UNIVERSITI PUTRA MALAYSIA

DETERMINING K-COEFFICIENTS VALUE IN PAYMENT FOR ENVIRONMENTAL SERVICES PROGRAM OF BU NDOR'S COMMUNITY FOREST, DAK NONG PROVINCE, VIETNAM

HO DINH BAO

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By

HO DINH BAO

Thesis Submitted to the School of Graduate Studies, Universtiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

DETERMINING K-COEFFICIENTS VALUE IN PAYMENT FOR ENVIRONMENTAL SERVICES PROGRAM OF BU NDOR'S COMMUNITY FOREST, DAK NONG PROVINCE, VIETNAM

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Chairman : Professor Awang Noor Abd. Ghani, PhD
Faculty : Forestry

Payment for Environmental Services (PES) has been implemented in Vietnam to prove the buyers about the services that they benefit. The environmental values in PES are calculated via a K-coefficient which present different type of forest characteristics of a particular area. The main objective of this study was to determine the K-coefficient value that is used to adjust the payment in the payment for environmental services program within Bu N'Dor community forest.

The research used SPOT-5 satellite image that was captured in 2012 to classify forest status. One hundred and four sample plots were collected in the field corresponded with three forest status which were rich, average, and poor forest. To classify forest status based on satellite image, Envi 4.7 software was used as a core software that interpreted forest condition according to digital value of the pixels in the image. The K-coefficient (K_1) was assigned based on forest status and it vary from 0.90 to 1.00. The second K-coefficient (K_2) is based on the essential soil erosion. The Revised Universal Soil Loss Equation was used to calculate the essential soil erosion in the area. The essential soil erosion value was classified to eight classes according to Vietnam standard in 1995 (TCVN 5299 – 1995). Essential soil erosion K-coefficient (K_2) map was then created corresponded with soil erosion level. It value varies from 0.75 to 1.00. The third K-coefficient was defined by the forest managed purposes (K_3). Extracting the forest managed purposes map and assigning the K value based on production forest (K=0.90) or protection (K=0.95) forest. The fourth K-coefficient map (K_4) was defined by the difficulty in forest protection. Four groups who were responsible for forest protection were interviewed, they divided the forest into three levels from average to very difficult in term of forest protection on a map that was provided. These maps were scanned, digitized, and assigned the K value (0.90 – 1.00) to create K_4 map. The general K-coefficient map was built by overlay four K-coefficient maps which are K_1, K_2, K_3 and K_4 following the PES policy. The general K values are from 0.73 to 0.95. From that map, the value of environmental services that the community forest served

was calculated by multiply with the price per hectare (USD 20). The total environmental services value is USD 15,729.60. The essential soil erosion K-coefficient (K_2) was calculated by some factors that related to forest conditions so that could replace K_1 to calculate the new K-coefficient and the value of the community forest was reduced to USD 13,170.24. In conclusion, the K-coefficient map that reflected the different on providing environmental services of different areas could be used to calculate the environmental value of the community forest and contribute to the payment method of PES program in Vietnam.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENENTUAN NILAI PEKALI-K DALAM PROGRAM BAYARAN PERKHIDMATAN EKOSISTEM DI HUTAN KOMUNITI BU N'DOR, VILAYAH DAK NONG, VIETNAM

Oleh

HO DINH BAO

November 2016

Pengerusi : Profesor Awang Noor Abd. Ghani, PhD
Fakulti : Perhutanan

Bayaran Perkhidmatan Alam Sekitar (PES) yang telah dilaksanakan di Vietnam terbukti memberi manfaat kepada para pembeli melalui perkhidmatan ini. Nilai-nilai alam sekitar dalam PES dikira melalui pekali K yang mewakili ciri-ciri perhutanan yang berbeza dalam suatu kawasan yang tertentu. Objektif utama kajian ini adalah untuk menentukan nilai pekali K yang digunakan untuk menyesuaikan pembayaran dalam pembayaran untuk program perkhidmatan alam sekitar dalam komuniti hutan Bu N'Dor.

