# ວາລະສານ

ສັງລວມບົດຄົ້ນຄວ້າວິທະຍາສາດ ຄູອາຈານ
ຄະນະວິທະຍາສາດປ່າໄມ້

ສະບັບທີ 2
ມັງກອນ 2020

# ຄຳນຳ

ວາລະສານ ສະບັບນີ້ສ້າງຂຶ້ນເພື່ອສັງລວມການຄົ້ນຄວ້າວິທະຍາສາດຂອງຄູອາຈານ ຄປມ ເພື່ອເຜີຍແຜ່ຜົນງານການການຄົ້ນຄ້ວາທີ່ກ່ຽວຂ້ອງກັບວຽກງານປ່າໄມ້, ທີ່ດິນ ແລະ ສິ່ງແວດລ້ອມ ພ້ອມກັນນັ້ນຍັງເພື່ອເປັນການເອກອ້າງຜົນງານ ແລະ ທັງເປັນເວທີສຳລັບແລກປ່ຽນຂໍ້ຄິດເຫັນ ລະຫວ່າງນັກຄົ້ນຄ້ວາ, ຜູ້ອ່ານ, ແລະ ນັກວາງແຜນ ທີ່ຈະເປັນປະໂຫຍດໃຫ້ແກ່ການພັດທະນາ, ການນຳໃຊ້ຊັບພະຍາກອນ ລວມໄປເຖິງການຈັດການຄຸ້ມຄອງໃຫ້ເກີດມີຄວາມຍືນຍົງ ບໍ່ວ່າຈະເປັນທັງພາຍໃນຊຸມຊົນ ກໍ່ຄືປະເທດຊາດ.

ການປ່ຽນແປງຂອງສະພາບດິນຟ້າອາກາດໃນປະຈຸບັນນີ້ມີທ່າອ່ຽງເພີ້ມຂຶ້ນຢ່າງຕໍ່ເນື່ອງ ສາຍເຫດສ່ວນໜຶ່ງແມ່ນເກີດມາຈາກກິດຈະກຳການພັດທະນາ ເຊິ່ງເຮັດໃຫ້ມີຜົນກະທົບທາງລົບ ບໍ່ວ່າຈະເປັນຊັບພະຍາກອນເທິງໜ້າດິນ ແລະ ໃຕ້ດິນ, ພື້ນຖານໂຄງລ່າງ ເຊິ່ງກໍ່ໃຫ້ເກີດຂໍ້ຂັດແຍ່ງຕ່າງໆ. ສະນັ້ນ, ການຮວບຮວມວາລະສານນີ້ແມ່ນເປັນການສ້າງເງື່ອນໄຂໃຫ້ແກ່ຜູ້ອ່ານມາດສາດເຂົ້າເຖິງຜົນງານການຄົ້ນຄວ້າ ທີ່ລວມທັງການນຳໃຊ້ເຕັກນິກ ແລະ ເຕັກໂນໂລຊີທີ່ທັນສະໄໝ, ເຊິ່ງຈະເປັນໂຕຊ່ວຍໃນວາງແຜນ ເພື່ອແກ້ໄຂບັນຫາຕ່າງໆທີ່ເກີດຂຶ້ນ, ພ້ອມທັງເປັນຂໍ້ມູນສະໜອງໃຫ້ແກ່ວຽກງານການຄົ້ນຄ້ວາ, ການສຶກສາ ຈົນເຖິງຕອບສະໜອງຂໍ້ມູນໃຫ້ແກ່ລັດຖະບານໃນການວາງຍຸດທະສາດ ແລະ ນະໂຍບາຍອື່ນໆໄດ້.

ຫວັງຢ່າງຍິ່ງວ່າ ວາລະສານ ສະບັບນີ້ຈະໄດ້ຮັບການຈັດພິມ ເຜີຍແຜ່ ຢ່າງຕໍ່ເນື່ອງ ແລະ ຍາວນານ ພ້ອມທັງເປັນທີ່ໜ້າສົນໃຈ ແລະ ເປັນຜົນດີສຳລັບການຄົ້ນຄ້ວາ, ການສຶກສາ, ການສົ່ງເສີມ ແລະ ສາທາລະນະຊົນທົ່ວໄປ. ພ້ອມດຽວກັນນັ້ນ ກໍມີຈຸດມຸ່ງໝາຍເພື່ອບັນລຸມາດຕະຖານທຽບເທົ່າກັບວາລະສານທີ່ຄ້າຍຄືກັນທັງພາຍໃນ ແລະ ຕ່າງປະເທດ.

ໃນການຈັດພິມວາລະສານສັງລວມຜົນງານການຄົ້ນຄວ້າຄັ້ງນີ້ ຫາກມີສິ່ງໃດຂາດຕົກບົກຜ່ອງປະການໃດ ຂໍໃຫ້ພວກທ່ານຈົ່ງປະກອບຄຳຄິດເຫັນ, ຕຳນິສົ່ງຂ່າວໃຫ້ຄະນະຮັບຜິດຊອບ ເພື່ອພວກຂ້າພະເຈົ້າຈະໄດ້ນຳໄປປັບປຸງ ແລະ ເປັນບົດຮຽນໃນຄັ້ງຕໍ່ໄປ.

ທ້າຍນີ້ ຂໍສະແດງຄວາມຂອບໃຈ ແລະ ອວຍພອນໃຫ້ບັນດາທ່ານທີ່ໄດ້ອ່ານວາລະສານສະບັບນີ້ ຈົ່ງມີສຸຂະພາບແຂງແຮງ, ປະສົບຜົນສຳເລັດໃນໜ້າທີ່ການງານທີ່ຕົນເອງຮັບຜິດຊອບ.

ຄະນະວິທະຍາສາດປ່າໄມ້, ມະຫາວິທະຍາໄລແຫ່ງຊາດ

ຮອງຄະນະບໍດີ

# ວາລະສານ

ສັງລວມບົດຄົ້ນຄວ້າວິທະຍາສາດຂອງ ຄູອາຈານ ຄປມ

ສະບັບທີ 2

**ເຈົ້າຂອງ:** ຄະນະວິທະຍາສາດປ່າໄມ້, ມະຫາວິທະຍາໄລແຫ່ງຊາດ

**ສຳນັກງານ:** ຄະນະວິທະຍາສາດປ່າໄມ້, ມະຫາວິທະຍາໄລແຫ່ງຊາດ

**ຜູ້ຮັບຜິດຊອບ:** ທ່ານ ຮສ.ປອ. ສີທອງ ທອງມະນີວົງ ຮອງຄະນະບໍດີ

**ຄະນະບັນນາທິການ:** ທ່ານ ປອ. ຈິດຕະນາ ພິມພິລາ ຫົວໜ້າພະແນກຄົ້ນຄວ້າວິທະຍາສາດ ແລະ ບໍລິການວິຊາການ

ທີມງານ ພະແນກຄົ້ນຄວ້າວິທະຍາສາດ ແລະ ບໍລິການວິຊາການ

**ອອກແບບ ແລະ ຈັດໜ້າໂດຍ:** ປທ. ວັນສະເຫຼີມ ແພງວິຈິດ ວິຊາການ ພະແນກຄົ້ນຄວ້າວິທະຍາສາດ ແລະ ບໍລິການວິຊາການ

ພະແນກຄົ້ນຄວ້າວິທະຍາສາດ ແລະ ບໍລິການວິຊາການ
ຄະນະວິທະຍາສາດປ່າໄມ້
ມະຫາວິທະຍາໄລແຫ່ງຊາດ
ຕູ້ ປນ: 7322, ນະຄອນຫຼວງວຽງຈັນ, ສປປ ລາວ
ໂທ: 021 770813, 770097, ແຟັກ: 021 770294
www.ffs.nuol.edu.la

# ສາລະບານ

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# ວາລະສານວິທະຍາສາດຄົ້ນຄ້ວາຂອງຄູອາຈານ ຄປມ

## 1. ຈຸດປະສົງ ແລະ ຂອບເຂດຂອງວາລະສານ (Aims and Scope)

ວາລະສານວິທະຍາສາດການຄົ້ນຄ້ວາ ແມ່ນວາລະສານທີ່ໄດ້ຮັບການກວດກາ ແລະ ຮັບຮອງຈາກຄະນະວິທະຍາສາດປ່າໄມ້, ມະຫາວິທະຍາໄລແຫ່ງຊາດ ໂດຍຜ່ານການຮັບຮອງຈາກອົງການຈັດຕັ້ງທຸກຂັ້ນ. ວາລະສານວິທະຍາສາດ ເປັນວາລະສານ ທີ່ແນ່ໃສ່ເພື່ອສົ່ງເສີມວຽກງານຄົ້ນຄວ້າວິທະຍາສາດປ່າໄມ້ຮອບດ້ານ ລວມທັງການຈັດສັນຄຸ້ມຄອງຊັບພະຍາກອນປ່າໄມ້, ເຄື່ອງປ່າຂອງດົງ, ການອະນຸລັກສັດນໍ້າ-ສັດປ່າ, ການນໍາໃຊ້ທີ່ດິນ, ການຄຸ້ມຄອງອ່າງໂຕ່ງ, ການພັດທະນາປ່າປູກ, ນິເວດວິທະຍາປ່າໄມ້, ນະໂຍບາຍປ່າໄມ້, ການທ່ອງທ່ຽວແບບອະນຸລັກ, ການປ່ຽນແປງດິນຟ້າອາກາດ ແລະ ບັນຫາສິ່ງແວດລ້ອມອື່ນໆ. ຄະນະຮັບຜິດຊອບວາລະສານຍິນດີຕອນຮັບບົດຄົ້ນຄວ້າທີ່ມີລັກສະນະວິທະຍາສາດ ແລະ ການປະຕິບັດຕົວຈິງທີ່ກ່ຽວພັນກັບຄວາມຫຼາກຫຼາຍທາງດ້ານຊີວະວິທະຍາ. ສະນັ້ນ, ພວກຂ້າພະເຈົ້າຊຸກຍູ້ບົດຄົ້ນຄວ້າທີ່ເນັ້ນໜັກໃສ່ບັນຫາ ທີ່ກ່ຽວຂ້ອງກັບລະບົບນິເວດວິທະຍາໃນທົ່ວໂລກ ຫຼື ບັນດາຂົງເຂດອື່ນໆ ແລະ ລວມທັງບົດຄົ້ນຄວ້າຕ່າງໆ ທີ່ໄດ້ນໍາໃຊ້ວິທີການຕ່າງໆ ເພື່ອວິເຄາະ ແລະ ແກ້ໄຂບັນຫາດັ່ງກ່າວ.

## 2. ກຸ່ມເປົ້າໝາຍ (Audience)

ແມ່ນແນ່ໃສ່ບັນດານັດຄົ້ນຄ້ວາວິທະຍາສາດປ່າໄມ້, ນັກສຶກສາ, ວິຊາການ, ນັກພັດທະນາ, ຜູ້ບໍລິຫານ ແລະ ນັກວາງແຜນການຕ່າງໆ ທີ່ມີສ່ວນພົວພັນກັບ ວຽກງານການຈັດສັນຄຸ້ມຄອງຊັບພະຍາກອນປ່າໄມ້, ເຄື່ອງປ່າຂອງດົງ, ການອະນຸລັກສັດນໍ້າ-ສັດປ່າ, ການນໍາໃຊ້ທີ່ດິນ, ການຄຸ້ມຄອງອ່າງໂຕ່ງ, ນິເວດວິທະຍາປ່າໄມ້, ການທ່ອງທ່ຽວແບບອະນຸລັກ, ການປ່ຽນແປງດິນຟ້າອາກາດ ແລະ ບັນຫາສິ່ງແວດລ້ອມອື່ນໆ.

