



KHEOBS Day 2024

KHmer **E**arth **OBS**ervation **D**ay

28 May 2024

Institute of **T**echnology of **C**ambodia, Phnom Penh

Book of abstracts



KHEOBS
Khmer Earth Observation Laboratory



Espace DEV
OBSERVATION SPATIALE, MODÈLES
& SCIENCE IMPLIQUÉE

KHEOBS Day 2024

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The **first Earth Observation Day (KHEOBS Day)** was a special opportunity for **all those involved or interested in remote sensing in Cambodia**, whether in the research, institutional or private sectors, to share their experiences. The event took place on **Tuesday 28th of May at the Institute of Technology of Cambodia (ITC)**, Room A-109, ground floor of the main Building A, at ITC in Phnom Penh.

An open call for abstract for oral presentations or posters was opened during one month. This first 2024 edition of the KHEOBS Day featured 16 oral presentations and 7 posters in five sessions:

1. Presentation of remote sensing laboratories
2. Coastal management / spatial hydrology
3. Land management/ecology
4. Climate and urban planning
5. Satellite and aerial data

Organizing committee:

- HERBRETEAU Vincent, Researcher at the French National Research Institute for Sustainable development (IRD), co-Director of KHEOBS Lab at the Institute of Technology of Cambodia (ITC), Phnom Penh, Cambodia
- ANN Vannak, Lecturer and Researcher at the Institute of Technology of Cambodia, co-Director of KHEOBS Lab, Phnom Penh, Cambodia
- HENG Chhenglang, PhD candidate at the Institute of Technology of Cambodia and the University of Montpellier, KHEOBS Lab, Phnom Penh, Cambodia
- HOEUN Sokeang, Geomatician at the KHEOBS Lab at the Institute of Technology of Cambodia (ITC), Phnom Penh, Cambodia

and **organizing team from KHEOBS** (by alphabetical order): BASSE Manon, BUN Phanna, CHY Sreypich, GE George, KHIM Sopheak, POV Kakda, SOY Makara, YORNGSOK Chamroeun

Thanks to: the **Institute of Technology** for hosting the event, and to **IRD - Espace-Dev** for funding meals, coffee breaks and printing

Website: <https://kheobsday2024.sciencesconf.org>

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08:00 - 8:50	Registration and welcome coffee	Room A-109, ground floor of the main Building A, ITC
Introduction		
08:50 - 9:00	HERBRETEAU Vincent (IRD) and ANN Vannak (ITC)	Introduction of the conference
Session 1		Presentation of remote sensing laboratories
09:00 - 9:20	ANN Vannak (ITC), HERBRETEAU Vincent (IRD)	Presentation of the Khmer Earth OBSvation (KHEOBS) Laboratory at the Institute of Technology of Cambodia
09:20 - 09:40	POK Sophak (RUA)	Presentation of the Faculty Land Management and Land Administration at the Royal University of Agriculture
09:40 - 10:00	MAC CARTNEY David (KGI)	Presentation of the Khmer Geographic Institute (KGI)
10:00 - 10:20	TECK Vanna (SIG)	Strengthening the Measurement, Reporting and Verification (MRV) System in Cambodia
Session 2		Coastal management / spatial hydrology
10:20 - 10:40	HOSTACHE Renaud (IRD)	The CASCADE SCO project: Towards a codesigned platform for the decadal monitoring of surface water using Earth observation Sentinel satellite data
10:40 - 11:00	BRANG Sokhorn (ITC)	Shoreline Evolution over the past Four Decades in Koh Kong, Cambodia
11:00 - 11:20	CATRY Thibault (IRD)	An open-source multi-sensor methodology for the mapping of mangrove structural types using remote-sensing
11:20 - 11:30	1-minute presentations of posters	
11:30 - 11:50	Group picture	
11:50 - 13:30	Lunch and Poster session	
Session 3		Land management, ecology
13:30 - 13:50	POV Kakda (ITC)	Land Surface Temperature and Green Health Vegetation Variability across Lithology and Land Use and Land Cover in the Chrey Bak Catchment
13:50 - 14:10	LOGN Raksmeay (RUA)	Mapping Forest Disturbances in Prey Lang Wildlife Sanctuary Using Landsat Satellite Images
14:10 - 14:30	SATH Sithea (ITC)	Environmental variables determining carbon stocks and soil physical properties at the catchment scale, Stung Chrey Bak observatory, Cambodia
14:30 - 14:50	MOL Pengkheang (RUA)	Estimating Leaf Area Index of Cassava Plantation using UAV Imagery
14:50 - 15:10	Coffee break	
Session 4		Climate and urban planning
15:10 - 15:30	SE Bunleng (RUPP)	The Role of Urban Climate Map in Phnom Penh's Future Development Plan, Cambodia
15:30 - 15:50	KHIM Sopheak (RUA, ITC)	The Effects of Land Use/Land Cover Changes on Surface Urban Heat Island Intensity in Phnom Penh
15:50 - 16:10	EAVHONG Oeng (RUA)	A Study on Possibility for Climate-Resilient Urban Planning in Chbar Morn Municipality, Kampong Speu Province
Session 5		Satellite and aerial data
16:10 - 16:30	GE George (IRD, ITC)	Sen2extract @KHEOBS: Access Sentinel-2 Indices Time Series within a few Clicks
16:30 - 16:50	YORNGSOK Chamroeun (IRD, ITC)	GeoCambodia: A web application to visualize Cambodia Then and Now (FSPI-R KAPA Project)
16:50 - 17:00	Closing words	