Imej satelit SPOT-5 yang telah diperoleh pada tahun 2012 telah digunakan untuk mengklasifikasikan status hutan untuk penyelidikan ini. Sebanyak seratus empat plot sampel telah dikumpulkan yang merujuk kepada tiga status hutan iaitu hutan yang kaya, sederhana, dan miskin. Untuk mengklasifikasikan status hutan berdasarkan imej satelit tersebut, program perisian Envi 4.7 telah digunakan sebagai perisian utama yang menafsirkan keadaan hutan mengikut nilai digital piksel dalam imej. Pekali K (K_1) diberikan berdasarkan status hutan dan boleh berubah dari 0.90 – 1.00 manakala pekali K (K_2) adalah berdasarkan kepada bacaan hakisan tanah. Persamaan Semakan Kehilangan Tanah Universal akan digunakan untuk mengira hakisan tanah dilakukan di kawasan itu. Nilai hakisan tanah yang dikira diklasifikasikan kepada lapan kelas mengikut standard Vietnam pada 1995 (TCVN 5299 - 1995). Peta hakisan tanah pekali K (K_2) kemudiannya akan dihasilkan berdasarkan kepada bacaan aras hakisan tanah yang diperolehi dan bacaan tersebut boleh didapati dalam julat 0.75-1.00. Pekali K yang ketiga pula ditakrifkan sebagai (K_3) bagi mengekstrak informasi dari peta pengurusan perhutanan serta memberikan nilai K berdasarkan produksi pengeluaran (K = 0.90) atau perlindungan (K = 0.95) hutan. Peta pekali keempat (K_4) ditakrifkan mengikut kesukaran perlindungan hutan. Empat kumpulan yang bertanggungjawab untuk melindungi hutan telah ditemuramah dan mereka membahagikan hutan kepada tiga peringkat dari peringkat biasa hingga ke peringkat yang sangat sukar dari segi perlindungan hutan berdasarkan kepada peta yang disediakan. Peta ini telah diimbas dan diberikan nilai K (0,90-1,00) bagi penghasilan peta K_4. Peta umum pekali K dibina melalui proses tindihan keempat-empat peta pekali K iaitu K_1, K_2, K_3 dan K_4

berdasarkan kepada dasar PES. Nilai K umum adalah dari 0.73-0.95. Nilai kos perkhidmatan alam sekitar hasil kiraan peta tersebut dikira melalui hasil daraban dengan harga satu hektar bernilai USD 20. Jumlah nilai perkhidmatan alam sekitar yang dikira adalah USD 15,729.60. Nilai hakisan tanah pekali K (K_2) yang dikira melibatkan beberapa faktor-faktor yang berkaitan dengan keadaan hutan supaya dapat menggantikan K_1 bagi proses pengiraan pekali K yang baru, maka nilai hutan masyarakat telah dikurangkan kepada USD 13,170.24. Kesimpulannya, peta pekali K menyediakan perkhidmatan alam sekitar untuk kawasan yang berbeza dan boleh digunakan untuk mengira nilai alam sekitar hutan masyarakat dan menyumbang kepada kaedah pembayaran program PES di Vietnam.

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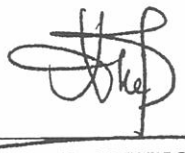
I certify that a Thesis Examination Committee has met on 30 November 2016 to conduct the final examination of Ho Dinh Bao on his thesis entitled "Determining K-coefficients Value in Payment for Environmental Services Program of Bu NDor's Community Forest, Dak Nong Province, Vietnam" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

Mohd Nazre bin Saleh @ Japri, PhD
Associate Professor
Faculty of Forestry
Universiti Putra Malaysia
(Chairman)

Zaiton binti Samdin, PhD
Associate Professor
Faculty of Forestry
Universiti Putra Malaysia
(Internal Examiner)

Mohd Nazip Suratman, PhD
Professor
Universiti Teknologi MARA
Malaysia
(External Examiner)



NOR AINI AB. SHUKOR, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 27 December 2016

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Awang Noor Abd. Ghani, PhD
Professor
Faculty of Forestry
Universiti Putra Malaysia
(Chairman)

Ahmad Ainuddin Nuruddin, PhD
Professor
Faculty of Forestry
Universiti Putra Malaysia
(Member)

Syamsul Herman Bin Muhammad Afandi, PhD
Senior Lecturer
Faculty of Forestry
Universiti Putra Malaysia
(Member)

ROBIAH BINTI YUNUS, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

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Signature: _____
Name of
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Supervisory
Committee: Prof. Dr. Awang Noor Abd. Ghani

Signature: _____
Name of
Member of
Supervisory
Committee: Prof. Dr. Ahmad Ainuddin Nuruddin

Signature: _____
Name of
Member of
Supervisory
Committee: Dr. Syamsul Herman b. Mohammad Afandi

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LIST OF ABBREVIATIONS

ACP	Agricultural Conservation Program
ARBCP	Asia Regional Biodiversity Conservation Program
ARS	Agricultural Research Service
BA	Basal area
BDS	Benefit Distribution System
CAA	Clean Air Act
CAFs	Cloud Affected Forests
CE	Choice Experiment
CDM	Clean Development Mechanism
CGIAR-CSI	The Consortium for Spatial Information
CNES	Centre National d'Etudes Spatiales
CO_2	Carbon dioxide
CRP	Conservation Reserve Program
CWA	Clean Water Act
DBH	Diameter at Breast Height
DEM	Digital elevation model
ENVI	Environment for Visualizing Image
EQIP	Environmental Quality Incentives Program
ES	Environmental Services
ESA	Environmentally Sensitive Areas
ETS	Emissions Trading Scheme
EU	Europe United
FAO	Food and Agriculture Organization
FLITCH	Forests for Livelihood Improvement in The Central Highlands
GHGs	Green House Gases
GPS	Global positioning System
HRG	High Resolution Geometry
HRS	High Resolution Stereoscopic
ICRAF	The World Agroforestry Center
IFAD	International Fund for Agricultural Development
IPES	International Payments for Ecosystem Services
MA	Millennium Ecosystem Assessment

