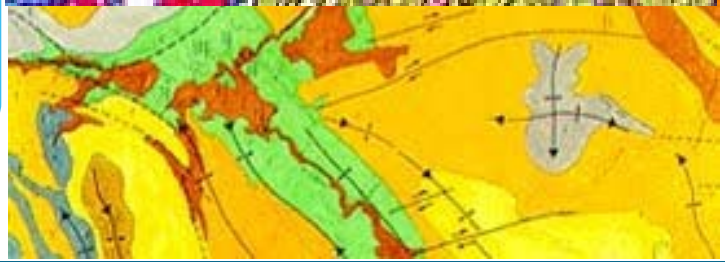
ASM Operations Monitoring

Identify activity enclaves and delineate these into zones

- Train local operations and supervisory teams in zones on the use of handheld GPS and automated phones for prompt communications to the sub-stations and onward transmission to main station
- Deploy quick response team to sites to address encroachment and illegal mining issues.
- Earth Observation and Remote Sensing technologies for detailed explorations to improve knowledge on resources.

Mineral Exploration





RS is used to analyze land surface structure, composition or subsurface.

Multispectral data provide information on lithology or rock composition.

Sub-meter multispectral satellite systems provide near airphoto quality imagery.

Hyperspectral data are capable of mapping individual mineral species and chemical substitutions within individual minerals.

Radar provides surface topography and roughness, and integrated with other data sources to provide detailed:

- Mapping relief, surficial deposit / bedrock, lithology, and structural elements

Mineral Exploration

A) Geological map showing locations of skarn and associated silver (Ag), zinc (Zn), copper (Cu) and magnetite (Fe) mineralization.

B) Geoscan band 10, 11, 12 RGB image showing garnets in yellow and silica in blue.

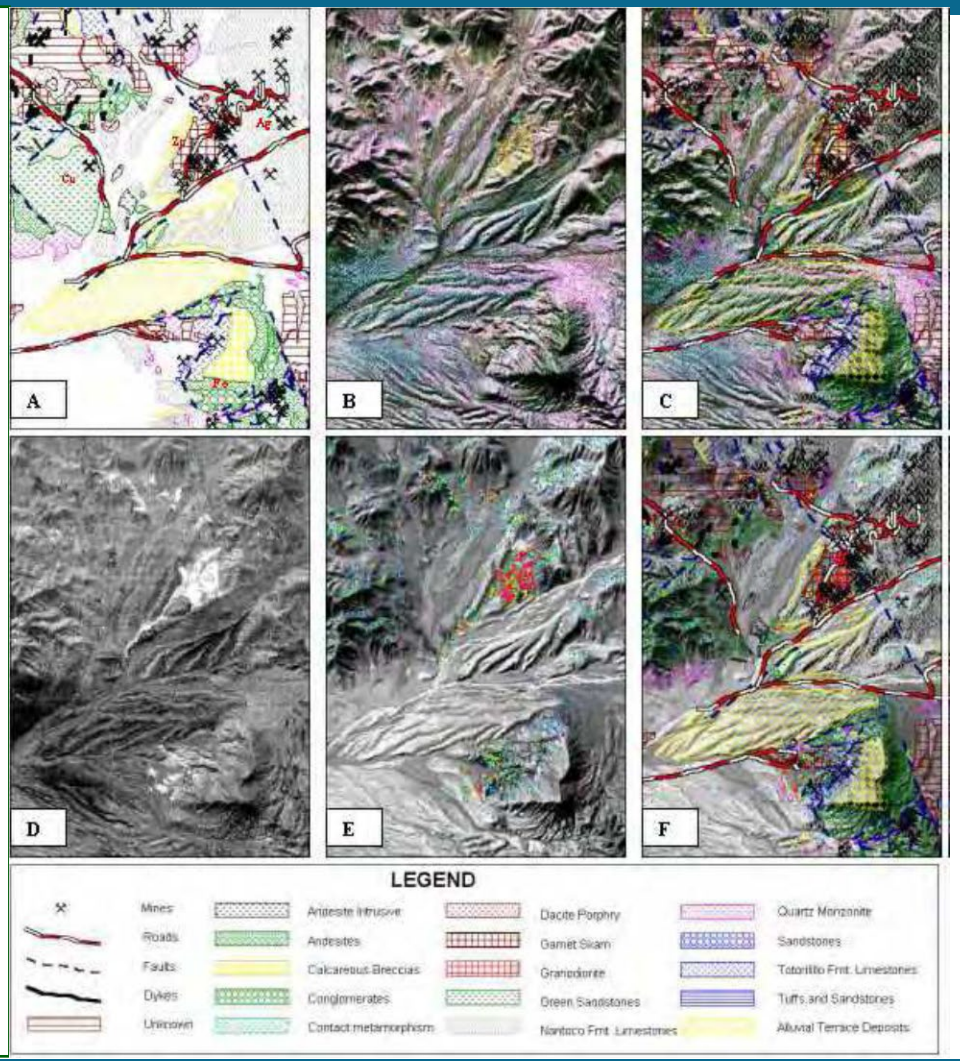
C) The same image as in B with the geology (A) superimposed.