Poster session (alphabetical order)

BAN Liheang (ITC)	Extreme Rainfall Event Analysis in Cambodia
BASSE Manon (Univ Montpellier)	Evaluating geographical accessibility by car to healthcare facilities from the lens of the country scale: a study case in Cambodia
CHY Sreypich (ITC)	Remote Sensing Techniques for Precipitation and Flood Estimation and their Relationships with Spectral Indices in the Delta Mekong Region
KHOR Sothyda (ITC)	Rainfall Trend Analysis in Cambodia
POV Kakda (ITC)	Land Surface Temperature and Green Health Vegetation Variability across Lithology and Land Use and Land Cover in the Chrey Bak catchment
SOPHEA Choun (RUA)	Study on Relationship between Land use/Land cover and Land surface temperature in Siemreap municipal
SOY Makara (ITC)	Detection of urban green spaces in Phnom Penh in 1993 using historical aerial pictures

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Presentation of remote sensing laboratories

Khmer Geographic Institute

David Mac Cartney ^{*† 1}

¹ KGI – Cambodia

Khmer Geographic Institute (KGI) is a company specialized in photogrammetry and lidarogrammetry. Our mission is to measure the earth in order to safeguard it. KGI is a company committed to the philosophy of sustainable development, training and educating local staff with basic schooling in the sciences of photogrammetry.

KGI director David Mac Cartney has managed some of the world's largest aerial photogrammetry projects for clients such as Microsoft and Google. Today, KGI benefits from over 27 years' experience, and can handle production projects of any size. We will present a complete stereo workstation with data acquired in Cambodia with our partners Jeb-engineers.

Keywords: photogrammetry and lidarogrammetry

*Speaker

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Remote sensing applications in land and environmental monitoring

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Remote sensing technology has been an essential approach for land and environmental monitoring due to its large-scale and dynamic observation. Remote sensing images are captured by satellites, airplanes, drones, etc., and allow users to extract useful information through performing visual interpretation and data analytics. Our remote sensing laboratory, based in the Faculty of Land Management and Land Administration, the Royal University of Agriculture focuses on a number of research areas. We use remote sensing to map local and regional land cover change and we highlight drivers of the change. In addition, we research appropriate methods to accurately map croplands with the use of drone, multi-spectral satellite imagery and field measurements. We also use remote sensing to monitor land surface temperature in cities and municipalities in Cambodia and investigate the impacts of urbanization on surface urban heat island, with the aims of contributing to resilient and sustainable urban planning and development.

Keywords: remote sensing, satellite imagery, drone, land use and land cover, cropland, land surface temperature, urban heat island

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Presentation of the KHmer Earth OBServation (KHEOBS) Laboratory at the Institute of Technology of Cambodia

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Inaugurated in November 2022, KHEOBS (KHmer Earth OBServation Laboratory) is a joint laboratory between the Institute of Technology of Cambodia (ITC) and the French Research Institute for Sustainable Development (IRD), designed to develop training, expertise and resources in remote sensing in Cambodia. More specifically, it aims to:

develop expertise in remote sensing by training and supervising students,

set up or contribute to projects using remote sensing, to ensure the continuity of the laboratory's funding,

set up a hardware infrastructure at the ITC to enable the storage of large spatial data sets and large-scale data processing, in order to contribute to projects in Cambodia.

Since its establishment, KHEOBS has been involved in projects in the fields of spatial hydrology, ecology and health, as well as training students. The laboratory has also started to deploy its computing and storage infrastructure, enabling it to host the IGN archive of aerial photographs of Cambodia as well as all Sentinel-2 satellite images covering Cambodia. Web applications are being developed to facilitate access to and use of this spatial data.

Keywords: Remote sensing, Earth Observation, satellite, aerial photo, infrastructure, training

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Strengthening the Measurement, Reporting and Verification (MRV) System in Cambodia

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¹ Spatial Informatics Group – Cambodia – Cambodia

Current data on forest and land cover dynamics in Cambodia have not been updated since 2018, presenting a significant gap in understanding landscape changes essential for environmental programs such as REDD+ and MRV. This project aims to leverage the latest advancements in AI foundation model technology to map forests and forest changes with a focus on high-resolution monitoring. We propose to utilize satellite imagery with a spatial resolution of 10 meters to provide regular updates on forest cover. Additionally, the project will explore various methodologies to map forest degradation, a challenging aspect due to the subtle nature of these changes. The integration of these advanced technologies is expected to enhance the accuracy and reliability of land cover data, supporting effective environmental management and policy-making.

