



# International Joint Laboratory Impacts of rapid Land Use change on Soil Ecosystem Services (LUSES)

**ACTIVITY REPORT**  
June 2017 to June 2018





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### Project title Impacts of rapid Land Use change on Soil Ecosystem Services (LUSES)

#### 1. Executive summary

Following formal approval by the CEO of IRD, Pr Jean-Paul Moatti on 3 February 2017, the second phase of the International Joint Laboratory (IJL<sup>1</sup>) LUSES effectively started in June 2017, under the joint coordination of Dr Nivong Sipaseuth, Deputy Director General of the Department of Agricultural Land Management (DALaM), Vientiane Laos, and Dr Alain Pierret, Institute of Ecology and Environmental Sciences of Paris (iEES-Paris), research scientist with the Institut de Recherche pour le Développement (IRD).

The current LUSES project corresponds to the consolidation of an initial 5-year phase (from June 2012 to June 2016) that has been jointly coordinated by Mrs Nopmanee Suvannang (then director of the Soil Analysis Technical Section, Office of Science for Land Development, Land Development Department (LDD), Bangkok, Thailand) and Dr Alain Brauman (Eco&Sols), research scientist with the Institut de Recherche pour le Développement (IRD) then posted at LDD.

This initial 5-years phase demonstrated successful regional collaboration across three Southeast Asian countries, namely Laos, Thailand and Vietnam, resulting in synergies in approaches, particularly through the establishment of the SEALNET quality assurance network for soil analyses (which has captured the interest of ASPAC, FAO) and enhanced local research capacity (including 9 PhD that will now be completed within months). The first phase of LUSES also demonstrated the interest of drawing upon long-term observatories of the environment, such as the MSEC/M-Tropics Critical Zone observatory to further strengthening the relevance of impact assessment of land use changes.

Comments from the evaluation committee of the first phase of the LUSES indicated that no direct synergies had been established between research themes. With the start of the second phase of LUSES, efforts have been deployed to try to improve this point with the launching of new initiatives such as the SoilBag activity which established a link between OMM and ECOFILTER and which, through the replication of a single field experimental at sites chosen to conduct other LUSES activities, also potentially represents a means for LUSES participants to develop more common research interests.

While the first phase of LUSES strongly focused on rubber tree plantation agroecosystems, the evaluation committee also indicated that it was important to consider new cropping systems. With the work undertaken over the last past year on the impact of cultivation practices on soil functioning in coffee plantations, in particular by new LUSES partners from the Faculty of Agriculture of Chiang Mai University (CMU), Thailand, LUSES has moved a big step forward towards addressing this recommendation. Through the continued collaboration between LUSES and M-Tropics (previously known as MSEC), new research on heavy metal concentration in soil and water invertebrate has been initiated with a new Vietnamese partner institution, the University of Science and Technology of Hanoi.

SEALNET has continued to develop and was officially extended to Asian Soil Partnership member countries of the FAO (ASP-FAO) which led to the election of Mrs Nopmanee Suvannang, co-PI of SEALNET, as Chair of the FAO's Global Soil Laboratory Network (GLOSOLAN).

Financially, LUSES has maintained a level of co-funding of roughly 80% over the years 2016 and 2017, which is undoubtedly the sign of a now well-established and appreciated scientific stature.

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<sup>1</sup> IJL is the translation of the French acronym LMI for Laboratoire Mixte International

## 2. Objectives of LUSES

LUSES involving Southeast Asian and French member institutions that share a common research interest in understanding co-evolving social and agricultural systems and their environmental impacts, particularly on soil ecosystems. Therefore, LUSES aims to foster regional and international scientific collaborations and build capacity in fields related to the impact of land use change on soil-related ecological services. The knowledge and capacity generated through LUSES is expected to assist with the sustainable management of the region's constantly mutating agro-ecosystems.

