VIETNAM NATIONAL UNIVERSITY

STUDYING EFFECTS OF AGRICULTURAL LAND USE CHANGE ON SOIL ORGANIC CARBON IN THE COASTAL PLAIN OF QUANG TRI: A CASE STUDY OF HAI LANG DISTRICT

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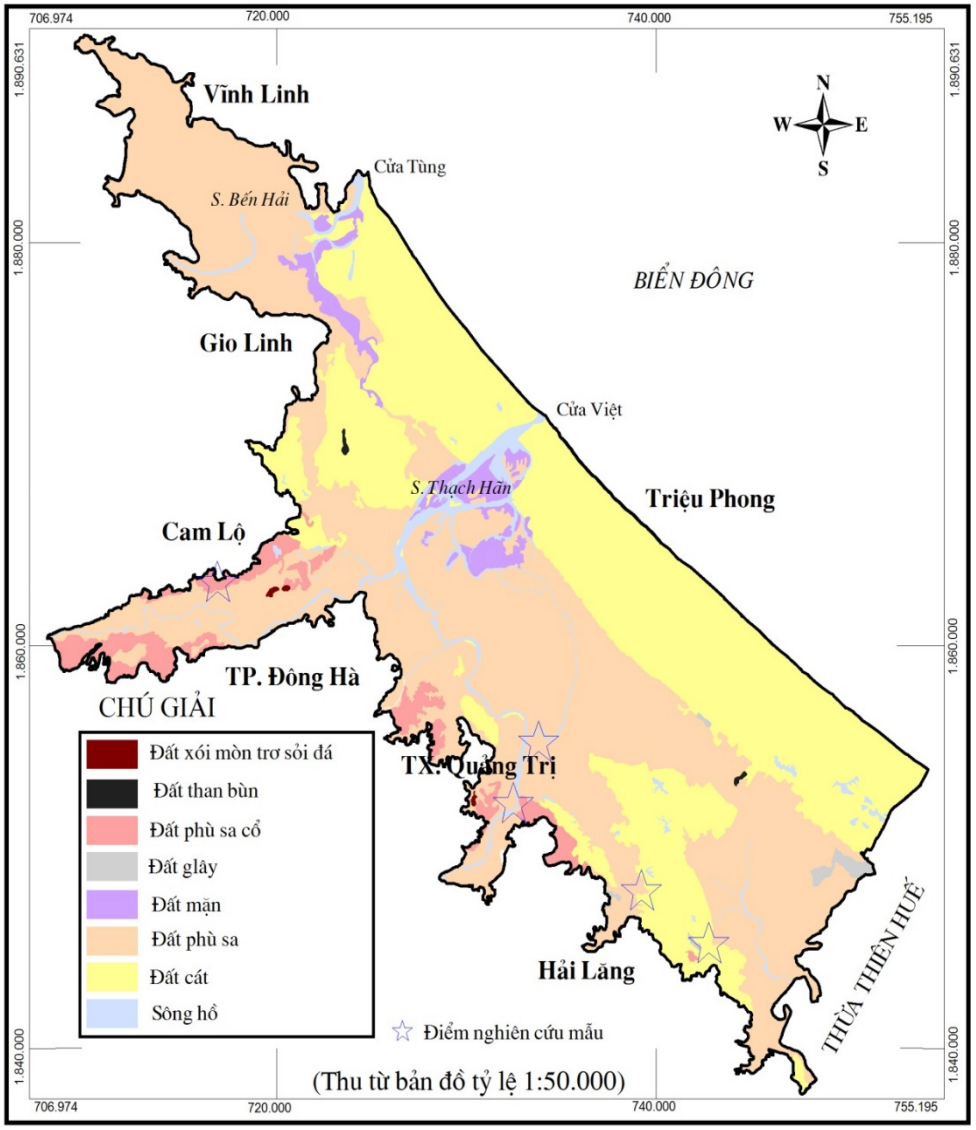
RESEARCH MOTIVATION

- Changes in agricultural land use have significant impacts on greenhouse gases emission and soil organic carbon (SOC)
- According to IPCC, because of agricultural land use change and cultivation, about $136 \pm 55 \times 10^9$ tons of CO_2 were emitted in the atmosphere from 1850 to 1998, in which, $78 \pm 12 \times 10^9$ tons was caused by SOC decline

