Impacts of Climate Change to Eleocharis Habitat in Tram Chim National Park, Dong Thap province, Vietnam

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Abstract. Combining the current remote sensing platform combined and field survey is one of the effective methods to assess the impact of climate change on the distribution of plant cover as well as their structure. This study combined field surveys in April 2019 and image analysis from google earth pro in real-time in May 2006, 2009, 2013 to assess the change of Eleocharis group in Tram Chim national park. The results of the study showed that Eleocharis group, which admirably adapts to the acidic soil conditions (pH <4.5), had significant changes. Although water storage has created an extremely safe environment to avoid the impacts of wildfires, temperature rising at midday made Eleocharis less alive. It could be seen that climate change had affected the physiological characteristics of the tropical grass group, more specifically, made their ecological limits change and narrowed the distribution area of the most developed group in the national park.

1. Introduction
Climate change may decrease some stressors while intensifying other factors. Warmer temperatures and shifting precipitation patterns are predicted that could strongly influence ecosystem drivers. The yearly temperature increase is considered the most widely reasonable stress factor, strongly influencing another stress and ecosystem responses such as a longer growing season, earlier melting spring, and later first frosts in fall could lead to higher growth and productivity, but only if provided adequately water. The nature and timing of precipitation will change. Annual precipitation amount may increase, but higher rates of precipitation may occur in winter, leaving summers longer and drier. Soil moisture will change, with drier soil conditions towards the end of growing season. Changes in Rainfall pattern and evaporation are expected to make the soil more moisturized. The frequency, scale, and severity of natural disturbances will vary across the landscape. Windstorms, ice storms, droughts, wildfires, and floods can probably cause more damage.

The impact of climate change effects long-term and very slowly, so the assessment of the expression of climate change through rainfall and temperature factors is difficult to recognize in the inland area. However, climate change has a significant apparent impact on groups of organisms that are less likely to live only in ecological habitats. Climate change directly affects and significantly changes the growth and dispersal of the herbaceous plant group.

Eleocharis are the group of plants indicating acidic soils (pH<4) in the alum-flooded provinces Dong Thap Muoi. The Grus antigone sharpie group, of which Eleocharis is a main food source, has been declining in population in Tram Chim park. This has been associated with the decrease in
Eleocharis population [8]. *Eleocharis* take a lead role in the reduction of aluminum in the acid soil exude organic compound and improved the quality of acidic surface water.

Most riparian zones and wetland ecosystems may encounter some level of increased stress in a warmer climate, including the secondary effects of wildfire increases and non-native species. Some changes may occur slowly, and others may occur episodically (e.g., the period following wildfire). Therefore, long-term monitoring is necessary to identify where, when climate change effects happen, and how they do. Hence, it can institute a foundation for assessing the impacts of climate change on Tram Chim National Park.

2. Methodology

2.1. Study area
Tram Chim National Park is located in Dong Thap Muoi, Tam Nong district, Dong Thap province, in the Mekong Delta with an area of 7313 hectares located in the boundaries of 4 communes (Phu Duc, Phu Hiep, Phu Thanh B, Phu Tho) and Tram Chim Town. The study area is the protected zone of Tram Chim National Park. The area has 7588 hectares of seasonally submerged grasslands and planted *Melaleuca cajuputi* forest separated in an array of small to medium-sized patches. The outer boundaries of the protected zone abut agricultural and residential lands (A4, A5)

![Figure 1. Location of Tram Chim National Park including Management Zones](image1)

2.2. Methods
2.2.1. Data collection. Secondary data collection including:
- The ecological situation, natural and environmental factors in Tram Chim National Park.
- Status of forest in Tram Chim National Park (TCNP).
- Maintenance water level and plant to maintain the water level in Tram Chim National Park.
- Vegetation map of TCNP Quoi

![Figure 2. Vegetation map of Tram Chim NP- Quoi May 2006, 2009, 2013 [7]](image2)
2.2.2. Methods of data analysis. STAGRAPHIC XVIII tools were used to synthesize, analyse, calculate data and graph.