## 3. Partnership and governance

### Name and contact detail of project coordinators

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### Partners and research teams involved

#### Academic Institutions

*Lao PDR* - The Faculty of Agriculture of the National University of Laos (NUoL);  
*Thailand*: The Faculty of Agriculture of the Khon Kaen University (KKU); The Faculty of Agriculture of the Kasetsart University (KU); The Faculty of Agriculture, Chiang Mai University (CMU);  
*Vietnam* - Vietnamese Academy of Science and Technology (VAST): Institute of Chemistry (ICH) and Université des sciences et des technologies de Hanoi (USTH).

#### Research Institutions

*Lao PDR* - Department of Agricultural Land Management (DALaM);  
*Thailand* - Land Development Department (LDD);  
*Vietnam* - Soils and Fertilizers Research Institute (SFRI).  
*France*: Eco&Sols - Functional Ecology and Biogeochemistry of Soils and Agrosystems; GET - Geosciences Environment Toulouse; iEES-Paris - Institute of Ecology and Environmental Sciences;

Collaborations with:

CIRAD Partnership Devices HRPP and CANSEA;  
CGIAR centres, notably IWMI in Laos and CIAT in Vietnam,  
Universities of Hohenheim, Germany; Louvain La Neuve, Belgium; Basel, Switzerland; Oxford, UK.  
Lao Oxford-Mahosot Hopital -Wellcome Trust Research Unit, Vientiane, Laos



## 4. Scientific structure - Research activities and main results and achievements

### Thematic priorities

Land use and land use change; soil ecosystem services; co-evolving social and agricultural systems

### Topic(s)

Soil science; hydro-geochemistry; hydrology; soil ecology; soil microbiology; soil physics; soil erosion; biogeochemical cycles; aquatic microbiology and ecology; agronomy; plant ecophysiology; plant ecology; human geography; political ecology; environmental health.

### **BIODIV-TREE: Impact of tree plantations on soil functioning (co-leaders: Dr. Supat Isarangkool (KKU), Dr. Alain Brauman (IRD))**

- **Impact of land conversion to rubber plantation on turnover of soil organic carbon** (PI Dr Pruksa Lawongsa, faculty of Agriculture, Khon Kaen University, Thailand). coll. UMR Eco&Sols, Montpellier France (co-PI Dr Alain Brauman); University of Hohenheim, Germany.

Aim: to assess the impact of rubber tree plantations on soil organic matter dynamics and soil C sequestration, a major soil ecosystem service.

Results / achievements: ongoing measurements of rates of CO<sub>2</sub> emissions from soil along rubber plantation chronosequence and reference arable land; identification of the source pools of decomposition using <sup>13</sup>C isotope abundance analysis; assessment of the rate of carbon accumulation and contribution of new carbon input to SOC after land use change from arable land to rubber plantation.

- **Soil Properties and Plant Diversity as Influenced by Different Coffee Production Systems** (PI Dr. Choochad Santasup, Department of Plant and Soil Science, Faculty of Agriculture, Chiang Mai University, Thailand). Coll. with CIRAD, UMR Eco&Sols, Montpellier, France; CIAT-Asia, Hanoi, Vietnam (co-PI Dr Didier Lesueur).

Aim: To determine indicators of ecosystem functioning, namely soil properties and plant diversity, in conventional and organic coffee agro-systems of the highlands of Northern Thailand, an area that has been subject to rapid change in agricultural practices since the 1980s, from intensive cultivation with high input of agro-chemicals, which resulted in severe soil degradation, yield decline and serious environmental problems, to more environment-friendly and sustainable practices.

Results / achievements: chosen indicators of coffee agro-system functioning (soil chemical properties: pH, EC, OM, P, K, Ca, Mg; soil physical properties: texture, bulk density, aggregate stability, porosity, water infiltrability; N, P, K content of fruit; plant communities; C stocks; surface water quality; soil microbial properties: bacteria, actinomycetes, fungi, arbuscular mycorrhizal fungi infection of coffee plant roots) functioning have been successfully measured at five locations corresponding to conventional, organic and natural farming systems.

### **ECOFILTER: Effect of land use on stream-ground water interactions in the critical zone of tropical agrosystems (co-leaders: Mr. Oloth Sengtaheuanghoung (DALaM); Dr. Olivier Ribolzi (IRD))**

- **Heavy metal concentration in different earthworm species in soil and mollusc species in water compartments in the Dong Cao catchment** (PI Dr. Mai Huong, Water, Environment and Oceanography Department, University of Science and Technology of Hanoi). Co-funding from the Hoa Lac project of USTH. coll. with M-Tropics partners.

