Evaluation physico-chemical deterioration of ferrallisol in three sites of Tsiroanomandidy district Madagascar

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ABSTRACT

The assessments physico-chemical deterioration of ferrallisol in three sites Tsiroanomandidy district is a decision-making tool for the prediction of this phenomenon in time and space.
The appreciation of physical deterioration makes itself by the assessment of compactness soils while being based on the qualitative approach. The appreciation of chemical deterioration and biologic make themselves by the assessment of the yearly reduction of saturation in bases's complex and by the yearly reduction of content in organic matter.
The objective of this study is to assess the risks of soil deterioration at the three sites.
The results obtained are: picture of profile compact degraded soil; histogram's saturation rate some base of the complex and the histogram of the organic matter rate as according to the age of enhancement's soils.

Keywords: assessment, degradation, soils, Tsiroamandidy / Madagascar.

1. Introduction

Currently, much of the arable land in Tsiroanomandidy district is undergoing advanced degradation for climatic reasons and anthropiques. An accentuation of this phenomenon during the last ten years has been recorded.
Soil degradation is a threat to the agro-sylvo-pastoral activities of the district. Threats deemed to be of greatest concern are: soil compactness; reduction of the saturation rate at the base's adsorbent complex; reduction of the content in organic matter's soil .
The purpose of this study is to evaluate the physico-chemical degradation of ferrallisol.

2. Presentation of the sector

The sector is located in the Middle West of Madagascar (Fig 1). It belongs to the Bongolova's region and Tsiroanomandidy district (Fig 2).

