KHEOBS Day 2024

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Institute of Technology of Cambodia, Phnom Penh

1-minute presentations of posters

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BAN Liheang [et al.]

Extreme Rainfall Event Analysis in Cambodia

Extreme Rainfall Event Analysis in Cambodia

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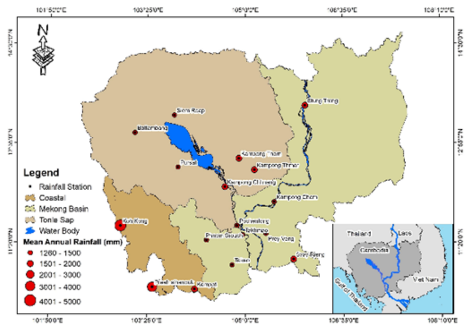
INTRODUCTION

Nowadays, the topic of climate change and global warming have attracted the attention of researchers regrading the future climate condition of the world. Changes in extreme events, such as heavy precipitation, drought, and heat waves, have attracted a lot of attention because of their devastating consequences on society and the economy. This research focuses on the extreme changes in precipitation using the RClimDex model in Cambodia between the year 1991 to 2021.

METHODOLOGY

Study Area

The Kingdom of Cambodia, a country in Southeast Asia, is located on the southern tip of the Indochina Peninsula. Specifically, it located in tropical region lying between latitudes 10ºN and 15ºN and longitudes 102ºE and 108ºE. It has a tropical climate and is affected by both southeast and northwest monsoons. The Mekong River, Tonle Sap Lake, and Coastal are the main sources of water for Cambodia.



This study investigates trends in extreme precipitation indices at 17 stations in three main regions in Cambodia, the Tonle Sap Lake, the Mekong basin, and the Coastal region, between 1991 and 2021.

Software Tools/ Programme

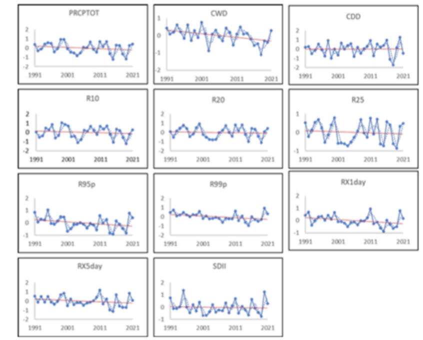
Excel ArcGIS R

CONCLUSION

- An increasing trend in annual rainfall indices (PRCPTOT) was observed in the the Coastal region and Mekong Basin region, notably at the Krong Khemarak Phummin and Prey Veng rainfall stations, with slope values of 89.94 mm/year and 32.50 mm/year, respectively.
- The number of consecutive wet days indices (CWD) in the Coastal region and Mekong Basin region increased at most of the stations.
- Most of the consecutive dry days (CDD) in stations revealed a negative trend, except for Phnom Srouch, Pursat, Kampong Thmar, and Battabang Stations in Tonle Sap Lake and the Mekong Basin.
- The maximum 1-day and 5-day precipitation (RX1day and RX5day) were observed at the Krong Khemarak Phummin station in the coastal region, showing slope values of 5.03 mm/year and 6.85 mm/year, respectively.
- 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 key results strongly support disaster management and planning through comprehensive extreme event information.

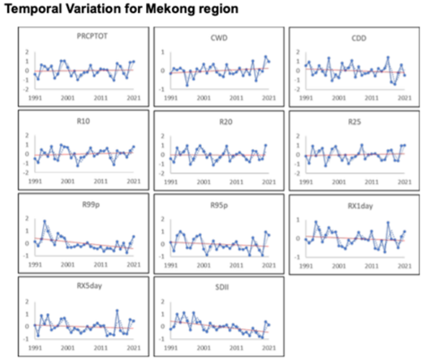
RESULTS

Temporal Variation for Tonle Sap region



Temporal Variation for Coastal region

Temporal Variation for Mekong region



BASSE Manon [et al.]

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

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

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INTRODUCTION

Since the middle of the 20th century, Cambodia has developed its public health infrastructure and adopted a series of measures in order to improve healthcare accessibility to Cambodian citizens. The first social security law was founded in 1955, and a lot of changes have occurred since then. The current National Social Security Fund, implemented in 2008, strive 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 such as availability of services, accessibility, accommodation, affordability, and acceptability of the healthcare system [2]. Accessibility of services, in particular, refers to the geographical location of services in relation to the location of patients, considering geographical factors such as road network quality, slopes and landscapes, which determine travel time, distances and costs. Assessing spatial accessibility to healthcare facilities is a key to evaluating the coverage of the healthcare system and identifying healthcare gaps where there may be poor knowledge of the health status of populations. Indeed, travel time and distances to facilities can affect the use of the healthcare system and the way people receive needed treatments. The time accessibility criteria set for referral hospitals by the *Third Health Strategic Plan* [1] edited by the World Health Organization (WHO) is a maximum of 2 hours of driving for urban areas and a maximum of 3 hours for rural areas. This criteria was used as a reference for the whole accessibility calculus.