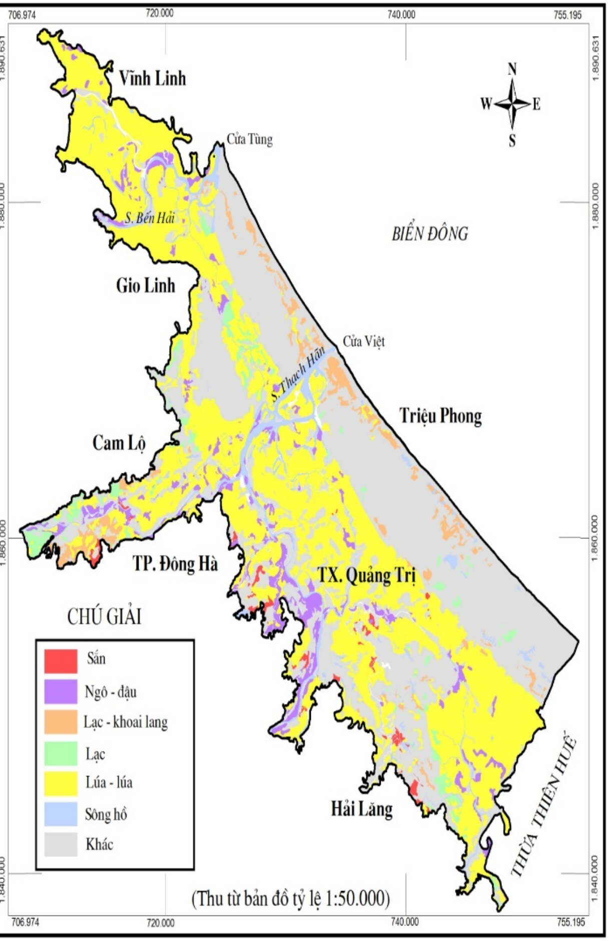
RESEARCH OBJECTIVE

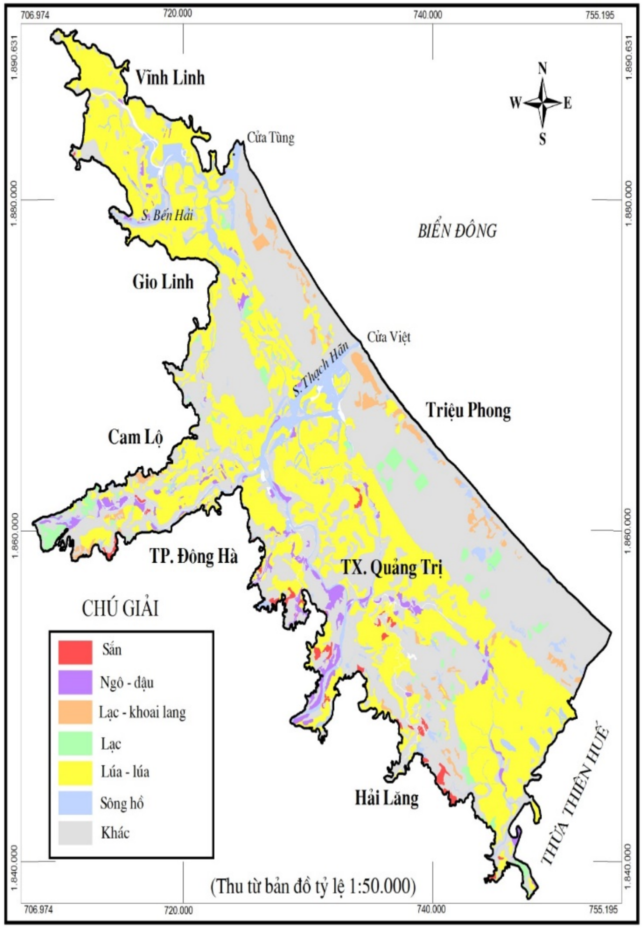
To assess impacts of agricultural land use changes on SOC in the coastal plains of Quang Tri with a case study in Hai Lang District. The land use changes are particularly changes in space and time of cropping systems.

