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Spatial distribution of carbon stock in various soil types and under land use/land cover classes in the Bretelle River watershed (Cabaret/Haiti)

Wesly Jeune* [1,2], Maxim Desruisseaux[2], Mackenson Marrion[1]
[1] Faculté des Sciences de l'Agriculture et de l'Environnement, Université Quisqueya, 218 Avenue Jean Paul II, Port-au-Prince, HT 6110
[2] Feed the Future Haiti-AREA Project | University of Florida, Institute of Food and Agricultural Sciences, Gainesville, Florida, USA
*Corresponding author: wesly.jeune@ufl.edu; weslyjeune@hotmail.com

Background

- Soil carbon sequestration is a sustainable solution to mitigate greenhouse gas emissions
- Carbon sequestered in the soil has a positive impact on soil health while helping to combat global warming. Soils rich in organic carbon are more productive and able to play the contributing role to ecosystem services
- Carbon stored in the soil contributes to various soil functions including biomass production, water retention and filtration, and biodiversity maintenance

Objectives

- To estimate and spatialize soil organic carbon stock (SOC) in the watershed of the Bretelle River (Cabaret / Western Haiti)
- To assess the influence of soil types and land use and land cover (LULC) on the spatial distribution of SOC

Methodology

- The study area (72° 22' 58'' W and 73° 25' 37'' W longitude and 18° 42' 52'' N and 18° 46' 12'' N latitude) is a sub-basin (1,242 ha) of the Bretelle River watershed, located in Cabaret in western Haiti (See Figure 1.)
- Limestone rocks associated with intrusions of arenite and basalt predominate in the hills. Sedimentary deposits occur in the lowland, which is intensively cultivated.
- According to the Köppen-Geiger climate classification system, the climate type is Aw with a mean annual rainfall of 1,079 mm,
- The vegetation is a mixed xerophytic species with secondary herbaceous and tree species
- A soil survey supported by a randomly stratified sampling technique allowed classifying 70 geo-referenced observation points according to the Soil Taxonomy system
- Soil samples were collected at 20 cm depth for soil bulk density determination and organic matter analyses though LOI method
- SOC = DaxCxE, where SOC (t/ha)
  Da: soil bulk density (Mg/m3)
  C: organic carbon (%)
  E: thickness or depth (cm).
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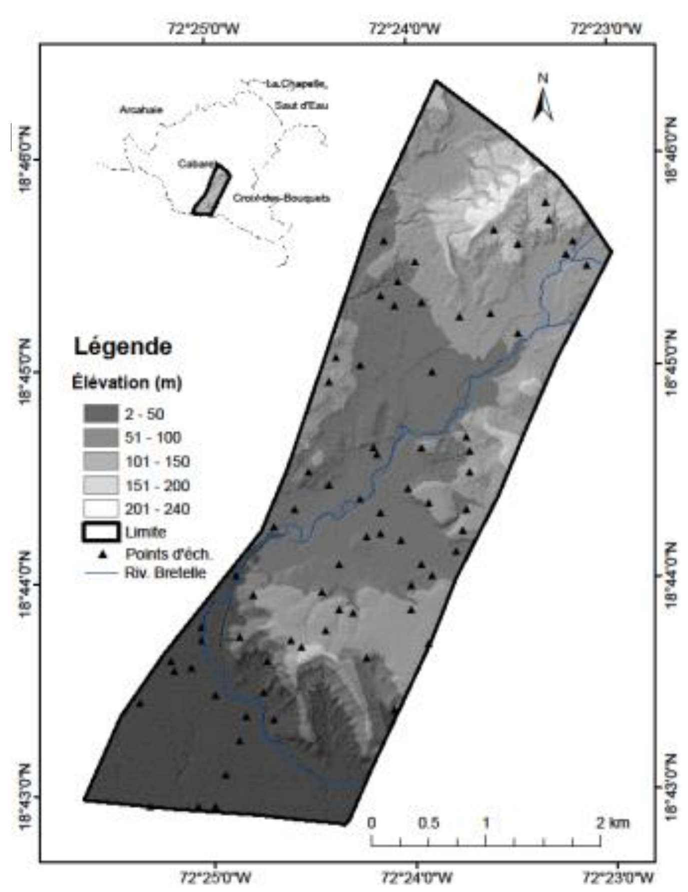
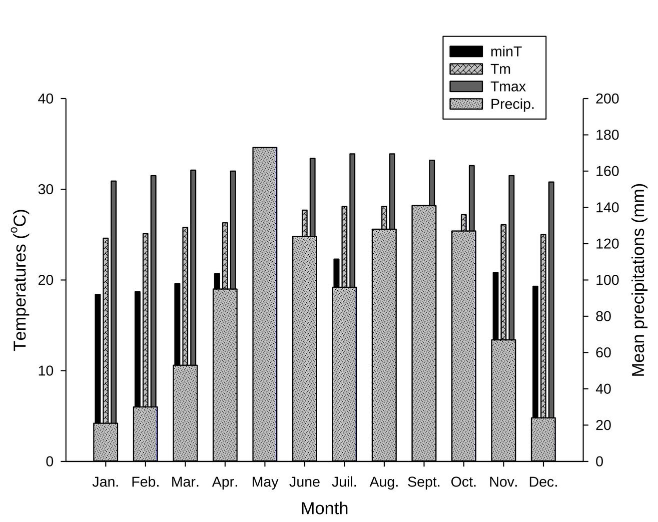


Figure 1. The study area.