ຕາຕະລາງ 1. ບົດຄົ້ນຄວ້າແທດເໝາະກັບ ວາລະສານວິທະຍາສາດ

| ສາຂາບົດຄົ້ນຄວ້າຕົ້ນຕໍ | ຕົວຢ່າງຂອງບົດຄົ້ນຄວ້າທີ່ແທດເໝາະ |
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| ການຈັດສັນ-ຄຸ້ມຄອງປ່າປ້ອງກັນ/ສະຫງວນຂອງແຂວງ ຫຼື ແຫ່ງຊາດ | • ປະສິດທິຜົນຂອງການການຈັດສັນ-ຄຸ້ມຄອງປ່າສະຫງວນ<br>• ການການຈັດສັນ-ຄຸ້ມຄອງປ່າສະຫງວນແບບມີສ່ວນຮ່ວມ<br>• ການສ້າງແຜນທີ່ ແລະ ການພັດທະນາການນໍາໃຊ້ທີ່ດິນ ຫຼື ການປັບປຸງການບໍລິຫານການຄຸ້ມຄອງທີ່ດິນ (ການແບ່ງເຂດທີ່ດິນ, ການຈັດສັນພື້ນທີ່ ແລະ ເຂດເຊື່ອມຕໍ່)<br>• ການສ້າງແຜນທີ່ເພື່ອການຈັດສັນຂອບເຂດທີ່ຢູ່ອາໃສຂອງສັດປ່າ ແລະ ເຂດອະນຸລັກພຶດພັນ<br>• ການສົ່ງເສີມປະຊາຊົນເຂດຫ່າງໄກຊອກຫຼີກ<br>• ບັນຫາການຈັດຕັ້ງປະຕິບັດດ້ານນິຕິກໍາ ແລະ ກົດໝາຍການຄຸ້ມຄອງຊັບພະຍາກອນປ່າໄມ້<br>• ບັນຫາຈັດສັນຂອບເຂດ ແລະ ການອະນຸລັກສັດປ່າ<br>• ໄຟຂົນຂູ່ຕໍ່ກັບຊີວະນາໆພັນໃນຂອບເຂດ ແລະ ອອ້ມເຂດພື້ນທີ່ປ່າສະຫງວນ<br>• ການລ່າສັດປ່າ ແລະ ການນໍາໃຊ້ສັດປ່າແບບຍືນຍົງ<br>• ການສໍາຫຼວດສັດປ່າ (ລວມທັງການສໍາຫຼວດເພື່ອຂຶ້ນບັນຊີສັດປ່າ) |

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| | • ບັນຫາການບໍລິຫານ ແລະ ການຄຸ້ມຄອງລະດັບທ້ອງຖິ່ນ<br>• ບັນຫາສິດທິຂອງຊຸມຊົນ<br>• ຜົນກະທົບທາງດ້ານເສດຖະກິດ-ສັງຄົມ<br>• ການຈັດສັນ-ຄຸ້ມຄອງຊັບພະຍາກອນແບບຊົມຊົນມີສ່ວນຮ່ວມ |
| ນິເວດວິທະຍາປ່າໄມ້ | • ພຶກສາດວິທະຍາ ແລະ ຊາກພຶດວິທະຍາ (ນິເວດວິທະຍາ ແລະ ການຟື້ນຟູຊະນິດພັນພຶດທີ່ໃກ້ຈະສູນພັນ, ການສືບພັນຂອງແນວພັນທ້ອງຖິ່ນ ແລະ ການສຶກສາຊະນິດຕົ້ນໄມ້ ພື້ນເມືອງ, ການພົວພັນລະຫວ່າງ ພືດແລະສັດ (ການກະຈາຍແກ່ນພັນ, ການສືດພັນເກສອນ, ຊະນິດພັນຕົ້ນຕໍ), ການສຶກສາການຕິດຕາມກວດກາສະຖານະພາບຂອງພືດ ການຄັດເລືອກຊະນິດພືດເປັນຢາ ແລະ ethno botany<br>• ການສຳຫຼວດ ແລະ ການຄຸ້ມຄອງເຄື່ອງປ່າຂອງດົງ<br>• ເກັບຮັກສາກາກບອນ ແລະ ຊີວະມວນ<br>• ຟື້ນຟູປ່າໄມ້ ທີ່ມີສ່ວນຮ່ວມຂອງປະຊາຊົນ (ແຜນການຄັດເລືອກຊະນິດພັນ, ການຟື້ນຟູທາງທຳມະຊາດ, ການແຜ່ພັນໂດຍແກ່ນໄມ້ໂດຍກິ່ງ , ລັກສະນະທາງສັງຄົມຂອງການຟື້ນຟູປ່າໄມ້ ແລະ ອື່ນໆ) |
| ເສດຖະກິດຊັບພະຍາກອນປ່າໄມ້ | • ປະເມີນຄຸນຄ່າຂອງຊີວະນາໆພັນ, ການທອບແທນ ແລະ ການບໍລິການທາງດ້ານການອະນຸຮັກລະບົບນິເວດ<br>• ເສດຖະສາດຊັບພະຍາກອນ, ຊີວະນາໆພັນ, ດຳລົງຊີວິດ ແລະ ການນຳໃຊ້ຊັບພະຍາກອນທຳມະຊາດ<br>• ການທ່ອງທ່ຽວທາງທຳມະຊາດ ແລະ ການທ່ອງທ່ຽວ ວັດທະນະທຳ (ການປະເມີນຜົນກະທົບຂອງການທ່ອງທ່ຽວ ອະນຸຮັກ ແລະ ການດຳລົງຊີວິດ) |
| ການພັດທະນາຊີວິດການເປັນຢູ່ ແລະ ຊຸມຊົນປ່າໄມ້ | • ການບໍລິຫານຊັບພະຍາກອນສັດນ້ຳ<br>• ກະສິກຳປ່າໄຫ້, ເຄື່ອງປ່າຂອງດົງ ແລະ ປ່າໄມ້ບ້ານ<br>• ແນວຄວາມຄິດກ່ຽວກັບກະສິກຳແບບອະນຸລັກ ຫຼື ກະສິກຳແບບປອດສານພິດ<br>• ການສ້າງໂອກາດໃນການພັດທະນາການດຳລົງຊີວິດ (ການຜະລິດເຄື່ອງຫັດຖະກຳແລະ ການຕະຫຼາດ, ການລ້ຽງສັດເພື່ອເປັນສິນຄ້າ , ການປູກຜັກອິນຊີ ແລະ ການລ້ຽງເຜີ້ງ ແລະ ແມ້ງໄມ້) |
| ການນຳໃຊ້ການສຶກສາ ແລະ ສ້າງຈິດສຳນຶກດ້ານສິ່ງແວດລ້ອມ | • ການຈັດຕັ້ງປະຕິບັດ ແລະ ການປະເມີນຜົນຂອງການສຶກສາການອະນຸລັກ ແລະ ສ້າງຈິດສຳນຶກ<br>• ຮູບແບບ ແລະ ວິທີການທີ່ມີປະສິດທິພາບໃນການສຶກສາສ້າງຈິດສຳນຶກແກ່ຊຸມຊົນ |

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# Agrarian Land Use Transformation in Northern Laos: from Swidden to Rubber

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and Thoumthone VONGVISOUK***

**Abstract**

Land use and farmers' livelihoods in mountainous regions of northern Laos are rapidly moving away from subsistence to market based agricultural systems, changing farmers' relationship with land and natural resources. The current study examines patterns of land use change in northern Laos, especially focusing on the expansion of agricultural land in upland areas. It also examines factors that influence local farmers' livelihood and their decisions on land use. A series of government policies that were implemented since the 1980s restricted upland farmers' access to upland fields and fallow forests, and led to the relocation of upland communities. The opening of regional borders for trade in the early 1990s, which brought new economic opportunities for local farmers, further accelerated the demand for agricultural land and led to a concentration of population in settlements along the road. A combination of both external and internal factors are influencing households in rural areas to actively seek new economic opportunities and adapt their livelihood basis, as well as altering their relationship with land and resources. This rapid transformation also questions the effectiveness of the government's resource management policy that developed during the 1990s aiming to control expansion of upland shifting cultivation practices through delineation of resource boundaries.

**Keywords:** northern Laos, upland, land use, livelihood change, rubber

## I Introduction

Recent studies on land use change point out a complex relationship between direct and indirect factors that influence deforestation [Geist and Lambin 2002; Lambin *et al.* 2003]. In order to better understand the cause and process of deforestation, it is not only necessary to observe the physical patterns of change but also examine local contexts, and factors that influence different stakeholders' relationship with resources. Case studies on land use change in Southeast Asia indicate mounting political and eco-

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nomic pressure on commercially valuable natural resources and upland agricultural systems as leading causes of forest degradation [Fox and Vogler 2005; Kummer and Turner 2007].

The current study in northern Laos brings focus to local transformation of land use and livelihoods in Luang Namtha province bordering southwest China where a network of new roads are being developed and improved as part of the Greater Mekong Sub-region's Economic Corridor supported by the Asian Development Bank (ADB).[1] Upland swidden and fallow forests in this region are rapidly being converted into commercial agricultural lands as rural farmers become increasingly engaged in cash crop production [Thongmanivong and Fujita 2006]. The study not only assesses changing land use patterns, but also examines different factors that influence stakeholders' decisions on resource use and management.

In order to examine changing patterns of land use, we have applied a spatial analysis in selected districts of Luang Namtha province. Our study also incorporates interviews with key local stakeholders (i.e. district authorities, farmers and investors) on agricultural production and land use. We also analyzed local stakeholders' narratives on land use to understand complex factors that influence their decisions to regulate what each stakeholder perceived to be external resource users or "others,"[2] while justifying ones own cause for claiming land, and expanding commercial agricultural land use. Finally, our study examines the effectiveness of the government's resource management policy that aims to regulate deforestation in the uplands.

## II Research Site and Method

### II.1 *Research Site*

Luang Namtha province lies northwest of Laos bordering China and Burma. It's landscape is predominantly mountainous with elevation ranging between 560 to 2,094 m above sea level. The average

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1) ADB supports development of Economic Corridors across the Greater Mekong Sub-region, which only includes countries of mainland Southeast Asia and Yunnan Province of China. Three main corridors include North-South, East-West and Southern, while there are numbers of road projects within each proposed corridor (See http://www.adb.org/GMS/). See also Thomas Fuller's article on the implications of the road on regional economies in the New York Times (21 March 2008).

The current research is part of a regional multidisciplinary project funded by the National Science Foundation, and carried out by researchers from the Chiang Mai University of Thailand, the Kunming Institute of Botany of China (Yunnan province), the National University of Laos, the World Agroforestry Centre (ICRAF Chiang Mai) and the East West Center (Honolulu, Hawai'i, U.S.A.). The overall goal of the regional research project is to understand dynamic patterns and drivers of land use and livelihood change across the Mountainous Mainland Southeast Asia (MMSEA). A group of researchers from the Faculty of Forestry of the National University of Laos and the Environmental Program of the East West Center jointly conducted the current study.

2) Often villagers used Lao words like *kachao* and *phun* which is referred to as "them" to distinguish "others" from the villagers themselves or *hao* or *peuak hao* which refers to "us."

annual rainfall is 1,340 mm/year reaching a maximum of 1,800 mm during the rainy season (between April and September). We selected Sing and Viengphoukha districts for our study considering the historical significance of the region as a crossroads for trade, and its mountainous landscape traditionally dominated by forest and upland swidden farming (Fig. 1).

Sing district borders present day Xishuangbanna prefecture of Yunnan province and Burma. Sing district was historically known as a principality[3] of *Xieng Kheng* (which later changed its name to *Muang Sing*) that stretched along the Mekong River and was ruled by ethnic Tai Lue people [Grabowsky 1999]. Yunnanese traders caravanned through *Muang Sing* to and from China, Burma and Siam. Izikowitz [2001], a Swedish ethnographer that reached *Muang Sing* in 1937 illustrated colourful and lively local markets in *Muang Sing* filled with people of different ethnic groups. While the region prospered from trade during the colonial period, trade and livelihoods were disrupted during the Indochina wars, as it became a major battlefront [Mirsky and Stonefield 1970]. Viengphoukha also played an important role in pre-colonial trade as the Yunnanese caravan travelled to and from China and Siam [Walker 1999].

The trade through Viengphoukha and Sing districts persisted during the French colonial administration much to its dismay, and continued until the late 1940s when the Communist took over China and restricted cross border trade. In the period that followed, the Indochina war decimated the population of the region and inhibited regional trade with Thailand.[4] After 1975 when Laos became a socialist country, the region was repopulated. However, regional trade was inhibited due to mounting political tension between Laos, China and Thailand. In 1990, Luang Namtha regained political and economic significance as regional political tensions with neighbouring countries relaxed. The mining and tourism sectors grew as the road networks improved and regional borders were reopened in the early 1990s. Chinese investments in agriculture especially sugarcane and rubber also increased, accelerating conversion of upland swidden and fallow into permanent agricultural land. Concurrently, international and bilateral agencies' supported food security and livelihood improvement programmes in the uplands in an effort to promote sustainable resource management.