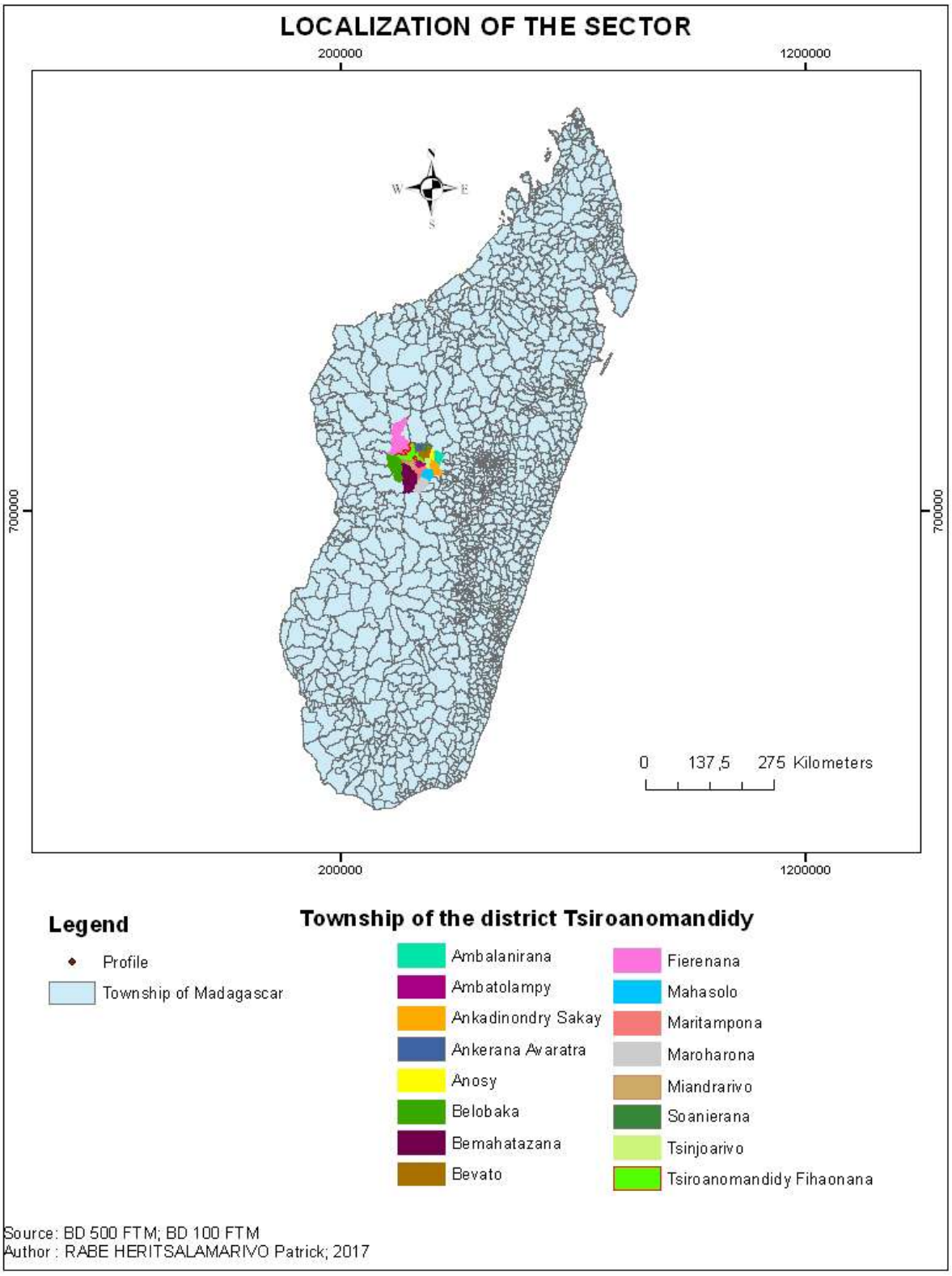

Fig 1: card of localization sector (source: author)