Keywords: Deforestation, REDD+, Measurement, Reporting and Verification, governance

*Speaker

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Coastal management / spatial hydrology

Shoreline Evolution over the past Four Decades in Koh Kong, Cambodia

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Coastal areas have historically been favored for significant commercial development due to their access to fertile soils, freshwater sources, diverse ecosystems, and convenient transportation routes. However, the ongoing loss of coastal land due to shoreline recession poses serious challenges to the conservation of coastal ecosystems. This study aimed to address shoreline changes over the past four decades and identify key factors influencing shoreline evolution on the Pak Khlong (PK), Prey Dach (PD), and Koh Kapik (KK) coasts of Koh Kong province. The available satellite images from 1985 to 2023, which were georeferenced into Universal Transverse Mercator projection Zone 48 with the World Geodetic System 1984, were used to extract historical shoreline positions along these three coastlines. The Digital Shoreline Analysis System, an extension tool in ArcGIS, was employed to analyze shoreline change statistics. The results indicate a net land loss of approximately 10.2 ha, 54.8 ha, and 2.7 ha in PK, PD, and KK, respectively, while there was land growth of roughly 11.6 ha in PK, 4.1 ha in PD, and 202.0 ha in KK, throughout the study period. This coastline evolution on the three coasts was mainly attributable to coastal processes, especially storm waves. The construction of hydropower dams at the upstream river, on the other hand, is not a major cause of the coastline erosion in this region. It was reported that sand mining activities occurred both in the river and coastal zones. Therefore, it should be considered in future studies of coastal evolution and other related studies. These analyses provide valuable insights for informed decision-making regarding coastal management and conservation efforts in the face of ongoing environmental challenges.

Keywords: Digital Shoreline Analysis System, Shoreline Erosion, Shoreline Accretion, Storm Waves, Hydropower Dam, Sand Mining.

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The CASCADE SCO project: Towards a codesigned platform for the decadal monitoring of surface water using Earth observation Sentinel satellite data.

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Water is essential to life of various ecological and social systems. Unfortunately, water is one of the natural resources most impacted by climate change, with increasingly intense hydro-meteorological extremes (floods, droughts, etc.) and growing societal demand. To help manage this vulnerable resource, it is vital to assess and monitor its availability on a regular basis, as well as to track its trajectory over time to better understand the impact of global change on it. Surface water (lakes, rivers, flood plains, etc.) represents an important component of total water resources, and it is of primary importance to monitor it to better understand and manage the consequences of climate change. Surface water resource provides populations around the world with essential ecosystem services such as power generation, irrigation, drinking water for humans and livestock, and space for farming and fishing.

In this context, the CASCADES project proposes to implement end-to-end processing chains for satellite Earth observation data, including Sentinel-1 and 2 (S-1 and S-2), in order to provide surface water products (surface water body and inundation depth maps) that will be made available via an interactive platform co-constructed with identified users. These processing chains will be based on several state-of-the-art automatic water level and water body mapping

*Speaker

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algorithms developed and frequently used by consortium members. They will enable all (or a subset, at the user's discretion) of the S-1 image archive and S-2 images to be processed automatically over a pre-selected area, providing temporal monitoring of surface water resources. In the project, we propose to implement this processing chain and the associated platform on 6 contrasting, large-scale test cases: i) the Tonle Sap lake basin and upper Mekong delta in Cambodia, ii) Madagascar (with a focus on the Betsiboka basin), iii) several floodplains of the Amazon basin in Brazil, iv) the TDPS system in Bolivia and v) the Guayas in Ecuador, and vi) the Goulbi Maradi and N'Kaba basins in Niger. These areas, frequently affected and impacted by hydro-meteorological extremes exacerbated by climate change, and where water resources are central to human societies and ecosystems, are representative case studies of water-related issues worldwide.

Keywords: Satellite earth observation, Sentinel satellite constellations, surface water resource, water body mapping, flood depth mapping, interactive platform

An open-source multi-sensor methodology for the mapping of mangrove structural types using remote-sensing.