### II.2 *Research Method*

In order to understand the land use and livelihood changes in northern Laos, the current study incorporates different methods. Spatial analysis was used to assess forest and agricultural land use change in the study sites. Time series satellite images of two districts were analyzed by using a supervised

3) Region ruled by Tai Lue (a branch of Tai-Kadai ethnolinguistic group) prince.
4) According to Evrard and Goudineau [2004], more than 50 percent of the population in Luang Namtha was displaced during the period between 1960s and 1970s.

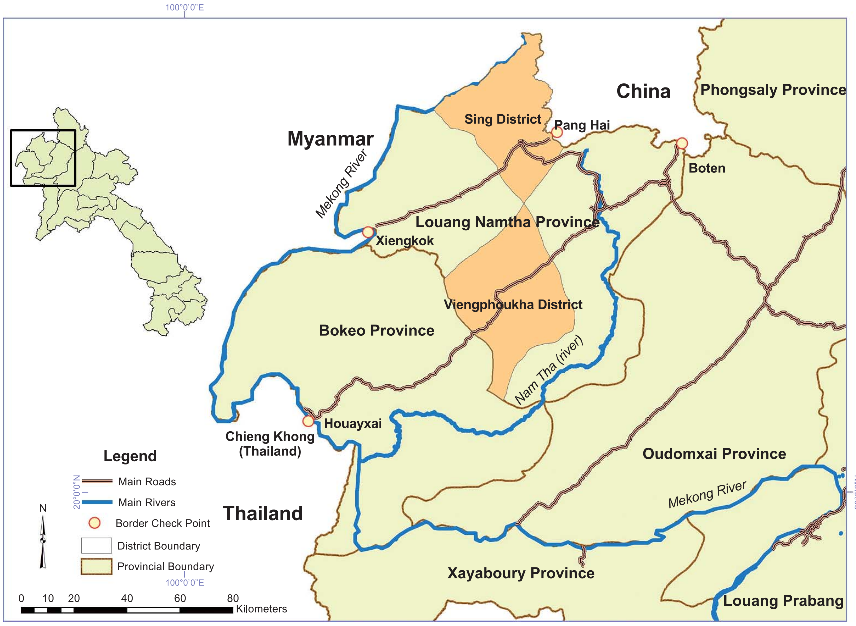


**Fig. 1** Map of Northwest Laos and Research Site (Sing and Viengphoukha Districts)

Source: by Phanvilay

classification method. Based on the interpretation of satellite images and observations in the field, we classified land use into five main categories, which include dense forest, secondary forest, grass and shrub, upland agricultural land, and lowland agricultural land (see Table 1 and Appendix for definition of land use categories).

From the spatial analysis, we can identify land use change patterns such as deforestation, and expansion of agricultural land use in two districts. The results of our spatial analysis were compared with information on agricultural production collected in each district. We also interviewed staff at the District Agriculture and Forestry Office (DAFO)[5] and villagers in the district to understand the causes of land use changes and resource management practices.

Information from 1995 and 2005 Population Census was also spatially analyzed in the current study

5) In August 2005 District Agriculture and Forestry Office (DAFO) was renamed as District Agriculture and Forestry Extension Office (DAFEO) and placed under the supervision of Provincial Agriculture and Forestry Service Centre (PAFESC) to emphasize its role as a provider of extension services. In 2008 PAFESC was reorganized as a division within the Provincial Agricultural and Forestry Office (PAFO). In 2009, DAFEO reverted back to DAFO. In the current paper, we will use DAFO to refer to this line agency of the Ministry of Agriculture and Forestry at district level.

to understand the movement of villages, and distribution of population in two districts over a decade. This allows us to assess areas of population concentration, as well as the mobility of ethnic groups and villages. In order to understand the reasons for population movement in each district, we interviewed local stakeholders including district administrative offices (i.e. District Planning Office, DAFO) and village organizations (i.e. village leaders, village elders).

We also analyzed the narratives of stakeholders in the current study to understand factors that affected their decisions on land use, and actions that they took which influenced the existing land and resource management practice. We interviewed local stakeholders including local government authorities and the development agency (German Technical Cooperation Agency, GTZ), as well as private investors and local farmers to understand their perceptions and reasons for land use change. The narratives of different stakeholders are analyzed in order to examine the effectiveness of government policies that aim to control upland shifting cultivation.

## III Land Use and Demographic Changes

### III.1 *Land Use Change*

From the spatial analysis of satellite images, land use change in the study districts are summarized in Table 1. Analysis indicates a greater loss of dense forest area in Sing district from 60 to 40 percent between 1991 and 2004, compared with a less dramatic decline of dense forest in Viengphoukha, which remains at approximately 70 percent of land area. Steady decline of primary forest area in Sing district is replaced by expansion of secondary forest and upland agricultural land. Upland agricultural land in particular has increased from three to seven percent in Sing district between 2000 and 2004. In contrast, both dense and secondary forest declined in Viengphoukha while grass and shrub area increased significantly. During our fieldwork, we found that areas classified as grass and shrub included areas of

**Table 1** Landcover and Land Use Changes in Sing and Viengphoukha Districts

| Land Use Categories* | Sing | | | Viengphoukha | |
|---|---|---|---|---|---|
| | 1991 | 2000 | 2004 | 1997 | 2007 |
| Dense forest | 60% | 52% | 42% | 74% | 69% |
| Secondary forest | 23% | 36% | 35% | 21% | 12% |
| Grass and shrub | 8% | 2% | 5% | 3% | 15% |
| Upland agriculture | 3% | 3% | 7% | 2% | 3% |
| Lowland agriculture | 7% | 8% | 11% | 1% | 1% |

Source: Based on spatial analysis using data from Landsat TM [2007]
Note: * See appendix for definition of each categories.

newly established rubber field suggesting a landscape in transition: from a landscape dominated by forest and long fallow cycle swidden landscape to intensive monoculture.

The results of the spatial analysis questions the effectiveness of government policies during the 1990s that aimed to control deforestation, especially efforts to regulate expansion of shifting cultivation in the upland areas. Provincial and district agriculture and forestry offices led programmes that delineated state conservation forests throughout the 1990s with the support of international donors [See also Fujita and Phengsopha 2008]. Land and Forest Allocation (LFA) policy was among these polices that developed during the early 1990s, and was implemented throughout the 1990s to delineate village boundary and promote forest conservation at the village level.[6] While LFA recognized the customary rights of villagers to access and manage resources, the main goal of the policy was to increase forest conservation by restricting villagers' access to upland swidden fields and fallow forests by converting these lands into different categories of conservation forests.

In both districts, DAFO led the delineation of resource boundaries in villages throughout the 1990s and the early 2000s. It also collaborated with provincial agricultural offices to manage national conservation forest including the Nam Ha National Biodiversity Conservation Area (NBCA), as well as areas designated as provincial conservation forests.[7] However, as Table 1 suggests, that the implementation of policies such as LFA and the introduction of national and provincial forest areas, were far from protecting or increasing dense forest areas.

In contrast to the results from the spatial analysis, agricultural statistics of Luang Namtha province indicate an overall decline of upland rice production area from over 14,000 ha to 6,000 ha between 1990 and 2005 [MAF 2006]. District statistics in Sing district also show a dramatic decline of upland rice production area from over 1,500 ha to 500 ha between 1999 and 2005 [DAFO 2005]. While there is political pressure upon local government agencies to minimize the area of shifting cultivation, we also learnt during the field interviews that an increasing numbers of farmers were converting swidden and fallow forests into permanent agricultural land. In Sing district, farmers converted swidden and fallow forests especially along the road into sugarcane and rubber plantations. In Viengphoukha, farmers are increasingly clearing fallow forests into agarwood and rubber plantations.

The conversion of swidden and fallow forests into permanent agricultural land began early in Sing district, as the formal opening of the regional border with China brought investors from China who

6) LFA is led by local authorities such as DAFO. There is numerous literature which discusses problems of LFA including Vandergeest [2003]; Evrard and Goudineau [2004]; Ducourtieux *et al.* [2005]; Fujita and Phanvilay [2008]; Fujita and Phengsopha [2008].

7) Nam Ha NBCA particularly became a model for eco-tourism, as it provided economic benefits to local communities as well as to the local government in order to maintain forest conservation [Schipani 2007].

provided inputs for local farmers. Land conversion was especially prominent in areas along the road. An increasing number of farmers began to cultivate rubber since 2000, as groups of pioneer farmers that planted rubber during the early 1990s began to sell dried latex to Chinese traders and make profits given the appreciating price of rubber. By 2003, local authorities including the DAFO and District Planning Office (DPO) in Sing District expressed the view that the widespread expansion of rubber, and clearance of forest areas in the upland region, especially along the road, was "out of control."

In Viengphoukha, the conversion of upland swidden and fallow forests into permanent agricultural land is still a new phenomenon. However, since the mid 2000, an increasing numbers of investors from outside of the district are approaching provincial and district authorities to seek land concessions and opportunities to engage local villagers into contract farming. The influx of new agricultural investment in Viengphoukha in the last few years has resulted in the rapid clearance of old fallow forests into permanent agricultural land. Encroachment and clearing of forest is also becoming a critical issue in Nam Ha NBCA [Schipani 2007].

### III.2 *Demographic Change*

Based on the 2005 Population Census, the total population in Sing district and Viengphoukha is 30,548 and 18,800 respectively. The average annual growth rate of the population between 1995 and 2005 in two districts was 3.6 and 5.3 percent respectively, higher than the national average of 2.3 percent [NSC 1995; 2005]. Fig. 2 spatially represents census data from two districts to understand demographic changes. We crosschecked village names with local authorities and corrected locations during the fieldwork. In both districts, population became highly concentrated along the road over time.

Table 2 also shows that the number of registered villages declined in the two districts between the two census periods. The decline of villages are due to both government policy encouraging relocation, and due to spontaneous relocation. During the 1990s, the government encouraged the consolidation (*kan taohom*) of small upland communities to areas along the road where district government can provide public services such as schools and health care. The effort was often supported both directly and indirectly by international donors to develop "focal sites" for rural development [Baird and Shoemaker 2007]. Both Table 2 and Fig. 3 indicate that consolidation particularly affected upland minority villages: Akha people in Sing district, and Khmu people in Viengphoukha.

Although we observe "consolidation" of upland villages and the relocation of upland communities to areas along the road, Cohen [2000] claims that in Sing district, the district governor abandoned plans to relocate upland communities in the mid 1990s. This was based on considerations to curtail any emerging ethnic tensions over access to resources in the lowland and its periphery where productive

**Table 2** Numbers of Villages by Ethnicity

| Sing<br>Ethnic Groups | 1995 | 2005 | Viengphoukha<br>Ethnic Groups | 1995 | 2005 |
|---|---|---|---|---|---|
| Tai Lu, Nua, Dam | 28 | 25 | Tai Lu, Yang | 3 | 3 |
| Khmu | 1 | 1 | Khmu | 44 | 26 |
| Akha | 69 | 55 | Akha, Kui | 7 | 9 |
| Hmong, Mien | 9 | 9 | Hmong | 2 | 2 |
| Mix | 3 | 4 | Mix | 9 | 6 |
| Total | 110 | 94 | Total | 65 | 46 |

Source: Based on National Census of 1995 and 2005

agricultural land was increasingly becoming scarce. Representatives from DAFO also confirmed during the interview that the "district no longer supported relocation" since 2000 but that the problem persisted: "more (upland) people wanted to come down." This indicated that movement of the upland population was not only directly influenced by the government's consolidation policy but triggered due to the emerging economic opportunities especially in areas with road access.[8]

In their studies, Evrard and Goudineau [2004] as well as Vandergeest [2003] claim that more recent cases of displacement in Laos are being induced by development projects and government policies. For example, policies that restrict upland farmers' access to agricultural land, such as LFA, have led to shorter periods of fallow and loss of agricultural productivity [Lestrelin and Giordano 2007]. As a result, farmers are forced to seek new economic opportunities for family survival including the option of relocation [Vandergeest 2003]. Cohen [2000] and Lyttleton *et al.* [2004] claim that government policies regulating shifting cultivation and opium production in Sing district led many upland Akha people to become more dependent on agricultural wage labour outside of their own villages. Based on our fieldwork, we also found that government policies pressured households to adapt their land and resource use practices. However, at the same time household responses to political and economic pressures were variable. Households with capital and social assets adopted new agricultural practices (i.e. lowland paddy rice cultivation) and commercial crops (i.e. rubber, sugarcane). Their adaptation to emerging economic opportunities involves early migration to new territory, as well as the transformation of old swidden and fallow fields into permanent agricultural land, excluding "other" users. On the other hand, households with less capital and social assets are becoming dependent on wage labour and economic opportunities outside of their villages while loosing access to communal land and resources [See also Thongmanivong and Vongvisouk 2006].