Aim: To assess the heavy metal accumulation through bioindicators such as earthworm species for soil and

mollusc species for water bodies in the downhill of Dong Cao catchments. Such bioindicators of heavy metal pollution can reduce the need for complex / expensive chemical analysis.

Results / achievements: Collection of soil, sediment, worm cast, root, litter and water samples completed at 3 sites in the Dong Cao catchment for analysis of concentrations in 10 heavy metals, namely toxic heavy metals: As, Cd, Pb, Hg, Cr and essential heavy metals: Se, Ni, Cu, Zn, Mo.

**- Interactions between land use, morpho-pedological features and the occurrence of the pathogenic bacterium *Burkholderia pseudomallei*** (PI Dr Alain Pierret, iEES-Paris, posted at DALaM, Laos), coll. with DALaM, Laos; GET, Toulouse, France; Lao-Oxford-Mahosot Hospital-Wellcome Trust Research Unit (LOMWRU), Laos (co-PI Dr Sayaphet Rattanavong); Department of Environmental Sciences, University of Basel, Basel, Switzerland; 2. Centre for Tropical Medicine and Global Health, Nuffield Department of Medicine, Old Road Campus, University of Oxford, Oxford, England, UK; Faculty of Infectious and Tropical Diseases, London School of Hygiene and Tropical Medicine, London, UK.

Aim: the environmental previous studies have shown that rice fields are an anthropogenic factor that potentially amplifies the risk of contamination by *B. pseudomallei*. This research activity therefore focuses on an irrigated paddy area where *B. pseudomallei* is known to be present. A first axis of the work aims to characterize the local distribution of *B. pseudomallei* according to soil structural features. In addition, we this work also analyses seasonal variations associated with soil water saturation (resulting from the infiltration of rainwater and the variations of the water table in the plain of the Mekong), with the aim of documenting the seasonal variations of the soil physico-chemical conditions at the soil profile scale and relate them to the presence and abundance of *B. pseudomallei*.

Results / achievements: a field monitoring station has been established in may 2018 in an irrigated paddy area of the Vientiane plain, Phonhong District, where the presence of *B. pseudomallei* has been first identified in 1995. Preliminary results indicate confirmed the presence of *B. pseudomallei* in both water and soil and a possible association of the organism with soil redoximorphic features.

**- Siltation estimation of the Maethang reservoir, Phrae province, North Thailand** (PI Dr Jean-Louis Janeau, iEES-Paris, posted at LDD, Bangkok, Thailand), coll. with LDD, Department of National Parks (DNP) of Thailand and M-Tropics CZO; GET, Toulouse, France.

Aim: since 1998, the M-Tropics Critical Zone Observatory (CZO) (<https://mtropics-fr.obs-mip.fr/>), monitors the impact of land use on the hydro-sedimentary response of 3 montane catchment of Northern Laos, Thailand and Vietnam. In Thailand, the Huai Ma Nai catchment has been used for intensive and mechanized maize production for more than 15 years, which has led to severe soil degradation with strong negative externalities both on- and off-site. In 2004, a first survey of the siltation of the Maethang reservoir located downstream of the catchment's outlet revealed that one extreme rainfall events could explain nearly half of the sediment delivery of a 12-year period. The objective of this work is to conduct a similar siltation survey of the Maethang reservoir to further document the long-term off-site impact of land use in the Huai Ma Nai catchment.