MATERIALS AND METHODS

The location of public healthcare facilities was obtained from the Cambodian Ministry of Health (MoH), for 2019. These facilities include 11 national hospitals, 25 provincial hospitals, 85 referral hospitals, 1246 health centers and 126 health posts (mainly in remote areas). The location of hospitals has been corrected (constant offset for all hospitals, probably due to projection errors). We used the population data by district from the 2014 census, provided by the National Institute of Statistics of Cambodia – Ministry of Planning (MoP). We modeled routing using the OpenStreetMap (©OpenStreetMap contributors), made available by Geofabrik for 2024 for Cambodia. To calculate distances and travel times outside the road network, we used the WorldCover landuse/ land cover (LULC), produced by the European Spatial Agency (ESA), at 10 meters spatial resolution, based on Sentinel-1 and Sentinel-2 satellites. We also used the SRTM Digital Elevation Model at 30 meters spatial resolution provided by NASA.

The first step was to map the catchment area of each structure by calculating Voronoi polygons. Sectorization of the dot distribution highlights the catchment area (i.e. influence zone of each point, according to the location of the nearest neighbor around this point) of each public healthcare facility for Cambodia. A distribution is considered even when each polygons share a similar size and shape. A perfect spatial distribution is supposed to record only hexagons (six-sided shape) [3]. The second step involved modeling travel times from any location in Cambodia to the nearest facility, using the shortest path technique, depending on a pre-set travel mode. The travel mode includes a specified maximum speed, a moving mode (here motorized representing a travel by car for the road network, and pedestrian for the LULC) set for each class (*Tab. 1*). AccessMod5 software (https://ww.accessmod.org), developed by WHO, was used to produce these accessibility analyses. Finally, by intersecting these spatial models with population data, we were able to quantify access to healthcare in Cambodia.

Class	Name	Max Speed	Mode
1.	Highway	100	MOTORIZED
2.	Main Road	80	MOTORIZED
3.	Primary Road	70	MOTORIZED
4.	Secondary Road	40	MOTORIZED
5.	Residential	20	MOTORIZED
6.	Pedestrian	5	MOTORIZED
7.	Track	10	MOTORIZED
8.	Ferry	3	MOTORIZED
0	999	0	WALKING
10	Tree_cover	2	WALKING
20	Shrubland	3	WALKING
30	Grassland	4	WALKING
40	Cropland	4	WALKING
50	Built-up	5	WALKING
60	Bare sparse vegetation	3	WALKING
80	Permanent water bodies	1	WALKING
90	Herbaceaous wetland	2	WALKING
95	Mangroves	2	WALKING

Table 1 : Traveling scenario travel set for 3000 minutes accessibility calculus by car

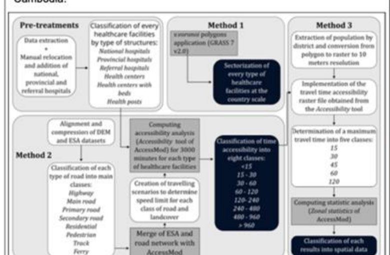


Figure 1: Work flowchart

RESULTS AND DISCUSSION

Figure 2: Catchment area of each type of healthcare facility: all type, national hospitals, Kantha Bopha IV and JaYa VII national hospitals, provincial hospitals, referral hospitals, health centers, health centers with beds, health posts.

The classification of facilities by type reveal some disparities in the location of these points. Spatial accessibility to provincial hospitals, which have smaller catchment areas is better than for national hospitals, which have larger catchment areas. The uneven distribution of national hospitals (*Fig.2.b*), which are concentrated in Phnom Penh and Siem Reap cities, shows a poorer accessibility, and an increasing difficulty to reach more population, whose will have to travel more to be able to reach these structures. However, the health centers' distribution (*Fig. 2.f*) shows a better coverage of the country, and consequently, a better accessibility to facilities. The same result can be observed for provincial and referral hospitals (*Fig.2.d-e*).