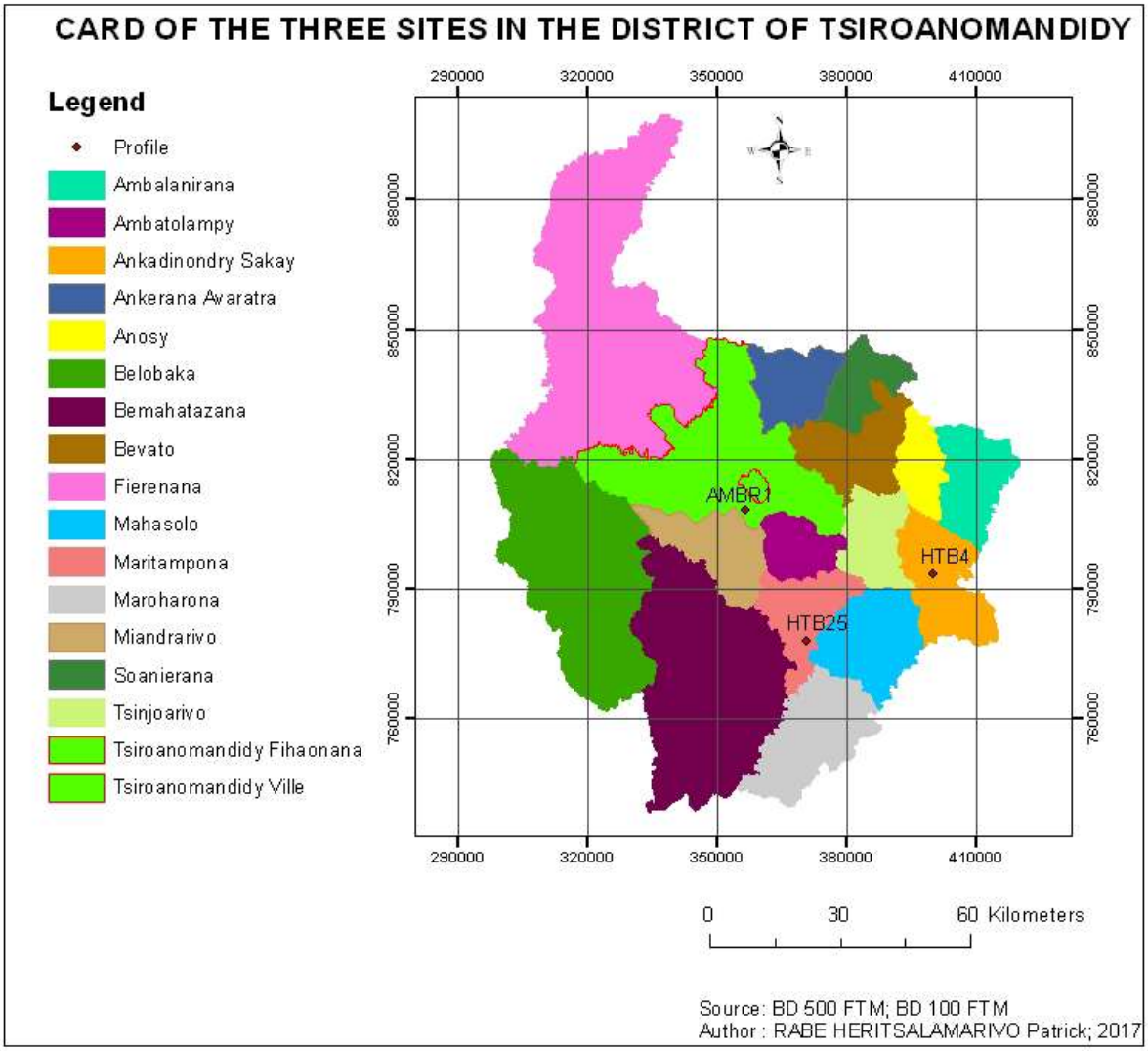

Fig 2: map of sites HTB4, HTB25, AMBR1 (source: author)

3. Methodology

3.1 Measurement method of compactness by internal soil deterioration

Compaction is the rearrangement of soil particles under the effect of external pressure. Resulting in increased density, it is usually accompanied by a decrease in macroporosity and hydraulic conductivity **[7].**

In principle, compaction cannot be estimated using direct measurements. The only method of assessing this form of physical soil degradation is based on differences between physical measurements on control soil not subject to compaction and compacted soil **[9].**

The main approaches to estimating soil compaction are qualitative approaches and quantitative approaches. In this study we chose the first approach.

3.2 Method of assessment chemical degradation's soil

F.A.O **[6]** took in account the saturation in bases and the annual decrease of this saturation for appreciation's chemical degradation of the grounds. The soil analysis is not regular in the sector, so we should be compare the current results with that of the previous results.

Laboratory analyzes were performed to obtain saturation levels of the adsorbent complex. If S represents the sum expressed in milliequivalent of exchangeable cation and T the cation exchange capacity also expressed in milliequivalents, the saturation is determined by the following formula:

((SX100)) / T = V (saturation rate)

Or S is the exchangeable basis sum determined from the atomic absorption spectrometer (Fig 3)

Or T is the cation exchange capacity determined from the device of distillation (Fig 4)

Fig 3: Picture of the distillation device

Fig 4: Atomic absorption spectrometer picture

3.3 Mode of evaluation of the biological degradation of soils

F.A.O **[6]** took in account the annual rate of humus depletion in the 0 - 30 cm soil depth layer for soil biological assessment.

In absence of reliable data on the rate of annual humus depletion in the upper horizons of soils, consideration will be given to the decrease over time of organic matter content's upper horizons (A horizon) to evaluate biological soil degradation of the sector.

The total organic matter content of the soil is generally obtained by measuring the carbon content. It is estimated that the ratio (M.O) / C **[3]** is approximately constant and equal to:

M.O. = C x 2, in soils with permanent vegetation (forest) and **[4]**;

M.O. = C x 1.72 in cultivated soils **[4].**

4. Results

4.1 Evaluation's soil compactness of the sector

The method of assessment form physical soil degradation relies on differences between physical measurements on control soil not subject to compaction and compacted soil (Fig 6). The qualitative approach was chosen to evaluate soil compaction in the sector.

Figure 5 and figure 6 show the comparison between the profile of a rejuvenated soil (not subject to compaction) to a degraded soil profile (compact soil).

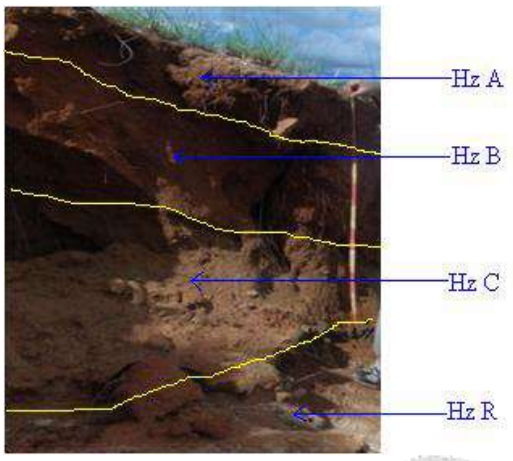

Fig 5: Photographs's profile rejuvenated Ferrallisol in village of Antsampanimahazo not subject to compaction

