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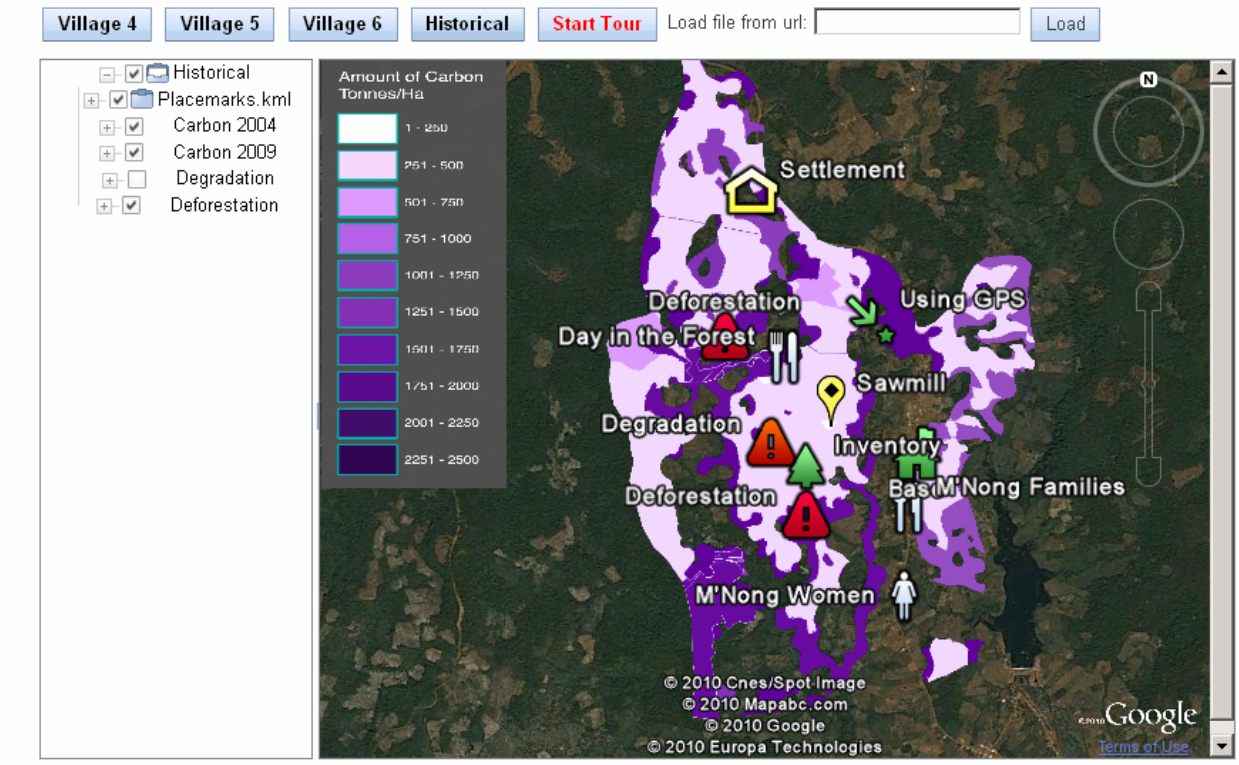
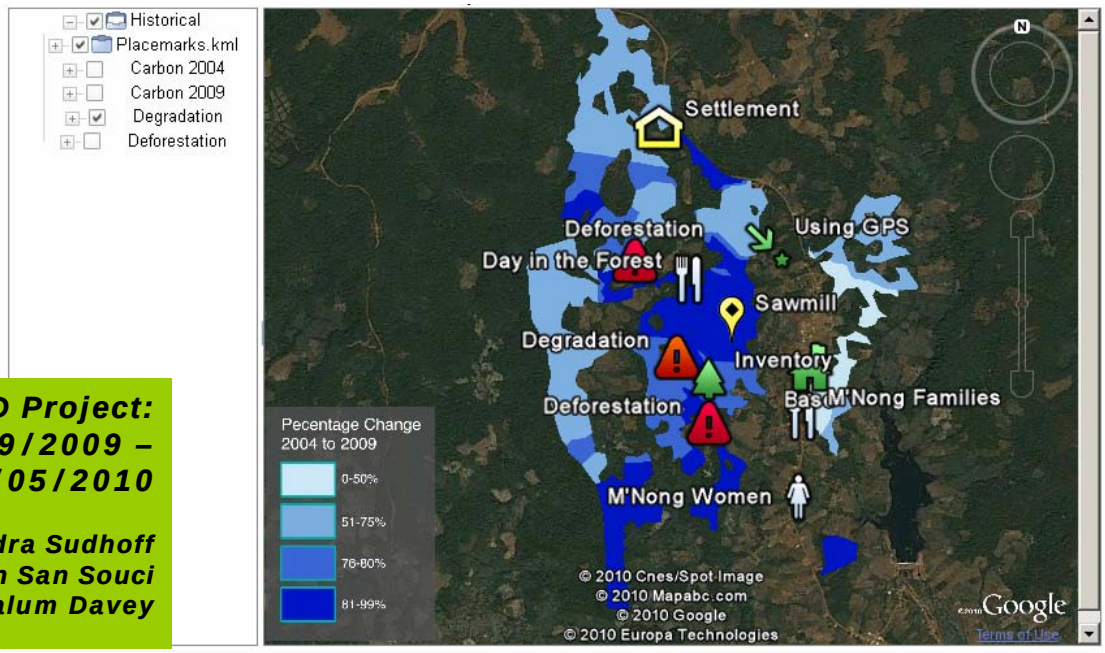
IN COLLABORATION WITH