8) Based on interviews with villagers, as well as personal communications with staffs from GTZ, and DAFO.

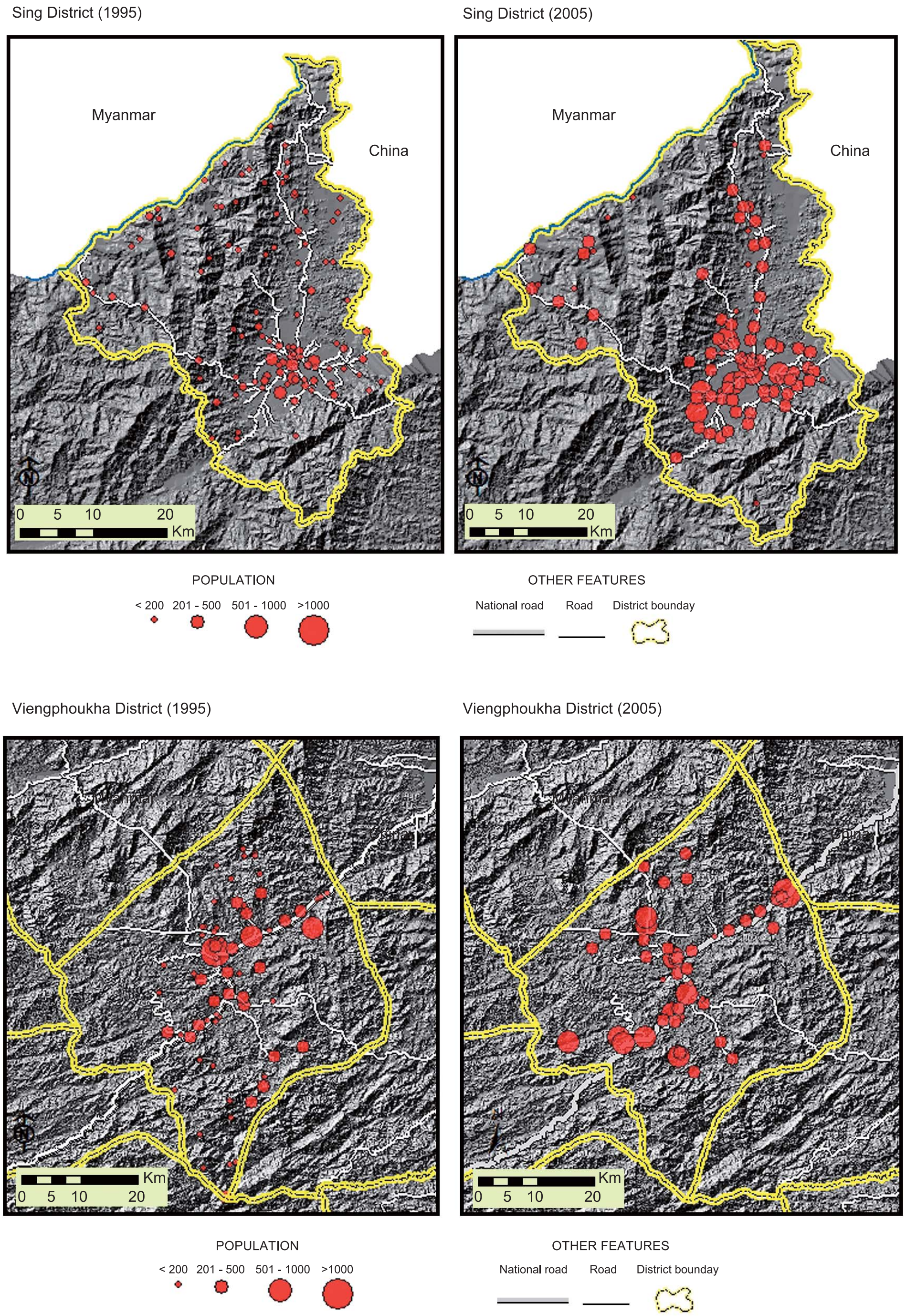


**Fig. 2** Population Distribution in Sing and Viengphoukha (1995–2005)

Source: Based on National Census of 1995 and 2005

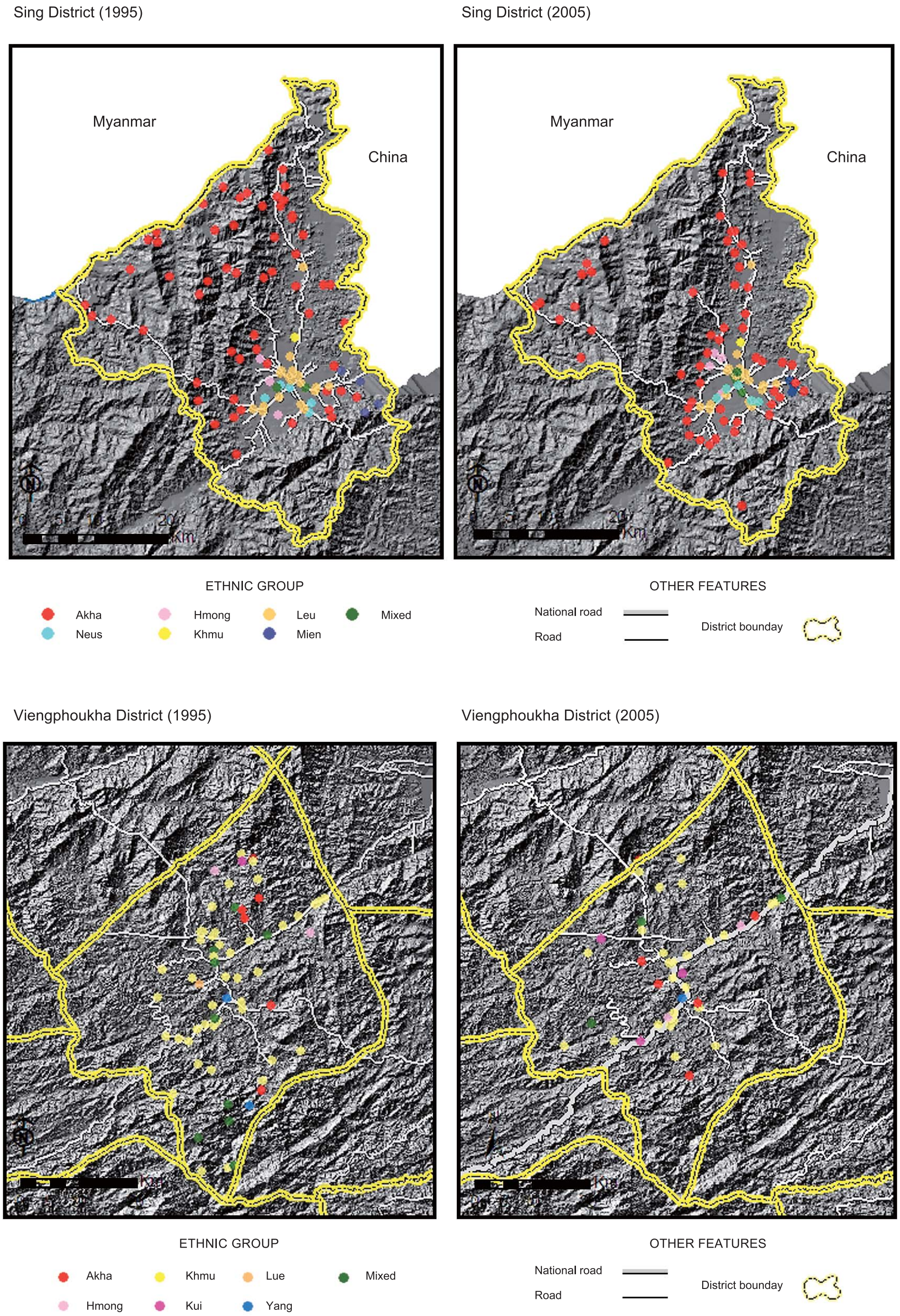


**Fig. 3** Ethnic Distribution in Sing and Viengphoukha District (1995–2005)
Source: Based on National Census of 1995 and 2005

## IV　Narratives of Stakeholders

In this section, we examine the narratives of local farmers in Sing district to understand the causes of land use and livelihood change. We also examine the narratives of investors that support the expansion of rubber cultivation in Sing district, as well as the narratives of local authorities on development and management of resources in the upland region.

### IV.1 *Farmers*

The first Akha farmers that planted rubber in Sing district included a village leader and his family from a village located in Mom sub-district along the national border with China. The family's biggest motivation for planting rubber was its profitability. Since the opening of the border with China, it became easier for villagers to visit their relatives on the other side of the border. "Our relatives in China were poor like us before. Now they are rich because they plant rubber. They live in a nice house, they have motorcycles."[9] Village leader's family already accumulated wealth from livestock and sugarcane. Village leader considered rubber as a long-term investment for his family.[10] He was the first in his village to claim and convert areas of swidden and fallow land into a rubber field. He was also the first to convert areas of sacred forest into smallholder rubber. He claims "people used to be afraid of spirits in the past, but now the spirits are afraid of people," indicating a change in customary rule for managing sacred forest.

In a neighbouring lowland Lu village, villagers also began to cross the border into China when the road was improved in the early 1990s. Starting in the same period, villagers also began to cultivate sugarcane for a Chinese sugar factory. They used old swidden and fallow fields surrounding their village, as this was the customary territory of the village. It was traditionally reserved as an agricultural land during difficult times, especially when the yield from rice paddy was low. It was also a communal resource where villagers collected forest products, and grazed cattle. Access for this land by other villagers were loosely recognized until 2000 when the villagers began to cultivate rubber. By then the population in the areas surrounding the village also became denser as upland Akha people relocated to the area. Although the newly introduced LFA defined village boundaries, demand for agricultural land grew and pressures on forest areas increased as the farmers' production shifted from subsistence-based

9) Akha or Hani farmers on the other side of the border in Xishuangbanna prefecture in China began to plant rubber during the mid 1980s (1982–85) after the Chinese government allocated agricultural lands to households for smallholder production of rubber See also Chapman [1991] and Sturgeon [2004].

10) Sugarcane was considered as less of a long-term investment, as it required capital for replanting every three to five years.

to market-based agricultural production system focused on crops such as rubber. Furthermore, pressure on forest areas was aggravated as the provincial governor of Luang Namtha granted rights to local military unit to clear forests in the village along the Chinese border to plant rubber, encroaching into the village conservation forest. This created resentment and anxiety among the villagers and accelerated their efforts to make claims to existing land prior to "others," including neighbouring villagers and state agencies.

According to a representative of DAFO in Sing district, incidences of encroachment, and overlapping claims to agricultural land became rampant from 2000, as increasing numbers of farmers began to engage in commercial farming. "Most of the villages in our district now plant rubber." DAFO was one of the district authorities where village leaders reported complaints of "others" encroaching into their village territory. This notion of "others" often included neighbouring villagers that encroached into one's village, as well as state agencies such as the local military unit, as well as relatives and traders from China, and local politicians that supported few villagers to plant rubber. Increased competition over resources caused conflicts among villagers and "others." The competition was not only externally induced. In some of the villages, farmers reported incidences where young seedlings were stolen from the fields by village members indicating a persisting conflict within the village.

### IV.2 *Investors*

Since 2000, there are a total of 16 Chinese and four Lao companies registered to promote rubber plantations in Luang Namtha [PCIP 2008]. The majority of these investors registered officially after 2005. Chinese investors promoting rubber favour Luang Namtha for its proximity to Xishuangbanna and its similar climatic and environmental setting. Many of the investors from China that officially registered their business in Luang Namtha also justified their cause claiming that land is abundant and "under utilized" in northern Laos, and that rubber would bring "development and progress" to the region and alleviate the backward ethnic minorities from rural poverty. Other Chinese investors emphasized the importance of rubber as "an alternative to opium production" and that their investment will help to "industrialize" the agricultural sector in Laos. Chinese investors also claimed that they were equipped with "experience," and "scientific knowledge" to promote rubber in Laos. These positions and perspectives taken by Chinese investors reflect politicized motivation of their investment activities in Laos. There is also an economic motivation for investment in Laos, as one Chinese investor claims, "it is cheaper to set up a rubber plantation in Laos compared to China." This is due to a lower cost of labour and land in Laos.