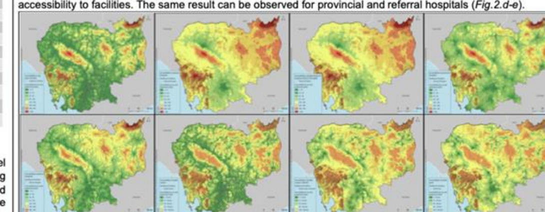
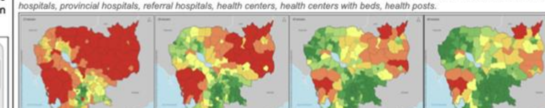
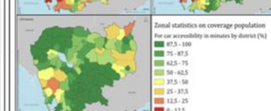


Figure 3: Travel time to each type of healthcare facility: all type, national hospitals, Kantha Bopha IV and JaYa VII national hospitals, provincial hospitals, referral hospitals, health centers, health centers with beds, health posts.





Accessibility is considered good when a facility can be reached within 2 hours of driving. A correlation between time travel and the number of facilities is observed, particularly when facilities are evenly distributed. If national hospitals' accessibility seems poorer than for other facilities, this can be explained by their uneven distribution. Provincial hospitals have one of the best accessibility, due to an even distribution.

Figure 4: Zonal statistics on covered population for car accessibility in minutes by districts for 15, 30, 45, 60, 120 minutes.

Health centers on the other hand, which are the most important facilities on the health journey, reach the 2 hours driving goal. Furthermore, zonal statistics, based upon the previous analysis, shed lights on the percentage of population covered by the travel time calculus. If only 41% of the population is located within 15 minutes of a facility, this percentage reach 92% for 120 minutes of accessibility. Eventually, accessibility to any type of facilities in Cambodia is really good, the only parts of the country which are not covered by the 120 minutes isochrones are mountainous and forested areas, which are less populated.

CONCLUSION

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

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CHY Sreypich [et al.]

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

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

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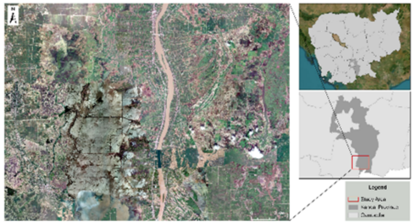
INTRODUCTION

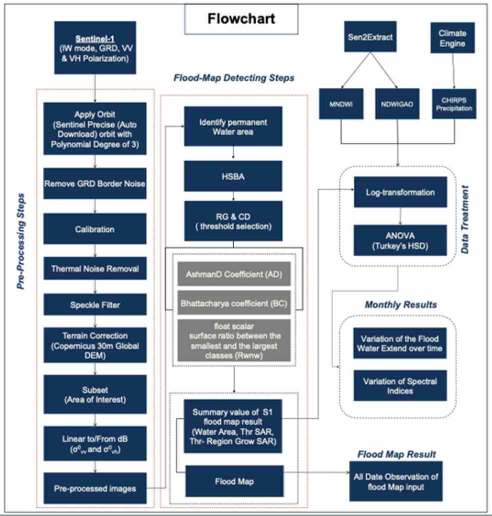
Cambodia is experiencing the adverse effects of climate change, including seasonal flooding in the lowland regions. During the rainy season (November to October), the commune of Preaek Sdei, which is home to extensive agriculture areas, is frequently exposed to the risks associated with floods due its flat topography. The current study utilizes CHIRPS rainfall estimates and optical (Sentinel-2) and RADAR (Sentinel-1) satellite images from European Space Agency (ESA, Copernicus) to analyse rainfall and water area, respectively. The objective of this study is to assess the effectiveness of remote sensing techniques in precipitation and flood estimation and subsequently link these two variables with the spectral indices, such as Modified Normalized Difference Water Index (MNDWI) and Normalized Difference Water Index Gao (NDWI-Gao), to explore their relationships.

METHODOLOGY

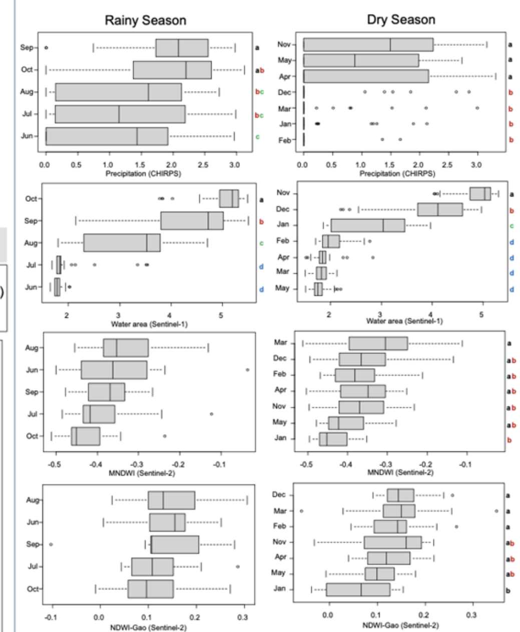


The study area about 429.46 sq.km is located along the Bassac river on the centered of Preaek Sdei commune, Kandal Province, Cambodia.

