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Mapping of built up areas in the Cameroonians shores of Lake Chad and its hinterland through based object classification of sentinel 2 images

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1. Context

In the Cameroonian side of lake Chad and hinterland, the data of population census in Cameroon show that the demography of the Logone and Chari administrative division, has steadily increased from 276 170 to 486 997 inhabitants between 1987 and 2005 (BUCREP 1992, 2010). The growing urbanization observed in this zone increases the need of control on the natural resources exploitation. However, the rural settlement is dominant, more expanded, and the characteristic of built-up is patchwork of huts constructed with ground, covered with stalk of millet or gramineous grasses. Consequently, it is important to focus on the distribution and the quantification of the built-up, to further considering its impact on the biological and physical processes of the environment

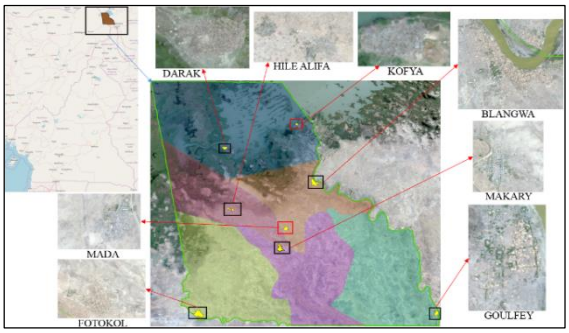

Figure 2: principal localities (framed in black) and rural space (framed in red)

Data availability?

According to the spatial resolution of the image available (Corona, Landsat MSS, Sentinel 2), it is then difficult to map the built up areas for the previous dates. Therefore, these constraints do not enable a diachronic study of the built up areas.

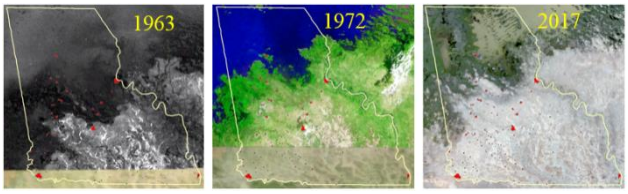

Figure 1: Data evolution and spatial variation of built up area extent

2. Methodology

The study area (figure 2) is located in the Far north administrative region of Cameroon and shares borders with the Republic of Chad to the north and east, the Federal Republic of Nigeria to the west and the rest of country to the south. For the purpose of the study, two Sentinel 2 satellite images acquired on April 29, 2017 are used. These images have 13 bands, but for this study, we only use the four bands at 10 meters in addition to the band eleven and the band twelve.

The study was carried out in two phases: (1) pre-processing of satellite consist in a simple atmospheric scattering correction by using the processor sen2core (Müller-Wilm *et al.*, 2013); (2) classification of the main occupation classes follows by the characterization of the built up areas.However, the built up area in this territory is constituted of several types of housing principally houses built with local materials (huts of ground covered with stalk of millet or gramineous grasses) and are difficult to differentiate at this spatial resolution with other class like bare soil. To highlight the difference between built up area with other classes, NDBI and UI index, and component 3 and 6 of PCA are computed as neo bands and merged with the original bands. The new image is then classified according to the SVM's method which is a supervised learning algorithms based on statistical learning theory, and his aim for classification is to determine a hyperplane that optimally separates classes (Srivastava *et al.*, 2012), (Gunn, 1998), (Zhang, 2012).

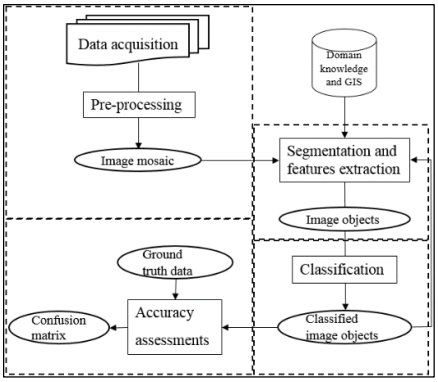

Figure 3: Flowchart of the methodology

3. Results

3.1 classification

The land cover at this time of the year is dominated by the soil class with 65,53% (311195,61 hectares) of the total extern of the study area. Water covers an area of 52627,81 hectares, with a rate of 11,08% and vegetation covers 108349,09 hectares (22,81%). The built up area occupies an area of 2669,76 hectares which represents 0,56% of the total surface of the zone studied.