On the other hand, numerous other small-scale investments operate locally without official registration [See also Shi 2008]. For instance, an owner of a small agriculture trading company based in Sing district is an ethnic Han born in China near the Lao border. He moved to Sing district in the late 1980s and started a small furniture business. He then built a guesthouse catering to Chinese business persons and labourers in the early 1990s as the regional border was re-opened for trade. As he made connections with representatives of the State Seed Company in Xishuangbanna, he began to sell agricultural inputs supplied through the State Seed Company to local farmers in Laos. He provided high-yielding rice varieties and vegetable seeds as well as other inputs such as fertilizers and pesticides to Lao farmers on credit. The trader then purchased products after harvest and sold them in China.

In the late 1990s, the trader began to invest in rubber. His company first rented land from local farmers in Sing district and produced rubber seedlings. Then, the company approached local farmers that wanted to plant rubber, and offered to provide inputs and a service to plant rubber for them in exchange for sharing 50 percent of planted trees on farmers' land. He explained his operation as such that "villagers kept their land and trees while I maintained my share of trees." This arrangement allowed the trader to maintain rubber with his own company workers. In other words, the Chinese trader did not have legal access to rubber fields but by negotiating directly with local farmers he gained *de facto* access to land. The arrangement is beneficial for the Chinese trader from three main perspectives. First, he gained access to land without formal land registration. Secondly, his company can manage plantation with skilled labour from China and maintain productivity of rubber trees, ensuring a steady supply of latex. Thirdly, by directly negotiating and agreeing on the terms and conditions of investment with villagers, his company did not register their new investment activities. Instead, local villagers reported rubber planting as their own agricultural investment to DAFO.

Such small-scale investment practice is not only limited to the Chinese. Similarly, relatively well-off local individuals in Laos are acquiring land outside of their own village to plant rubber. In one Lu village, an entrepreneurial farmer provides inputs on credit to Akha farmers in a neighbouring village. In return, Akha farmers agreed with the Lu farmer-investor to share 50 percent of their profits from sales of latex. However, many Akha farmers lost their rubber trees prior to tapping as they continued to borrow money and rice on credit from the Lu villager-investor. The accumulating debt is settled by giving away the right to own the rubber trees. As the Akha farmers gave their rights away, the Lu investor regained access to upland agricultural land, which was once part of his village but was allocated to Akha migrants during the 1990s following the LFA. Although the land still officially belonged to Akha farmers, the rubber trees belonged to the Lu investor giving him *de facto* tenure to land. The Lu investor says that he needs to "train and hire Akha people" when the tapping begins.

The narratives of small-scale investments in Sing district indicate a high success of informal investment arrangement to set up a rubber plantation involving local traders and farmers. Officially registered investors on the other hand are struggling with local bureaucracy to find land and setting up their activities in Luang Namtha. A representative of a registered Chinese company based in Sing district is frustrated with the reluctance of district authorities to assist his company's investment project through the Provincial Committee Investment and Planning (PCIP) after it was approved by the provincial governor. The company registered investment activity to plant rubber and develop a processing factory in the northern areas of Sing district. According to the representative of the company, delay is largely caused by DAFO, which is authorized to identify 500 ha of land for the company to promote contract farming with local farmers. The representative of the company complained about the frequent "changes" and "lack of consistency" in government policy in Laos.

### IV.3 *Local Policy Makers*

As part of the national effort to decentralize the decision-making process, and to expedite screening process, PCIP is authorized to screen investment under a million US dollar and seek approval from the provincial governor. In Luang Namtha, the governor encourages foreign investment, but he declared in 2005 that rubber should not be promoted as a concession but instead involve farmers without taking away their rights to land. Following the governor's decision, PCIP also encouraged smallholder rubber investment in Luang Namtha. Representatives of PCIP consider that smallholder rubber can create economic opportunities for rural households and alleviate poverty. However, under the current process of screening and approving investment proposals, neither the availability nor suitability of land for rubber is fully considered by a joint investment committee led by PCIP prior to the investment approval. There is hardly any consideration on whether local farmers are willing to participate in the proposed investment activity. Instead, PCIP authorizes PAFO and DAFO to define the land area for investors after the governor approves investment proposal.

Luang Namtha's PAFO supports rubber as one of the potential cash crops that farmers can introduce to their upland agricultural system in order to minimize their dependence on shifting cultivation. Both PAFO and DAFO take a position that shifting cultivation (*tang pa het hai*) is a cause of deforestation. However, foresters at PAFO that led forest conservation activities and LFA in the province during the 1990s are concerned about the increasing conflicts over land, particularly as interest in rubber became widespread. "In the past, land was abundant and cheap, people traded and transferred (land) without payment. Now with increased interest in rubber, the land value has increased. Poor households are often disadvantaged in making claims to land. Communal land areas are lost." This suggested a break-down of communal resource management practices due to changing livelihood and agricultural system in rural communities. Members of PAFO felt that the encroachment into conservation forests was threatening the management framework introduced during the 1990s. Members of PAFO especially emphasized the need for the "scientific assessment considering the suitability for rubber" prior to the investment decision and reconsidering the existing resource management framework including LFA to accommodate the growing demand for agricultural land use. This implied a criticism of current investment approval process that disregarded the existing resource management framework.

At the district level, DAFO is faced with mounting pressures to resolve conflicts over access to land and resources as investors and government agencies demand land and labour for rubber, and also at the same time as local villagers and small-scale investors clear upland forests for rubber. The widespread interest in rubber among multiple stakeholders makes it difficult for members of DAFO to mediate and resolve conflicts effectively using the existing resource management framework. The premise of existing resource management framework, such as LFA assumes a subsistence livelihood basis of upland farmers, and prioritizes forest conservation. It has not adapted quickly to accommodate to the growing demand for agricultural land use. Furthermore, a lack of clear legal tenure for customary land further resulted in open-access resource problems compounded by a rising numbers of people accessing resources and a high demand for agricultural commodities such as rubber.

## V　Conclusion

Our case study in northwest Laos indicates an increasing expansion of upland agricultural land at the expense of forest loss and degradation. The conversion of swidden and fallow forest into commercial agricultural land is especially rampant in areas along the road where population is concentrated. In both Sing and Viengphoukha, ethnic minority groups such as Akha and Khmu whose livelihood once was dependent on upland agricultural system are significantly affected by this change. The movement of population is not only due to government policy to consolidate rural villages, but also a combination of responses to government policies that regulate upland farmers' access to land and resources (induced migration), and a response to new economic opportunities (spontaneous migration).

As our study showed, tracts of old upland swidden and fallow forests that were classified as conservation forest during the 1990s are especially under pressure of being converted into rubber plantations. The limited capacity of local agencies including PAFO and DAFO, as well as village communities, to regulate overlapping claims to resources means that clearing and planting rubber is a direct means to exclude "others" and justify one's own claim to land. As we have seen in the narratives of farmers and investors, the planting of rubber, a long-term crop is often a direct way of acquiring exclusive rights to land regardless of the ambiguous legal status of land ownership. The expansion of rubber thus, commoditizes the upland swidden and fallow forests, which had been a part of the customary resources of the past. This not only magnifies the weakness of current resource management institutions such as LFA by questioning its basic assumption and premises, but also leads to a break down of communal resource use and management practices.

Farmers' narratives provide an insight into factors that influenced their decision to introduce new commercial crops like rubber in their upland agricultural system. Many farmers were influenced through knowledge about rubber conveyed through their sometimes transboundary social networks more so than through the government extension programs. The success of farmers in China and in Laos that adopted rubber earlier stirred farmers' interest in the new crop. Information about the increasing price of rubber also attracted upland farmers that were already growing sugarcane on swidden and fallow lands. Regardless of the drop in the price of rubber during 2007 and 2008, farmers continue to indicate an interest in rubber as a long-term investment. As we have seen in the narratives of farmers, some are anxious of losing access to land and potential economic opportunities to "others." The breakdown of resource management framework also implies that planting rubber is a means to secure one's claim to land. The narratives of investors also highlight different ways in which investors approach local farmers in order to access land. Our study highlights that small-scale investors based on existing family and business ties are more successful in making claims to land and operating their investment as they directly negotiate with farmers.

Our study also elucidates the presence of pioneer farmers, or farmers that are able to quickly transform their existing asset such as livestock, or profit from other commercial crops (i.e. sugarcane, maize, watermelon, etc.) in order to capture emerging economic opportunities. By planting a long-term crop like rubber on swidden and fallow forests, which had been a communal resource but is now becoming an open-access resource, pioneer farmers legitimatize their claims to land, while excluding other resource users. Competition for agricultural land is increasingly intensifying in our case study site, especially as farmers find different ways to work with investors. Other than formal contract farming, there are other small-scale investors including relatives, and local traders, wealthy local individuals and politician that provide inputs for farmers quickly and more flexibly based on informal arrangements.

Finally, our study suggests the need to consider the effects of the market economy on different groups of households. While there are farmers that can quickly mobilize assets and adapt their production system to the market economy, others are loosing their land-based assets and becoming increasingly dependent on wage-labour. Widespread conversion of swidden and fallow forests into rubber particularly affects the latter group of farmers, as buffer resources from swidden and fallow forests for food and income are lost. Another pressing issue for the latter group of farmers is the limited livelihood option as they begin to loose access to land and resources, forcing them to relocate as the only option for their survival.

## Appendix

**Definition of land use classification categories**

| | |
|---|---|
| Dense forest | Land cover dominated by trees and has crown cover density of 20 percent or higher. Trees have DBH (Diameter, Breast, and Height) measurement of more than 10 cm and height is more than 10 m tall. These land cover are usually classified as protection forest, conservation forest and are found on steep terrain that are difficult to access. |
| Secondary forest | No presence of large trees but mostly dominated by bamboo. Trees have DBH of less than 10 cm and are shorter than 10 m. Most of this area is old swidden fallow forests. This category is found throughout the district, and often is adjacent to active swidden fields. |
| Grass and shrub | This type of land cover is often a young fallow field where the vegetation is predominantly bushes and grass. However, in some instances this includes recently established rubber plantations. |
| Upland agriculture | All agricultural lands with slopes greater than 8 percent. This includes active shifting cultivation area, and areas that were newly cleared for agricultural purpose (i.e. rubber, sugarcane production). |
| Lowland agriculture | All agricultural lands with slope equal to or less than 8 percent. This category is mainly lowland paddy field, pasture for cattle grazing and other clear lands. |

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# REDD+ on hold: Lessons from an emerging institutional setup in Laos

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**Abstract:** *The prospects of receiving funding for REDD+ have set many developing countries on a pathway of policy reforms to integrate REDD+ in national legislation. Progress has been slow partly due to the lengthy international negotiations on REDD+ but also because the policy reforms have not been backed by sufficient commitment to make REDD+ implementation feasible. To contribute to a better understanding of why policy and institutional reforms have not been successful in taking REDD+ implementation further, we analyse the institutional landscape of the forestry and environmental sectors in Laos as a case in point. We interviewed stakeholders from national to village levels and found that REDD+ has been effectively on hold in Laos. This is because of recent institutional transformations, rapid staff turnover and limited implementation capacity of government agencies at the national and sub-national levels all of which have led to a heavy reliance on international support and external consultants. The result is that Laos may not be ready to benefit from the international agreement on REDD+. The situation in Laos provides a compelling example of how difficult REDD+ implementation has proven to be in countries where institution building is still in process.*

**Keywords:** *capacity, forest carbon governance, institutions, Laos, REDD+, Southeast Asia*

## Introduction

The prospects of receiving substantial funding for Reducing Emissions from Deforestation and Forest Degradation (REDD+) have set many developing countries on a pathway of policy reforms to integrate REDD+ into national legislation. These efforts have been seen as a good opportunity to strengthen legislation not only with respect to the management of forest areas but also to stimulate land reform, increase land tenure security, and improve local development, thus creating an atmosphere of optimism that REDD+ could be a driver of better governance and appropriate development as a co-benefit of mitigating climate change (Korhonen-Kurki *et al.,* 2014). However, the slow progress of international negotiations on REDD+ and the realisation that, despite substantial donor support, REDD+ remains only one of multiple forest governance strategies in developing countries have somewhat dampened this optimism (Angelsen and McNeill, 2012). However, the decision at the United Nations Framework Convention on Climate Change (UNFCCC) 21$^{st}$ Conference of the Parties (COP21) to go ahead with REDD+ may spark renewed interest, especially if adequate funding is provided (UNFCCC, 2015).