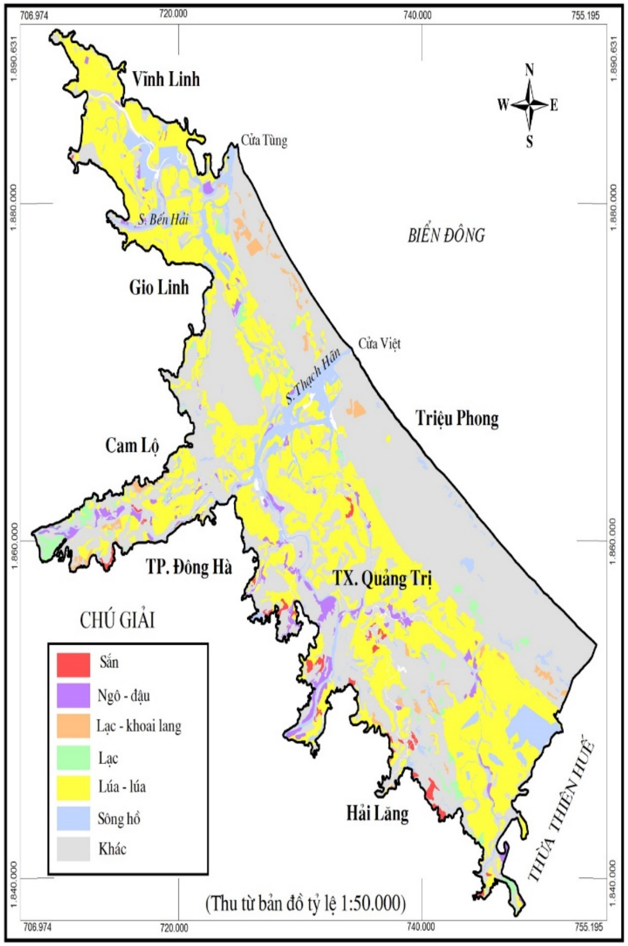


Soil Map of Hai Lang District

CHANGE IN LAND USE IN 2000, 2010 AND 2020 (PLANNING)







Agricultural land of the province is mainly concentrated in coastal plains. The coastal region includes 5 cropping systems: (1) rice - rice; (2) corn - beans; (3) peanuts; (4) peanut - sweet potato; (5) Cassava

II. STUDY METHODS AND DATABASE

Model verification method

The estimated SOC result of DNDC 2012 is compared with the analysis result of 5 soil profiles

Most sensitive factor method

allows determining the estimated SOC value range of cropping systems in a regional scale

Geographic Information System (GIS)

links DNDC results and to manage and analyze data

Database

of cropping systems, pedology, climate and soil analysis in 2000 - 2012

DNDC model (Denitrification - Decomposition)

- is a biogeochemical model, which allows to estimate SOC content, lost of Nitrogen content, emissions of certain greenhouse gases such as $CO_{2,}$ CH_4 from the agricultural ecosystem
- to evaluate changes in the SOC amount in agricultural ecosystems is one approach
- has been tested and applied to calculate SOC in agricultural ecosystems both in scale and regional points across various areas of the world: the United States, China, Canada, the UK, Thailand, Bangladesh.

III. RESULTS AND DISCUSSION

1. Cultivation method

Farming practices of cropping systems in Hai Lang (winter-spring/ summer crops)

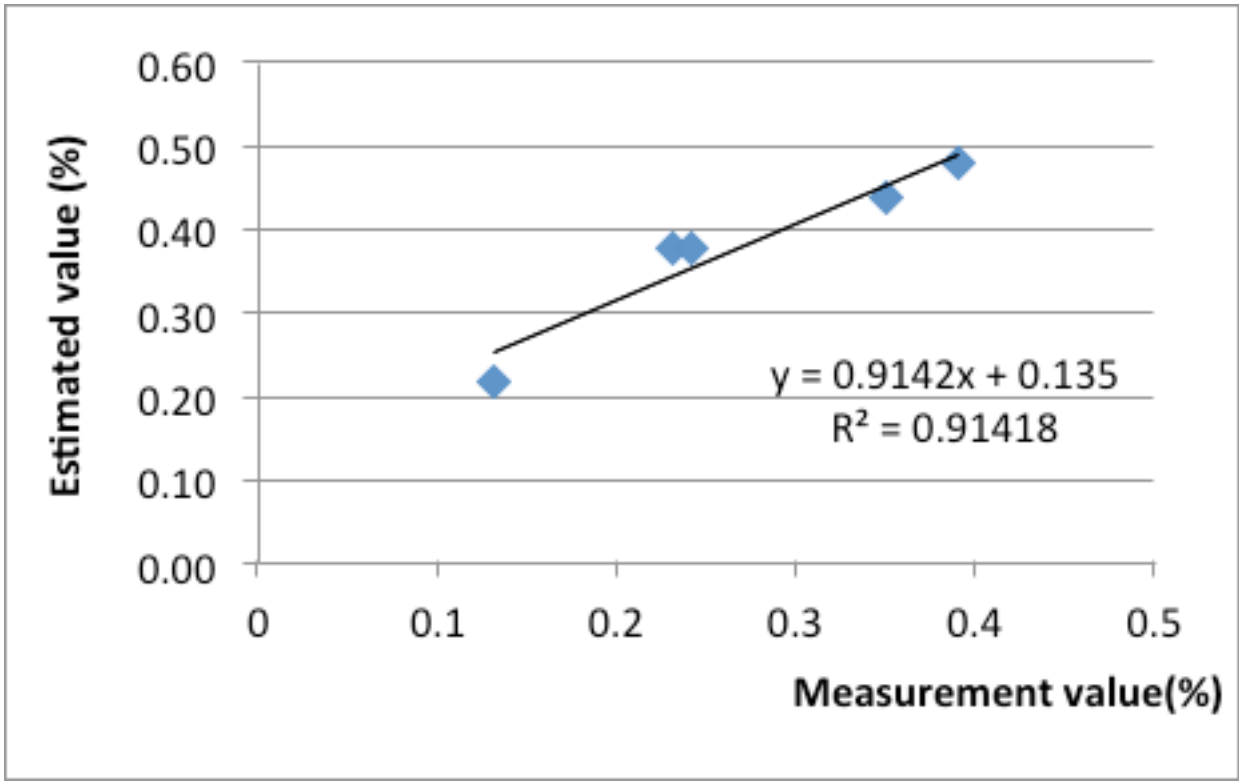
Rice – Rice	
Plowing times; depth (cm)	2; 20/2; 20
Crop residues at fields (stem + root) (%)	15/20
The amount of nitrate fertilizers used (Ure) (kg/ha/season)	145
The amount of manure used (kg/ha)	0
Inundation (irrigation) (cm)	0 – 10
The rate of leaves taken away from fields when harvesting (%)	100
Corn – Beans	
Plowing times; depth (cm)	2; 20/2; 20
Crop residues at fields (stem + leave) (%)	5/10
The amount of nitrate fertilizers used (kg/ha)	320/60
The amount of manure used (kg/ha)	0
Inundation (irrigation) (cm)	0
Peanuts	
Plowing times; depth (cm)	2; 20-25
Crop residues at fields (stem + leave) (%)	5
The amount of nitrate fertilizers used (Ure) (kg/ha)	80
The amount of manure used (kg/ha)	8500
Irrigation index [e]	0,1
Times of pruning	1
The rate of stem taken away from fields when harvesting (%)	100
The rate of roots taken away from fields when harvesting (%)	95
Peanut – Sweet potatoes	
Plowing times; depth (cm)	2; 20-25/ 2; 20-25
Crop residues at fields (stem + leave) (%)	5/10
The amount of nitrate fertilizers used (Ure) (kg/ha)	80/120
The amount of manure used (kg/ha)	8500/6000
Irrigation index [e]	0,1
The rate of roots taken away from fields when harvesting (%)	90/80
The rate of peanut stems taken away from fields when harvesting (%)	100
Times of pruning stem and leaves of sweet potatoes	5
Cassava	
Plowing times; depth (cm)	2; 20
Crop residues at fields (stem + leave) (%)	10
The amount of nitrate fertilizers used (Ure) (kg/ha)	160
The amount of manure used (kg/ha)	0
Irrigation index [e]	0,1
Times of pruning leaves	1
The rate of stem taken away from fields when harvesting (%)	100
The rate of roots taken away from fields when harvesting (%)	90