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Growing at the land-sea interface, mangroves are adapted to harsh environmental conditions. This ecotone provides fundamental ecosystem but the extent of mangroves is continuously declining across the globe. Since 2000, there has been increased awareness of the essential role played by mangroves, and remote sensing has proven essential for monitoring and mapping these vast, often inaccessible ecosystems. Although various global products on the distribution of mangroves are available, the assessment of their extent is not completely consensual, as recent publications show. This highlights the importance of accurate mapping methods for assessing the area, structure and dynamics of mangroves. In this context, we propose a methodological framework based on open-source multi-sensor and multi-resolution remote sensing combined to in-situ measurements to map mangroves at fine scale. This study proposes to build a standardized approach for the processing of Pléiades Very High Spatial Resolution images (50 cm) to characterize the structural types of mangroves. The use of the Iota2chain on the Sentinel time series allows, via a supervised algorithm (RF) trained on available global products such as GMW, to rigorously map the extent of mangroves in the bay, which is then used as a mask to apply the unsupervised FOTO method in order to analyze the texture of the mangrove canopy on Pléiades images. Unsupervised Kmeans classification is then applied to extract mangrove classes based on textural information. This methodological framework was implemented on two study sites: Cambodia and Madagascar. In Madagascar, in-situ measurements of structural variables of the mangrove from two field campaigns carried out in May 2023 and March 2024 were used to construct and label the structural typology of the mangroves of Bombetoka Estuary. We were able to extract 5 classes of mangrove structural types based on texture and in-situ variables. This approach, based on free data and tools currently being made available to the community, is intended to be replicated on other sites in order to assess the reproducibility and genericity of the method. It was notably tested in Cambodia, where texture classes were extracted, and field validation data are needed to label the classes.

Keywords: mangrove, sentinel, Pleiades, texture, structural types

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Remote Sensing Techniques for Precipitation and Flood Estimation and their Relationships with Spectral Indices in the Delta Mekong Region

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Cambodia is experiencing the adverse effects of climate change, including seasonal flooding in the lowland regions of the Mekong River. The objective of this study is to assess the effectiveness of remote sensing techniques at a fine local scale, to estimate precipitation (CHIRPS) and flood (Sentinel-1) and subsequently link these two variables with spectral indices calculated from optical satellite images (Sentinel-2), and explore their monthly relationships. Two indices were calculated: the Modified Normalized Difference Water Index (MNDWI) which describes the presence of water, and the Normalized Difference Water Index Gao (NDWI-Gao), which shows the humidity on the ground. A significant degree of variability was observed in precipitation between the 2019-2023 period, with fluctuations observed throughout both seasons. The rainy season saw the highest precipitation in September, while the dry season also showed in November, May and April. The lowest precipitation occurred in June (i.e., rainy season) and January to March and December (dry season). The water area varied significantly, with the highest extent in October and November (rainy season), and the lowest extent in June, July, and February (dry season). MNDWI and NDWI-Gao values remained consistent during the rainy season compared to the dry season with significant differences, possibly due to their detection of flooded rice fields with irrigation. Although these are the current results, a further study needs to be verified.

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Keywords: RADAR, CHIRPS, SAR satellites, water body, flood detection, spectral indices

Land management, ecology

Mapping Forest Disturbances in Prey Lang Wildlife Sanctuary Using Landsat Satellite Images

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Changes in forest disturbances can have strong impacts on forests. However, we lack consistent data on Cambodia's forest disturbances and their changes over time. Employing Landsat time series for the characterization and mapping of forest disturbance been popular over the past 15 years. Here we used Landsat satellite data with LandTrendr algorithm to map a decade of forest disturbances across Prey Lang Wildlife Sanctuary in Cambodia, and analyzed the patterns and trends in disturbance size, frequency and severity. Landsat 5 7and 8 satellite images were selected between January 1st and April 30th each year from 2010 to 2020. With some pre-processing to remove noises (clouds, clouds shadow, etc.) and mask water from all images. The Normalized Burn Ratio (NBR) was used as the change index for the operation of this method. This study is mainly focused on the dense forest in the study area. While the method performed well for the disturbance event in dense forest, its application is not always applicable to all types of forests, especially non-dense forests. On the other hand, some deforestation is done only on one or two trees (selective logging), so with the pixel size of the Landsat image, such disturbances will not be captured. In addition, noise generated by clouds or cloud shadows is still a complication of the Time Series Images Analysis process, despite the use of QA (Quality Assurance) data. However, those noises will not be 100% removed from satellite imagery. Thus, the limitations of this method are important for researchers to consider when applying it.

Keywords: Forest disturbance, LandTrend, Time Series Images

*Speaker

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Estimating Leaf Area Index of Cassava Plantation using UAV Imagery

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Cassava is a crucial crop for Cambodia, ranking fourth in Asia and tenth globally in terms of production. This study uses remote sensing technologies, specifically multispectral images from a Parrot Sequoia camera, to estimate the Leaf Area Index (LAI) of cassava in Battambang Province. LAI is essential for understanding crop health and productivity. The study tests several vegetation indices, such as OSAVI, NDVI, EVI2, GCL, and REGCL, to find the best indicator for LAI estimation. A simple linear regression was used on the most effective index to create a formula for predicting LAI. To validate the remote sensing estimates, ground-truth data were collected using the LAI-2200C device, which measures the cassava canopy. The study emphasizes the use of regression analysis to verify the accuracy of the predictive model. The results of this research have significant implications for improving cassava management and advancing agricultural practices in Cambodia. By enhancing LAI estimation techniques, the study aids in better crop management and supports informed decision-making and strategic planning. By integrating modern remote sensing technologies with traditional farming techniques can expand the horizons of the agricultural productivity and stability.