In this paper we argue that the slow REDD+ preparation makes it relevant to analyse why the policy and institutional reforms in many countries have not been successful in taking REDD+ implementation further and also to evaluate to what extent governments allocate the necessary resources and commitment to create a fertile policy environment for climate change mitigation such as REDD+. We use the Lao People's Democratic Republic (Lao PDR, hereafter Laos) as a case in point to show how international environmental mechanisms may or may not be implemented under national governance regimes that, from an overall policy perspective, can accommodate the new mechanisms. However, when it comes to 'real-politik' they may not be interested in making them work as intended, e.g. by excluding important drivers


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such as land concessions and infrastructure (Dwyer and Ingalls, 2015). We identify a range of reasons why this is the case including the presence of contradicting spatial governance and institutional restructuring and the absence of transformational coalitions and brokers between state and non-state actors – all of which leave REDD+ policy implementation in limbo.

First, we outline some of the challenges in other countries to illustrate the importance of this problem. In Indonesia, for example, the government shows strong ownership of REDD+. Considerable donor support has been committed, but only spent to a limited extent because the policy reforms have not been backed by sufficient commitment to make REDD+ implementation feasible (Korhonen-Kurki *et al.,* 2014). Even though the Indonesian readiness plan was made several years ago (Di Gregorio *et al.,* 2012), national forest cover reference levels were reported in 2014, and a committed REDD+ agency has been pushing the agenda with some success (Astuti and McGregor, 2015), there is still limited activity on the ground. The transfer in 2015 of the REDD+ agency from the President's office to the Ministry of Environment and Forestry is likely to further slow-down REDD+ progress (Luttrell *et al.,* 2014; Astuti and McGregor, 2015), which is also under pressure from strong criticism from civil society organisations that point to inadequate planning and implementation of REDD+ pilot projects (Howell, 2015).

The REDD+ policy process has also been slow in Vietnam, where it is dominated by governmental institutions that leave very limited space for involvement and contribution from other actors. REDD+ consultation workshops have mainly been held at the national level, with very limited participation from local stakeholders and indigenous communities. Moreover, while international and domestic NGOs, donor organisations and the private sector have been involved in national REDD+ policy consultation events, they have not necessarily influenced REDD+ policy discussions and decision making – as pointed out by Pham *et al.* (2014): "70% of interviewed actors felt that their participation and contribution were not reflected in the final decision". Experiences with Free Prior and Informed Consent at local level also showed that one-way communication tools and lack of feedback on how decisions were made were common (Pham *et al.,* 2015). Thus, although Vietnam has strong national ownership in REDD+, the low degree of participation leaves multiple interests in the REDD+ policy process unaccounted for (Korhonen-Kurki *et al.,* 2014).

Looking beyond Southeast Asia, a case study from Brazil shows that governmental organisations are the main agencies driving the REDD+ policy arena, although there is some coordination with donor institutions, domestic NGOs, the private sector and local communities (Gebara *et al.,* 2014). Korhonen-Kurki *et al.* (2014) indicated that Brazil has the strongest national ownership of REDD+ and the most inclusive policy process (within their 12 study countries), but the most recent REDD+ activities in the country (subnational nested initiatives) and REDD+ policy and information exchange are still mainly controlled by the key governmental agencies at the national level (Gebara *et al.,* 2014). This is also the case in Cameroon where REDD+ preparation is strongly centralised and led by international agencies, leading to low national ownership (Brockhaus *et al.,* 2014b; Dkamela *et al.,* 2014).

This takes us back to Laos, which has also embarked on a REDD+ preparation pathway with strong support from international donors. Laos is of specific interest as it has – according to the Lao government's definition of forest – one of the highest forest covers in Southeast Asia with some 40% forest that has more than 20% canopy closure (DoF, 2012b). Using the FAO definition of forest cover (10% canopy closure) sets the forest cover at 66% in 2010 (FAO, 2010), but none of these definitions say anything about forest quality. The Government of Laos (GoL) has long been aiming at strengthening its control of national forest resources and limiting illegal deforestation and logging, but there have been important limits to actual implementation of these aims (Lestrelin *et al.,* 2013b,2013a). As a result, forest cover continues to decline – from 47.2% in 1992 to 41.5% in 2002 and 40.3% in 2010 according to official statistics in Laos (GoL, 2005; Tong, 2009; DoF, 2012b). Thus, several decades of government policy on forest governance have been unable to stop deforestation and it seems unlikely that the government goal of having a 70% forest cover of the country's total land area by 2020 will be realised.

 

Multiple causes have been identified to explain this. With regard to timber extraction and illegal logging, a lack of financial and human resources for forest resource monitoring by state agencies is often put forward by the government (GoL, 2005). However, policy loopholes and legal exceptions also play an important role. Several decrees have been passed in the 2000s establishing strict bans on log export and commercial logging activities outside state production forests. Furthermore, logging in production forests has to adhere to a national logging quota system. Yet, it has been easy for logging operators and other private investors to circumnavigate legislation (Barney and Canby, 2011), e.g. by obtaining concessions for various investment purposes such as agriculture, hydropower development or mining. By doing so, they can obtain the logging quotas from the government in order to clear the area intended for development. However, the companies often sell the development licences to other developers after the logging phase (Barney and Canby, 2011), practices typically related to transnational networks involving powerful private investors and some officials and their allies (Baird, 2010; Lestrelin *et al.,* 2013a). Consequently, timber harvesting continues on a large scale in Laos, much of which serves the Vietnamese, Chinese and Thai markets (Barney and Canby, 2011; To *et al.,* 2014), thereby continuing the displacement of deforestation from neighbouring countries to Laos (Meyfroidt and Lambin, 2009).

To reduce pressure for forest conversion at the local level, various forest and land-use management programmes have been implemented using spatial planning instruments such as land-use planning and forest land allocation (LUPLA) and more recently participatory land-use planning (PLUP) (Ducourtieux *et al.,* 2005; Lestrelin, 2010; Bourgoin *et al.,* 2012; Castella *et al.,* 2014; Dwyer and Ingalls, 2015). In theory, these programmes should contribute to transferring responsibilities to local levels to ensure that local communities play a more important role in managing land and forest resources (Lestrelin *et al.,* 2012), but regulations under these programmes seem to be disregarded by different levels of government. For instance, a case study in southern Laos revealed that although LUPLA was implemented, villagers still lost their land to a private investment company that established a rubber plantation (Kenney-Lazar, 2010) and other studies suggest that LUPLA is a means of dispossession as it identifies degraded land for allocation of concessions (Barney, 2009). Moreover, the land-use plans – usually supported by donor and civil-society organisations – are frequently disregarded after the project support ends (Lestrelin *et al.,* 2012). Such outcomes are not uncommon as new policies and laws on forest-resource governance developed at the national and global levels may indeed lead to the transfer of responsibility to local level, but as elsewhere the rights to resources are still predominately retained by central governments (Agrawal and Ribot, 1999).

These governance issues and the historical failure to reverse a continuous deforestation trend could make REDD+ just another questionable policy measure to reduce deforestation in Laos. Even if adequate legislation is passed, there is an urgent need to understand how governance is played out from the local to national levels in the new REDD+ structures that have been created. Therefore, in this paper, we review the historical and current forest governance in Laos. We then analyse the ongoing processes of institutional reconfiguration, policy revision and capacity building within Laos' forestry sector and look at the REDD+ demonstration activities that are expected to inform the national REDD+ policy formulation. Our objectives are to assess whether these processes are helping future REDD+ implementation in Laos, to evaluate the challenges faced by the emerging REDD+ administration in relation to human capacity, financial and human resources and their allocation at different levels of governance and, in more general terms, to discuss whether policy and institutional reform are indeed needed for REDD+ to be successful.

## Methods and study area

This paper is based on reviews of official documents, 'grey' literature and scientific papers in combination with stakeholder interviews. Primarily, the official documents reviewed included forestry-related policies, laws, decrees, regulations, and REDD+ related official reports such as decisions and agreements of the government, Readiness Program Idea Note (R-PIN), Readiness Preparation Proposal (R-PP), and REDD+ progress reports. The grey literature reviewed included unofficial reports such as consultancy and project reports. The documents were found in two ways. The first was by using the Google search engine and the keywords "institutional reform in Laos", "forest governance in Southeast Asia", "land-use planning and land governance", "policy implementation" and "REDD+" and the second involved collecting directly from government agencies at the national and sub-national levels, non-governmental organisations (NGOs), research institutions, and projects.

We also conducted semi-structured interviews with 59 representatives from 29 organisations. These included four departments and one research institute under the Ministry of Agriculture and Forestry (MAF), two divisions of the Department of Forest Resource Management (DFRM) under the Ministry of Natural Resources and Environment (MoNRE), six provincial and district government offices in the forestry, land and environment sectors, seven NGOs, six project organisations, one private company, and two villages (Soblao and Homephan) in Hua Meuang District, as well as district authorities from Viengthong District (by early 2014, Viengthong District was divided into two districts named Hiem and Xon), Huaphan Province. We interviewed key informants during fieldwork in November 2012 and then in April–May and November–December 2013. The intermediary results were presented and discussed at a workshop held in Sam Neua, Huaphan Province on 10 March 2015 with 36 delegates from four districts (Hua Meuang, Sam Neua, Hiem and Xon) and Provincial and National REDD+ officials. Interview and workshop notes were coded according to key aspects of the research questions and analysed using the 'NVivo' software for analysis of qualitative interview data.

In-depth interviews were carried out in Hua Meuang District because it is a focal REDD+ pilot district, and in the former Viengthong District because a large part of its land area is included in the Nam Et-Phou Loey (NEPL) National Protected Area (NPA), which was initially selected by the Climate Protection through Avoided Deforestation Project (CliPAD) as a pilot area for REDD+ activities. This project is developing a jurisdictional approach to REDD+ at the provincial level, with climate change mitigation activities conducted in pilot districts under high threat of deforestation and forest degradation (Moore *et al.,* 2012). Among other REDD+ related initiatives in the area are the *Proceed* project (www.laos-proceed.com) and the *Lowering Emission in Asia's Forests project* (*LEAF*, http://www.leafasia.org). With the selection of a province and districts targeted by multiple climate change adaptation and mitigation projects, we expected that global concerns for the environment in terms of forest cover and forest quality would be strongly expressed by local communities. Likewise, we expected that here – if anywhere in Laos – the goals, activities, and challenges of the REDD+ pilot activities would be well understood and reflected among district and provincial level staff. Based on this assumption, we expected REDD+ to have a strong presence in terms of allocation of human resources, maintenance and acquisition of technical capacity, despite the recent institutional transformations. Similarly, any weakness or lack of capacity or priority found in these settings could be expected to be even bigger in other districts and provinces that have not been selected as priority areas for REDD+ implementation.

## Results

### *Institutional transformations in the forestry sector*

As mentioned earlier, Laos has been continuously developing and revising its legislation and institutional structures to address issues in the forestry sector and we thus start by outlining the institutional transformations that are necessary to understand the current situation for REDD+ implementation. A first comprehensive effort towards forestry regulation came with Decree No. 74 on forest protection in 1979. This decree detailed forest resource ownership, outlined permissions to use forest for conservation and logging, and dealt with the prohibition of shifting cultivation. At the same time, the GoL established nine State Forest Enterprises (SFEs) with the aim of increasing national income from forest resources (GoL, 2005; Dwyer and Ingalls, 2015) and all forestry activities were directly controlled by government. In the mid-1980s, the GoL introduced the New Economic Mechanism (NEM) to shift from a command to a market economy (Fujita, 2006; Lestrelin *et al.,* 2012). In the forestry sector, this led to further legislation and the organisation of the first national forestry conference in 1989. The same year, the government issued several decrees on the management of forests, wildlife, hunting, and fishing, and two years later, a first logging ban was issued. An overview of relevant legislation is presented in Table 1.