- CHIRPS rainfall was derived from Climate Engine.
- Water area was calculated by using Hierarchical Split-Based Approach (HSBA) for Parametric Thresholding of SAR Images from 2019-2023.
- MNDWI and NDWI-Gao were extracted from Sen2Extract.



RESULTS AND DISCUSSION



The lower letters (a>b>c>d) exhibited a statistically significant different at a P-value of less than 0.05.

- The precipitation exhibited significant variability throughout both seasons. The highest precipitation was observed in September during the rainy season and in November, May, and April during the dry season. The lowest precipitation occurred in June (i.e., the rainy season) and in January to March and December (i.e., the dry season).
- The water area exhibited a significant variation, especially in October (which coincides with the rainy season) and in November (i.e., the dry season), while June and July, and February and March to May, witnessed the lowest water area during the rainy and dry seasons, respectively.
- Values for MNDWI and NDWI-Gao were not significantly different during the rainy season in contrast to their values measured during the dry season, probably because these indices detect the flooded rice fields with irrigation.

CONCLUSION

The precipitation exhibited significant monthly fluctuations during both seasons. These fluctuations may be attributed to the monthly changes in water area observed during the study period, which in turn impacted the spatial indices, but only during the dry season.

ACKNOWLEDGEMENTS: This work is supported by the PREZODE AfriCAM-Cambodia project, funded the Agence Française de Développement (AFD)

KHOR Sothyda [et al.]

Rainfall Trend Analysis in Cambodia

Rainfall Trend Analysis in Cambodia

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Introduction

Variations in precipitation patterns are one of the main effects of climate change, and they can have an impact on locally supplied and replenished water supplies either directly or indirectly. The effects will be an increase, decrease, or complete change in the quantity, length, and intensity of rainfall. These changes pose challenges to agricultural productivity, water availability, and environmental sustainability, necessitating adaptive measures to mitigate adverse effects.

Cambodia, one of the developing countries, is extremely susceptible to climate change due to a sizable section of the population depends on climate-sensitive industries like agriculture and fishery. Because Cambodian agriculture is heavily dependent on a rain-fed system, any changes in the country's climate will affect crop production and ultimately the national economy.

The goal of this study is to assess the annual, seasonal, and monthly rainfall variations at seventeen stations distributed in four main regions in Cambodia, namely Tonle Sap, Mekong Delta, Coastal, and 3S Basin between 1991 and 2021, using Mann-Kendall and Sen's Slope Estimator test.

Methods

The Mann-Kendall test (Kendall, 1970; Mann, 1945), a non-parametric model, was utilized to analyze seasonal, annual, and monthly rainfall data in order to identify directions of rainfall trends. Additionally, the Sen's Slope Estimator test was employed to determine the magnitude of these rainfall changes (Gilbert, 1987). These statistical tests were conducted using MAKESENS, a Microsoft Excel template developed by the Finnish Meteorological Institute specifically designed for detecting and estimating trends in time series data. MAKESENS is a widely recognized software tool utilized for researching and identifying trends in rainfall patterns.

From the daily precipitation data, we calculated the monthly total rainfall. The annual and seasonal rainfalls were calculated from the monthly total rainfall.

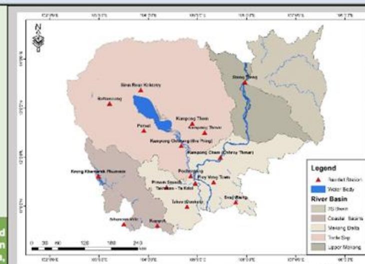

Figure 1.Study Site

Study Site

This study was conducted in Cambodia. The observed historical rainfall data from seventeen rain gauge stations (**Figure 1**) were used for the analysis. All the stations have recorded the daily rainfall data for more than 30 years except the Krong Khemarak Phummin station in Koh Kong province. The available dataset collected for the trend analysis is from January 1991 and December 2021 for all stations except Krong Khemarak Phummin and Sihanouk Ville station which available data is from January 1997 and January 1992, respectively.

