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RESEARCH ARTICLE

LDS APPLICATION FOR FRACTURE NETWORKS DETECTION FROM SATELLITE

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ABSTRACT

The methodologies used to characterize the structural elements have experienced a major boom in hydrogeology. It happens that these methods have limitations manifested by a high failure rate because of the risk of subjectivity. The aim is to propose a methodology for establishing a fracturing card minimizing human intervention and as close as possible to reality. SRTM (Shuttle Radar Topography Mission) images were used for this study. The Sobel filter was applied to accentuate the major litho logical discontinuities. A segment detection algorithm was applied for extracting structural features. The analysis of the orientation shows that the highest lineament density extract the SRTM image was recorded in the NW-SE direction. This helped to establish the fracturing map of Poro region.

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INTRODUCTION

To meet the needs of increasingly growing population in water, a relevant hydrogeological study is necessary for the selection of forges implantation sites and the construction of dams. Various methods are applied for the research of drilling implant region. (Dubois, 1999), says that the recognition of lineaments on an aerial photo or satellite image is something subjective and may vary according to the interpreter, he deduced that the experience of an individual and his knowledge of the study area are key factors in identifying lineaments. However, the tedious manual tracing is a complex way to get a map of lineaments consistent with the reality on the ground. The extraction method of use or computerized tracing is a means to overcome the weaknesses of human interpretation (Ouattara *et al.*, 2012). According to (Anwar, 2013), the automatic method minimizes the time taken by hydrogeologists to extract useful information, but has the advantage of quickly processing the image in an objective and systematic way. Our study is based on the proposal of a methodology for extraction of lineaments (fractures networks) in order to better define geological units and thus contribute to the study of aquifers in Africa cracked backgrounds of 'Where is.

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The study area is located north of the Ivory Coast, between longitudes 5 ° 15 to 6 ° 20 West and latitudes 8 ° 30 and 10 ° 25 North. It covers a total area of 12 500 km2 (see Figure 1). The relief of the area is monotonous with altitudes ranging on average between 300 and 400 m and the majority of slopes between 2 and 4%. We note in the landscape of granite peak inselbergs sometimes over 500 meters. The department consists of lateritic plateaus of varying heights of 0-3 m. The tropical climate of the region translates into an average annual precipitation of around 1300 mm fluctuating for the past 20 years. Also note, groundwater recharge is thus made directly by infiltration of rainwater from the surface (Jourda, 2005). The study of fracking and characterization of lineaments is based on the geology of the medium studied. The geological and tectonic setting also fits in the history of the West African craton. Several studies focused on the geology and tectonics of the region. It is clear from these studies that tectonics is multiphase, led to the establishment of a very developed in these formations fracturing. The petrographic point of view, there are five main sets which are: volcanic and plutonic together all volcano-sedimentary, all of metasediments, gneisses and migmatites, finally granitoids.

MATERIAL AND METHODS

Data

SRTM data: SRTM data were used: N10W007, N10W006, N09W007, N09W006, N08W007, and N08W006.