MARD	Ministry of Agriculture and Rural Development
MES	Market for Environmental Services
NDVI	Normalized Difference Vegetation Index
NGO	Non-government Organization
OECD	The Organization for Economic Cooperation and Development
PES	Payment for Environmental Services
REDD	Reduced Emissions from Deforestation and Degradation
ROI	Region of Interest
RUPES	Rewarding Upland Poor for the Environmental Services
RUSLE	Revised Universal Soil Loss Equation
SNV	Netherlands Development Organization
SPOT	Satellite Pour l'Observation de la Terre
SWAT	Soil and Water Assessment Tool
SWIR	Short Wave Infrared
TC	Transaction Costs
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
USAID	US Agency for International Development
USD	US.Dollar
USLE	Universal Soil Loss Equation
UTM	Universal Transverse Mercator
VND	Vietnam currency
VNFF	Vietnam Forest Protection and Development Fund
WM	Weighting Matrix
WTA	Willingness to Accept
WTO	World Trade Organization
WTP	Willingness to Pay

CHAPTER 1

INTRODUCTION

1.1 General Background

Today, environmental problems are taking awareness by managers, policy makers and scientists both nationally and internationally. In recent decades, the world has been facing with a lot of extreme environmental and climate change events like the increasing of greenhouse gases (GHG), carbon dioxide (CO_2) in the atmosphere. Consequently, the global warming and climate change have resulted in more extreme weather phenomenon than before, for instance, more irregular and difficult to control flood and drought which have recently happened. Referring to these problems, sustainable forest resource management is one of the best methods to mitigate and adapt with climate change, extreme climate events in the national or global scope.

Forest resources include a variety of tangible and intangible values which were underestimated or nonmarket values. It is believed that human well-being and social development strongly depends on the forest resources, especially in the rural areas of the developing countries. Beside the timber, non-timber forest products, gene etc. the environmental services values such as watershed protection, carbon sequestration and landscape beauty services are to be paid attention by the society and market trade. From early 1990s a lot of Payment for environmental services (PES) programs have been implemented around the world as well as in Vietnam. The PES program in Vietnam was established in 2008 under the Decision No.380/QĐ-TTg by Prime Minister (Hoang and Do, 2011). According to this decision, the PES program set up two pilot projects in the North and Central Highland of the country. Following this decision, after two years implementing pilot projects, the government has implemented the PES program throughout the country under the Decree No.99 NĐ-CP in 2010 in order to solve the decreasing of forest area and forest quality as well as to alleviate rural community's poverty where the people's livelihood is depend on forest resources.

PES is a payment mechanism for environmental services that the forest provided to human. Through this mechanism, the users have to compensate for the forest owners in the upland who protect forest by which the services are supplied such as water regulation, soil protection, flood control, biodiversity protection and landscape beauty protection. In this mechanism, service providers are organizations, people or households who participated in forest protected activities or forest owners, and the users are who benefit from forest environmental services.

The environmental services that are compensated relate to many invisible values of the forest in which maintaining these functions include water regulation, landscape beauty, erosion and flood control are the 'key factor' which was called as K-coefficient in PES program (REDD Vietnam, 2015). According to Vietnamese PES policy, K-coefficient is defined based on the following factors: forest status, type of forest, origin of forest

and unfavorable and favorable conditions for forest protection (Hoang and Do, 2011). Because in different forest areas there are different forest type, status, canopy cover, forest origin, slope and so on. These factors contribute directly to water supply ability, soil protection, flood control, and landscape beauty in the watershed. Within the appropriate different characteristics of each forest area there is one unique K-coefficient corresponds with payment amount to ensure that the compensation is equitable and impulse the community or owners develop the forest quality to increase K-coefficient and get more income.

One of the most complicated issues in the world nowadays is forestry, especially in developing and poor countries. In that context, Vietnam is not an exception. To develop the economy, a huge amount of natural resources has been used including forest resources in the second half of 20th century. The forest cover in Vietnam has been decreased dramatically over the last 70 years. It declined from 43% of the country's area to 30% in 1985, and 28% in 1995 and then it was increased to 38% in 2009 (MARD, 2010). The increasing of forest cover in the last two decades was contributed by forest plantation, including rubber plantation. The decreasing of forest cover was not only caused by developing purposes but also by other reasons such as eradicated chemicals, fire, bomb, and so forth. In the war time, the large areas of Vietnam natural forest were eradicated by chemical, and bomb by the US Army. The estimation was about 104,909 ha of mangrove forests and about 3,000,000 ha of inland forests were eliminated (Nakamura, 2007).