GTZ, PLANET ACTION AND GISCORPS

SATELLITE IMAGE ANALYSIS: CARBON CONTENT IN STUDY AREA IN 2004 AND 2009





REDD Project: 01/09/2009 – 31/05/2010

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SATELLITE IMAGE ANALYSIS: CARBON CONTENT IN STUDY AREA IN 2004 AND 2009: PROGRESS REPORT

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Acronyms

DN	Digital Number
GIS	Geographical Information Systems
GPS	Global Positioning System
GPL	General Public License
GTZ	German Technical Cooperation
HH	Households
KML	Keyhole Mark-up Language; file format used by Google for mapping
KMZ	Compressed kml
NDVI	Normalised Differenced Vegetation Index
NGO	Non Governmental Organisations
REDD	Reducing Emissions from Deforestation and Forest Degradation
SHP	Shapefile; file format used by many GIS mapping programs
SFM	Sustainable Forest Management
THON	Vietnamese expression for Village

1 EXECUTIVE SUMMARY

When comparing fieldwork results from 2004 and 2009 on determining carbon content of one village in the Vietnamese Highlands, the carbon ranges differed enormously, suggesting that either the methods of fieldwork have changed or that the carbon stock was depleted through deforestation and degradation. However, analyzing SPOT satellite images from 2004 and 2009 on carbon content, verified the findings of the fieldwork and demonstrated that the carbon stock had declined through both, deforestation and degradation.

2 BACKGROUND INFORMATION

2.1 DESCRIPTION OF THE FULL PROJECT

Deforestation and forest degradation have continued over the last decades despite all the attention and efforts to implement **Sustainable Forest Management (SFM)**. One of the reasons for the continuation of unsustainable practices is the underestimation of the multi-functionality of

forests. Most non-timber forest goods and services are not generating their potential financial value when managed sustainably because of lack of markets or other compensation mechanisms. One of the main challenges faced by many countries in stopping forest degradation and deforestation — and in enhancing the contribution of forests to development — is the need to increase the competitiveness of SFM and generate more investment in and revenues from forests.

Forests play an important role in providing alternative sources of energy and mitigating climate change. The concept of **Reducing Emissions from Deforestation and Forest Degradation (REDD)** is yet another recognition of the forests' role in climate-change mitigation. REDD, irrespective of timber quality or accessibility, increases the economic value of natural forested land and thus, could lead both public and private sectors to invest in areas previously considered not commercially viable. REDD makes an important contribution to SFM through evaluating the carbon stocks of a sustainably managed forest, thus increasing their financial value and decreasing the conversion into agricultural lands.