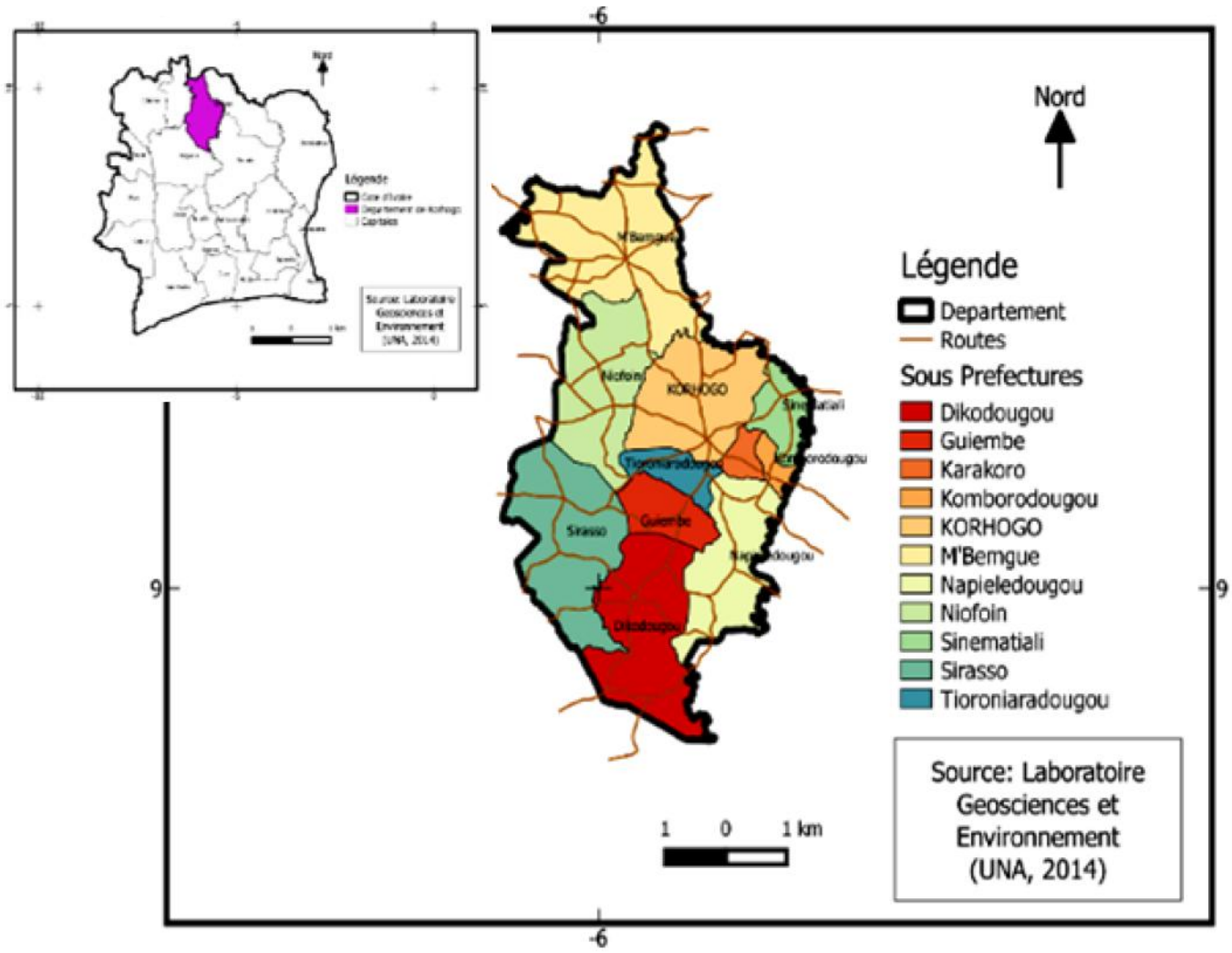

Figure 1. Presentation of the study area

This data is in the coordinate system WGS 84, 30 northern zone. They have a resolution of 90 m or 3 arcs seconds covering the entire study area.

Hydrogeological data (surveys of wells and boreholes)

The drilling data used in this study come from 1180 drilling data sheets provided by the Laboratory of Geosciences and Environment NanguiAbrogoua University. These data refer to the following parameters: flow rate, total depth, the thickness of the base and the water inlets. The total depth of the structures in the region ranges from 4.2 to 104.4 m with an average depth of 54.3 m. The base drilled thicknesses range from 0.60 to 9.70 m with an average value of 5.15 m. In the region, there are two water inlets that match the hydraulically active fractures. These are the first water inlets which are the most productive. Their water has an average depth of 5.35 m. They vary from 0.8 m to 9.90 m. The flow rates of boreholes vary from 0.10 to 36 m3 / h. The highest rate is 36 m3 / h was recorded in the granite

Application of directional filters

The directional filters improve the perception of lineaments causing an optical shadow effect focused on the image as if it were illuminated by oblique light (Marion, 1987). Furthermore this type of filter allows you to improve the lineaments which are not favored by the illumination source (Drury, 1986) in(Coulibaly, 1996).