Methodology (continued)

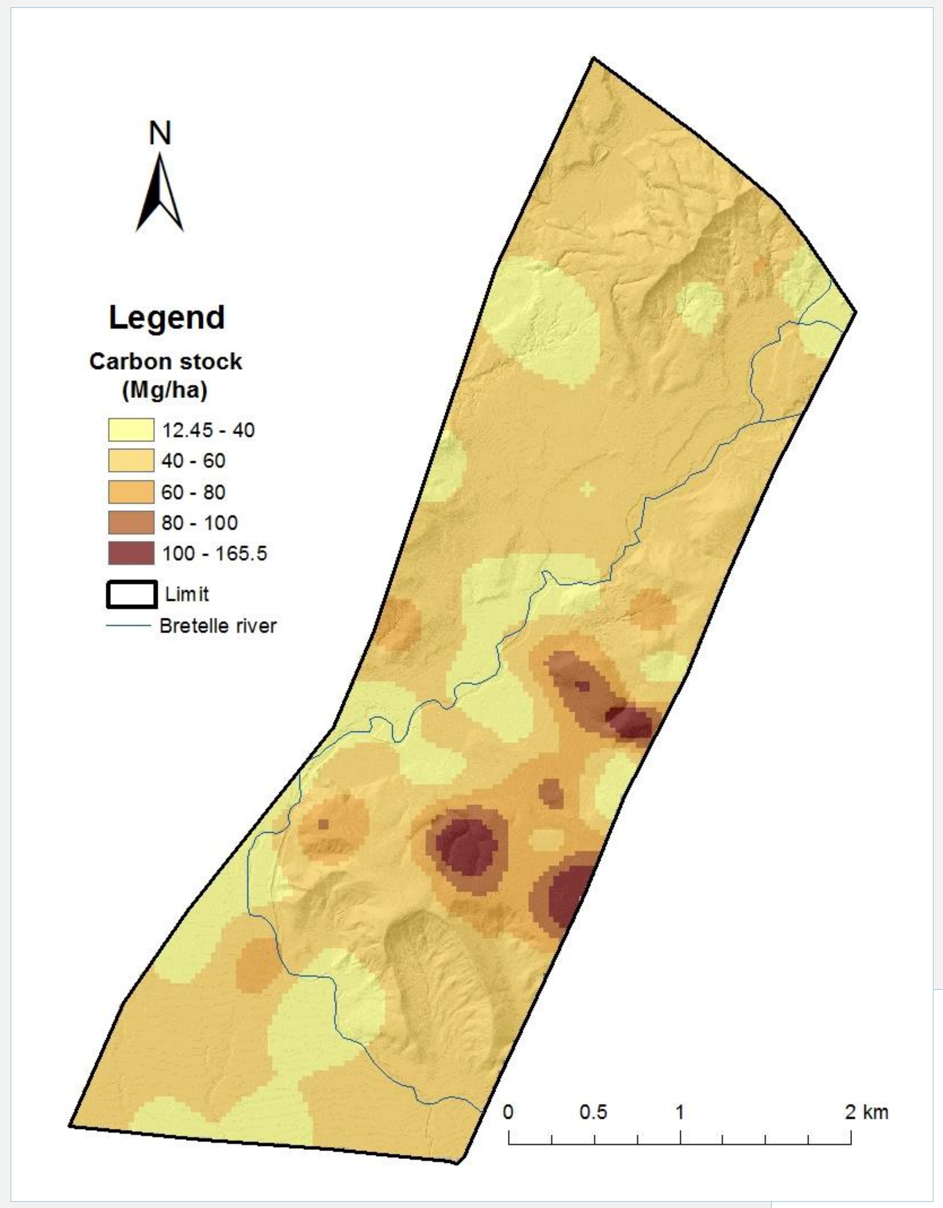
- The LULC mapping was performed using the Random Forest classifier according to the supervised classification technique with Landsat 8 OLI imagery
- SOC spatialization was interpolated from the ordinary kriging
- The comparison of SOC between soil classes and LULC relied on ANOVA with a Tukey test (5%)

Results

- The pedosystem of the studied area is dominated by Inceptisols (Fluventic Haplustepts, Lithic Calciustepts) and Entisols (Lithic Ustorthents, Typic Ustorthents)
- The Kappa index (0.89) suggests excellent agreement between classified and ground-measured LULC
- Agricultural land and vegetation occupied 30.8% and 26.9% of the study area, respectively
- Bare soil and built-up areas accounted for 25.5% and 16.8%, respectively
- SOC ranged from 12.45 to 165.7 Mg/ha with a mean of 48.9 ± 7.3 Mg/ha (See Figure 2.)