Under the **Climate Change Convention** and **Kyoto Protocol** various financing instruments have been developed for climate change adaptation and mitigation measures that include projects on forest management, afforestation and deforestation. The evolving policy discussions within UNFCCC to establish a financing mechanism for Reducing Emissions from Deforestation and Degradation (REDD) have created high expectations for its role as a financing tool for SFM and forest conservation.

Some countries growing tropical forests have increased their efforts in combating climate change through pioneering a new initiative called the **UN-REDD** Program. This program will support the respective countries as part of an international strategy to include REDD in a new and more comprehensive **UN climate change arrangement** to get started after 2012. Furthermore it aims at changing the economic balance in favor of sustainable management of forests so that their excellent economic, environmental and social goods as well as services benefit countries, communities and forest users while also contributing to important reductions in greenhouse gas emissions.

Vietnam is among the 14 countries which were **selected within the UN-REDD Program** and has already started two pilots, one in Lam Dong province and another one in Son La province. The steps envisioned include the elaboration of national developing strategies, establishing robust systems for monitoring, assessment, reporting and verification of forest cover and Carbon stocks, and building necessary capabilities-with support to others to follow in due course.

Vietnam's forest area increased over the last years from **9.18 Mill ha** (27.2%) in 1990 up to **12.61 Mill ha** (37%) in 2006. Whereas this is can be seen as an achievement, it is necessary to point out that forest gains are mainly attained by **fostering plantation establishment**, while exploitation and degradation of natural forest areas still continue. In the last years Vietnam made

some progress in slowing down the rate of natural forest degradation. Recently, there was a reformation process in the forestry sectors, which transfers forest land from big state forest farms to households (HH) or communes. Simultaneous forest management plans for the communes/HH and trainings were provided. For further improvement, Vietnam is currently testing and analysing the potential of other ways to increase the value of the forest, e.g. **Payment for Environmental Services, REDD or FSC Certification**. The aim of the grant is to support Vietnam to find a mechanism to improve the livelihood of the poor by increasing the value of their forests through the set-up of a REDD pilot.

The project is a **joint project** between the **GTZ** (German Development Cooperation) and **CartONG**. As the topic requires expertise in Forestry and Natural Resource Management, content and data collection as well as all training measures related to data collection and development of carbon stock models will be executed and monitored by GTZ staff. CartONG's role is to process the data for Google Earth and Google Map API, as well as training measures related to the creation and update of the KML layers.

The overall goal of the project is to support the Vietnamese government within this REDD development process. The project will be monitoring and displaying deforestation rates for *two pilot communes in the Central Highlands*. Satellite or aerial maps provide exact area measurements, but forest ecosystems are very diverse and calculation of Carbon stocks varies among different forest types. Thus, the project will carry out forest inventories and based on these findings the Carbon stocks will be calculated through developing appropriate models (*forest type + soil type + area gaining/reduction = Carbon Emission Certificates*). Area changes can be recorded easily by using aerial or satellite images and the Carbon stocks updated.

2.2 SATELLITE IMAGE ANALYSIS CONDUCTED BY GISCORPS VOLUNTEER

After the fieldwork started and was completed in one of the villages; it was found that whereas the newly collected data would give a good overview and provide a good base for the Carbon stocks model projecting future carbon contents under different forest management scenarios; the data on carbon content which could be obtained through **past forest inventories was fragmented** and **verification** needed. Especially the range on carbon content was reported to be much higher in 2004 than 2009. Whereas this was to be expected, the differences were striking and raised questions.

Therefore, it was decided to find a specialist who would be able to work on extracting carbon content values based on the fieldwork conducted in 2009 and compare it to 2004. Satellite images for both periods were available; donated through the Planet Action Initiative by SPOT image as well as SNV (Image references: S5_277-326_15032009, SCENE 5 277-326/0 04/01/03 03:15:45 1 J). For 2004, only the interpolated Carbon Content in forms of shapes was available and therefore could not be taking into consideration as the coordinates of the original plots were unknown.