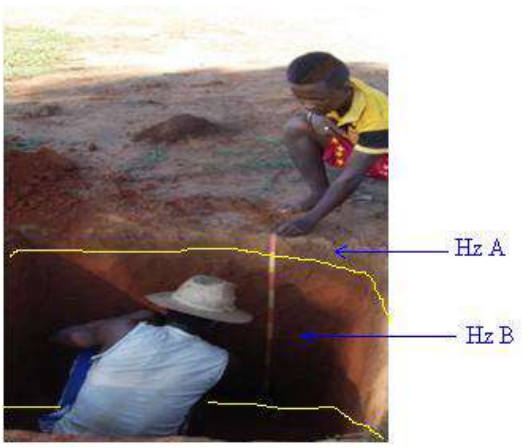

Fig 6: Photographs's profile ferrallisol Degraded in village of Antsapanimahazo

4.2 Assessment of chemical soil degradation in the sector

The evaluation of the chemical deterioration's soil is made by comparing saturation rate at the base's complex of profile HTB4 and profile HTB25 with profile AMBR1 (Fig 7).

4.3 Assessment of biological soil degradation in the sector

The evaluation of the biological degradation's soil is achieved while comparing the organic matter content of the previous results (profile HTB 4, profile HTB 25) with the current results (profile AMBR1) (Fig 8).

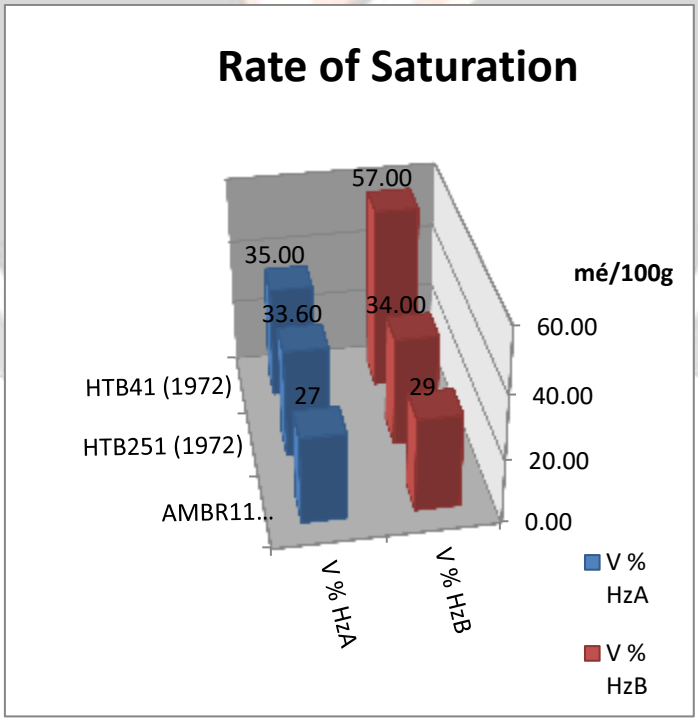

Fig 7: Histogram's V content of Bourgeat (1972) and author (2017)

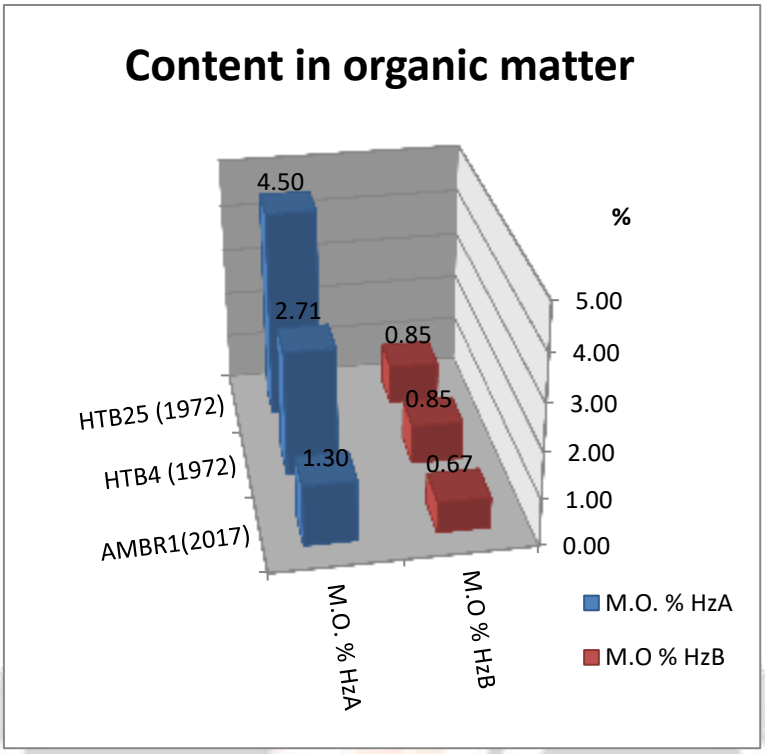

Fig 8: Histogram's organic matter content of Bourgeat (1972) and author (2017)

