

# CHARACTERIZATION OF PROTECTED AREAS OF IVORY COAST ACCORDING TO OBSERVED TRENDS IN MODIS NDVI TIME SERIES BETWEEN 2002 AND 2014

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## ABSTRACT

This paper proposes a new and very simple method of classification of protected areas in three classes: progression, regression, and stability of vegetation cover. Ranking can also be performed. It provides an overview of the protected areas which are well conserved or not. The MOD13Q1 MODIS NDVI 16-day composite grid data product is studied with Kendall's correlation. 14 protected areas are characterized predominantly by a significant negative correlation and 23 protected areas are characterized predominantly by a significant positive correlation. Cartography of land cover using LANDSAT images has allowed for the quantification of land cover changes to assess accuracy. The correlation coefficient is 0.84. This very simple method could be used as a prior diagnostic of protected area conservation status, much easier than multispectral methods and so, offered as an automatized tool for policymakers in Africa for regular and regional surveys.

## KEYWORDS

Remote sensing; Protected areas; Time series analysis; Mann-Kendall; land cover changes; Ivory Coast.

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## 1. INTRODUCTION

The conservation of forests is one of the principal environmental issues for tropical and equatorial regions (Singer, 2015). Indeed, tropical forests have diminished at an estimated rate of 6 million hectares per year between 2005 and 2015. During the 1990s, the rate was approximately 10 million hectares per year (FAO, 2015). Despite this decline, the conservation of forests is key to the preservation of biodiversity (Bawa & Seidjer, 1988), the fight against climate change (Kienast *et al.*, 1998;

Zavaleta & Heller, 2009), and the mitigation of natural hazards and health risks (Kopnina, 2017). A large part of the decline in tropical forests can be explained by the spread of agricultural land (FAO, 2015). In response to this threat, the majority of governments have created protected areas. Within these areas, the conservation of biodiversity is prioritized and thus agriculture is forbidden. However, certain factors can limit forest conservation even within these protected areas. For example, the term protected area is quite generic and can have vastly different social and legal implications depending on its context. Furthermore, the effectiveness of each framework differs when it comes to this objective of conservation.

At first glance, Côte d'Ivoire (Ivory Coast) is not an exception to the aforementioned trends. On the one hand, the nation has created a network of protected areas to ensure the conservation of forests. On the other hand, however, its land has undergone a process of clearing strictly associated with the development of profitable agriculture, especially coffee and cocoa crops. Indeed, studies have demonstrated examples of forest conservation failures within protected areas of Côte d'Ivoire (Barima *et al.*, 2016; Sako *et al.*, 2013).

The Côte d'Ivoire country contains 244 protected areas totaling 60 023 km<sup>2</sup>, which corresponds to 18.6% of the 322 463 km<sup>2</sup> total land area of the nation. These protected areas are broken down into 8 national parks (18 441 km<sup>2</sup>), 5 nature reserves (1 054 km<sup>2</sup>), and 219 forests (40 528 km<sup>2</sup>).

When it comes to vegetation cover change in Côte d'Ivoire, three main contextual elements characterize the study period (2002-2014). Firstly, for the last several decades, the spread of cocoa crops, and to a lesser extent coffee crops, have been the principal cause of land cover change (Chauveau & Bobo, 2005). This change has taken the form of pioneer fronts, especially in the northern limits of the land with a climate that is especially cultivable for cocoa and coffee crops. During our study period, the decade from 2000 to 2010, the eastern portion of this

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