2. DNDC verification

The estimated value and the actual measurement value of SOC of cropping systems in research locations

No.	Cropping system	Layer depth (cm)	SOC (%)		Differential
			Estimated	Measured	
1	Peanuts	0 – 25	0,44[a]	0,35	0,090
2	Peanut – Sweet potatoes	0 – 29	0,22[a]	0,13	0,090
3	Rice – Rice	0 – 20	0,48	0,39	0,090
4	Corn – Beans	0 – 20	0,38	0,23	0,150
5	Cassava	0 – 18	0,38[a]	0,24	0,140

[a] The value has been measured with layer depth

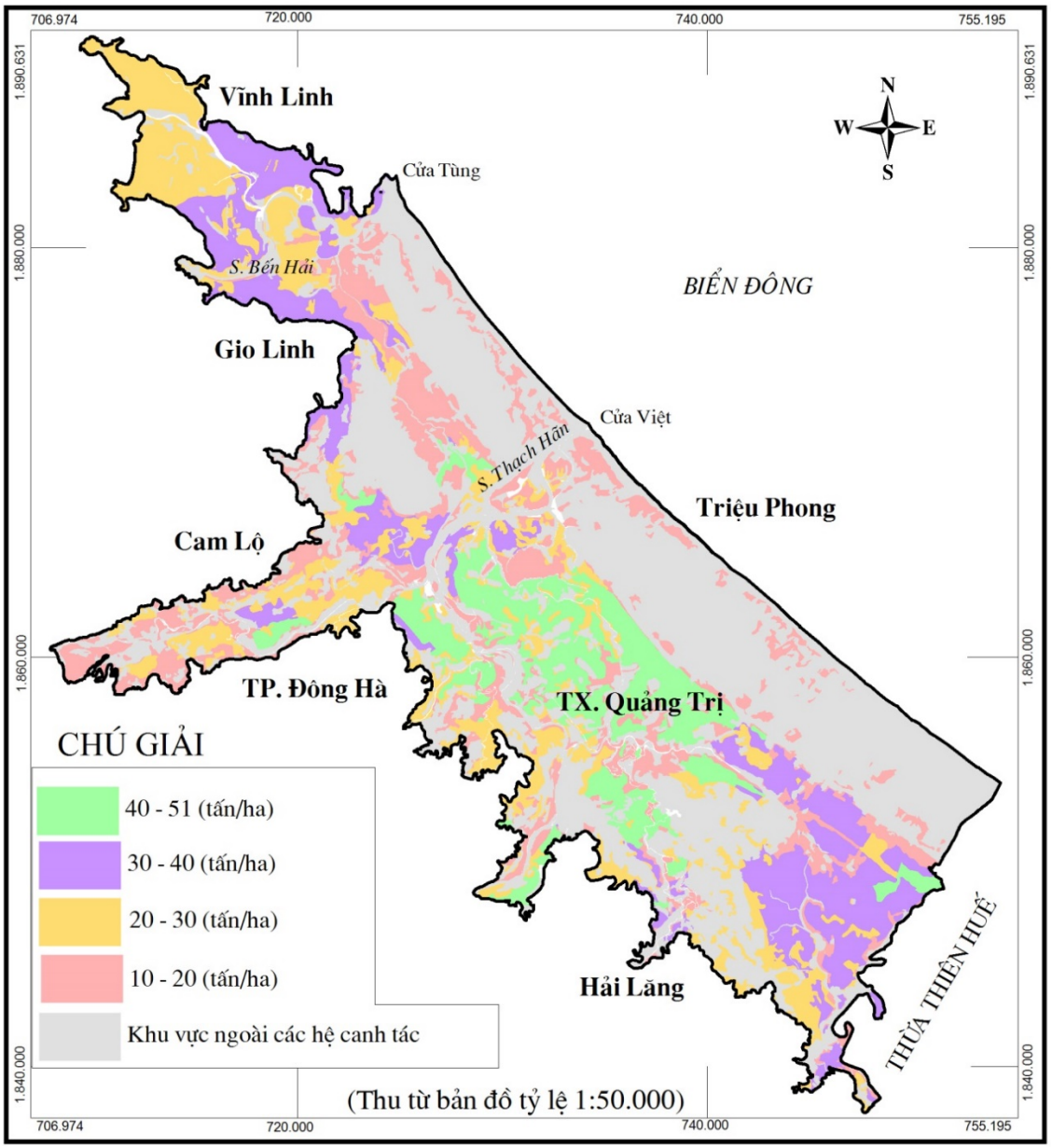


Correlation between the estimated value and the actual value of SOC at study points

3. SOC content of cropping systems in 2000

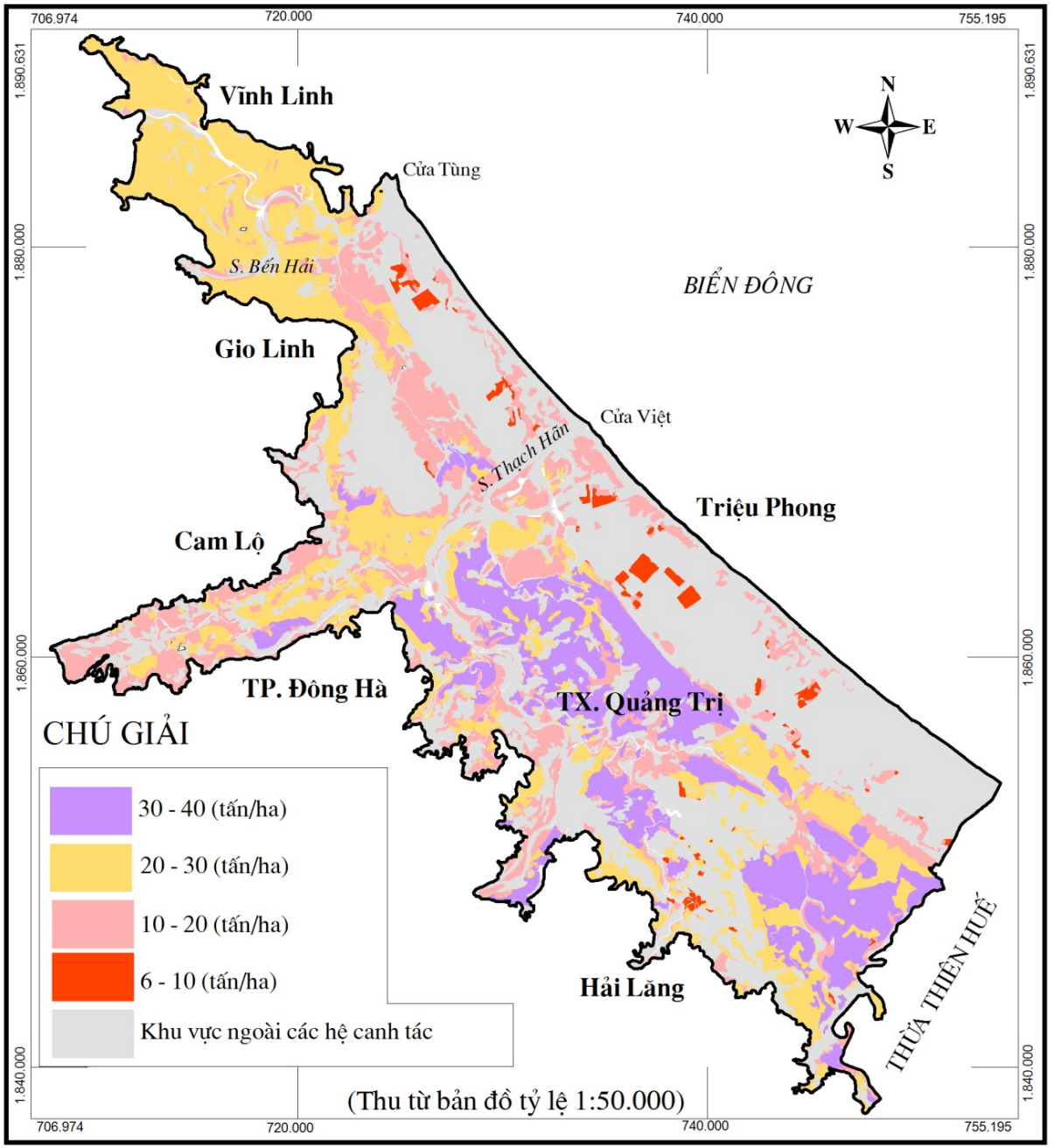
the total SOC content in the surface (0-30 cm) **in 2000** of cropping systems in different soil types in Hai Lang is **346,529.6 tons**.