Land Cover Change Analysis (Object-Based Approach combine with visually determine).

Visual plot characterization was used to visually determine tree and non-tree vegetation (colour tone of canopy, size, context, geometry, and drainage, were used and supported by field validation.)

The visual analysis of the digitally enhanced images was determined using the tools like (add polygon and auto measuring tool plugin, a ruler that comes standard with Google Earth® software). The value was used and appropriate level of aerial resolution (defined as the viewing height necessary to visually resolve individual scene elements such as trees, generally ~50–100 m above-ground), each plot was subdivided (if necessary) to facilitate a satisfactory visual estimate of percent tree and non-tree vegetation cover.

This research combined geometric populations and Annual Rate of Change of LULC approaching and Forest Fragmentation.

The annual rate of change for each land use (change) type and an annual fragment creation rate were calculated using the following formula suggested by [10].

\[
r = \frac{1}{t_2-t_1} \times \ln \left( \frac{A_2}{A_1} \right) \quad (1)
\]

Where \( r \) is the change for each type per year, \( A_2 \) and \( A_1 \) are the end and beginning class areas, respectively, during the time period to be evaluated, and \( t \) is the number of years in that time period.

That mean:

\[
r \times \Delta t = \ln \left( \frac{A_2}{A_1} \right) \quad (2)
\]

\[\leftrightarrow A_2 = A_1 e^{r\Delta t} \to \Delta A = A_1 - A_1 e^{r\Delta t} \quad (3)\]

The Nonlinear Regression procedure fits a user-specified function relating a single dependent variable distribution of Eleocharis to one independent variables Time (years).

3. Results and discussion

3.1. Climate change in Tram Chime National Park

3.1.1. Hydrological regime.

The hydrological regime is an essential factor, affecting the entire from the vegetation in reproduction stage to ripening stage [7]. The average annual rainfall is about 1,400 mm, with 85% occurring in the rainy season (May to October). Rainfall and water flow from the upstream result in annual flooding between August and November in the Park area. Water levels in canals around the park increase in May and June. The flood peak often occurs in October annually (4 m above mean sea level). The average water elevation in flooding season (August to November) and dry season (March to June). Most of the Park has water-saturated soil due to prolonged waterlogged conditions.

Notably, the variation of water regimes such as keeping high water levels in some years may create conditions for acid soil to enhance to degrade acid by sediment for death plant in prolonged waterlogged (Figure 3). The significant in 2 years (2009 and, 2010) show the condition of prolonged waterlogged with high-level form new carbon pools for sedimentation and peat regeneration in the future.
According to the water level data recorded at Tram Chim National Park from 2009 to 2013 [10], there was instability. This fluctuation considerably affects Eleocharis tubers could not be formed. One of the causes of disturbance of the hydrological regime in Tram Chim National Park was to store water by flooding in preventing forest fires. Besides, the arrangement of too many hydroelectric dams in the upstream caused severe water shortage in the downstream. Floods disturbed the hydrological regime in the Tram Chim National Park area, which directly affected the growth of Eleocharis. This group distributes optimally at areas that have moist soil and declines sharply with higher or lower water levels with soil pH 3.2-3.8. Eleocharis is the dominated species at the low pH soil that affects nutrient availability and decreases nodulation of legumes and nitrogen fixation in pastures [5].

Figure 3. Correlation among pH and Water levels from 2009-2013 in Zone A4, A5.

Figure 4. The waterlevel in Zone A4, A5 from 2009 to 2013 Analyzed based on Water levels recorded in Tram Chim NP from 2009 to 2013 [10].
3.1.2. Flood peaks decreased and abnormal rainfall.

The abnormal rainfall (Rainfall in the dry season) also affected the produce tubers of *Eleocharis* in Tram Chim National Park [7]. Rainfall was unevenly distributed, heavy rains at the beginning of the season, and less at the end of the season, also greatly affected the basin. This was also one of the causes that change the environmental properties and affect the habitat of *Eleocharis*.