This decision was taken at a late state of the project and there was no budget available to pay a specialist for the analysis. As CartONG has heard of the **GISCorps** Volunteer initiative through one of the satellite image interpretation projects it had been following; it was decided to contact them. Fortunately, GISCorps identified **Jason San Souci** a registered volunteer who not only had many years experience of working with satellite images, but also had worked on carbon content estimation before.

3 METHOD

- **Converting** the **DN values** to at-satellite reflectance; some input was given by the SPOT technical team
- **Image registration** for change detection
- **Radiometric correction** and **NDVI** layer generation
- Overlaying the **plot coordinates of 2009**; **extracting the NDVI** values.
- **Computing** the **average Carbon content** based on the extracted NDVI values
- **Applying** the **average Carbon content** on Thon 4 and 6 as well as on the full images
- **Accuracy Assessment** of Carbon content results with field data

4 PROJECT DESCRIPTION: ADMINISTRATIVE PART

A short project description on the administrative part is given in this chapter.

Co-operation with other actors

The following co-operations were vital to conduct the project:

- GTZ (German Technical Cooperation): fieldwork as well as the technical background on all forestry related questions
- Planet Action: providing the framework for donating the sat images
- GISCorps: providing a volunteer to work on the analysis of the sat images
- Dak Nong Forest Protection Department
- Tay Nguyen University, Buon Ma Thot, Vietnam

Staffing

Staffing consisted of Sandra Sudhoff (Overall coordination, Testing/Backstopping), Calum Davey (Fieldwork as well as creation of kml files and webpage), Christian Aschenbach (GTZ/GFA; coordination in the field and all content related to forestry), Michael Krause (PIK, elaborating the Carbon and Financial model for future forest management scenarios), Jason San Souci (GISCorps volunteer, Spot image analysis) as well as numerous local field staff for the forest inventories conducted in three villages.

Equipment/Data

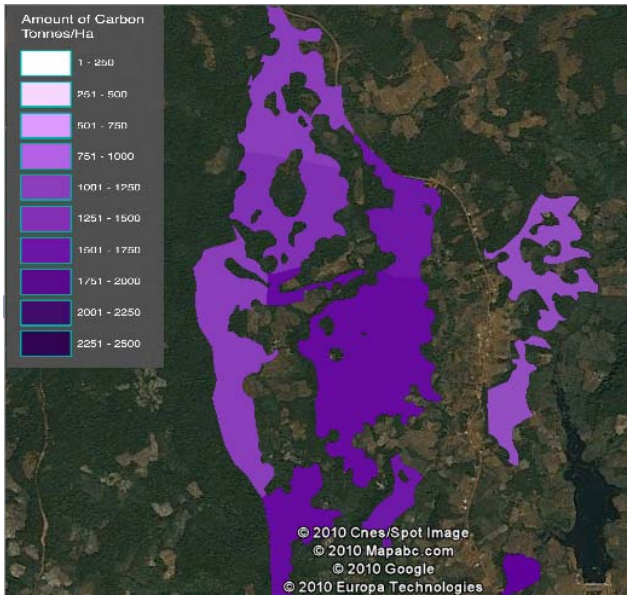
No equipment/hardware for the project has been purchased, the **SPOT satellite images**[1] have been donated by SPOT through **Planet Action** and **SNV** in the field. Software for analyzing the images has been provided by ITT (**ENVI**) and Definiens for free; however as there was a time limit on the Definiens license and the project delayed, only the ENVI license has been utilized for classifying the results of the Spot image analysis. The analysis itself was conducted by Jason San Souci, GISCorps Volunteer with **ERDAS Imagine**.