In recent years, the forest area and forest quality have been decreased continuously. According to the Vietnam Administration of Forestry (2010) the diversity of the forest in the past was very dense with vast of high wood quality species with the average volume was about 200 – 300 m^3/ha (from 1945 – 1975). However, the condition of forest was not maintained well, until 1995 the forest remain was almost poor forest with the average volume was about 76m^3/ha. The decreasing of forest quality was caused by shifting cultivation, land use change, over logging etc. The forests have been cut down and replaced by agriculture and urban land, for example in the Central Highland of Vietnam alone there were 50,000 ha of forest had been changed to rubber plantation in the period from 2007 to 2011 and some areas were replaced by agriculture, settlement land for some hydropower dams plan (Hoang, 2011). The main keys that leaded to this state were claimed by the enforcement of government role such resettlement programs, migration and logging by state forest company. In addition, illegal logging is another severe issue as it has declined the forest quality in every type of forest including national parks and natural conservation reserves.

1.2 Problem Statement

In this context, assuring the sustainable use of the remaining forests has never been more crucial. In recent years, the government has tried to manage natural forest sustainably and some community forests has been allocated to the minority people whose ancestor had lived in the area long time ago. In which only Bu N'Dor community forest is the one that is more successful (Bao et al., 2013). However, in

terms of PES program, the community has just become a participant in the late 2013 and they did not sure what are the services that their forest can provide.

The effectiveness of policy decisions intended at protection and sustainable use of forest lands are excellent, therefore, reliable and applicable information to quantify and assess forest quality in terms of environmental services such as water regulation, soil protection, carbon sequestration, landscape beauty, etc. are important. Thus, a suitable of forests classification and forest cover map will provide a comprehensive and accurate view of the environmental value that related to type of vegetation cover, topography, soil and rainfall are important to help forestry managers make appropriate decisions in payment for forest managers and communities (Nguyen, 2009).

In addition, as it was presented, the forest cover and forest quality have changed from time to time and this will affect the services that the areas provided. This means that each forest area has different value in terms of environmental services value which related to the K-coefficients that are used for making a payment.

At present, in PES program, there are not any K-coefficients that are used to calculate the amount that the sellers could earn or the buyers have to pay for the services that they are benefit from in through the country in general and also in the Bu N'Dor community forest. Thus, it needs an appropriate method to define K-coefficients value and mapping it for each forest areas accurately, rapidly and comprehensively by simple forest factors that can be surveyed and assessed in the field as well as create a database system that can be updated so that it can be applied for the payment in PES program. Hence, the forest owner can look forward to protect and manage their forest in sustainable way as well as develop the area by forest enrichment, afforestation, etc.

Because the target of PES program is enhancing the forest management in the upland watershed and also improving the livelihood of the communities who live near the forest and usually they are poor people. In addition, in PES program, only the owners who have the right of the forest area can be paid for the services it provided. In this term community's forest is the only one kind of forest owners who have the right of forest land privately, not government organizations, and they are usually poor and unable to do technical process on determining the K-value of the area to make a payment clearly.

To find the solution to this problem, this research was conducted in order to provide some useful information on K-coefficient values of a community forest in Dak Nong province, Vietnam.

1.3 Objectives of the Study

The general objective of this thesis is defining a K-coefficient map which can be used for calculating the environmental services value of the Bu NDor's community forest, Dak Nong province, Vietnam. Accordingly, the specific objectives of the study were:

a) To determine the values of K-coefficient by forest status (K_1), essential soil erosion (K_2), forest managed purposes (K_3) and the difficulty of forest protection (K_4).
b) To establish the K-coefficient map distributed within the community forest.
c) To calculate the environmental services value of the community forest.
d) To suggest the new methods on determining K-coefficients value.

1.4 Organization of the Thesis

The thesis was organized into 5 chapters: Chapter 1 present the general background, problem statement and objectives of the study; Chapter 2 describes an overview and general basis of community forest, environmental services, payment for environmental services (PES), the historical and development of PES, using the k-coefficient to calculate the environmental services value, and the previous studies on PES. Additionally, a literature review using the Revised Universal Soil Loss Equation (RUSLE) was presented in the last part of the chapter.

The research method of this study are presented in Chapter 3. This chapter specifies data, software, and equipment used. General information about material, location, topography, geology and soil, climate, and a description of the forest situation were given. The methods used to process remote sensing, to develop a set of field data, to specify forest status using satellite data, and to produce K-coefficient maps were also provided in Chapter 3. Chapter 4 presents the results and discussion from combining satellite image, secondary data, field data and Geographic Information System (GIS) software (Envi, Arc GIS) to specify the differences of each forest area in the ability of providing environmental services via K-coefficient from that the environmental services value was calculated. Chapter 5 provides the conclusions of the study and highlights recommendations for further research.

REFERENCES

Armsworth, P. R., Chan, K., Chan, M. A., Daily, G. C., Kremen, C., Ricketts, T. H., & Sanjayan, M. A. (2007). Ecosystem-service science and the way forward for conservation. *Conservation Biology*, 21(6): 1383–1384.