Results / achievements: a campaign of siltation estimation of the Maethang reservoir was conducted in November 2017. Bathymetric data of the reservoir were obtained using an echo sonar coupled with a GPS, to estimate the volume of sediment deposited during the last 13 years. in February 2018, sediment samples have been collected from the bottom of the Maethang reservoir. Particle size distribution and concentration of five metals (Cd, Pb, Cr, Cu, and Mn) will be determined for these samples

## **OMM: Organic Matter Management (co-leaders: Dr. Thuy Thu Doan (SFRI); Dr. Nicolas Bottinelli (IRD))**

**- Optimal pig liquid waste vermifiltration treatment impacts to quality water and earth worm growth under tropical condition.** (PI: Dr Doan Thu Thuy, Soils and Fertilizers Research Institute, Ha Noi, Viet Nam); coll. with University of Science and Technology of HaNoi (USTH); VietNam University of Agriculture (VNUA); University of Water Resource Management (TLU); Khon Kaen University, Thailand (KKU); INRA (Rennes, France).

Aim: to improve the understanding of the pig liquid waste vermifiltration system, its advantages and limits in Vietnamese context (tropical condition) through the establishment of pilot studies in household and pig farm contexts.

Results / achievements: first pilot study established at SFRI; chemical analysis at SFRI started; meetings with potential stakeholders for further applying this system via agro-ecology training/capacity building activities of CISDOMA's ongoing project.

**- Impact of organic matter addition on soil engineers' activity, biopore dynamics and soil water dynamics across contrasting pedoclimatic conditions (SoilBag)** (PI Dr. Nicolas Bottinelli, iEES-Paris, posted at SFRI, Hanoi, Vietnam) coll. with SFRI, Vietnam; LDD Khon Kaen, Thailand; DALaM, Laos; University of Kottayam, India; IRA, Tunisia; INRA, Avignon, France; Université de Tour, France.

Aim: The variability of water transfers in the upper the Critical Zone are for part regulated by the activity of soil engineers (macrofauna and roots), climate and human activities. The objective of "SoilBag" is to address, using a single field experimental scheme applied across several sites among which feature sites chosen to conduct other LUSES activities, the question the functional role of soil biodiversity in the regulation of soil hydraulic properties as well as the influence of surface organic matter on biopore dynamics.

Results / achievements: the "SoilBag" experiment has been started at 6 field sites (two in Thailand, one in Vietnam, one in Laos, one in India and one in Tunisia). First results come from Vietnam, where columns have been incubated for 3 months already. The abundance of biopores was twice higher in presence of buffalo dung as compared with columns without organic residue.

## **SEALNET - South East Asia Laboratory Network (co-leaders: Mrs Nopmanee Suvannang, Chair of Global Soil Laboratory Network (GLOSOLAN/FAO); Dr. Christian Hartmann (IRD))**

The South East Asia Laboratory Network (SEALNET) is lead jointly by Mrs Nopmanee Suvannang, Chair of Global Soil Laboratory Network (GLOSOLAN), Global Soil Partnership (GSP), FAO and Dr Christian Hartmann, iEES-Paris, France. SEALNET includes 17 laboratories in the 5 countries: Soil analysis laboratory of Land Development department (LDD), Thailand; Department of Agricultural Land Management, DALAM, Lao PDR; Soil and Fertilizer Research Institute, SFRI, Vietnam; Testing Laboratory of Indonesian Soil Research Institute, ISRI Indonesia; IRD Senegal.

Aim: One of LUSES's central objectives is to assess the impacts of land use change on soil ecosystem services, through, among other measurements, soil chemical analysis. To ensure sound scientific conclusions, it is obviously necessary that all laboratories involved in LUSES research provide reliable, traceable analyses according to international standards. This effort is the main purpose of SEALNET.