In this study, the enhancement of lineaments was performed by the directional Sobel filter. The Sobel filter is a selective variety of directional filters where the values of the convolution matrix are determined according to the distance from the central pixel (Deslandes and Et Gwyn, 1991). In this study, we used filters Sobel NS, EW, NE-SW, NW-SE, all gradients 7x7 size. This dimension has been chosen because it identifies major major discontinuities and contributes to improve the detection of structural features with the Segment Detection Algorithm (LDS).

Automatic extraction methodology lineaments

This section shows the methodology that was used to extract the outlines made on our image. The different steps of pretreatments to the extraction of lineaments are summarized in the diagram below.

Application of directional filters Sobel

RESULTS

Application of automatic extraction algorithm lineaments

Applying the LDS algorithm for automatic lineaments extraction gives the results as presented in the following figures 4 and 5.

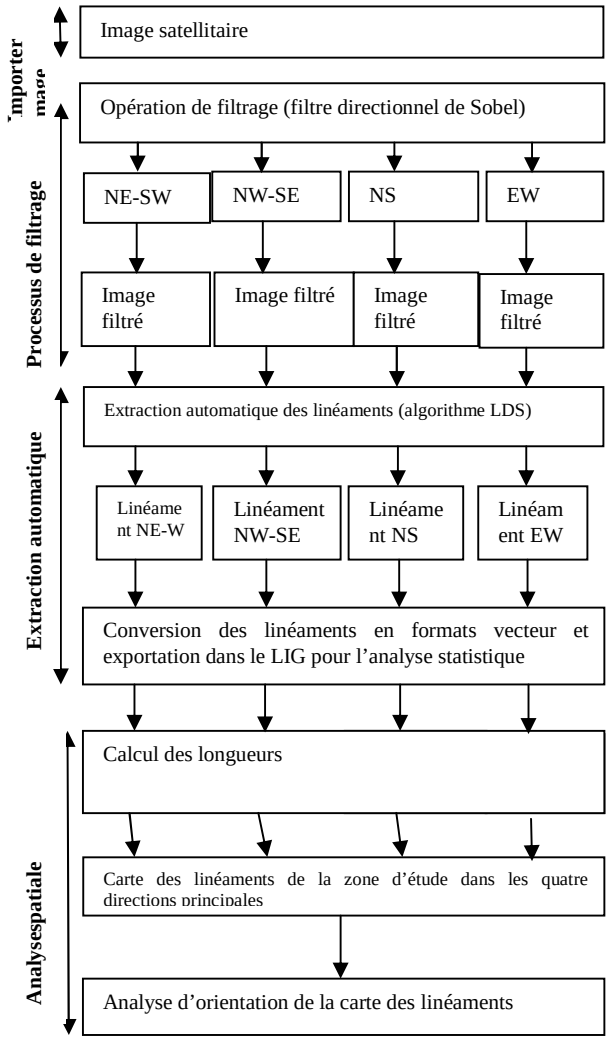

Figure 2. How to extract lineaments

Map Zoom lineament

Detail lineament map was obtained by melting the lineament maps obtained by automatic extraction in four different directions (NS, NE-SW, EW and NW-SE).
Figure 5: NEW lineaments direction, NW-SE and NE-SW

Statistical analysis of lineament networks

The number of lineaments documented on the map in Figure 12 amounts to 4906 structural elements, ranging in size from 2.746 km to 29.322 km, with an average length of 2.6 km on the field. The total length of the mapped lineaments is about 27, 328 837.008 km. The most important lineament which measures 29.322 kilometers in length, passes vertically through the study area in the NS direction. In addition to this lineament, all others have a size less than 25 km. The analysis of the rosette frequency lineaments (Figure 6) brings up four main structural directions on the study area: NW-SE; NE-SW; NS and EW. The NW-SE direction (6B) is the most dominant with 26% of the total number NS and a second direction (Fig. 6d) appears with 25%. Directional families are second order and direction N20-30 N 90-100 with 24.21% and 24.19% respectively (Fig. 6c and 6a). Among the fracture families identified in the histogram from image processing (Fig. 7), only the families of the NW-SE direction (N120-140) are strongly represented, which is perfectly in line with the outcrops observed by (Jourda, 2005).