![Plot of Fitted Model](image)

**Figure 5.** Simple Regression - flood in TCNP vs. Year (2000-2015)\(R^2= 30.2054\) (P-value<0.05)

3.2. *Eleocharis in Tram Chim National Park*

When dry conditions suitable for Eleocharis are met, within other drier parts of the Park (for example Zone A5) tuber production has been maintained [8]. The monitoring of vegetation responses to the draw-down experiment within Zone A4 in 2005 revealed the remarkable re-establishment of *Eleocharis*. However, it also showed that this re-growth was from seeds due to the death of underground tubers resulting from previously highwater levels. A return to high water levels in subsequent years will kill the new growth of *Eleocharis* as their roots will not be fully developed. The prolonged health of *Eleocharis*, including the production and sustained growth of tubers, requires lower water levels that are repeated in subsequent dry seasons. Therefore, the overall impact of the high-water areas may cause a decrease in the range and condition of *Eleocharis*. Panicum has been the most remarkable species which have profited at the expense of *Eleocharis*. Although *Eleocharis* growth is maintained in parts of the Park such as zones A4 and A5 which are currently drier, the inability to control water levels due to their permanent connection with the surrounding area has, until the recent construction of new spillways, limited management options in times of drought when water levels may fall beyond those required to maintain healthy vegetation growth.

| Table 1. Area changes of the *Eleocharis* in (2006-2013) |
|-------------|-------------|-------------|-------------|-------------|
| **Area of *Eleocharis*** | **Area changes of *Eleocharis*** |
| **Zone** | **2006 (m²)** | **2009(m²)** | **2013(m²)** | **2009-2006(m²)** | **2013-2009(m²)** | **2013-2006(m²)** |
| A4 | 3.786.119 | 2.516.641 | 1.119.635 | -1.269.478 | -1.397.006 | -2.666.484 |
| A5 | 1.853.394 | 1.341.910 | 1.121.106 | -511.484 | -220.804 | -732.288 |
The results of modifying a linear model to explain the relationship between rate of change area *Eleocharis* $F = A_2/ A_1$ (A2 and A1 are the class areas at $t_1$ and $t_2$) of in A5 and A4 area each year. The equation of the fitted model is:

$$\ln(F_1) = -0.175585\Delta t \text{ with R-squared = 98.89\% (p-value = 0.0156)}$$
$$\ln(F_2) = -0.0703623\Delta t \text{ with R-squared = 94.1055\% (p-value = 0.0299)}$$

$\Delta t$ and rate of change *Eleocharis* area at A4, A5 has statistically significant relationship at the 95.0\% confidence level (P-value < 0.05).

The results of modifying a model to explain the relationship between $\Delta A_4$, $\Delta A_5$ and $r*\Delta t$. The equation of the modified model is:

$$\Delta A_4 = \exp(13.2883 + 0.439721/\exp(-0.175585*\Delta t)) \text{ with R-squared = 99.6471\% (p-value < 0.05)}$$
$$\Delta A_5 = 1.652520 - 1.605620*\exp(-0.0703623*\Delta t) \text{ with R-squared = 41.2005\% (p-value > 0.05)}$$

In this case need more data to analyse and show the time begin of change *Eleocharis* area. However, by calculating (r), (r) is more than rate of deforestation constant number. It can show the time begin of change and compare with environment variable can show the effect of climate change.

### 4. Conclusions

The overall impact of the high-water areas may cause a decrease in the range and degree of *Eleocharis* Panicum has been the most remarkable species which has profited at the expense of *Eleocharis*. As results above for the 2006-2013 trend, the degrade of *Eleocharis* distribution area in Zone A4, A5 was presented as follow model of rate of change area *Eleocharis*:

$$\ln(F_1) = -0.175585\Delta t \text{ with R-squared = 98.89\% (p-value = 0.0156)}$$
$$\ln(F_2) = -0.0703623\Delta t \text{ with R-squared = 94.1055\% (p-value = 0.0299)}$$

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