Keywords: Battambang, Cassava, Leaf Area Index (LAI), LAI, 2200c, Multispectral image, Vegetation indices, Random Forest algorithm, R programming

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Environmental variables determining carbon stocks and soil physical properties at the catchment scale, Stung Chrey Bak observatory, Cambodia

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Land cover changes are a prominent driver of environmental change, impacting various ecosystem component including soil properties and the dynamics of natural resources, such as large soil particle sizes and organic carbon stocks. The aim of this research study is to disentangle the environmental factors (e.g. land use changes over time from 1952 to the current situation, soil geology, topography, distance to the river and the stream household or mountain, or bio-turbation and the presence of termite mounds) and the variability in soil properties observed in Stung Bak Catchment, Kampong Chhnang Province, in the Tonle Sap region. A total of 190 soil samples at 0-10 and 20-30 cm depths were collected all over the catchment from the four dominant land cover types for a measure of their properties (sand and silt fractions, C content, pH, conductivity and soil bulk density). In addition, all the samples were analyzed with a near Infrared Lab Spec5000 Carbon Analysis (NIRS) and the fractions < 50µm were analyzed with a SALD 2300 Particle size analysis for measuring the fractions of silt (50-2 µm) and clay (< 2 µm). The result of the bulk density and the percentage of the carbon were used to convert the data into stocks of C. All these data are currently mapped from combining spatial data on land cover types and for a visualization of the distribution of C and minerals (clay) in ecosystems. The final step will be to use Random Forest Analyses for determining the importance of the environmental variables (location, importance of the previous land uses, etc.) on the distribution of C and soil minerals in Stung Chrey Bak catchment.

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Keywords: Land use land cover changes, soil organic carbon, particle size, soil properties

Land Surface Temperature and Green Health Vegetation Variability across Lithology and Land Use and Land Cover in the Chrey Bak catchment

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A multitude of studies collectively emphasize the significance of comprehending the spatial distribution and interrelationships between land surface temperature (LST), vegetation greenness (NDVI), lithology, and land use and land cover (LULC), in order to assess environmental vulnerability and formulate targeted interventions for ecosystem health and climate resilience. Their interrelationships are complex and influenced by various factors. A single window algorithm was applied to Landsat-8 (Band 10-Thermal Infrared) satellite images with 82 sampling points situated at the center of fishnet cells (15 km x 15 km) across the Chrey Bak lithology in southern Cambodia. This yielded values for LST and NDVI. Additionally, a support vector machine (SVM) model was applied to Sentinel-2 satellite images, enabling the estimation of LULC classes. Over the eight-year period from 2015 to 2022, there were no discernible changes in LST and NDVI in dacites, old alluvium, and recent alluvium in relation to the LULC classes. However, the forest exhibited a significantly lower distribution of LST in comparison to agriculture (i.e., crop land and vegetation) in diorite and granites, which suggests a cooling impact of forest cover. In contrast, in forested areas, the distribution of NDVI was higher in diorite and eluvial sand. The findings of this study have significant implications for ecosystem functioning and human well-being.

Keywords: satellite images, machine learning, alteration, land use practices.

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Evaluating geographical accessibility by car to healthcare facilities from the lens of the country scale: a study case in Cambodia

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Since the middle of the 20th century, Cambodia has developed its public health infrastructure and adopted a series of measures to improve healthcare accessibility to Cambodian citizens. The current National Social Security Fund, implemented in 2008, strives to provide effective access to healthcare for all Cambodian employees. In 2023, a feasibility study was launched to plan the extension of social protection to self-employed people (“Strengthening Adaptive Social Insurance” – SASI Project). The efficiency of a healthcare system can be evaluated through various key parameters including the accessibility of services, which refers to the spatial location of services, considering road network quality, slopes, and landscapes. Assessing spatial accessibility is a key to evaluate the effectiveness of the healthcare system. In this study, public healthcare facilities only are considered, due to a lack of available data concerning private healthcare offers. In Cambodia, 1493 facilities are distributed across the whole country. To provide a better analysis of the healthcare accessibility, all these facilities are classified, and the analysis applied for all of them vary depending on their specificities. Three main methods are used to compute accessibility. Firstly, a sectorization, to highlight the catchment area (i.e. influence zone of each point, according to the location of the nearest neighbor around this point) of each dot distribution was produced. Secondly, a modelling of travel time from any location in the country to the nearest facility, using the shortest path technique was computed. The innovative point of this study is the use of the software AccessMod (<https://ww.accessmod.org>), developed by the World Health Organization, to produce these travel time analyses. Thirdly, an intersection between these spatial models and the population data by district was used to quantify access to healthcare and shed light on the percentage of population covered by these travel time calculus.

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Finally, these results (i.e. maps), produced on a very fine scale (10 meters), will provide very detailed knowledge of access to healthcare in Cambodia to guide social protection needs, but also to better interpret the representativeness of the health data emanating from these structures.