Annual rainfall varies from the lowest with a value of 1260 mm/year in Takhmao station, Kandal province to the highest with a value of 4180 mm/year in Krong Khemarak Phummin station, Koh Kong province (**Figure 2**). The other two stations in the Coastal catchment, Sihanouk Ville station and Kampot station have an average annual precipitation of 3,032 mm and 1887 mm, respectively. The average annual rainfall shows that the highest rainfall exists in coastal regions, and the lowest rainfall takes place in the Mekong Delta region.

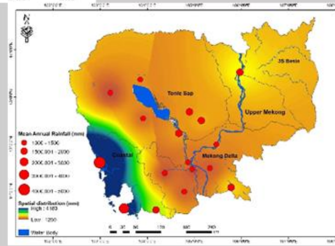

Figure 2. Mean annual rainfall distribution in Cambodia

Annual Rainfall Trend Analysis

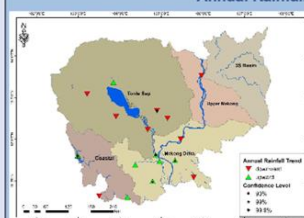

Figure 3. Mann-Kendall test results for annual trends detection

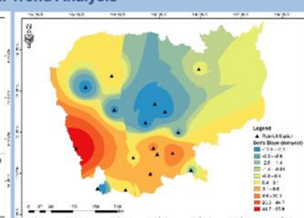

Figure 4. Results of Sen's Slope test for annual rainfall trend

The Mann-Kendall test depicted a discernible trend in annual rainfall from 1991 to 2021 as shown in **Figure 3**. The results show that 53% of rainfall stations (9 stations) demonstrated a downward trend in annual rainfall, while 47% (8 stations) displayed an increasing annual rainfall trend. An increasing trend in annual 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 99.9% 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.

Seasonal Rainfall Trend Analysis

Table 1. Seasonal rainfall trend using the Mann-Kendall test and Sen's Slope test

River Basin	Station Name	Wet Season			Dry Season		
		Trend	Sign. level (%)	Sen's Slope	Trend	Sign. level (%)	Sen's Slope
Tonle Sap	Pursat	∇	90	-7.596	Δ		2.321
	Kampong Chhnang (Sre Pring)	∇		-9.189	Δ	95	4.486
	Kampong Thom	∇	90	-8.157	Δ		0.090
	Kampong Tmar	∇		-6.400	Δ		0.123
	Battambang	∇		-5.064	∇		-1.552
	Siem Reap Koktatry	Δ		1.029	Δ	90	2.450
Mekong Delta	Takeo (Donkeo)	Δ		3.120	Δ		2.871
	Takhmao - Ta Kdol	∇		-0.911	Δ		3.160
	Phnom Srouch	∇		-2.900	Δ		3.271
	Pochentong	Δ		4.400	Δ		5.073
	Svay Rieng	∇		-1.683	Δ		1.988
	Prey Veng Town	Δ	99	13.363	Δ		5.104
	Kampong Cham (Chhroy Thmar)	∇		-3.471	Δ		1.574
Coastal	Kampot	∇		-6.252	Δ	99	7.500
	Sihanouk Ville	∇		-10.922	∇		-1.755
	Krong Khemarak Phummin	Δ	99.999	84.773	Δ	95	13.352
3S Basin	Stung Treng	∇		-3.900	Δ		2.600

Δ : indicates a positive trend and ∇ : indicates a negative trend

Monthly Rainfall Trend Analysis

Table 2. Monthly rainfall trend using the Mann-Kendall test

River Basin	Station Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tonle Sap	Pursat	Δ	∇	Δ	Δ	∇	∇+	∇	∇	∇**	∇	Δ	Δ
	Kampong Chhnang (Sre Pring)	∇	Δ	Δ	Δ*	Δ	∇+	∇	∇	∇	Δ	Δ	Δ
	Kampong Thom	Δ	Δ	∇	Δ	∇+	∇+	Δ	∇	∇	∇	Δ	Δ
	Kampong Tmar	∇	Δ	Δ	∇	∇	Δ	∇	∇	Δ	∇	Δ	Δ
	Battambang	Δ	∇	∇	Δ	∇	-	∇	∇	∇	∇	Δ	∇
	Siem Reap Koktatry	Δ	∇	∇	Δ*	Δ	∇	Δ	∇	Δ	-	Δ	∇
Mekong Delta	Takeo (Donkeo)	Δ	Δ	Δ	Δ	Δ+	Δ	Δ	Δ	∇	Δ	Δ	Δ
	Takhmao - Ta Kdol	Δ	Δ	∇+	∇	∇+	Δ	∇	∇	Δ	Δ	Δ+	Δ**
	Phnom Srouch	∇	∇	∇+	Δ	Δ+	Δ+	∇	∇	Δ	∇	Δ+	Δ*
	Pochentong	Δ	Δ	Δ	Δ*	Δ	Δ	∇	∇	Δ	Δ	Δ	Δ
	Svay Rieng	Δ	Δ	Δ	∇	∇	∇	Δ	Δ	Δ	Δ	Δ	Δ
	Prey Veng Town	Δ	Δ	∇	Δ+	Δ+	-	Δ	Δ+	Δ	Δ+	Δ	Δ+
	Kampong Cham	∇	Δ	∇	Δ	∇	∇	Δ	∇	∇	Δ	Δ*	Δ
Coastal	Kampot	Δ	-	∇	Δ	∇	∇	∇	∇+	Δ+	Δ	Δ**	Δ*
	Sihanouk Ville	Δ	Δ	Δ	∇	Δ	∇	∇	∇	Δ	-	Δ	Δ
	Krong Khemarak Phummin	Δ	∇	Δ	Δ+	Δ	Δ**	Δ	Δ*	Δ**	Δ+	Δ*	Δ
3S Basin	Stung Treng	∇	∇	Δ	Δ	∇	∇+	Δ	∇+	Δ	Δ***	Δ	Δ