Asquith, N.M., Vargas, M.T., & Wunder, S. (2008). Selling two environmental services: in-kind payments for bird habitat and watershed protection in Los Negros, Bolivia. *Ecological Economics*, 65: 675–684

Bao, H. (2012). *Xác định lượng CO_2 hấp thụ của rừng lá rộng thường xanh vùng tây nguyên làm cơ sở tham gia chương trình giảm thiểu khí phát thải từ suy thoái và mất rừng/Estimating Carbon sequestration ability of broadleaf ever green forest in Central Highland, a baseline for participating in Reducing emission from deforestation and forest degradation.* Hanoi: Ministry of Education and Training.

Bao, H. et al. (2013). *Phương án giao đất giao rừng cho cộng đồng dân cư Bon Bu NĐor, huyện Tuy Đức, Đăk Nông/Forest land allocated plan for Bu NDor community in Tuy Duc district, Daknong province, Vietnam*. Tuy Duc People's Committee.

Baylisa, K., Peplowb, S., Rausser, G., & Simon, L. (2008). Agri-environmental policies in the EU and United States: A comparison. *Ecological Economics*, 65(4): 753 – 764.

Bayon, R. (2004). *Making Environmental markets work: lessons from early experience with sulfur, carbon, wetlands, and other related markets*. Washington, D.C.: Forest Trends.

Bennett, M.T. (2008). China's sloping land conversion program: Institutional innovation or business as usual? *Ecological Economics*, 65: 699 – 711.

Chhatre, A., & Agrawal, A. (2009). Trade-offs and synergies between carbon storage and livelihoods from forest commons. *Proceedings of the National Academy of Science of the United States of America*, 106(42): 17667–17670.

Christie, M., & Rayment, M. (2012). An economic assessment of the ecosystem service benefits derived from the SSSI biodiversity conservation policy in England and Wales. *Ecosystem Services*, 1: 70-84.

Claassena, R., Cattaneo, A., & Johansson, R. (2008). Cost-effective design of agri-environmental payment programs: U.S. experience in theory and practice. *Ecological Economics*, 65: 737-752.

Corbera, E., Kosoy, N., & Tuna, M.M. (2007). Equity implications of marketing ecosystem services in protected areas and rural communities: Case studies from Meso-America. *Global Environmental Change—Human and Policy Dimensions*, 17: 365–380.

Costanza, R., d'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R. G., Suttonkk, P., & van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature,* 387: 253-260.

Costenbader, J. (2009). Legal Frameworks for REDD. Design and Implementation at the National Level. *IUCN Environmental Policy and Law Paper No. 77*.

Dam, V. B., Catacutan, D. C., & Hoang, M. H. (2014). Importance of National Policy and Local Interpretation in Designing Payment for Forest Environmental Services Scheme for the Ta Leng River Basin in Northeast Vietnam. *Environment and Natural Resources Research.* 4(1): 39 -53

De Jong, S. M. (1994). *Application of Reflective Remote Sensing for Land Degradation Studies in a Mediterranean Environment*. Utrecht: Netherlands Geographical Studies, University of Utrecht.

De Wit, M. (2012*).* Including the economic value of well-functioning urban ecosystems in financial decisions: Evidence from a process in Cape Town. *Ecosystem Services*, *2*: 38–44.

Derissen, S., & Latacz-Lohmann, U. (2013). What are PES? A review of definition and extension. *Ecosystem Services*, 6: 12-15.

Dobbs, T. L., & Pretty, J. (2008). Case study of agri-environmental payments: The United Kingdom. *Ecological Economics*, 65: 765-775.

Dudley, N., & Stolton, S. (2005). *The role of forest protected areas in supplying drinking water to the world's biggest cities*. Sacramento: California Institute of Public Affair.

Egoh, B. N., O'Farrell, P.J., Charef, A., Gurney, L.J., Koellner, T., Abi, H.N., Egoh, M., & Willemen, L. (2012). An African account of ecosystem service provision: Use, threats and policy options for sustainable livelihoods. *Ecosystem Services*, 2: 71-81.

Engel, S., Pagiola, S., & S. Wunder. 2008. Designing payments for environmental services in theory and practice – an overview of the issues. *Ecological Economics*, 65:663-674.

European Climate Exchange (2008). About ECX. European Climate Exchange. London. Retrieved on 20 July 2014 from http://www.ecx.eu/About-EXC.

Farley, J., & Costanza, R. (2010). Payments for ecosystem services: from local to global. *Ecological Economics*, 69: 2060–2068.

Frost, G.H.P., & Bond, I (2008). The CAMPFIRE program in Zimbabwe: Payments for wildlife services. *Ecological Economics*, 65: 776 – 787

Gómez-Baggethun, E., de Groot, R., Lomas, P. L., & Montes, C. (2010). The history of ecosystem services in economic theory and practice: from early notions to markets and payment schemes. *Ecological Economics*, 69a: 1209–1218.

Hall, A. (2008). Better RED than dead: paying the people for the environmental services in Amazonia. *Philosophical Transactions of the Royal Society Biological Sciences*, 363: 1925–1932.

Hauck, J., Görg, C., Varjopuro, R., Ratamäki, O., Maes, J., Wittmer, H., & Jax, K. (2013). Maps have an air of authority: Potential benefits and challenges of ecosystem service maps at different levels of decision making. *Ecosystem Services*, 4: 25-32.