Keywords: accessibility, health, spatial analysis, spatial modelling, transports

Detection of urban green spaces in Phnom Penh in 1993 using historical aerial pictures

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In the early 1990s, Cambodia was emerging from years of conflict and political instability and was embarking on major reconstruction efforts, particularly in terms of urban planning and development. Historical photographs are crucial for analyzing the city’s landscape prior to the rapid urban expansion of the late 20th and early 21st centuries. We utilized 445 high-resolution aerial photographs of Phnom Penh from 1993, taken by the French National Geographic Institute (IGN) and digitized in 2023 through the Khmer Aerial Photographic Archive (KAPA) Project. These images were orthorectified using Agisoft Metashape Professional software, with ground control points collected in 1993, and a Digital Terrain Model from ALOS to correct the geometry. The study focuses on Phnom Penh’s extent in 1993, covering five districts: Chamkarmon, 7 Makara, Daun Penh, Toul Kok, and the southern part of Reussey Keo. An advanced object-based image analysis (OBIA) was realized with eCognition Developer to detect green areas within the city. A vector layer of buildings from APUR (Atelier Parisien de Urbanisme) helped differentiate vegetation from buildings. Applying OBIA with a multiresolution segmentation to historical photos allowed the detection of vegetation. Vegetation in Phnom Penh was categorized into street trees and urban green areas. Street trees covered the largest extent with 535 hectares, while urban green areas spanned about 60 hectares across the five districts in 1993. The historical aerial imagery provides valuable data for assessing the evolution of green spaces. The study’s findings offer insights into urban development patterns, environmental degradation, and the preservation of green spaces in Phnom Penh over the decades. This research supports informed decision-making in urban planning and promotes sustainable management of urban environments in Cambodia and other rapidly urbanizing regions.

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Keywords: OBIA, eCognition, Aerial image, Satellite, Urban green, Environment

Climate and urban planning

The Role of Urban Climate Map in Phnom Penh's Future Development Plan, Cambodia

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Abstract Phnom Penh is one of the most rapidly urbanizing cities in Cambodia and in the world. Rapid urbanization of Phnom Penh city is creating the urban climatic crisis such as urban heat island. Because of the fast growth of Phnom Penh city, there is a requirement to develop the appropriate urban climate-related mitigation and adaptation strategies with a certain look at the urban climate in different climate scales. Urban climate analysis is an essential tool for climate adaptation in urban planning in Phnom Penh, Cambodia. It is very important to create urban climate map, which characterizes the atmospheric conditions within the urban canopy layer and measure urban climate-related parameters to use in an urban planning system. Particularly, the role of urban climatic map is to provide recommendations for urban development strategies to reduce heat-related issues using ventilation and shading materials. The measurements of air temperature, relative humidity, and ventilation are utilized to analyze the urban heat island effect on urban design. This approach will be used within the city of Phnom Penh in order to demonstrate a climatic urban design.

Keywords: Phnom Penh, urban climatology, urban development, urban heat island

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A Study on Possibility for Climate-Resilient Urban Planning in Chbar Morn Municipality, Kampong Speu Province.

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This research aims to explore the potential of integrating remote sensing technology into urban planning with a view to improve climate resilience of Chba Morn municipality, Kampong Speu province. In this regard, this research seeks to carry out an assessment of climate change vulnerability and risks in the urban area, such as floods, heatwaves, storms, and droughts based on satellite data as well as other reliable sources, such as National Committed of Disaster Management (NCDM). Furthermore, this research is using the integrated method by combining both qualitative and quantitative questions to capitalize on the interviews locals and authority to assess the climate hazards then use data from sources above to crosscheck the results. From the remote sensing analysis, we found a significant change in Land Surface Temperature (LST) in Chbar Morn over the last 20 years which was estimated by using Landsat images in ArcGIS Pro, which reveals the impacts of heatweave. From desk review, we found three other climate-related hazards: floods, storms, and droughts, using the reliable sources from various website such as; NCDM, the International Disaster Database (EM-DAT), Climate Change Knowledge Portal, and others relevant data that related to climate change in Chbar Morn. These hazards are projected to increase in both intensity and frequency. After conducting hazard risk assessment, we will try to identify the gaps and possibility of integrating the climate change mitigation/adaptation options in the municipality’s master plan by developing a framework for those who are technically involved in urban planning.