All these successive decrees were accompanied by reconfigurations of the roles and duties

**Table 1.** Chronology and overview of legislation on institutional reform, forestry, land, and REDD+ in Laos. Adapted from Lestrelin *et al*. (2013b)

| Year | Legislation | Text related to: |
|---|---|---|
| | **Legislation on land and forestry** | |
| 1979 | Council of Ministers' Decree No. 74 | Protection of forest |
| 1989 | Council of Ministers' Decree No. 117 | Management and use of forest and forest land |
| 1989 | Council of Ministers' Decree No. 118 | Management and protection of wildlife, fishery, hunting, and fishing |
| 1991 | Prime Minister's Decree No. 67 | Logging ban |
| 1993 | Prime Minister's Decree No. 164 | Establishment of national biodiversity conservation areas (National Protected Areas (NPA)) |
| 1996 | Agreement of the National Assembly No. 04 This law was revised in 2007, under the agreement of the National Assembly No. 06 | Endorsement of Forestry Law |
| 1997 | Agreement of the National Assembly No. 04 This law was revised in 2003 under the decree of the President of Laos No. 61 on the promulgation of the Amended Land Law | Endorsement of Land Law |
| 2005 | Prime Minister's Decree No. 229 | Endorsement and declaration of the Forestry Strategy to the year 2020 of Laos (FS) |
| | **Legislation on forest sector institutional reforms** | |
| 2004 | Prime Minster Decree No. 67 | Organisation and function of the National Land Management Authority (NLMA) |
| 2008 | Agreement of the Ministry of Agriculture and Forestry (MAF) No. 0340 | Organisation and function of the Department of Forest Inspection (DoFI) |
| 2008 | Prime Minister's Decree No. 149 | Organisation and function of Water Resource and Environment Administration (WREA) |
| 2011 | Prime Minister's Decree No. 435 | Organisation and function of the Ministry of Natural Resource and Environment (MoNRE) |
| 2012 | Agreement of the Minister MoNRE No. 3121 | Organisation and function of the Department of Forest Resource Management (DFRM) |
| 2013 | Announcement of the Prime Minister's Office No. 314 | Transfer the responsibility of forestry projects from MAF to MoNRE |
| | **Legislation on REDD+** | |
| 2007 | Official Notice of the Prime Minister's Office (PMO) No.1896 | Appointment of MAF as the Lao member of the Forest Carbon Partnership Facility (FCPF) of the World Bank |
| 2008 | Agreement of Minister of MAF No. 1313 | Organisation and function of the National REDD+ Taskforce |
| 2011 | Decision of the Minister of MAF No. 0006 | Establishing a Taskforce Committee for implementation REDD+ activities |
| 2013 | Agreement of Minister of MAF No. 7176 | Establishing a REDD+ Taskforce for implementation of REDD+ activities |

 

of governmental bodies such as MAF. In the mid-1990s, the GoL issued the first version of the Forestry Law, which was later revised in 2007, and the Department of Forest Inspection (DoFI) within MAF was created to regulate activities in the forestry sector and file charges against offenders (GoL, 2007b). In the mid-2000s, the government launched the National Forestry Strategy (FS) with the main goal of increasing national forest cover to 70% by 2020 (GoL, 2005). In order to respond to the FS, the DoFI drafted its own strategy to work on law enforcement (DoFI, 2010). In the mid-2000s, the government created the National Land Management Authority (NLMA) to respond to land issues in the country (NLMA, 2010), and in the late 2000s, the government further created the Water Resource and Environment Administration (WREA) to deal with water resources and environmental issues (GoL, 2007c). After the establishment of the new Ministry of Natural Resources and Environment (MoNRE) in 2011, NLMA and WREA were integrated as departments of MoNRE (GoL, 2011). The creation of MoNRE also had institutional consequences for the forestry sections of MAF as the government merged the former Division of Forest Conservation and the Division of Forest Protection and Restoration at MAF's Department of Forestry (DoF) into DFRM at MoNRE (MoNRE, 2012).

The GoL ratified the UNFCCC in 1995 and the Kyoto Protocol in 2003 (GoL, 2010) and when REDD+ was proposed in 2005, it was considered a valuable instrument to support the goal of increasing forest cover to 70% in 2020. Laos joined the Forest Carbon Partnership Facility (FCPF) in 2007 and the country's Readiness Proposal Preparation (R-PP) was approved in 2011 (DoF, 2011, 2012a). In 2008, the MAF established the first National REDD+ Taskforce composed of 12 members from various organisations and with a legal mandate for (1) management of FCPF processes, (2) promotion and coordination of plans and implementation of REDD+ projects and pilot activities, (3) participation in and observation of international climate change dialogues and REDD+ negotiations, and (4) capacity building through workshops and seminars (DoF, 2010). In July 2011, the MAF expanded the number of members of the Taskforce to encompass cross-sectorial organisations (MAF, 2011). Since the establishment of MoNRE, the most recent revision of the Taskforce was undertaken in October 2013 and it now includes 24 members from 18 ministries, the National University of Laos, and three Mass Organisations: the Lao Front for National Construction, the Lao Women's Union, and the Lao Chamber of Commerce (MoNRE, 2013).

The institutional setup for REDD+ is largely structured by the forestry administration and clearly centred on the National Environment Committee (chaired by the Deputy Prime Minister) as the main body responsible for the design and validation of REDD+ related policies. The Taskforce performs a cross-ministry coordinating function, while the REDD+ Division at DFRM and the REDD+ Office at DoF oversee seven technical working groups on (1) the REDD+ legal framework, (2) Reference Emission Levels, (3) participation of ethnic groups and local communities, (4) implementation and enforcement of mitigation measures, (5) land use, (6) measurement, reporting and verification (MRV), and (7) benefit-sharing. Plans devised by stakeholders at the central level are then to be implemented at provincial level by both the Provincial Agriculture and Forestry Office (PAFO) and the Provincial Office of Natural Resource and Environment (PoNRE).

Figure 1 shows the REDD+ institutional structure as it is planned to be set up at the national and provincial levels. However, REDD+ responsibility remains divided between MoNRE (the REDD+ Division) and MAF (the REDD+ Office) that are both at the same level in the administrative hierarchy. Existing institutions are added in the red box in Figure 1, while institutions outside the red box were not yet established at the time of writing. Likewise, none of the stated working groups for REDD+ had been established at national or provincial levels. Even though development projects and international NGOs push provincial REDD+ pilot activities– for example, CliPAD supports REDD+ pilot activities in Huaphan Province– neither PAFO nor PONRE have established a provincial REDD+ unit to coordinate these activities. Even in a REDD+ pilot project area like Huaphan, concerned institutions at the provincial level wait for official approval from the national level on how to set up the institutional framework around REDD+. According to the Terms of Reference (ToR) of DFRM, the REDD+ Division is

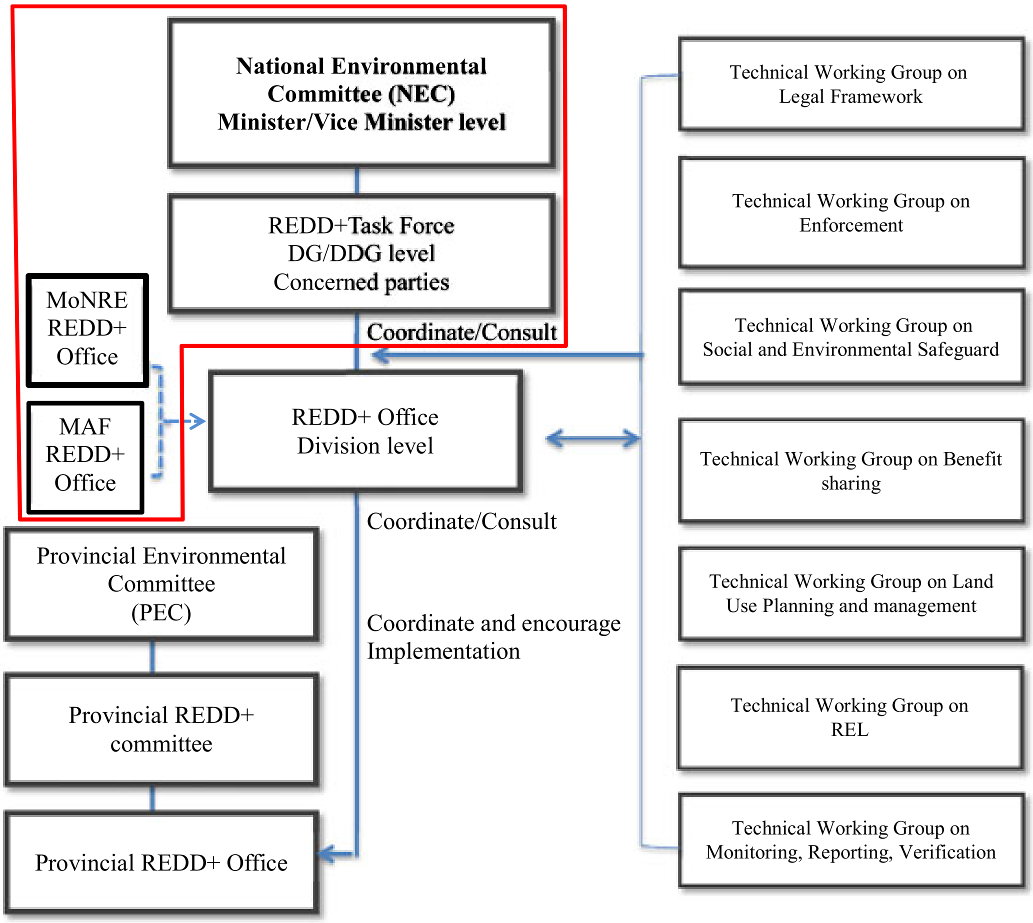


**Figure 1.** REDD+ institutional structure in Laos, implemented and planned

responsible for REDD+ policy development and implementation of pilot activities on the ground, but the human resources with knowledge of REDD+ have remained at the REDD+ Office in MAF as also confirmed by others (Dwyer and Ingalls, 2015), making MoNRE unable to push the REDD+ agenda forward.

According to the R-PP and key informant interviews, the GoL favours a jurisdictional nested approach to REDD+ under the verified carbon standard (VCS), but this is challenged by the overlapping mandates of the REDD+ Division at DFRM and the REDD+ Office at DoF (MAF, 2011; MoNRE, 2012). When the World Bank and other donor organisations requested the GoL to clarify the division of responsibilities between DFRM and DoF (FCPF, 2013a), DoF was designated as the implementing agency for FCPF and DFRM as the implementing agency for REDD+ activities supported by other donor institutions (FCPF, 2013b). Moreover, in March 2013, the GoL announced that all responsibility of forestry projects supported by foreign countries and previously handled by MAF should be transferred to MoNRE (except for REDD+ activities implemented in production forests) and that the REDD+ Division at the DFRM eventually will become the only national REDD+ unit (GoL, 2013).

These mandate redistributions raise questions of implementation capacity at the national level as shown by our interviews with governmental organisations. Different levels of understanding among key staff at national institutions were revealed by respondents from DoF and DFRM to the same question "what do you understand by REDD + ?" A respondent at the DFRM responded that "REDD+ is not very clear in the Lao context. To my understanding, it is not different from recent forest conservation in Laos. It is additional as it aims to sell carbon and improve forest law enforcement. However, since REDD+ is new for me, I am not fully aware of the plan of the government to move ahead with REDD+ and I do not have a deep understanding of REDD+ in the global context". However, the respondent at the DoF was able to explain REDD+ in much more detail: "REDD+ aims to increase forest cover with its focus on protecting the existing forests, afforestation and replanting, and sustainable use and management of forests. This fits well with our Forestry Strategy to increase forest cover to 70% in 2020. REDD+ involves many factors including political issues. The government aims to sell its carbon credits to the voluntary carbon market based on the Kyoto Protocol. However, if a new protocol is agreed, the government may sell the credits to the compliance market". Until key players have fully understood REDD+, the DFRM will be in a difficult position to coordinate REDD+ activities at the national level. This was made clear by the DoF in a story printed in the media where it was stressed that Laos progresses slowly with REDD+ because the national agencies in charge have not clearly understood the concept (Anonymous, 2014).