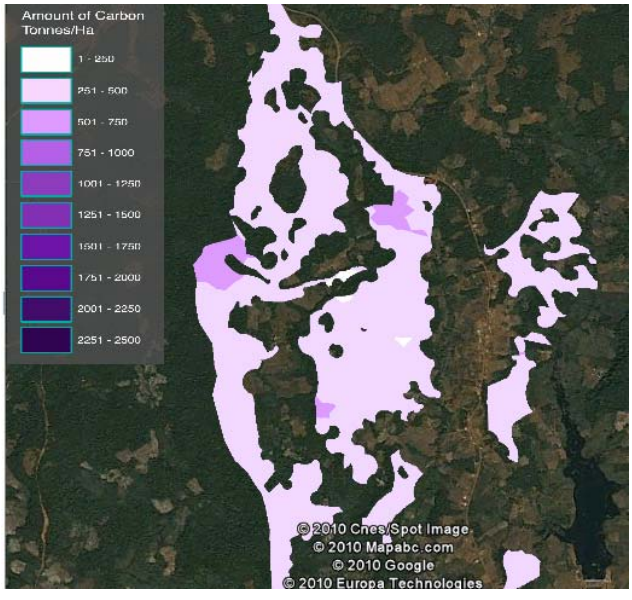
5 RESULTS

When comparing the overall computed results it becomes evident that the trend identified during the fieldwork with a strong deforestation and degradation since 2004 can be confirmed through the Satellite Image Analysis.

The **Carbon range** in the satellite images is slightly below the carbon range determined through fieldwork in 2004 and 2009. This can be explained through the fact that trees with a bigger diameter will store more Carbon, which the mixed pixel value of the image can't reflect to the same extent.

Range of Carbon Content	2004	2009
Fieldwork	827 - 2268	202 - 1166
Satellite Image Analysis	626 - 1347	195 - 405

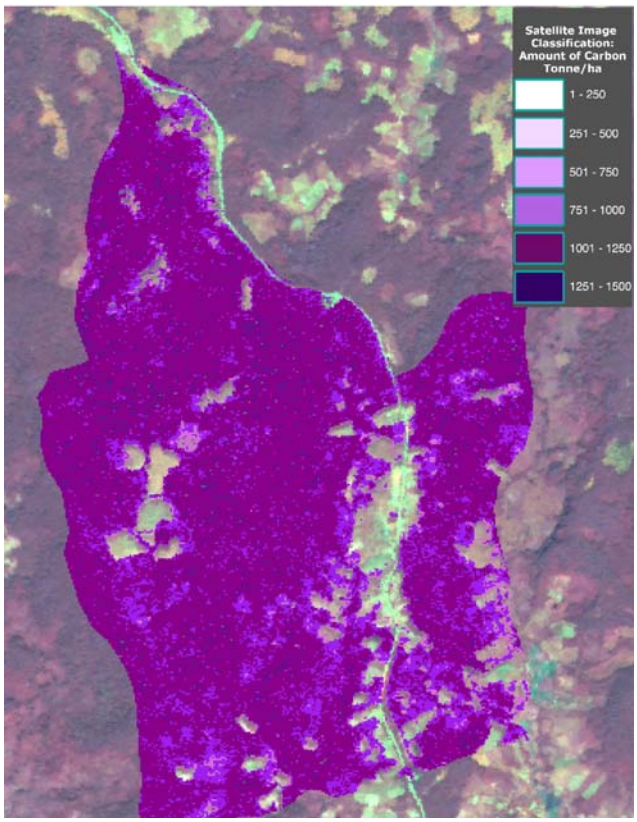




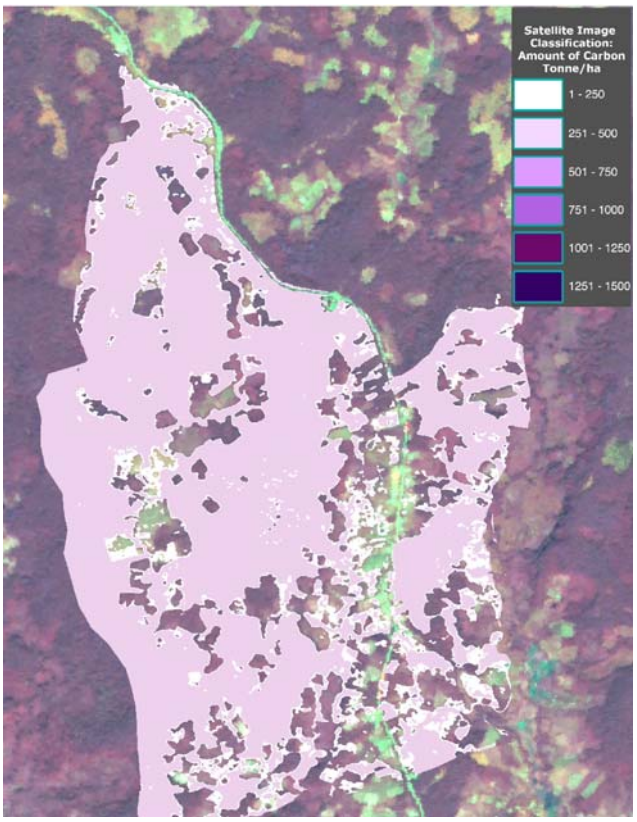
[1] Image references: S5_277-326_15032009, SCENE 5 277-326/0 04/01/03 03:15:45 1 J