Validation of the map of lineaments

To characterize the hydraulic role of regional accidents, the proposed technique is to analyze the relationship between speed and distance of the drilling of these wells to the closest lineament. Drilling speeds are generally low.

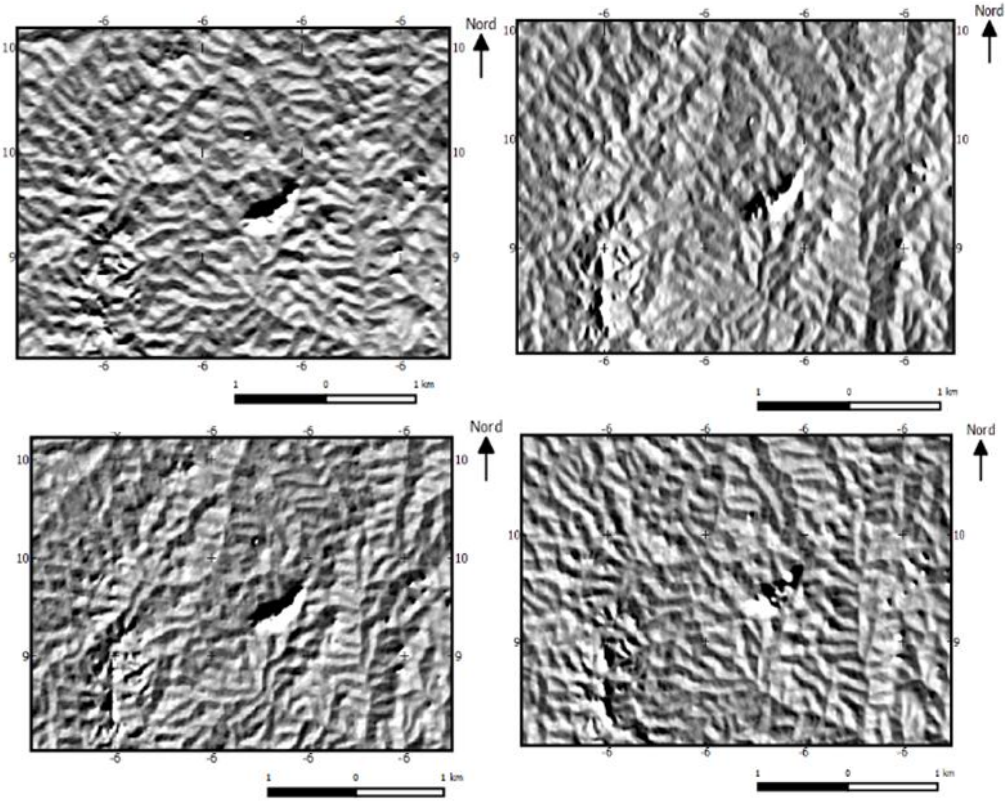

Figure 3. Applying filters Sobel in four main directions

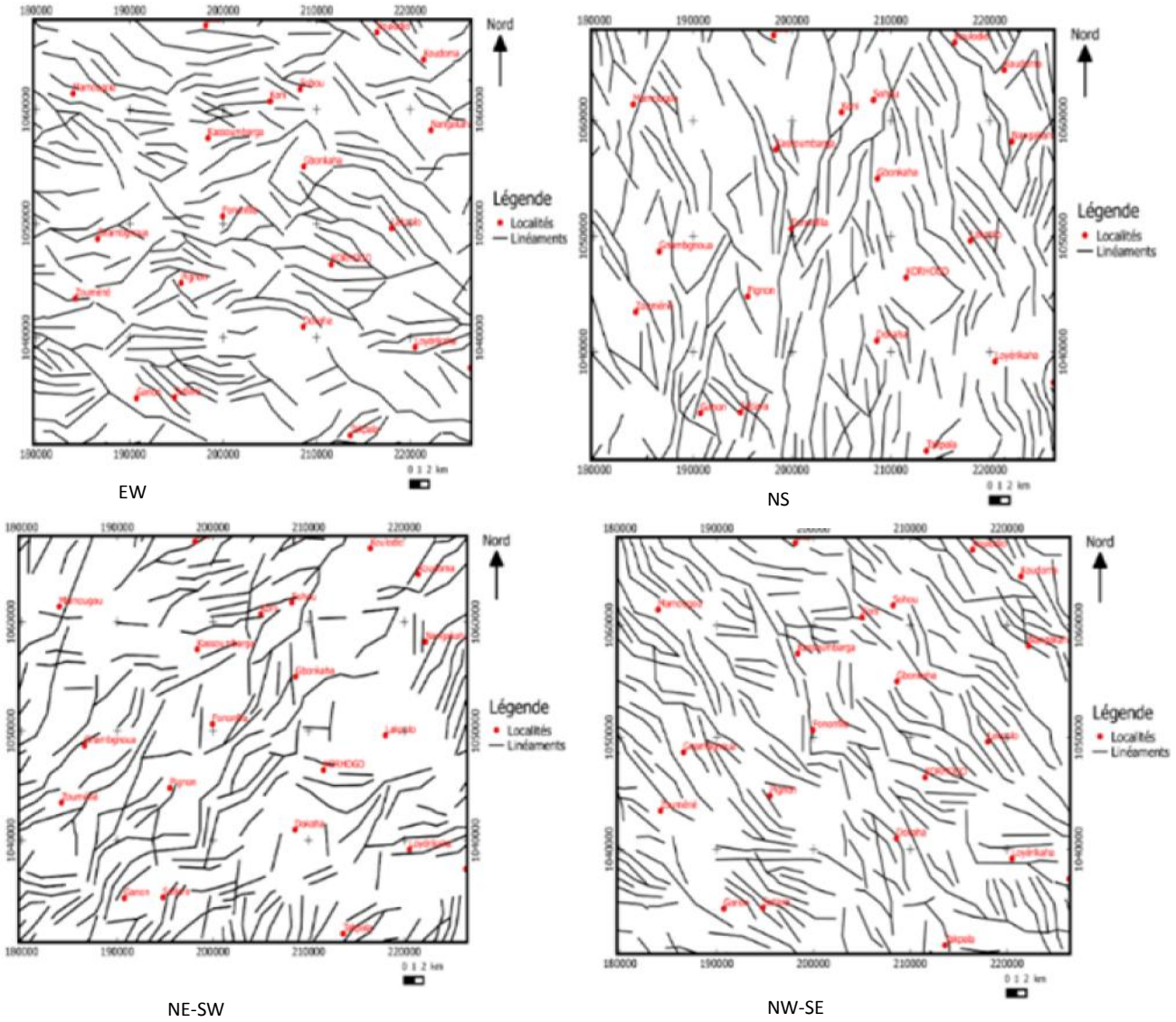

Figure 4. Map of the main lineaments in four directions

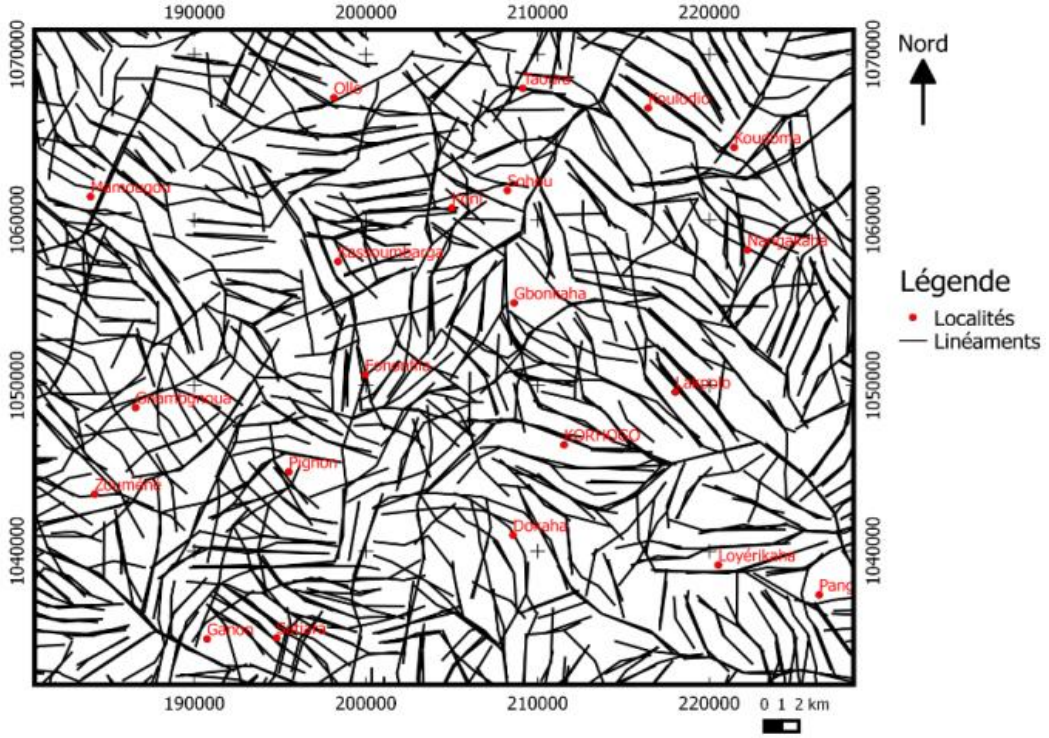

Figure 5. NEW lineaments direction, NW-SE and NE-SW

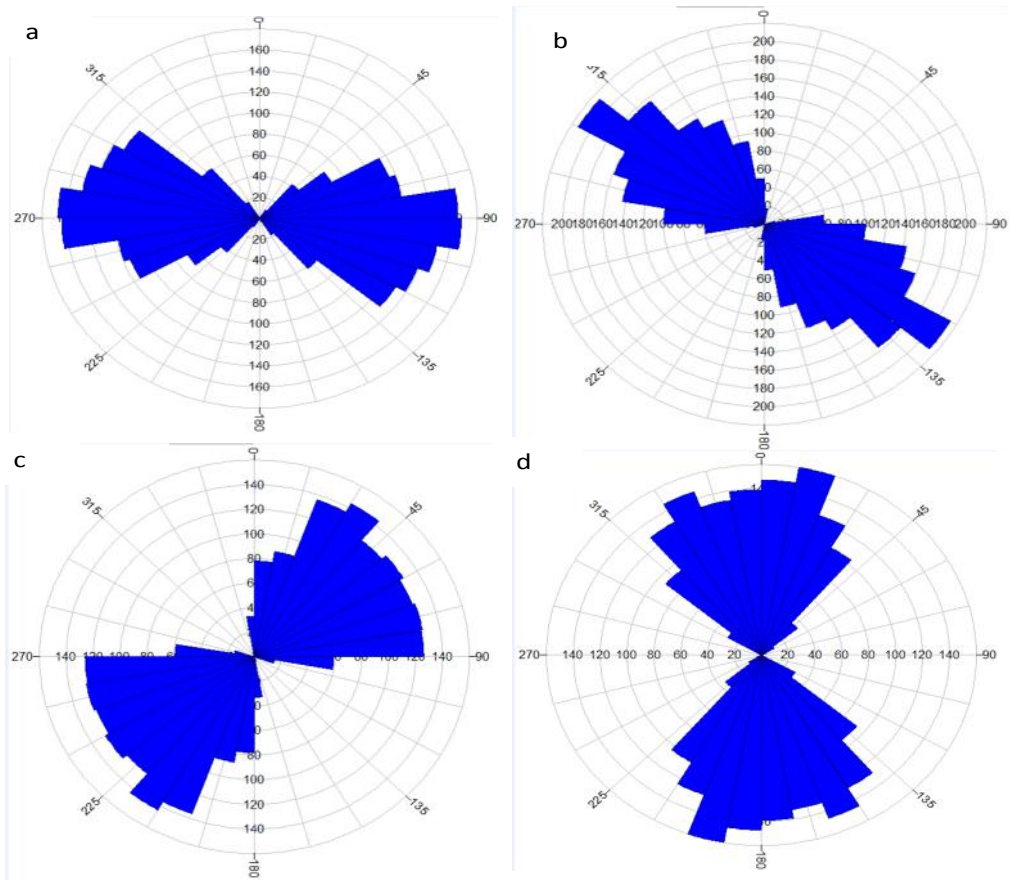

Figure 6. Diagram of directional rosettes lineaments

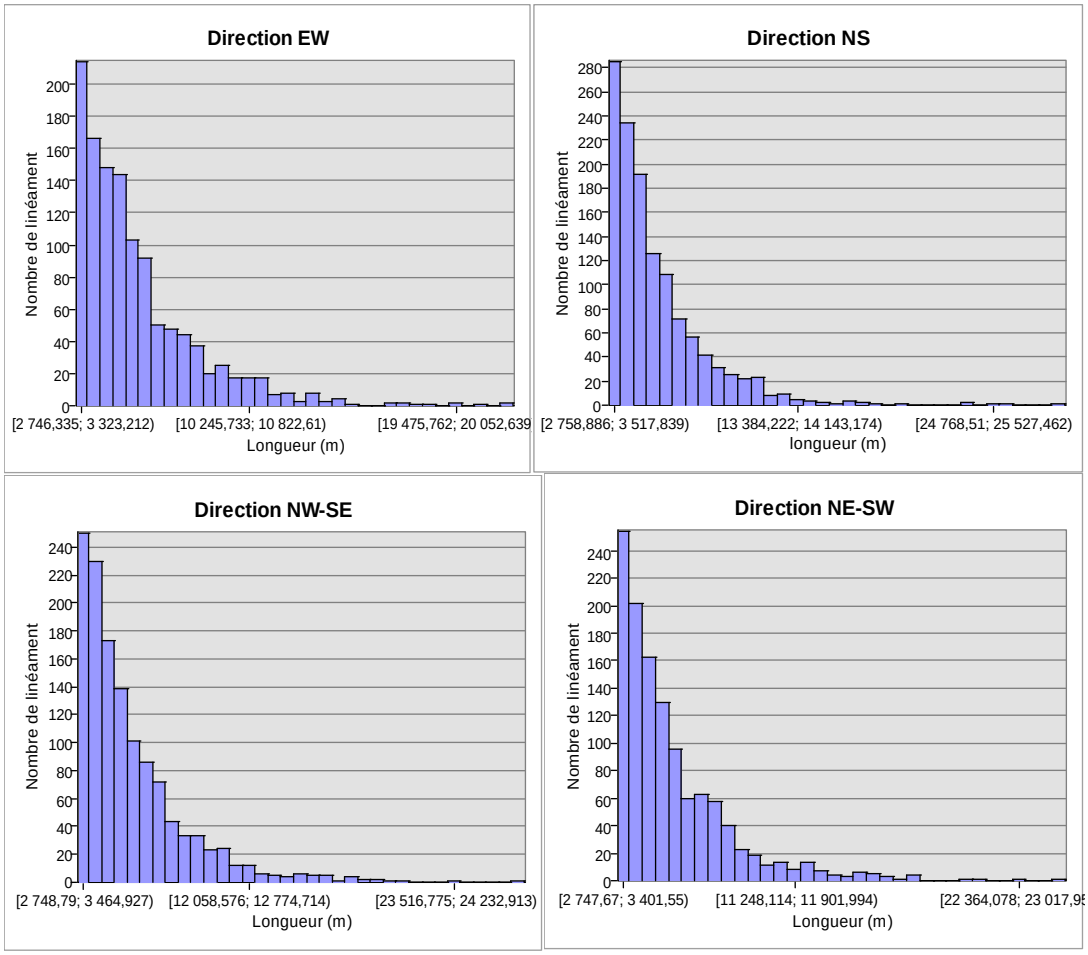

Figure 7. Histogram of the lengths of lineaments

They vary between 0.1 and 36 m^3/h. About 1180 readings and well executed drilling 887 produced flow rates of 0.1 to 4.9 m^3/h. Representing a percentage of 75.17%. Only 293 have a higher rate or equal to 5 m^3/h. Drilling is discriminated in two speed classes, the first corresponding to 293 holes having a rate greater than 5 m^3/h (high speed drilling) and the second corresponding to 887 holes having a lower rate of 5 