Δ : indicates a positive trend ∇ : indicates a negative trend
* : indicates 95% confidence level of increase * : indicates 95% confidence level of decrease
+ : indicates 90% confidence level of increase + : indicates 90% confidence level of decrease
** : indicates 99% confidence level of increase ** : indicates 99% confidence level of decrease
*** : indicates 99.999% confidence level of increase - : indicates no trend

Conclusion

- The findings reveal diverse spatial and temporal variations in rainfall trends.
- For annual rainfall trend analysis, all areas in Tonle Sap showed a tendency towards drier conditions, except for Siem Reap province, where an increase in rainfall was observed. In the Mekong Delta region, Kampong Cham, and Svay Rieng stations are becoming drier, while other areas are experiencing an increase in rainfall. Along the Coastal regions, Kampot and Krong Khemarak Phummin stations are experiencing a wetter climate due to an increase in annual rainfall, while Sihanouk Ville is expected to receive less rain as well as Stung Treng station in 3S Basin.
- The most significant increasing trend occurred in the Coastal region (and Krong Khemarak Phummin), followed by Mekong Delta; meanwhile there was no such significant decreasing trend.
- The precipitation patterns exhibit a decreasing trend during the rainy season and an increasing trend in the dry season. This signifies that the wet season becomes drier and the dry season becomes wetter.
- The results of monthly rainfall trend corresponds with the seasonal rainfall trend. Overall, most months in the wet season demonstrate a downward trend in monthly rainfall at all stations, while most months in the dry season exhibit an upward trend in monthly rainfall. Therefore, it is evident that there would be a change in precipitation patterns across all stations in Cambodia.

Discussion

In our analysis, the Coastal region experiences a significant increase in rainfall with the highest slope. However, there is a notable decrease in annual rainfall in Preah Sihanouk, which raises concerns about water availability for this city since it is an industrial center of Cambodia and a rapidly urbanizing city of economic importance among the second-tier cities in Cambodia. Kampot and Koh Kong province will likely suffer from floods when rainfall intensifies in the future. Similarly, urban areas in the Mekong Delta basin are likely to experience increased annual precipitation. Urbanization and deforestation contribute to land use and land cover changes, which in turn, affect the region's topography. This effect is particularly pronounced in areas situated on the leeward side of the mountains, such as the Mekong Delta, resulting in heightened rainfall patterns similar to those observed in the Coastal basin.

The results are highly dependent upon the period of data and the stations whose data are used. The longer observed data will be more accurate for temporal analysis, while more rainfall stations will be better for spatial analysis. The sparse and uneven distribution of rain gauges in Cambodia poses a significant challenge to environmental modeling, with Satellite Rainfall Estimates (SREs) crucial for filling data gaps when gauge observations are lacking.

Future studies focusing on rainfall projections at a downscale level and specific timeframes are essential for better understanding and preparing for climate variability and extremes in Cambodia. Moreover, research on extreme precipitation and other rainfall indices is imperative, given their direct impact on local livelihoods, particularly in the agricultural sector, which holds significant importance for Cambodia's economy.

POV Kakda [et al.]