On the left hand side graph *Amount of Carbon* shows the Carbon range prevailing in 2004 in Thon 6; as can be seen, none of the forested areas are below 751 Tonnes/Ha. On the right hand side the situation in 2009 is depicted. Here none of the forested areas contains more than 750 Tonnes/Ha.

This trend is reflected in the results of the satellite image analysis as well. In 2004, the lowest carbon value is ranging between 501 – 750 Tonnes/Ha; in 2009 the highest value is not exceeding 500 Tonnes/Ha. The boundaries are not as defined which is linked to the fact that the boundaries shown in the plot analysis have been obtained by interpolating (kriging).



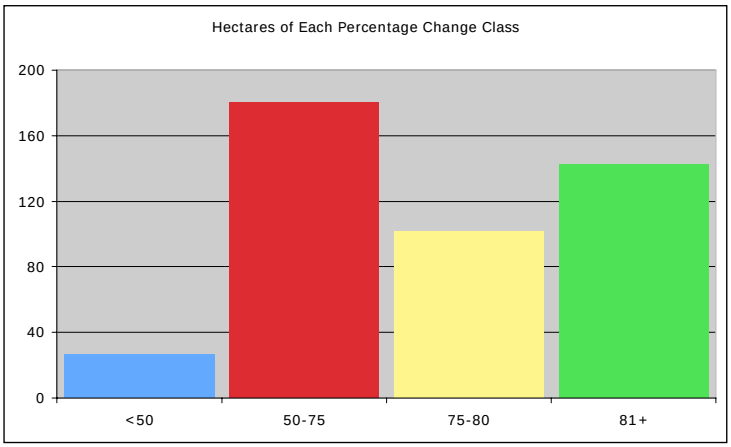
Thon 6 Carbon Content in 2004: values between 1001 – 1250 Tonnes per Ha are prevailing, followed by values ranging between 751-1000.



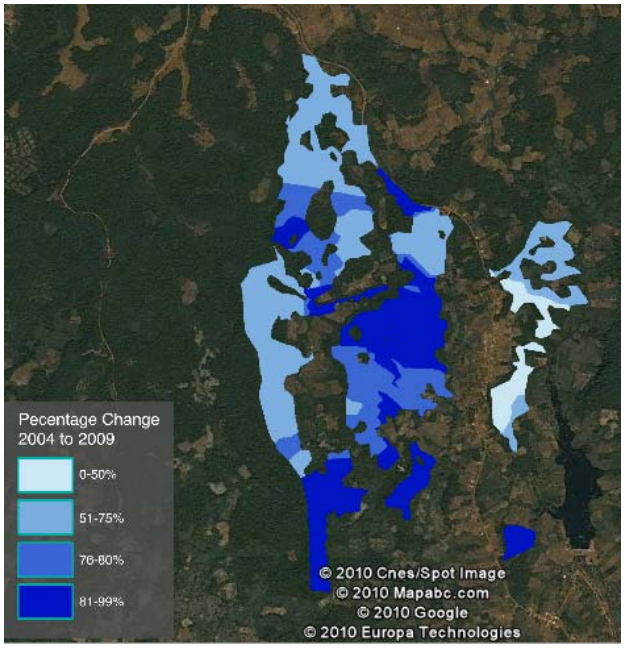
Thon 6 Carbon Content in 2009: values between 251 – 500 Tonnes per Ha are predominant.