5. Interpretation

5.1 Interpretation on the assessment of soil compactness in the sector to study

The difference in structure between figure 5 and figure 6 has been marked to the level of the B horizon. The first to a clear polyhedral structure while the second to a solid and compact continuous structure. It is the same, the porosity of the B horizon of figure 5 and figure 6 was different: the figure 5 has a high porosity; while Figure 06 has a low porosity.

5.2 Interpretation on the Assessment of Chemical Soil Degradation in the sector

The histogram of figure 7 presents the results of saturation rate V of BOURGEAT in the year 1972 and the current author (2017) for ferrallisol. The comparison of the levels in these elements shows that they decrease according to the age of development's soil (fig 7).

From the results of figure 7, there is evidence of increased chemical degradation of rejuvenated ferrallisol in the sector as function of time.

Low saturation means too much acidity and low base reserves ($Ca2^{+}$, $Mg2^{+}$, K^{+})

Soil acidification is an important concept in agriculture and forestry because it is a process that influences: degradation of the soil structure; degradation of soil fertility; the decrease of the biological activity of soil; the increase in the solubilization of certain minerals which may be at the origin of toxicities; the greater risks of pollution **[8]**.

Artificially acidified soils as in our sector are vulnerable to agriculture, because many pollutants are more active there.

5.3 Interpretation on the assessment of biological soil degradation in the study's sector

The comparison of BOURGEAT (1972) organic matter content in rejuvenated ferrallisol with the author in 2017 shows that the contents of this element decrease with the age of soil development (Fig 8).).

A low content of organic matter may result in: a low useful reserve; low structural stability ; a reduction in the mineralization of nitrogen and sulfur; low biological activity. In long term, this leads to soil deterioration.

6. Discussion

6.1 Evaluation of the soil compactness's study sector

The main approaches for estimating soil compaction are qualitative approaches (making a visual diagnosis, making a crop profile), and quantitative approaches (measurements of bulk density of soil, measurement of soil mechanical resistance, measurement of conductivity soil hydraulics).
In the absence of effective means for measuring soil bulk density, soil mechanical resistance and hydraulic conductivity in quantitative approaches, we chose the first approach (qualitative approaches with crop profiles) to evaluate the compactness of soils in the area study.

6.2 Assessment of chemical and biological degradation of soils

In assessing the chemical and biological degradation of soils, FAO's **[6]** proposed method of assessing soil degradation is ideal, but the scarcity of research studies conducted in this area is a limit for the study.
The assessment of chemical and biological degradation is possible by comparing the current work (AMBR1 profile) with that of previous work (HTB4 and HTB25).
In the Middle East, only BOURGEAT (1972) **[1]** and RANDRIAMBOAVONJY (1996) **[5]** have surveyed soils.
For the chemical and biological evaluation's sector, we will take into consideration the results of analysis (chemical analysis) of BOURGEAT in 1972. We used the results of analysis of BOURGEAT in 1972, because, only him that did a prospecting on ferrallisol in this district. We compared these results with those in the current state. Note that for the evaluation results to be reliable, the comparison should be made: on the same type of soil; on the same morphological unit; on the same topographic unit; on the same lithological unit. The comparison of the results of BOURGEAT in 1972 with the author's results in 2017 for the chemical parameters show that the levels of chemical elements saturation rate and organic matter content decrease with the age of development's soil.

7. Conclusion

This study contributes to the assessment of ferrallisol degradation at the three sites's Tsiroanomandidy district. From this study it can be seen that: physical degradation of soils is a threat if we rely on the compactness of top-level hill soil's studied site; chemical degradation and biological degradation of soils are a serious threat in the district, based on a comparison of current ferrallisol results with those of previous results.
The assessment of physical soil degradation is based on the differences between physical measurements on control soil not subject to compaction and on compacted soil, while the chemical deterioration and the biologic deterioration of soils are valued while comparing the chemical results and the present biologic results to the previous results. While turning around the results, the clean reduction's contents in rate of V saturation and the reduction of the contents in organic matter according to the age of enhancement is remarkable within the ferrallisol.

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