Hoang, D. Q. (2011). Chuyển đổi rừng nghèo kiệt sang trồng cao su ở Tây Nguyên/Converting poor forest to rubber plantation in Central Highland of Vietnam. *Tạp chí Hội KHKT Lâm Nghiệp Việt Nam số 41 (2011)/Journal of Vietnam Forest Science and Technology Foundation* No.41/2011.

Hoang, M.H., Do, T.H., Pham, M.T., van Noordwijk, M., & Minang, P. (2011). Benefit distribution across scales to reduce emissions from deforestation and forest degradation (REDD+) in Vietnam. *Land Use Policy*, 31: 48-60.

Hoang, M. H., & Do, T. H. (2011). *Assessing the potential for, and designing a payment for environmental services scheme in Bac Can province, Vietnam*. Hanoi: World Agroforestry Centre (ICRAF).

Hoang, M. H. (2013). Importance and impacts of intermediary boundary organizations in facilitating payment for environmental services in Vietnam. *Environmental Conservation*, 37: 64-72.

Huang, M., Upadhyaya, S. K., Jindal, R., & Kerr, J. (2009). Payments for watershed services in Asia: a review of current initiatives. *Journal of Sustainable Forestry*, 28: 551-575.

Kari S., & Korhonen-Kurki, K. (2013). Framing local outcomes of biodiversity conservation through ecosystem services: A case study from Ranomafana, Madagascar. *Ecosystem Services*, 3: 32-39.

Karousakis, K., & Perry, E. (2013). *Payments for ecosystem services in biodiversity conservation.* World Social Science Report 2013, 485-486. ISSC, UNESCO.

Kubiszewski, I., Costanza, R., Dorji, L., Thoennes, P., & Tshering, K. (2013). An initial estimate of the value of ecosystem services in Bhutan. *Ecosystem Services*, 3: 11-21.

Landell-Mill, N., & Porras, I. T. (2002). *Silver's bullet or fool's gold? A global review of markets for forest environmental services and their impact on the poor*. London: International Institute for Environment and Development (IIED).

Lang, C. (2001). Deforestation in Vietnam, Laos and Cambodia. In: *Deforestation, Environment, and Sustainable Development: A Comparative Analysis.* Vajpeyi, D. K. (Ed.) 111-137. Westport, Connecticut and London: Praeger Publishers.

Le, H. T., Nguyen, D. L., Truong, P. M., & Nguyen, K. L. (2011). *Assessing soil erosion in Datam watershed, Lam Dong province using GIS technique.* Paper presented at the Vietnam GIS conference in 2011.

Madeira, E. (2009). REDD in design: Assessment of planned first-generation activities in Indonesia. *Discussion Paper—Resources for the Future (RFF)* 09–49: 1–16.

MacLellan, L. K., & Duinker, P. (2012). *Community forest – a discussion paper for Nova Scotians.* Halifax: Dalhousie University.

Mayrand K., & Paquin, M. (2004). *Payment for environmental services: A survey and assessment of current schemes.* Unisféra International Centre: For the Commission for Environmental Cooperation of North America, Montreal September 2004.

Mercer, E., Cooley, D., & Hamilto,n K. (2011). *Taking stock: Payment for ecosystem services in The United States*. Washington, D.C.: Forest Trends.

Moore, I.D., & Bruch, G.J. (1986). Physical basis of the length-slope factor in the universal soil loss equation. *Soil Science Society of America Journal*, 50(5): 1294 - 1298.

Muñoz-Piñaa,C., Guevarab, A., Torres, J.M., & Brañaa J. (2008.) Paying for the hydrological services of Mexico's forests: Analysis, negotiations and result. *Ecological Economics*, 65: 725 – 736.

Nakamura, G. (2007). Defoliation during the Vietnam War. In De Jong, W., Donovan, D., & Abe, K.I. (Eds.). Extreme conflict and tropical forests (pp. 149-158). Springer, Netherlands.

Nguyen, B.N., Nguyen, H.Q., & Kuester, E. (2005). Vietnam Community Forestry 2005. *Proceedings of a First Regional Community Forestry Forum held in Bangkok, Thailand – August 24-25, 2005.*

Nguyen, Q. T. (2011). Payment for environmental services in Vietnam: An analysis of the pilot project in Lam Dong province. *Institute for Global Environmental Strategies: Discussion Paper.*

Nguyen, T. B. T., Nguyen, T. C., Nguyen, T. P., Bonnardeaux, N. T., Cotterill, D., & Riedel, D. C. (2011). *Payment for environmental services: a case study on pilot implementation in Lam Dong province, Vietnam (2006-2010).* USAID and Winrock-International.

Nguyen, T. T. H. (2009). *Classification of broad-leaved evergreen forests based on multi-data forest inventory in the Central Highland of Vietnam.* Doctoral thesis, Albert Ludwig University of Freiburd, Germany.