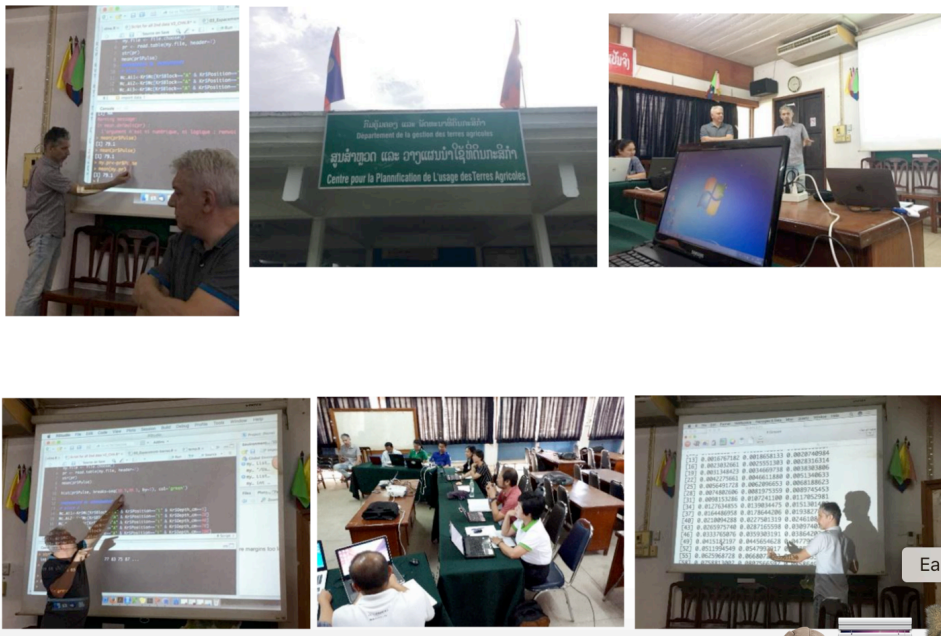
Results / achievements: SEALNET was officially extended to Asian Soil Partnership member countries of the FAO (ASP-FAO) on the occasion of an international meeting to which 17 ASP countries participated; SEALNET activities were showcased as an example for the forthcoming RESOLAN (Regional Soil Laboratory Network) and GLOSOLAN (Global Soil Laboratory Network) activities and strategies; Mrs Nopmanee Suvannang, PI of SEALNET, was elected Chair of the Global Soil Laboratory Network (GLOSOLAN).

## **5. Training activities and main results**

- A BIOFUNCTOOL training was organized in Laos from 30th October to 4th of November 2017 in collaboration with the National Agriculture and Forestry Research Institute (NAFRI) and the FIRST Project (CANSEA-ACTAE). BIOFUNCTOOL is a field package to assess the impact of agricultural practices on soil functioning. "Biofunctool®" includes 9 cost and time-effective tools to assess 13 soil functions. This training, animated by Pascal Lienhard (CIRAD), Alexis Thomazeau (PhD candidate CIRAD-IRD), Phantip Panklang (PhD candidate, LDD) and Alain Brauman (IRD), involved 13 participants from DALaM, DAFO and NAFRI (Laos), 4 participants from Kasetsart University, Chiang Mai University, Naresuan University and LDD (Thailand).



- A practical workshop on “Statistical analysis of agronomical experiments using R” was organized at the Department of Agricultural Land Management (DALaM), Vientiane, Lao PDR, from 9 to 11 October 2017. The workshop was animated by Drs. Alain Pierret and Christian Hartmann (IRD). The objective of this workshop was to go through the basic concepts of ANOVA and examine how to apply them to real data sets. The workshop informed the principles of statistics and the R program and how to use it for statistics. The course covered the practical issues in statistical computing by programming in R with experimental datasets from participants. The workshop was attended by 11 participants, including 4 from DALaM, NUoL, IRD (Laos); 1 from SFRI (Vietnam) and 6 from LDD, CMU, IRD (Thailand).

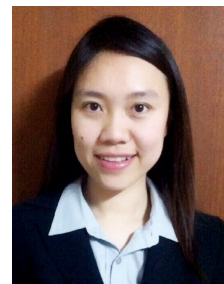




- Through LUSES - SEALNET's initiative the first lab managers meeting was organized in Bogor, Indonesia, from 20 to 25 November, 2017 where it was hosted and co-funded by IAARD. This meeting's objectives were to: 1. start defining calibration and harmonizing soil testing procedures and practices in reference laboratories in ASP countries; and 2. set up a regional inter-laboratory proficiency program to implement QA/QC procedures and processes. Expected outcomes were to: - decide some SOPs; - decide priorities of GLP to have quick impact on lab quality (precision); - launch INTERLAB COMPARISON (accuracy); - start implementing error measurement; - make decisions about safety priorities. 40 participants from 17 Asian countries participated in the meeting.