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

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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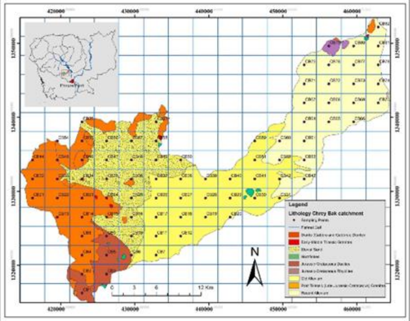
INTRODUCTION

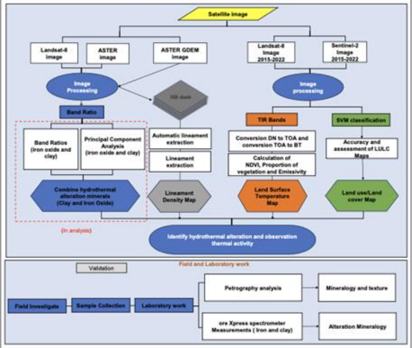
An understanding of **the spatial distribution and relationships** among land surface temperature (LST), normalized difference vegetation index (NDVI), lithology, and land use and land cover (LULC) can assist in the assessment of **environmental vulnerability** and the formulation of targeted interventions for **the health and resilience of ecosystems and climate**. Previous research has demonstrated the significance of the LULC changes in influencing the variability of LST and NDVI. Nevertheless, the impact of underlying lithology (i.e., rock formations) on LST and NDVI, through different LULC changes, remains to be elucidated. This study examines the relationships among those variables in question at the Chrey Bak catchment in Cambodia.

MATERIALS AND METHODS

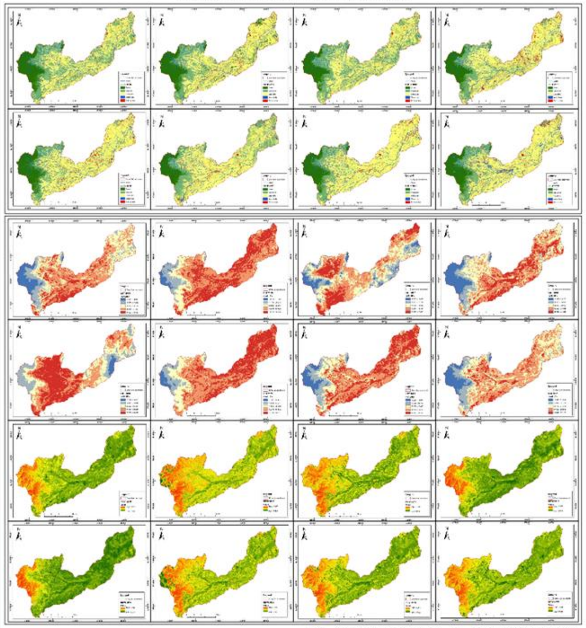
- The Chrey Bak lithology map (700 sq. km) from JICA 2010 was covered by fishnet cells (15 km x 15 km), and the 82 sampling points were in the middle of each cell.
- Each of the sampling points was to detect land use and land change (LULC) using Sentinel-2, land surface temperature (LST), and normalized difference vegetation index (NDVI) using Landsat-8 between 2015 and 2022.

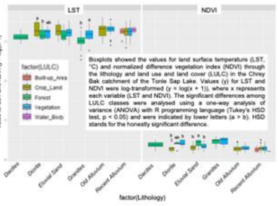


Work Flowchart



RESULTS AND DISCUSSION





- The lithology comprises six rock units: dacites (0.66%), diorite (5.14%), eluvial sand (19.87%), granites (20.10%), old alluvium (26.55%), and recent alluvium (27.20%), with LULC classes, such as forest ranging from 14.54 to 8.17%, vegetation (16.62-8.45%), crop land (12.33-9.07%), water body (25.25-3.22%), and built-up (19.98-5.67%).
- There were no discernible changes in LST, ranging from 32.5 to 41.5 °C, and NDVI (0.59-0.97) 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, while a higher distribution of NDVI was observed in diorite and eluvial sand.

CONCLUSION

Land surface temperature (LST) and vegetation greenness (NDVI) are influenced by lithology and land cover dynamics. These findings underscore the significance of investigating the spatiotemporal dynamics of climate-driven and plant responses for the purpose of sustainable management and climate resilience in the Tonle Sap region.

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CHOUN Sophea [et al.]

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

SOY Makara [et al.]

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

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

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INTRODUCTION

The early 1990s were a pivotal period for Cambodia, as the nation was emerging from years of conflict and political instability. This era marked the beginning of substantial reconstruction efforts, which included urban planning and development. Historical aerial photographs serve as a crucial tool in this analysis, offering a visual record of the city's landscape before the rapid urban expansion that characterized the late 20th and early 21st centuries. Despite there single band, aerial pictures at a very high spatial resolution offer the possibility to detect green spaces, which is crucial for urban planning and environmental conservation efforts in Phnom Penh city, facing a loss of vegetation and green spaces under rapid urbanization. The aim of this study is to see how these old aerial images can be used to detect vegetation with a view to using them later in comparison with the analysis of satellite images at an equivalent very high spatial resolution.