Nguyen, T. Y. L. (2013). *Evaluating the pilot implementation of payment for environmental services in Lamdong, Vietnam*. WorldFish (ICLARM) - Economy and Environment Program for Southeast Asia (EEPSEA): Manila, The Philippines.

Nguyen, T.H. (1996). *Xác định các yếu tố gây xói mòn và khả năng dự báo xói mòn trên đất dốc Determining erosion factors and the ability to forecast erosion on slope land*. Doctoral thesis, Ha Noi Water Resources University.

Nguyen, T. P. (2008). *Chi trả dịch vụ môi trường rừng ở Việt Nam/Payment for environmental services in Vietnam*. Government Office, 2008.

Nguyen, T. X., & Thai, P. (1999). *Đất đồi núi Việt Nam thoái hóa và phục hồi/ Vietnam mountainous land: regression and recover*. *Agriculture Publishers*, 74 - 126.

Nguyen, V.T. et al (2010). *Biến đổi khí hậu và tác động ở Việt Nam/Climate change and the effects in Vietnam*. Hanoi: The Institute of Hydrology and Environment.

Pagiola, S., & Platais, G. (2007). Payments for environmental services: From theory to practice. *Ecological Economics*, 65(4): 663–675.

Palomo, I., & Martin-Lopez, B. (2013). National Parks, buffer zones and surrounding lands: Mapping ecosystem service flows. *Ecosystem Services*, 4: 104-116.

Paul, J. F. (2009): Regional review of payments for watershed services: Sub-Saharan Africa. *Journal of Sustainable Forestry*, 28: 525-550.

Pereira, S. (2010). Payment for environmental services in the Amazon forest: how can conservation and development be reconciled? *Journal of Environment & Development*, 19: 171–190.

Perrot-Maître, D. (2006). The Vittel payments for ecosystem services: a "perfect" PES case*? Project Paper No.3. IIED, London, UK*.

Peskett, L., Schreckenberg, K., & Brown, K. (2011). Institutional approaches for carbon financing in the forest sector: learning lessons for REDD from forest carbon projects in Uganda. *Environmental Science and Policy*, 14: 216–229.

Pham, M. T., Phung, V. K., Enright, A., Nguyen, T.T, & Nguyen, T.B.S. (2012). *Final report on A Pilot of Establishment of R-coefficients for REDD+ Benefit Distribution in Di Linh District, Lam Dong Province, Vietnam.* UN-REDD program report.

Pham, V.D., & Phung, V.K. (2013). Xây dựng bản đồ hệ số K phục vụ chi trả dịch vụ môi trường trong lưu vực/ Building K-coefficient maps for payment for environmental services in the watershed. *Tạp chí khoa học lâm nghiệp/Journal of Forest Science*, 2: 2753 – 2763.

Pham, T.T., Bennett, K., Vu, T.P., Brunner, J., Le, N.D., & Nguyen, D.T. (2013). *Payments for forest environmental services in Vietnam: From policy to practice.* Brief No. 22. Bogor, Indonesia: CIFOR.

Pham, X. P., (2008). *Tổng quan về chính sách giao đất giao rừng tại Việt Nam, thực trạng và định hướng trong thời gian tới/ The overview of land and forest allocated policy in Vietnam, the situation and direction in the future.* Hanoi – 2008.

Rojahn, A., & Engel, S. (2005). *Direct payments for biodiversity conservation, watershed protection and carbon sequestration: contract theory and empirical evidence*. Institute for Environmental Decisions, Chair of Environmental Policy and Economics. ETH, Zurich.

RUSLE online soil erosion assessment tool. Retrieved on 10 December 2014 from www.iwr.msu.edu/rusle.html.

Saenz, L., & Mulligan, M. (2013). The role of cloud affected forests (CAFs) on water inputs to dams. *Ecosystem Services,* 5: 69-77.

Scattler, C., & Matzdorf, B. (2013). PES in a nutshell: From definitions and origins to PES in practice—Approaches, design process and innovative aspects. *Ecosystem Services,* 6: 2-11.

Scherr, S.J.,White, A., & Khare, A. (2004). *For services rendered: The current status and future potential of markets for the ecosystem services provided by tropical forests.* ITTO Technical Series No. 21..

Scherr, S. J., Bennett, M. T., Loughney, M., & Canby, K. (2006). *Developing future ecosystem service payments in China: Lessons learned from international experience.* Forest Trend: Washington D.C.

Schomers, S., & Matzdorf, B. (2013). Payments for ecosystem services: a review and comparison of developing and industrialized countries. *Ecosystem Services,* 6: 16-30.

Schumacher, E.F. (1973). *Small is beautiful: Economics as if people mattered*. London: Blond and Briggs.

Sikor, T., Gritten, D., Atkinson, J., Bao, H., Dahal, G.R., Duangsathaporn, K., Hurahura, F., Phanvilay, K., Maryudi, A.. Pulhin, J., Ramirez, M.A., Win, S., Vaz, S.T.W., Sokchea, T., Marona, S., & Zhao, Y. (2013). *Community forestry in Asia and the Pacific-Pathway to inclusive development*. Bangkok: RECOFTC – The Center for People and Forests.