In order to get an overview and make the user of the data and the data model understand how important Sustainable Forest Management is, degradation of the forest was categorized and displayed.

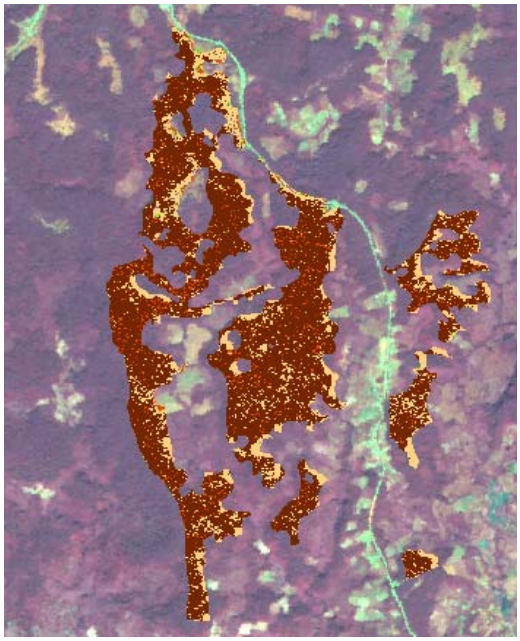
Degradation is defined as Percentage Change (excluding deforested areas) from 2004 to 2009.
As can be seen in the graph *Percentage Change of Thon 6*; most areas experienced degradation of more than 50%; with the percentage over 81% being strikingly high.



Thon 6 Fieldwork: *The majority of around 180 ha fall on changes between 50-75%, followed by 120 ha changes more than 81%.*



Thon 6: ***Percentage Change***: *Changes over 70% are prevailing with a high percentage even exceeding 81%.*



***Thon 6:* Estimated Degradation**; *Blue: less than 50%; Red: between 50 and 75%; Yellow: Between 75 and 80% and Green: more than 80% volume lost*

When roughly estimating degradation for Thon 6 from the results of the satellite analysis; the following figures were established:

Degradation	Area in ha
Up to 50%	85
Up to 75%	24
Up to 80%	439

6 ANNEX

A. LIST OF SOFTWARE UTILIZED

GIS software:

- Quantum GIS (open source) + ArcGIS (ESRI, proprietary)
- Google Earth (free version as well as Pro version)

GPS/data conversion software:

- GPS Babel (open source)
- Arc2Earth; ArcGIS plugin to create kml files from shapefiles.

Image software:

- ENVI (proprietary)
- ERDAS Imagine (proprietary)

B. WEBPAGES CONSULTED

Data downloads

Data on REDD & forest data from Vietnam:

http://www.un-redd.org/
http://www.redd-monitor.org/redd-an-introduction/
http://www.gtz.de/en/themen/laendliche-entwicklung/natuerliche-ressourcen/22939.htm
http://www.un-redd.org/NewsCentre/Newsletterhome/US438millionUNREDDVietNamProgrammelaunche/tabid/1469/language/en-US/Default.aspx
http://www.gtz.de/en/weltweit/asien-pazifik/vietnam/24188.htm
http://pid.adb.org/pid/LoanView.htm?projNo=34341&seqNo=04&typeCd=2&projType=GRNT
http://www.mekonginfo.org/mrc_en/Contact.nsf/e3b1f73debcd2275802565d50057124a/72603961293 39f0dc72566010070fb8c?OpenDocument
http://www.fao.org/docrep/005/ac778e/AC778E22.htm
http://mekonginfo.org/mrc_en/contact.nsf/0/EADF22637D91190647256AFB0018502B/$FILE/index.htm#MemberTOEB2
http://ekh.unep.org/?q=node/1732

Google + Other soft:

http://code.google.com/apis/maps/ (For reference)
http://www.youtube.com/watch?v=6BlecrkM7w4 (For reference)
http://code.google.com/apis/kml/documentation/kmlreference.html (for reference)

Final Data, link hosting:

CartONG: http://cartong.org/gredd/