D) A simple grey-scale garnet or skarn index developed from the Geoscan MKII image data.

E) The garnet or skarn index as a pseudo colour intensity index draped on a simple albedo image.

F) The same image as in D with the geology superimposed.

Source: Pavez & Agar (2001), Agar & Coulter (2007)



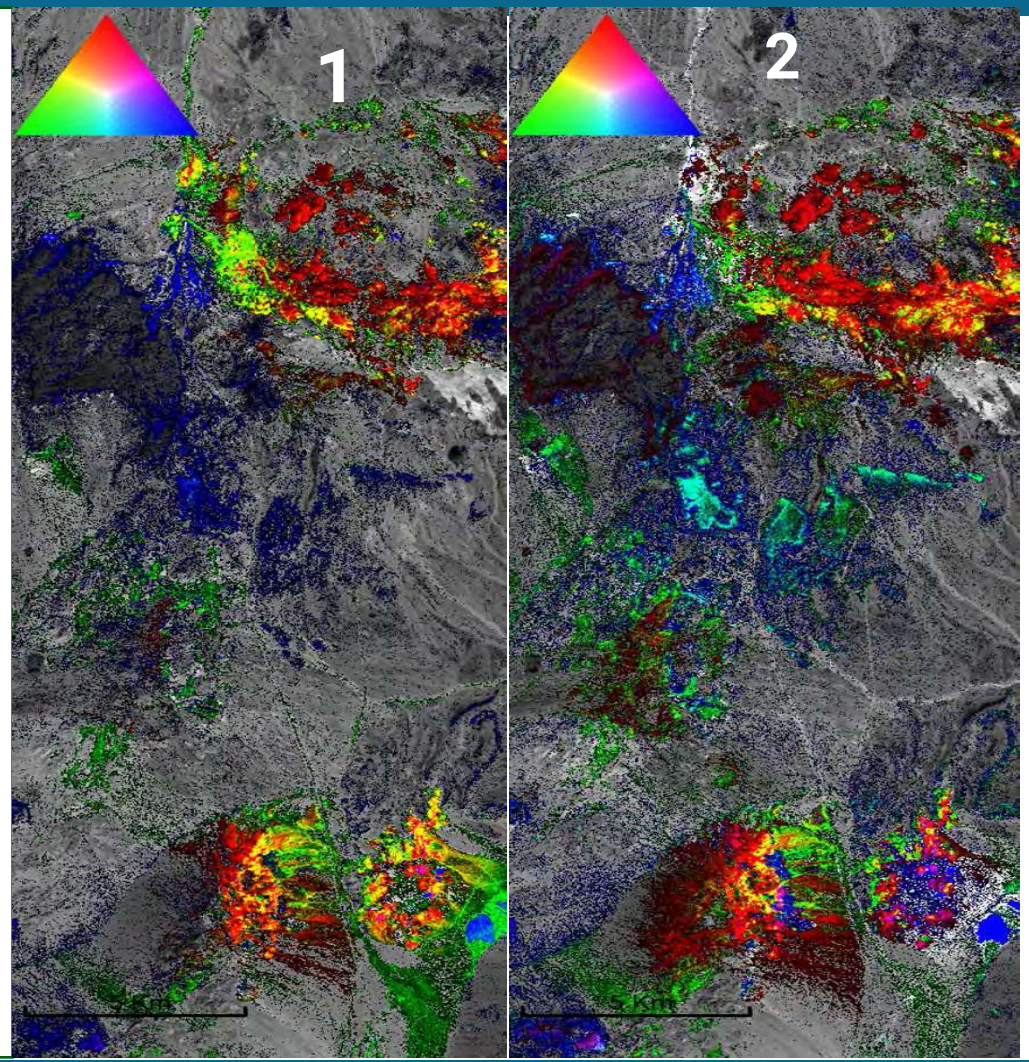
Mineral Exploration

1. Color ratio composite of TM imagery over Goldfield and Cuprite areas. RGB are mapped as OH (clay), Iron Oxide, and vegetation/non-altered.
2. Crosta analysis of TM imagery over Goldfield and Cuprite areas. RGB are mapped as OH (clay), Iron Oxide, and vegetation/non-altered.

Source: Agar & Coulter (2007)

Other methods for mineral mapping include:

- Support Vector Machine (SVM) and
- Optimized Cross Correlation Mixture (OCCM).



CONCLUSIONS

Looking Toward The Future

- To the reactivation of the Africa Minerals Development Centre (AMDC) for the attainment of the Africa Mining Vision (AMV) of the AU
- Addressing Goal 17 of the UN Agenda 2030 SDGs; Agenda 2063 of the AU, and CAP on Post-2015 Africa's Development Agenda
- UENR introduces postgraduate programmes on Geoinformatics for Mineral Exploration, Sustainable Mining, Development Minerals, and GEO-LDN
- Assessing the policy adoption and impact of Geoinformation for enhancing sustainable mining in Africa (Moomen et.al., 2019)
- Annual 2-day Transformational Dialogue on Small-scale Mining hosted by UENR, Sunyani, Ghana.

Thanks!

Any questions?

The Will & The Bill