Skutsch, M., Vickers, B., Georgiadou, Y., & McCall, M. (2011). Alternative models for carbon payments to communities under REDD: a comparison using the Polis model of actor inducements. *Environment Science and Policy*, 14: 140–151.

Southgate, D., & Wunder, S. (2009): Paying for Watershed Services in Latin America: A Review of Current Initiatives. *Journal of Sustainable Forestry*, 28: 497-524.

Suhardiman, D., Wichelns, D., Lestrelin, G., & Chu, T. H. (2013). Payments for ecosystem services in Vietnam: market-based incentives or state control of resources? *Ecosystem Services*, 6: 64 - 71.

The situation of land use, forest policy and governance in Viet Nam (2015). REDD Vietnam.

Tomich, T.P., Thomas, D.E., & Noordwijk, M.V. (2004*).* Environmental services and land use change in Southeast Asia: from recognition to regulation or reward? *Agriculture Ecosystems and Environment*, 104: 229 – 244.

Tran, Q. V., Dang, H. V., & Dao, C. T. (2011). Application of remote sensing and geographic information system in evaluating soil erosion. A Case study in Tam Nong district, Phu Tho province, Vietnam. *Science and Development Journal*, 9 (5): 823 -833.

Turpiea, J.K., Maraisb, C., & Blignaut, J.N. (2008). The working for water programme: Evolution of a payments for ecosystem services mechanism that addresses both poverty and ecosystem service delivery in South Africa. *Ecosystem Services*, 65: 788 – 798.

Ullman, D., Halsey, K., & Goldfinger, C. (2013*). Managing Eco-system services decisions*. BASS system white paper, 12p.

United Nations Environment Program (UNEP). (2005). *Millennium Ecosystem Assessment.* Washington, DC: Island Press, 2005.

Vietnam Government (2010). Decree N. 99/2010/ND-CP On the policy of payment for forest environment services. *Ministry of Agriculture and Rural Development.*

Vuong, V. Q. (2010). Nghiên cứu xác định hệ số hiệu chỉnh mức chi trả dịch vụ môi trường tại tỉnh Daklak, Vietnam/Research on determining coefficient that adjust environmental services payment in Daklak province, Vietnam. Retrieved on May, 20th 2014 from: https://miennui.wordpress.com

Wertz-Kanounnikoff, S., Kongphan-Apirak, M., & Wunder, S. (2008). *Reducing forest emissions in the Amazon Basin: A review of drivers of land-use change and how payments for environmental services (PES) schemes can affect them*. Bogor, Indonesia: CIFOR Working Paper 40.

Westman, W. (1977). How much are nature's services worth? *Science*, 197: 960-964.

Willemen, L., & Drakou E. G., (2013). Safeguarding ecosystem services and livelihoods: Understanding the impact of conservation strategies on benefit flows to society. *Ecosystem Services*, 4: 95-103.

Wischmeier, W.H., & Smith, D.D. (1978). *Predicting rainfall erosion losses: A guide to conservation planning*. USDA – Agriculture Handbook No. 537, Washington DC, US government Printing Office.

Wunder, S. (2005). *Payment for environmental services: Some nuts and bolts.* Bogor, Indonesia: CIFOR Occasional Paper 42.

Wunder, S. (2008). Necessary conditions for ecosystem service payments. Paper Presented at the Economics and Conservation in the Tropic: A strategic dialogue. San Francisco, 2008.

Wilkins, F. G. (2005). Structure of Compounds. Paper presented at the meeting of the Canadian Chemical Association, Ontario. June 2005.

Zhangwei, G. et al (2001). Ecosystem functions, services and their values – a case study in Xingshan County of China. *Ecological Economics*, 38(1): 141 – 154.

BIODATA OF STUDENT

Ho Dinh Bao was born on September 16th 1983 in Dak Lak province, Vietnam. He received his secondary education at Hoa Le Secondary School and his higher secondary education at Krong Bong High School, Krong Bong district. He gained his undergraduate degree in 2008 majored in Forest Resources and Environment Management from Tay Nguyen University in Buon Ma Thuot city, Vietnam. He started his Master program on Forest Management and Conservation, Faculty of Forestry in September 2012. In 2011, he married to Ms. Nguyen Thi Tuyet Nhung. Since October 2010, he has been employed as a lecturer of Department of Forest Resources and Environment Management, Tay Nguyen University, Vietnam. He participated the first International Forestry Students Conference held by Faculty of Forestry, Universiti Putra Malaysia in 2013; Participated the 11th Regional Training Course on Wetland Ecology and Management in the Mekong Basin held by Mahasarakham University, Thailand 2014; Participated the training course on Land use planning and low emission scenario analysis held by USAID, Lam Dong, Vietnam 2014; Participated in the training workshop on Earth Observation for water resources management held by The University of Technology of Ho Chi minh city, Vietnam 2015.

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