Keywords: Climate Resilience, Landsat, Land Surface Temperature, Flood, Storm, Drought, Master Plan

*Speaker

The Effects of Land use/Land Cover Changes on Surface Urban Heat Island Intensity in Phnom Penh

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The effects of land use/land cover (LULC) changes on the intensity of surface urban heat islands (SUHI) in Phnom Penh is a significant concern due to the city's rapid urbanization. As the capital of Cambodia, Phnom Penh has the highest population density, making it particularly susceptible to SUHI effects. These effects can lead to increased energy consumption and pose health risks to residents. This study examines the correlation between LULC categories (water, built-up areas, bare ground, green areas, and agricultural land) and SUHI during the dry season. The study also employed remote sensing techniques, analyzing Landsat 8 (OLI/TIRS) satellite data for land surface temperature (LST) and classifying LULC using a Support Vector Machine algorithm with Sentinel 2 satellite data. As a consequence, the SUHI was calculated by zonal analysis between the mean LST on built-up areas and non-built-up areas. The research findings indicate a mean LST increase in the study area from 28.17°C in 2015 to 30.33°C in 2023, an average rise of 0.27°C annually over eight years. The study also reveals a decline in water, green areas, and agricultural land, while built-up areas and bare ground have expanded, with built-up areas alone increasing from 30.82% to 45.83%. Furthermore, the analysis shows that the mean temperatures of bare ground, built-up, and agricultural land are higher than those of water and green areas. Notably, the average SUHI intensity index decreased from 1.12°C to 0.93°C during the same period. These results are important for promoting sustainable urban development and mitigating SUHI effects. They provide valuable insights for urban planners, policymakers, and relevant authorities to formulate effective strategies for Phnom Penh's urban landscape.

Keywords: Land use/land cover, Land surface temperature, Surface urban heat island, GIS, Remote sensing, Urban Planning, Climate change, Phnom Penh

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Rainfall Trend Analysis in Cambodia

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Rainfall has a significant role in influencing water availability to meet various demands. It has been observed that precipitation patterns in many locations around the world are evolving over time, including changes in quantity, duration, and intensity of rainfall. This analysis aims to examine the significant climatic variable, precipitation, to understand the trend of rainfall in the area. This study uses nonparametric tests, the Mann-Kendall test and Sen's Slope test to assess the annual, seasonal, and monthly rainfall variations at 17 stations in four main river basins in Cambodia, namely Tonle Sap, Mekong Delta, Coastal, and Upper Mekong between 1991 and 2021. The results of the rainfall trend vary spatially and temporally. The findings reveal diverse spatial and temporal variations in rainfall trends. An increasing trend in rainfall is observed in the Mekong Delta and Coastal basins, notably at the Krong Khemarak Phummin station, Koh Kong Province, with a confidence level of 99.999% and a slope value of 95.915 mm/year. Conversely, several stations in Tonle Sap and the Upper Mekong display decreasing trends. Notably, a significant decline in rainfall (at a 90% confidence level) is identified at the Kampong Thom station in the Tonle Sap basin, showing a slope value of -9.993 mm/year. The precipitation patterns are exhibiting a decreasing trend during the rainy season and an increasing trend in the dry season. This signifies that wet season becomes drier and dry season becomes wetter. This shift significantly impacts agricultural practices in Cambodia. These findings hold profound implications for Cambodia's agricultural practices and water management strategies. With changing precipitation patterns, agricultural productivity may be affected, necessitating adaptive measures.

Keywords: Trend analysis, Rainfall variability, Nonparametric, Mann, Kendall test, Sen's Slope test, Significance level

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Extreme Rainfall Event Analysis in Cambodia

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Extreme rainfall, also known as heavy rainfall or intense precipitation, is a weather event characterized by a significant amount of rainfall within a short period. This study analyzes trends in extreme precipitation indices at 17 stations in three main river regions in Cambodia, Tonle Sap Lake, the Mekong basin, and the Coastal region, between 1991 and 2021, using RclimDex. Consequently, the statistical analysis of annual and seasonal rainfall varied by location, revealing diverse spatial and temporal variations in rainfall trends. An increasing trend in annual rainfall indices (PRCPTOT) was observed in the Mekong Basin and the Coastal region, notably at the Krong Khemarak Phummin and Prey Veng stations, with slope values of 89.94 mm/year and 32.50 mm/year, respectively, during the study period. The value of R95p and R99p notably increased in the Krong Khemarak Phummin station and approximately 52.12% and 27% of PRCPTOT values, respectively. However, seven stations exhibited a negative trend in PRCPTOT, with values ranging from approximately -0.78 to -14.40 mm per year. The number of consecutive wet days indices (CWD) in the coastal region and Mekong basin increased at most of the stations. Conversely, most of the consecutive dry days (CDD) in stations revealed a negative trend, except for Phnom Srouch, Pursat, Kampong Thmar, and Battambang Stations in Tonle Sap Lake and the Mekong Basin. Notably, maximum 1-day and 5-day precipitation (RX1day and RX5day) were identified at the Krong Khemarak Phummin station in the Coastal region, showing slope values of 5.03 mm/year and 6.85 mm/year, respectively. Results of this study suggest that the Krong Khemarak Phummin and Prey Veng stations indicate an increase in the total amount of precipitation falling on days where rainfall exceeds the 95th and 99th percentiles of precipitation events. These results strongly support disaster management and planning through comprehensive extreme event information.

Keywords: Extreme rainfall, Rainfall indices, Tonle Sap region, Mekong Basin, Coastal region, RclimDex.