m^3/h (drilling low flow). This classification (high-speed drilling and low-flow) corresponds to the one adopted by the Inter-State Committee Hydraulics (CIEH) in West Africa. A screening rates between 5 and 36 m^3/h was carried out and it gave the following results (Fig. 8). The analysis of correspondences between lineaments extracts and drilling is initially locate all drilling (drilling and high-volume low-flow). Secondly, the card containing these holes is superimposed on that of lineaments extracted automatically. This superposition shows that most high-volume wells are located on these lineaments or near them (Fig.8). However, drilling low flow does not have any particular organization against lineaments (Fig. 9). Note that in certain areas are identified with high-speed drilling, are also present in low-speed drill, which suggests that the productivity of drilling is located, and not associated with an extended base area in which underground trains and productivity would almost generalized according (Koita, 2010). This validation of geological accidents extracted from SRTM digital processing of images is essential to judge the relevance of the method used. Recall here that the data and then drilling used for the confrontation of our results have been extracted from a manual record of lineaments on aerial images (photo interpretation).

Fracture map

This fracturing map of our study area was established after comparing the results of lineaments derived from the methodology used, with reference data (hydrographic network, well data and drilling). Thus, all the lineaments having a good agreement with the reference data were considered fractures. This confrontation has established fracturing card our study area that will serve as an aid in research into groundwater.

DISCUSSION

Automatic extraction of lineament

The realization of the tectonic map in the northern region of Côte d'Ivoire has been made possible through the application of satellite imagery (SRTM) available techniques for the detection of major fracture networks. According (Kouamé *et al.*, 2009), the radar system using the microwave is a powerful tool to aid geological and structural mapping. The method of manual extraction of lineament is a method subject to the assessment and the sensitivity of the human eye. This intrinsic feature of the method does not allow a precise structural geological mapping by (Ouattara *et al.