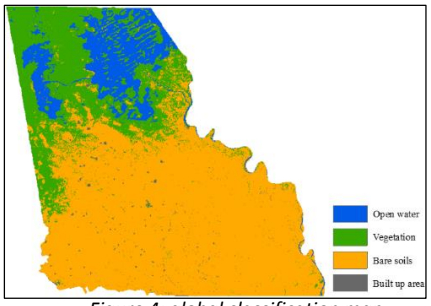

Figure 4: global classification map

3.2 Built up area extraction

The built up areas obtained for principals city after classification are distributed as follows: (a)Fotokol 942350,42 m², (b)Makari 673418,24 m², (c)Blangwa 663516 m², (d)Darak 474245,82 m², (e)Goulfey 251491,68 m², (f)Hile alifa 143137,32 m²

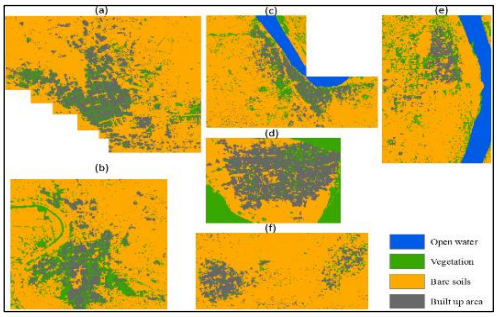

Figure 5: built up area in the principal localities

3.3. Morphology and structure of built up area

3.3.1. At the internal shores

The built up area is less important in Kofya (127187,92 m²) and appears less compact compared to Darak (474245,82 m²). The extension of the inhabited areas of Darak has reached its limit at the east of the city and continues towards the north, at the west and south of the city where the built up area becomes more scattered and where there are still open spaces not occupied (figure 6). At Kofya the built up area extension also continues to the bare soil areas especially to the north and south (figure 6).

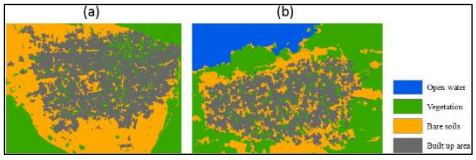

Figure 6: built up area at the internal shores of Lake Chad

3.3.2. In the hinterland

The Makari built up area (673418,24 m²) is more important than Mada (322458,21 m²) and the road network is difficult to identify in the both localities. However, following the line drawn by the trees it is possible to stand out the road network in the city of Makari (figure 7). Moreover, the organization of the neighborhood also appears more structured in Makari thanks to the trees planted in the heart of the city and which cuts it into neighborhood. The extension of built up area to Makari and Mada takes place on the unoccupied open spaces of their peripheries (bare soil).

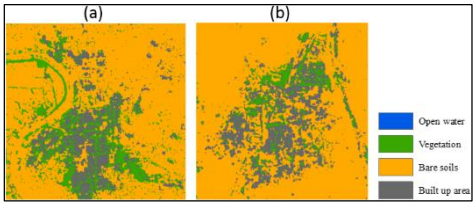

Figure 7: built up area in the hinterland of Lake Chad

4. Conclusion

The sequential image processing developed in this study provides a classification and a good analysis of the distribution of built up area and other occupation classes from Sentinel 2 image of April 29, 2017. Thanks to combined techniques of image processing as indices calculation, stacking and SVMs classification, added to statistics methods as principal component analysis, the problem of class confusion has been skirted and the built-up highlighted. The results obtained show the low rate of spatial extern of built up area throughout the study area (0, 56%), the variability in the size of cities and villages, and the differences in organization and distribution of the built up area according to their proximity to the lake.

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