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Study on Relationship between Land use/Land cover and Land surface temperature in Siemreap municipal

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Urbanization primarily transforms natural vegetation and permeable surfaces into impervious built-up areas, altering microclimates and ecological dynamics. The impervious surface areas, marked by their higher thermal conductivity, disrupt surface energy balance and accumulate solar heat, subsequently intensifying the land surface temperature (LST). This study explores the impact of land use/land cover (LULC) changes on LST in Cambodia's most popular tourist city of Siem Reap, from the 2020 to 2024 using remote sensing techniques and geographic information system (GIS). Here, LULC maps between 2020 and 2024 were produced from Sentinel-2 satellite images using supervised classification with Random Forest algorithm in Google Earth Engine (GEE). For LST, we used Landsat 8 images because it has thermal infrared band that is necessary for estimating LST. By analyzing the interplay between LULC and LST, our study sheds light on a multitude of interconnected environmental challenges. Preliminary results showed significant changes of LULC, and an increase in LST in Siem Reap over the last four years. This knowledge empowers us to develop more sophisticated temperature monitoring systems, formulate proactive heat control measures, and strategically plan future land development projects. A more detail of how specific land use/land cover types (e.g. built-up area and water body) influence LST deserves further study.

Keywords: Land use/Land cover and Land surface temperature

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Satellite and aerial data

GeoCambodia: A web application to visualize Cambodia Then and Now (FSPI-R KAPA Project)

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The French National Geographic Institute (IGN) came to Cambodia between 1952 and 1954 to carry out a large-scale photographic project, taking around 11,000 aerial images over a large part of the country. Today, this collection represents an exceptional archive that takes us back 70 years to the urban and rural landscapes of the time. In addition to these early aerial photographs, there is a higher resolution shot of Phnom Penh in 1993, with incredible details of life in the streets of the capital. This archive is of great interest in many fields, including history, geography, archaeology, urban planning and ecology. With this in mind, the French Embassy in Cambodia has supported the KAPA (Khmer Aerial Photographic Archive) project to dematerialise this archive and make it accessible and usable free of charge in Cambodia.

All the images were digitized and supplied to the KHmer Earth OBServation (KHEOBS) laboratory to create orthophotographs. Processing has been completed for the municipality of Phnom Penh, for the years 1953 and 1993. In order to make these images viewable by anyone, a web application, GeoCambodia, was developed to visualize Cambodia then (past) and now (present). The user-friendly interface includes an interactive slider to navigate and compare the old 1953 and 1993 aerial orthophotographs with the recent Google Earth images. Also, vector outlines of buildings from 1993, produced by the Atelier Parisien d'Urbanisme (APUR), have been integrated to enable visitors to click on a building and view the APUR's descriptive architectural sheets. Other functions and the extension of the aerial images to the whole of Cambodia are still to come in this interface.

GeoCambodia targets anyone who is interested in aerial and satellite imagery and how Cambodia evolves through time and space, especially geography enthusiasts.

This KAPA project is being conducted by the French National Research Institute for Sustainable

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Development (IRD) and the Institute of Technology of Cambodia (ITC) as part of the KHEOBS laboratory, in collaboration with IGNFI.

Keywords: Aerial imagery, orthophotograph, imagery comparison, web application

Sen2extract @ KHEOBS: Access Sentinel-2 Indices Time Series within a few Clicks

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Since the European Space Agency Copernicus’s launch of the Sentinel satellites in 2015, there has been a rising interest in adapting free and high-quality geospatial data to inform various areas of scientific research; among them are health and biodiversity.

In 2017, the UMR Espace-Dev research team at SEAS-OI Station developed an automatic data processing toolchain in Python for raw Sentinel-2 images, . Dubbed "Sen2Chain", this powerful tool provides researchers with a way to quickly download and host Sentinel-2 imaging data from a variety of providers, and it also enables advanced analytics on this data, including detection of changes in land cover, calculation of predefined radiometric indices (such as NDVI or NDWI), and extraction of time series data for these indices from specific areas and locations.

While Sen2Chain and its web server implementation, Sen2Extract, have greatly simplified the acquisition of Sentinel 2 data, there are limitations in storage, distance, and reliability of network connectivity which hinder the accessibility of the data for the region of Southeast Asia. Therefore, at the KHEOBS Laboratory, we decided to host Sen2Extract in Cambodia using on premise infrastructure.

In order to run the toolchain on our servers, we employed a collection of the latest technologies, such as Docker containerization, Python micro-services, and AWS Simple Storage Service protocol (S3); as a result, we greatly simplified the installation process of Sen2Extract. With the introduction of Gitlab’s continuous integration technology, we further improved the resiliency of the installation. In the end, not only did we successfully adapt Sen2Extract for usage in

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Cambodia (<https://sen2extract.kheobs.org/>), but we also opened an avenue for future scaling of data related to Sentinel-2 and other large data sources.

Keywords: Remote sensing, Earth Observation, processing chain, Python, Sentinel, 2, NDVI, MNDWI

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