*, 2012). The picture clarity is also an additional problem which affects the reliability of this method. Therefore, the application of this method even on a satellite image of high resolution, cannot afford a comprehensive interpretation of lineaments. The automatic extraction method using lineament detection algorithm not only offers better readability, but also the means of observation image in many ways through the use of filters (enhancement of structures). Such strengths allow mapping is as close as possible to reality. Compared to automatic extraction methods lineaments such as edge detection by mathematical morphology (Kouame *et al.*, 1999), detection limits by Hough transform (Poncelet and Cornet, 2010), detection of stops (Canny, 1986), the Geman and Jedynak detection method (1996) in (Dubois, 1999), the network detection method of cellular neural (Rouhana, 1998), the method Eleca (Gilles, 2005), the difference with these methods automatic extraction lies in the setting. Indeed, the LDS algorithm is easily configurable. The extraction of lineament after this setting is made in a single iteration. The running time depends on the hardware performance of the machine on which the software is installed.

Conclusion

We think that the results obtained in our study are very satisfactory. It is clear both that the algorithm to use for the fracture network detection is a rational method of efficient automatic extraction in the extraction speed of lineaments in the reduction of processing time and the elaboration of final maps. The automatic extraction method LDS has been designed to make for example the work of geologists and hydrogeologists less tedious and fill gaps in the manual extraction method. The LDS algorithm produces a precise rendering of lineaments. Radar interferometry image (SRTM) were used for the automatic extraction of outlines. Lineaments were extracted according to two factors are the length and density. Directions chosen for this extraction are (NE-SW) (NS) (EW) and (NW-SE). The most common trend is in the NW-SE direction and the maximum length is recorded in the NS direction north of the study area specifically east of the sub-prefecture of Sindjougou.

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