MATERIAL AND METHODS

This study benefited from the availability of 445 very high spatial resolution aerial photographs (0.2m) of Phnom Penh taken by the French National Geographic Institute (IGN) in 1993. These photographs were digitized and provided in 2023 by IGN through the Khmer Aerial Photographic Archive (KAPA) Project. Images were orthorectified with Agisoft Metashape Professional software, using ground control points collected in 1993 for this purpose. A Digital Terrain Model from ALOS was also used to correct the geometry.

The study focuses on the extent of the city of Phnom Penh, the capital of Cambodia, as it was in 1993. This area comprises 5 districts: *i.e.* Chamkarmon, 7 Makara, Daun Penh, Toul Kok, southern part of Reussey Keo (Figure 1).

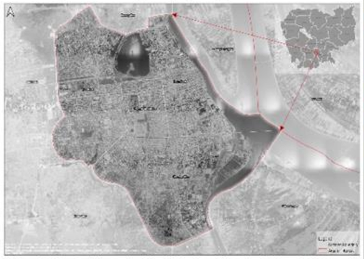

Figure 1: *Extent of Phnom Penh in 1993, viewed from the IGN aerial photographs*

An advanced object-based image analysis (OBIA) was realized with eCognition Developer to detect green areas within Phnom Penh City, Cambodia (Figure 2). A vector layer of buildings, provided by APUR (Atelier Parisien de Urbanisme) was used to help discriminating vegetation from buildings.

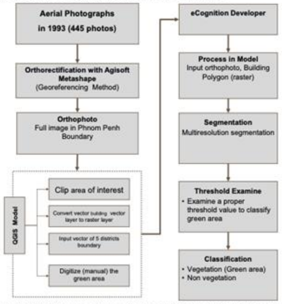

Figure 2: *Workflow of analyses, from aerial photographs to the vegetation map*

RESULTS AND DISCUSSION

Using OBIA applied to historical photos allowed to detect vegetation in the city of Phnom Penh. The separation between green and non-green area were analyzed using Multiresolution segmentation on historical photos (Figure 3).

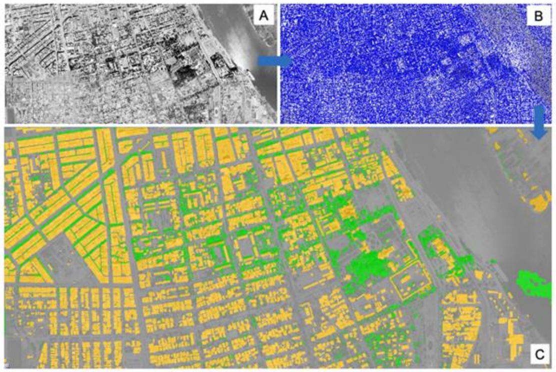

Figure 3: *A,B&C is objects classified as vegetation class outlines of the created.*

The detection of vegetation in Phnom Penh is divided into two categories: Street trees and Urban Green areas. Street trees have the largest extent with 535 hectares, while Urban Green areas cover about 60 hectares over 5 districts in 1993 (Figure 4).

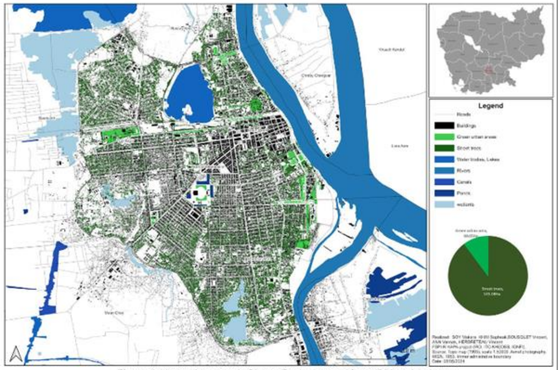

Figure 4: *Vegetation areas in Phnom Penh, detected from 1993 aerial photos*

CONCLUSION

Historical aerial imagery from 1993 serves as valuable input data, enabling researchers to assess the evolution of green spaces. The result from this study gives insights into urban development patterns, environmental degradation, and the preservation of green spaces in Phnom Penh over the past decades. Ultimately, this research contributes to inform decision-making in urban planning and promotes the sustainable management of urban environments in Cambodia and similar regions facing rapid urbanization.

ACKNOWLEDGEMENTS

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