Open Env. Data Center Ghana-Benin: Env. Monitoring and Data Processing

Idea

Establishment of an **interdisciplinary and international open environmental data center in West Africa** to support regional agriculture: from sensors, drones and satellites to forecasts and recommendations for action for smallholder farmers.

Installation of a high-performance compute (HPC) servers dedicated to analyse remote sensing images with drones for agriculture, environmental protection and conservation.

Reference project called “Twin Regions” utilizing the environmental data center facility to estimate potential CO2 storage capacities in West Africa.

Collection of own open environmental data

- Drones and multispectral remote sensing
- Micrometeorological stations for agrometeorological applications
- Environmental monitoring systems by means of IoT enabled wireless sensor networks

Data analysis and provision

- All collected data is **open data** and will be provided online for everybody **without fee**.
- All softare to be used is **free and opensource software (FOSS)**.
- Installation of a high performance computing (HPC) platform based on a **high-end NVIDIA GPU** (e.g. L40S) and large persistant storage (NAS)
- Installation of a **file sharing and communication** platform (Nextcloud)
- Realization of a **bulk upload** path for large drone image sets.
- Installation of **Web ODM**, (ODM = Open Drone Map) to **process drone images** for environmental monitoring and agriculture.
- Implementation of a **cloud computing environment** (Kubernetes) on the HPC system
- Installation of an **interactive data analysis enviroment** (Jupyter Hub)
- Setup of an **identity and access management** (IAM) system (Keycloak) for user management

Partners

Roles

- GHANA: Focus on **technology**, data acquisition, and data analysis
- BENIN: Focus on **agriculture**, soil protection, and data acquisition

People

Germany

- HSRW
  - Rolf Becker, Environmental Physics, Head of the labs: Earth Observation Lab, IoT Lab, Drone Lab
  - Florian Wichern, Sustainable Agriculture, Head of the FSP Sustainable Food Systems

BENIN

- National University of Agriculture
  - Elie Antoine Padonou, Ph.D., Associate Professor, National University of Agriculture, Benin, School of Tropical Forestry, Sustainable Land Use Management (SLAM), https://www.researchgate.net/profile/Elie_Padonou2?
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- Ecology
  - Natacha
- Afris Network
  - Marc Bernard
  - Frank

GHANA

- The Council for Scientific & Industrial Research (CSIR),
  - Dr. Paul Danquah (Director),
  - Ing. Michael Wilson (Head, Electronics Division)

Workshops

Workshop 1, in Germany: First commissioning of technical systems

The two **drones** for GH and BJ will also be sent to HSRW first to train the African drone pilots and special camera operators. The drone team of the HSRW has already gained experience with the same drone and instrument type and will train the colleagues from Africa.

The three identical **HPC servers** for DE, GH, BJ will be delivered to HSRW first to install hard- and software. The earth observtion lab team at HSRW has already experience in setting up cloud platforms for remote sensing data analysis with drones. An external expert will be engaged additionally to increase to supervise the system setup and train the workshop participants in system administration, cloud computing, platform as a service, and software as a service. The workshop participants will do an hands-on-traing to implement their cloud computing system. After the

workshop two servers will be delivered to Ghana and Benin.

The third part of the workshop covers the installation of **weather stations** based on semi-professional sensors and own data loogers including data transmission. The workshop participants will learn utilize internet of things technologies (IoT) in conjunction with enviromental and meteorological monitoring.

Workshop 2, in Ghana

Focus on

1. drone technology (robotics) and
2. electronic development of own data loggers (IoT technology) as core components for weather stations.

Workshop 3, in Benin

Focus on

1. Application of drone remote sensing in agriculture,
2. Vegetation classification,
3. Biomass estimation

Hardware

High Performance Computing

(Thank you, Moritz Kaimann!)

- Server: ASUS RS520A-E12-RS24U/1G
- CPU: EPYCGenoa9254 (24C/48T | 128 MB Cache)
- RAM: 384 GB(24x16GB) DDR5 ECC
- GPU: **2 x NVIDIA L40S**, 48GB PCIe 4.0
- Network: 2x 1Gbps on Board + Broadcom P210TP
- Storage:7 x KioxiaCD8-V 6.4TB in RAID 5 (> 32 TB usable)
- Approx. Price (w/o VAT | w. VAT): ~ 32.000€ | ~ 38.000€

- https://www.deltacomputer.com/
- https://www.thomas-krenn.com/
- https://ctt.de/value-add/serverbau
- https://www.broadberry.de/asus-servers
- https://www.ico.de/asus-server
- https://server-konfigurieren.de/product/GPU-Rack-Server/
- https://www.office-partner.de/
- https://www.primeline-solutions.com/

Weather Station Instruments

Pyranometer

- Kipp & Zonen: https://www.omniinstruments.co.uk/weather-stations-and-instruments/pyranometers-solar-irradiance.html

Rain Gauge

- Young: https://shop.profec-ventus.com/product_info.php?products_id=264
- Young Datasheet: https://shop.profec-ventus.com/images/Datasheets/Rain_Gauge_Sensor/Rain_Gauge_Sensor_Young_52202_Data_Sheet.pdf
- NovaLynx: https://novalynx.com/store/pc/260-2500-Tipping-Bucket-Rain-Gauge-and-260-2500E-Electric-Heated-Rain-and-Snow-Gauge-p210.htm
- Vaisala: https://shop.profec-ventus.com/product_info.php?info=p539_vaisala-weather-transmitter-wxt536.html

Drones

- DJI Mavic 3 M (multispectral): https://ag.dji.com/de/mavic-3-m

Key Remote Sensing Institutes and Activities in West Africa

- **Centre for Remote Sensing and Geographical Information Systems (CERSGIS)** at **University of Ghana**, Accra: Involved in projects for the Ghana Government, UN Agencies, and development partners like the World Bank, GIZ, and USAID. Projects include land use and environmental monitoring, urban planning, and disaster management.
- **SERVIR-West Africa**: A collaboration between NASA, USAID, and regional institutions to use satellite data and geospatial technologies to address environmental and developmental challenges in West Africa. (International, USA)
- **African Regional Centre for Space Science and Technology Education in French (CRASTE-LF)**: Provides education and training in space science and technology, including remote sensing and GIS applications. (Morocco)
- **African Association of Remote Sensing of the Environment (AARSE)**: Promotes the use of remote sensing and GIS for sustainable development across Africa. (International NGO, registered in South Africa)
- **Centre de Suivi Ecologique (CSE)** in Senegal: Focuses on environmental monitoring and management using remote sensing technologies. (Senegal)

Additional non-African Institutes

- **National Institute of Geography (IGN)**: Uses remote sensing for various applications, including mapping, land use planning, and environmental monitoring. (in France)

Dead Links

- **Centre for Remote Sensing and Geographical Information Systems (CERGIS)** in Ghana: Involved in various remote sensing projects, including land use and environmental monitoring.
- **Regional Centre for Training in Aerospace Surveys (RECTAS)** in Nigeria: Provides training and research in remote sensing and GIS applications.
- **National Water Resources Research Institute (NWRRI)** in Nigeria: Uses remote sensing for water resource management.

Some Articles

- **Enhancing Satellite Oceanography-Driven Research**: Program introducing participants to extensive and often free, remotely sensed oceanographic datasets, enhancing research capabilities in satellite oceanography.
- **Sustainable and Precision Agriculture**: Remote sensing applications for sustainable and precision agriculture in the Northern Savanna Regions of Ghana, focusing on monitoring and improving agricultural practices.

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