In which, the SOC content of Peanuts, Peanuts – Sweet potatoes, Rice – Rice, Corn – Beans and cassava system are 11,209.9 tons, 4,875.7 tons, 313,619.1 tons, 11,351.6 tons and 5,473.2 tons respectively.

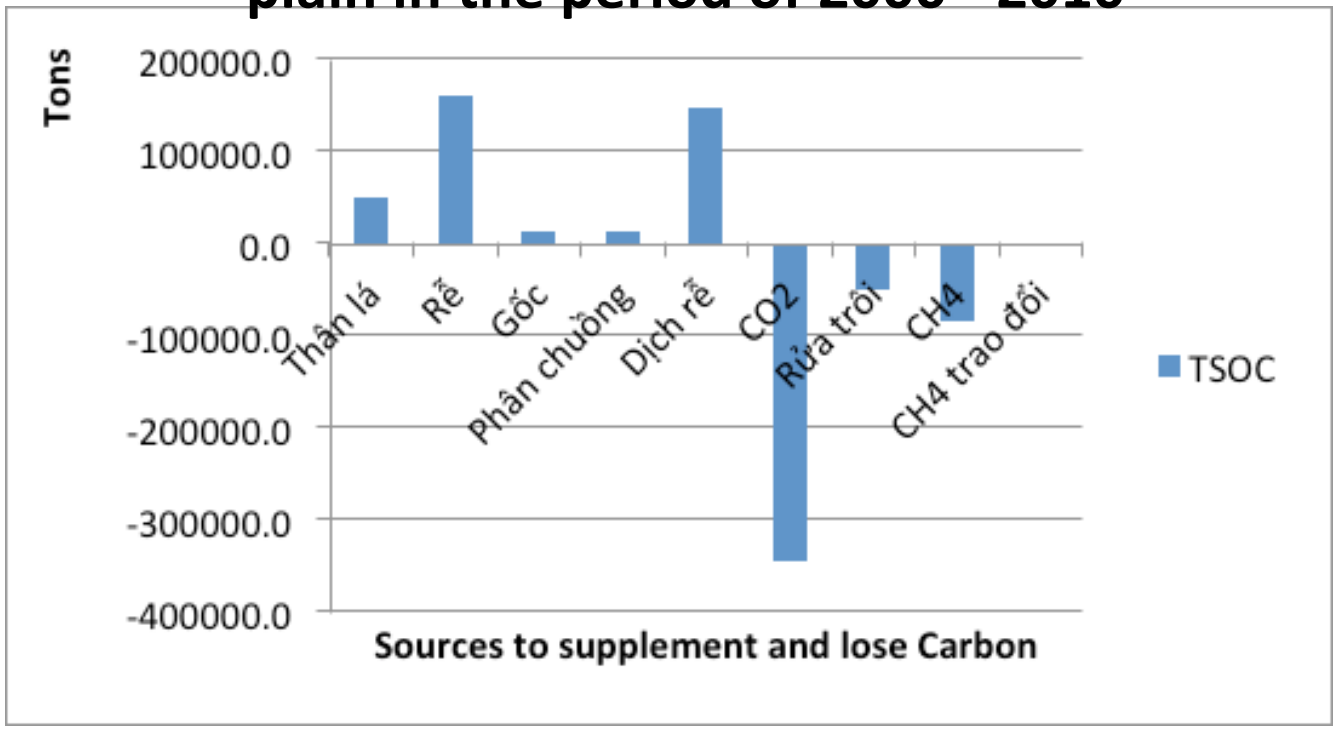


4. SOC content of cropping systems in 2010

The total SOC content in the surface (0-30 cm) **in 2010** of cropping systems in different soil types in Hai Lang is **272,354 tons**.
In which, the SOC content of Peanuts, Peanuts – Sweet potatoes, Rice – Rice, Corn – Beans, and cassava system are 7850.4 tons, 6207.2 tons, 248,493.2 tons, 4401.1 tons and 5401.4 tons respectively.