The Tukey test showed a statistically significant difference ($p = 9.28e-06 < 5\%$) between the soil classes, while no statistically significant difference was detected for the LULC categories. The results suggest that SOC storage was fundamentally controlled by the soil types, depending the LULC.

Treatments	Carbon stock (t/ha)
Soil classes	
Typic Ustorthents	74.3 a
Lithic Calciustepts	63.8 ab
Lithic Ustorthents	52.2 abc
Typic Haplustepts	41.0 bc
Fluventic Haplustepts	31.3 c
p-value	9.28e-06***
LULC categories	
Built-up area	59.0 a
Bare soil	52.8 a
Vegetation	49.4 a
Agriculture	32.4 a
p-value	0.749076 ns
SOC x LULC	0.000585***



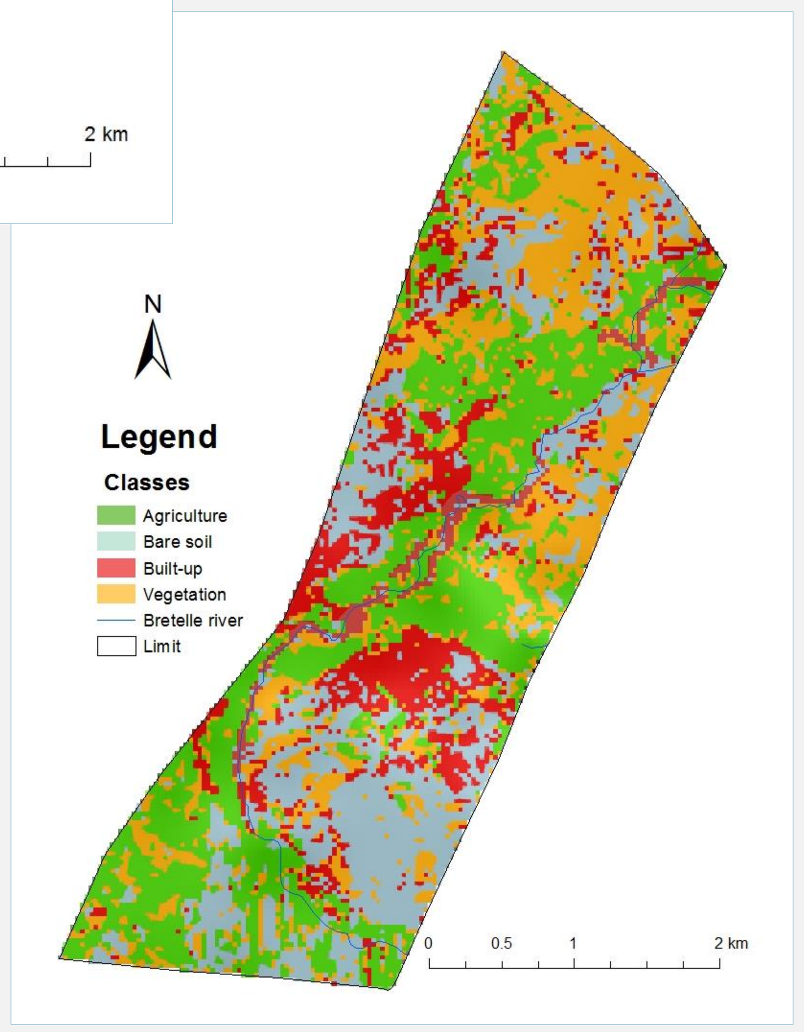


Figure 2: Carbon stock map (above); LULC map (right)

Conclusions

- The findings indicate that the carbon stock was governed by soil types, likely because of a set of intrinsic characteristics of these soils.
- The lowest carbon stock corresponded to the Fluventic Haplustepts class, which is the most intensively cultivated soil in the area, owing its location in the lowland area and its high natural fertility.
- The study did not clearly evidence the influence of LULC categories on soil carbon storage. This is probably because of the anthropogenic disturbances prevailing in the entire studied area.

This research is made possible by the generous support of the American people through the United States Agency for International Development (USAID) and its Feed the Future Haiti Appui à la Recherche et au Développement Agricole (AREA) project managed by the University of Florida. The contents are the responsibility of the University of Florida and do not necessarily reflect the views of USAID or the United States Government.

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