- as part of the Junior Research Fellowship Program 2018 of the Service of Cooperation and Cultural Action (SCAC) of the French Embassy in Thailand, Dr Fapailin Chaiwan, Division of Soil Science, Department of Plant and Soil Science, Faculty of Agriculture, Chiang Mai University, was granted a 3-month scholarship to conduct postdoctoral research at iEES-Paris on research on the fate of organic matter in interaction with the soil physical environment taking into account the role of the microbial decomposers that regulate its persistence.

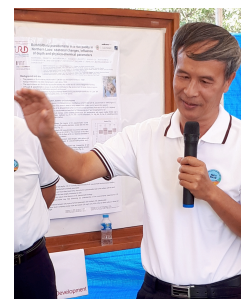


## 6. Expertise and results dissemination

- A Special Seminar “Soil Quality: The new vision of an old concept” was given by Dr. Alain Brauman at the Faculty of Agriculture of Chiang Mai University, on November 20, 2017. Around 40 participants attended this seminar.



- Mr Oloth Sengtaheuanghoung, DALaM, Laos, was invited by the organizers of the the FAO Global Symposium on Soil Pollution, FAO headquarters, Rome, Italy, 2-4 May 2018 (GSOP18), to present the main results of the ECOFILTER research on the impacts of land use change on the interactions between land use, fluxes of water and sediments, and the spread of bacterial contaminants in the uplands of northern Lao PDR. This invitation was an excellent opportunity to showcase some of the word-class science conducted within the framework of LUSES.



## 7. Financial summary of LUSES for years 2016 and 2017

With contributions from LUSES partner institutions of the order of 50 k€ in both 2016 and 2017 and external co-funding of 108 and 125 k€ in 2016 and 2017, respectively, LUSES co-funding had, in both years, a level of approx. 80% of its total annual budget with nearly 60% of this co-funding corresponding to external sources (i.e. excluding contribution LUSES partner institutions). This indicates that the financial momentum gained during the first phase of LUSES is likely sustainable, as a result of the scientific recognition that the International Joint Laboratory has gained and consolidated over years.

	2016	2017
<b>Tutelles du LMI</b>		
IRD (dotation LMI)	37,400 €	40,000 €
IRD (autres crédits)	2,500 €	2,500 €
	13,000 €	1,550 €
	1,000 €	1,000 €
	1,500 €	1,000 €
DALAM-CANSEA-ACTAE (FIRST)	14,000 €	13,000 €
SFRI (pour SEALNET)	5,000 €	
SFRI (1 site pour OMM)	3,000 €	3,000 €
LDD (2 sites pour OMM)	6,000 €	6,000 €
NUOL (1 site pour OMM)	3,000 €	3,000 €
DALAM-NUoL-CANSEA-ACTAE (STOCK)		2,200 €
LDD, Thaïlande	8,000 €	11,000 €
USTH, Thaïlande		1,700 €
KKU, Thaïlande		1,500 €
Eco&Sols (CIRAD)		2,000 €
<b>TOTAL</b>	<b>94,400 €</b>	<b>89,450 €</b>
<b>Financements extérieurs</b>		
ANR TecitEasy	6,000 €	6,000 €
FAO (pour SEALNET)		25,000 €
IAARD (Indonesian Agency for Agricultural Research and Development)(pour SEALNET)		15,000 €
ANR HévéAdapt (Eco&Sols-CRHYD_Hevea)	2,500 €	2,500 €
IFC convention Eco&Sols - CRHYD_Hevea	29,500 €	21,000 €
ANR HévéAdapt (part iEES-Paris)	35,000 €	26,000 €
AO RBV (INSU)	5,000 €	
ENS (These M. Neyret)	30,000 €	30,000 €
<b>TOTAL</b>	<b>108,000 €</b>	<b>125,500 €</b>



## 8. Recent scientific production of LUSES

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- Lawongsa, P., Puttaso, P. and Kaewjampa, N. (2016). Microbial and physical-chemical properties as influenced by land use change in the conversion of cassava into rubber tree plantation system. *KKU Research Journal*. 21(3): 36-43.