Equilibrium between the total OC amounts added to and loss from soil in cropping systems of Hai Lang district's coastal plain in the period of 2000 - 2010



In the period **of 2000 - 2010**, the total amount organic carbon **added to the soil was 348,704.3 tons**; the amount of organic carbon **lost from the soil was 481,292.8 tons** which is **1.25 times higher** than the amount organic carbon added to the soil.

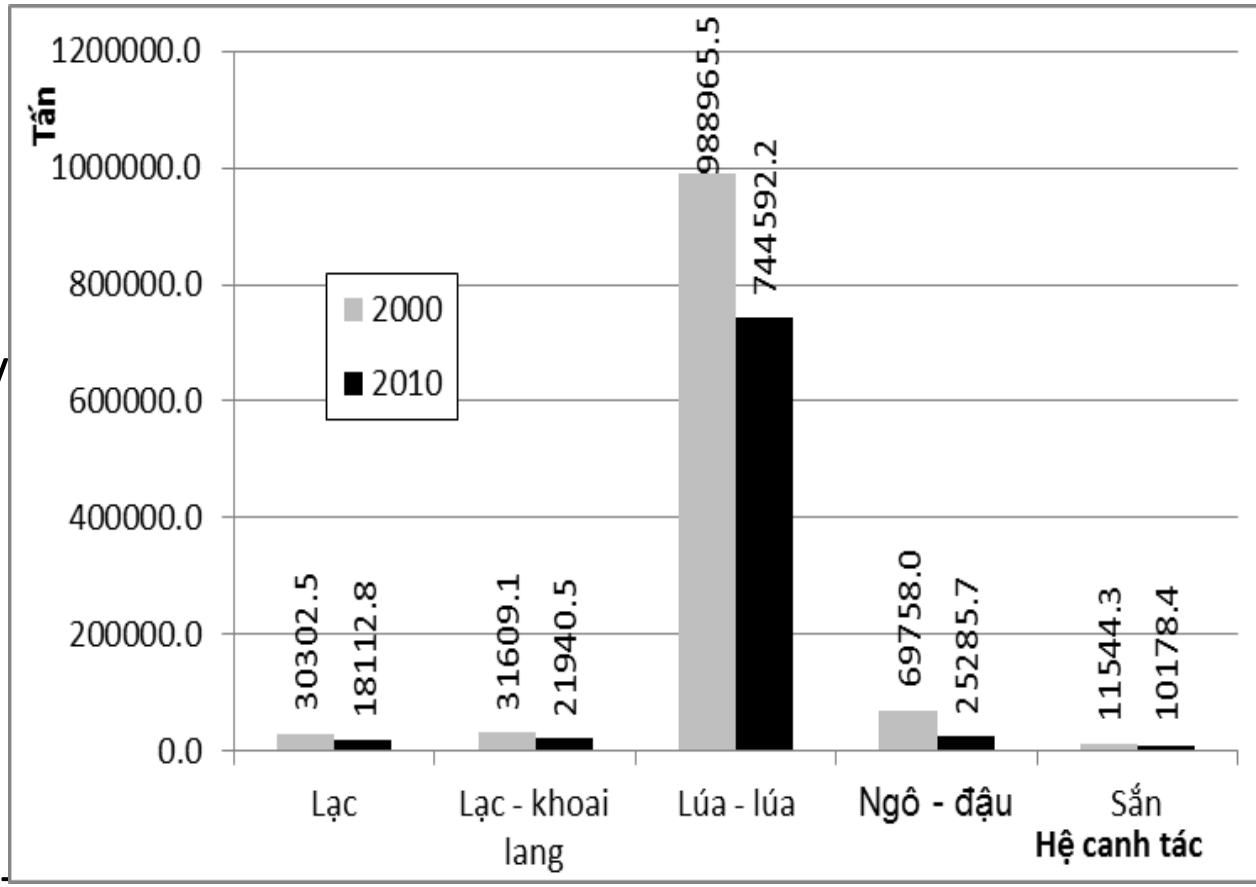
In which the amount of carbon from agricultural byproducts is 50,182.1 tons, particularly 161,789.4 tons from roots, 11864.6 tons from stumps, 12,412.9 tons from manures and 148,455.2 tons from roots exudation

5. Changes on the SOC amount in Hai Lang agricultural land from 2000 to 2010

a. Unconverted cropping systems:

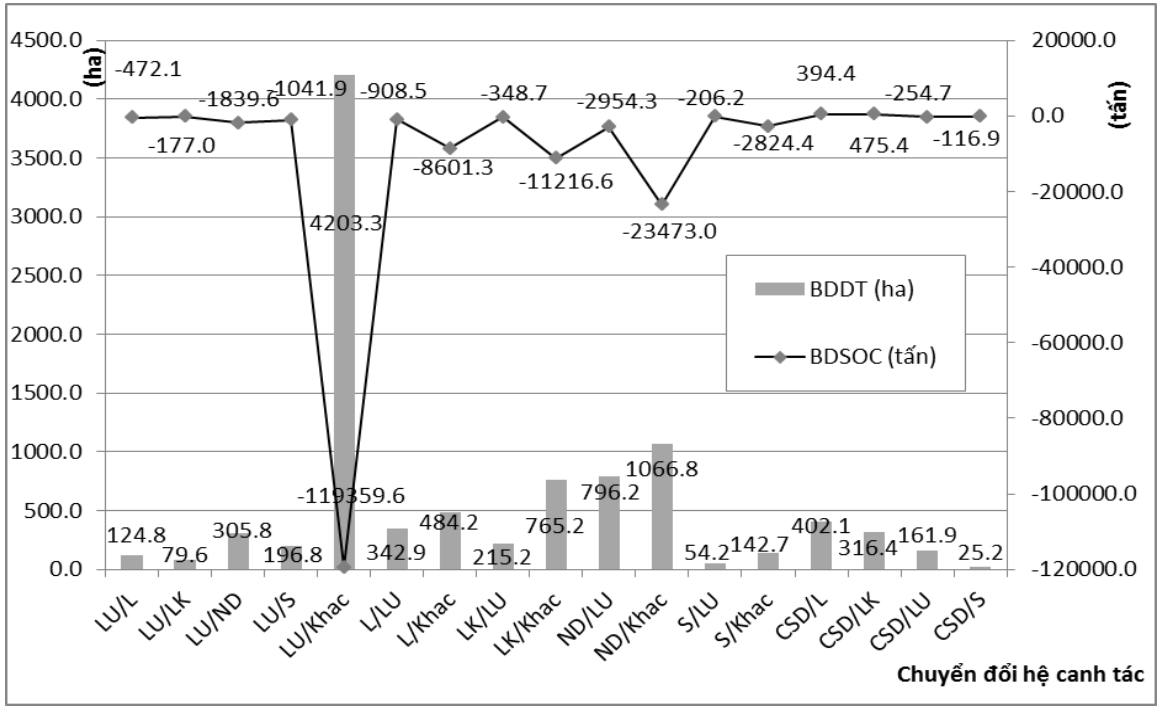
Carbon equilibrium value diminishes among types of soil, from -0.01 tons/ha/ year (rice, sandy soil, low SOC content) to -0.86 tons/ ha/year (rice, gley alluvial soil, high SOC content).

This trend is due to the gradual **increase of total emission amount of CO_2** during 2000 – 2010 in Rice - Rice system in the soils with high SOC content.



b. Converted cropping systems:

HCT: cropping system; LU: Rice – Rice; L: Peanuts; LKL: Peanuts – Sweet potatoes; ND: Corn – Beans; S: Cassava; Others: residential, specialized, aquacultural land;



From **Rice** system **to Peanuts - Sweet potato or peanuts** system, the SOC content increased because after the conversion, Carbon equilibrium value is 3 times (in peanuts) and 8 times greater (in peanut - sweet potato) than the non-conversion of Rice – Rice system on the same soil type.

From **peanuts - sweet potato or peanuts to rice**, the SOC content fell after the conversion because the Carbon equilibrium value decreased.

From **Rice to Corn – Beans or to Cassava**, the SOC content reduced after the conversion and conversely.

Conversion of **unused land** (coastal sand dunes) **to Peanuts, Peanut – Sweet potato**, the SOC content in 2010 raised, in comparison with 2000.

CONCLUSION

1) Change on agricultural land use of Hai Lang's coastal plain in the period of 2000 – 2010 **reduced SOC content in 2010 of cropping systems 30%** in comparison with 2000. The higher content of SOC, the stronger reduction is.

2) The maintenance of 28,777.9 ha of Rice, Corn – Beans and Cassava systems reduced 148,086.7 tons of SOC while 1,102.3 ha of Peanuts - Sweet potatoes systems raised 1,052.9 tons of SOC.

CONCLUSION

3) Conversion of 6,662.2 ha of agricultural lands to other puporse lands (residential, specialized, aquacultural) made a decline of 165,474.9 tons SOC.

4) Under current farming practices, conversion of cropping systems from Rice – Rice to Peanuts, or Peanuts - Sweet potatoes, **the SOC content tends to increase**.

And from Rice – Rice to Corn - Beans, or Cassava **the SOC content tends to decrease** and conversely.

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