*Consequences of institutional reforms for REDD+ governance*

The successive institutional reforms and associated legislation in the forestry sector are challenging REDD+ implementation in Laos in three main ways. Firstly, key national REDD+ stakeholders consider their work of clarifying and implementing the institutional setup to be a higher priority and a required first step prior to actual REDD+ activity implementation. As a result, REDD+ activities were on hold for several years while institutional rearrangements were underway leaving donor organisations, international NGOs, and projects in limbo while waiting for official approval from their local counterparts. At the time of writing, though, all projects had been assigned to the REDD+ Division at MoNRE.

Secondly, insufficient human resources coupled with limited financial resources to support the work of governmental institutions and insufficient coordination in forestry-sector institutions create mismanagement and misuse of land and forest resources (GoL, 2008; Lestrelin *et al.,* 2012). This is reinforced by the minimal local participation in land-use and forest-management planning. Our interviews indicated that negotiation, understanding, and implementation of the plans, as well as regulations on the ground, are all hampered by limited access to information and limited planning experience of local communities, poor facilitation capacities of district planners, and absence of incentives for follow-up monitoring and extension. Likewise, land use planning is hardly followed in practice by local communities as emphasised by technical staff from PoNRE: "although land use planning has been done in all villages in Hua Meuang District, not all villages have regulation on land and forest management. Even in villages that received the regulation, it is not fully enforced since technical staff from the district just handed the regulation to the villages without training and explanation. Part of this is because technical staff at the district does not fully understand the regulation and have limited funds to follow up on activities outlined in the land use planning". This lack of both clarity of what land use planning entails and capacity of district and provincial staff to act on plans make follow up activities of land use planning very difficult (Castella *et al.,* 2014). In addition, the overlapping roles during the initial phases of the institutional reform when MoNRE was created, coupled with legal exceptions and policy loopholes, create opportunities for the private sector to establish deals on land investment and forest-resource extraction with little or no participation of local communities (Barney, 2007; Baird, 2010; Kenney-Lazar, 2010; Barney and Canby, 2011).

Thirdly, the slow progress of REDD+ related policy development and revision appears also as a consequence of the need to revise legislation. The GoL, with strong support from donor and civil-society organisations, is responsible for developing the national legal framework for REDD+, but as the land and forestry laws (GoL, 2003, 2007a) are under revision, REDD+ is effectively on stand-by. These laws clearly state that land and forest resources are national property that local communities have rights to manage and develop and that these rights should be respected. However, the laws do not state clearly at which level of decision-making local communities shall be engaged, and implementation of the laws diverge from the texts. There is strong pressure nationally from civil society and internationally to clarify these land and resource tenure issues without which REDD+ will remain controversial and a source of potential conflict in Laos – as is unfortunately also the case in many other countries (Sunderlin *et al.,* 2009).

 

*Local forest management and governance of REDD+*

The national discrepancies of responsibility between the DoF and the DFRM are mimicked at provincial and district levels. In Huaphan Province, although the REDD+ activities are listed as part of the mandates for PoNRE, the provincial governor assigned one person from PAFO to be the provincial REDD+ coordinator. This forestry official had not participated in any REDD+ training or workshops before his assignment and had limited knowledge on REDD+. However, since the government announced its plans to transfer forestry projects supported by foreign institutions from MAF to MoNRE (GoL, 2013), the provincial REDD+ coordinator position was subsequently given to the Forestry Section at PoNRE. Delegates at the workshop in Huaphan, 10 March, 2015, emphasised how the unclear distribution of roles and responsibilities between PAFO and PoNRE and their line offices at the district level have made it challenging to work with REDD+. They argued that communication channels and human resource allocation have been muddled, but Ministry rivalry is probably also a cause since the proximity of offices in the small provincial capital of Xam Neua should in fact facilitate communication.

Thus, there appears to be a holding back of information between the different administrative levels, as well as between different line ministries. This creates a situation where institutions are keeping each other waiting for clear roles to be assigned to each of them, and waiting for the other to be the first to share information. Rapid staff turnover negatively influences the capacity building of staff on REDD+, and workshop delegates also identified a lack of knowledge transfer from departing staff to their replacements. Thus, design and planning of REDD+ at the sub-national level rely heavily on external experts funded by international development agencies. Furthermore, since the District Office of Natural Resource and Environment (DoNRE) is a newly established institution, there is a lack of forestry staff working at the DoNRE in Hua Meuang and former Viengthong Districts and they rely on staff from the District Agriculture and Forestry Office (DAFO) when working on forestry, including REDD+. Consequently, both REDD+ and other forestry activities progress very slowly at both district and provincial levels.

Despite participatory spatial planning programs aimed at strengthening local consultation and resource governance, in practice, there is still limited devolution of decision-making power to village and district levels. Combined with the inadequate allocation of state resources for forest monitoring and management to province and district levels, this raises questions about how REDD+ schemes will incorporate local communities' interests and responsibilities. Villagers located close to the core-zone of the NPA are involved in patrolling and biodiversity surveys, but the selection process is unclear and organisations like the Wildlife Conservation Society and the CliPAD project are pushing for more transparent, efficient, and equitable REDD+ benefit-sharing mechanisms. Moreover, staff at forestry offices in the province and districts suggests that if the government aims to sell carbon credits and ensure co-benefits such as poverty reduction, local communities should receive at least 60% of the revenue from carbon projects implemented in their managed forested areas. This is higher than what donor representatives expected would be achievable, but it indicates that local governmental staff recognises the need for sharing benefits with communities.

Whether these benefits will be competitive with other activities is another matter. REDD+ projects will be in direct competition with expanding cash crops, concessions and infrastructure (Dwyer and Ingalls, 2015), and in the case study villages good income is earned from hybrid maize cultivated under contract farming (Vongvisouk *et al.,* 2014, 2016). Although the land use plans have limited the areas to be used for agricultural purposes, villagers have managed to greatly expand the maize cultivation area (Vongvisouk *et al.,* 2016). For example, in Homephan villagers turned the area delineated as village production forest into a maize cultivation area and feeder road expansion to the maize cultivation area is progressing without being controlled by Hua Meuang District authorities. The local government turns a blind eye to economic activities that are hardly compatible with REDD+, and this could probably be labelled as part of what Dwyer and Ingalls term 'planned deforestation', which remains an obstacle to REDD+ implementation all over Laos (Dwyer and Ingalls, 2015).

## Discussion

It had been expected that REDD+ could contribute to overcoming current complex issues related to land and forest resource governance in Laos. However, the GoL efforts to improve forest governance have been inhibited by the weak law enforcement at both national and sub-national levels and despite formal assignment of responsibility on REDD+ at the sub-national level to one institution (i.e. PoNRE), no practical leadership has been achieved. This is partly because PoNRE has insufficient human resources, and partly related to the limited decision power to drive REDD+ ahead, as provincial institutions still wait for institutional clarity from the national level. The result is slow progress of REDD+ implementation on the ground. Moreover, institutional reforms and high staff turnover create a never-ending need for technical capacity building on forestry and REDD+ at all levels of government.

International actors can play a crucial role in facilitating information flows between organisations involved in REDD+ and the limited agency among domestic actors is interpreted by Dkamela *et al.* (2014) as an indicator of low levels of national ownership of the REDD+ process. While the international actors also have a key function for pushing REDD+ forward and providing information and training in Laos, there is at the same time limited political space for civil society actors to influence REDD+, a situation that is very similar to what is reported from Vietnam (Pham *et al.,* 2014, 2015). Korhonen-Kurki *et al.* (2014) found that strong national ownership of the REDD+ process, in combination with the presence of transformational coalitions between state and non-state actors and consideration of halting planned deforestation (Dwyer and Ingalls, 2015), are necessary conditions for positive REDD+ outcomes.

Local land and forest management in Laos appears to be based on many individual and minimally coordinated decisions by different government agencies and staff at national, provincial, district and village levels, resulting in what Lund (2011) calls fragmented sovereignty. This situation could make enforcement of rules and legislation related to REDD+ very difficult, especially as private investments in land development may proceed locally without coordination at national level (Lestrelin *et al.,* 2013a).

This situation is not unique to Laos and a comparative study of policy actor networks related to REDD+ in seven countries found that all national REDD+ policy areas are "still dominated by powerful business-as-usual interests" (Brockhaus et al., 2014a). However, as Brockhaus *et al.* (2014b) remind us, "Implementation deficits often arise because of the lack of political support" emphasising that the most important constraint for cross-sectorial coordination – a must for REDD+ implementation – is of political nature. Although all of the six countries analysed by Brockhaus *et al.* (2014b) have engaged in institutional reforms, they have failed to address cross-sectorial policy impacts and they maintain political power-structures that reinforce business-as-usual by not dealing with drivers of deforestation and forest degradation, as also shown in Laos by Dwyer and Ingalls (2015). The absence of brokers between state and non-state actors leads to a fragmented REDD+ policy arena and limits information flows (Gallemore *et al.,* 2014; Moeliono *et al.,* 2014), letting top-down approaches dominate the REDD+ policy development and this is unlikely to be an efficient setup for leveraging the adaptive management required for REDD+ (Brockhaus *et al.,* 2014a).

The situation in Laos provides a compelling example of how difficult REDD+ implementation has proven to be in countries where institution building is still in process, but it should also be recognised that there is a paucity of governance models for Laos to follow given the similar situation in many other countries (Korhonen-Kurki *et al.,* 2014). Even in large countries like Indonesia, where the national REDD+ agency was the driving force for REDD+ awareness and government commitment, new institutional restructuring seems to hamper more than advance the REDD+ agenda (Astuti and McGregor, 2015). There, as in Laos, it is obvious that the current governance conditions for REDD+ are not conducive to policy and implementation advances that will fulfil the promises of REDD+ as a driver of better land and forest governance. The persistent lack of resources and limited capacity for law enforcement and monitoring at the subnational level are also not specific to Laos (Romijn *et al.,* 2012). Likewise, the loss of institutional memory and high staff-turnover is a common problem in many developing countries and the pace of REDD+ policy formulation is generally much slower than initially expected (Angelsen and McNeill, 2012).

## Conclusions and perspectives

We have shown that REDD+ is on hold, or at best progressing slowly, in Laos, and while many countries are experiencing similar problems, the deadlock in Laos appears to be more persistent. More than eight years into the REDD+ readiness plan it is still unclear who, at which level, has the responsibility to drive REDD+ ahead. The institutional restructuring that created a new ministry and with it a lot of confusion regarding responsibilities, information flows and decision-making power is partly to blame. However, given the strong official commitment to the REDD+ mechanisms and the hope that it would support the government's goal of increasing forest cover to 70% in 2020, it is puzzling that there has not been more push to ensure implementation and resolve the administrative and institutional issues that have undermined practical implementation of REDD+.

Besides the lack of capacity to establish a functional governance system that can handle REDD+ implementation, the strong interests in economic development have also taken the focus away from REDD+ and pulled the limited human and financial resources of the country in their direction. It could thus appear that only the presence of international donor organisations and their push for REDD+ pilot projects has kept REDD+ on the table. As it stands, it is unclear when or if Laos will be ready for reaping the potential benefits of the COP21 decision on REDD+. Policy reforms and institutional reorganisation have been carried out, but they have so far mainly resulted in stalling REDD+ progress.

It may of course be argued that the governance and institutional issues blocking REDD+ are only minor problems and that the core of the problem lies with the REDD+ idea itself. Numerous critics have pointed to how difficult REDD+ will be to put into practice (Karsenty and Ongolo, 2012; Mertz *et al.,* 2012; Müller *et al.,* 2014; Ankersen *et al.,* 2015) and even if all the governance issues in Laos discussed here are resolved, REDD+ might still not be feasible to implement. This, however, is a wider discussion that will be better elucidated in the years to come as many countries are now in the final stages of REDD+ preparation.

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# Forest Cover Changes in Lao Tropical Forests: Physical and Socio-Economic Factors are the Most Important Drivers

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**Abstract:** Lao People's Democratic Republic (PDR) has been experiencing significant forest depletion since the 1980s, but there is little evidence to demonstrate the major causes and underlying drivers for the forest cover changes. In this study, we investigated the relationship between forest cover decrease and increase in the south of Lao PDR between 2006 and 2012 and selected physical and socio-economic factors. We used a map of forest cover changes derived from analysis of Landsat ETM+ imagery in 2006 and 2012, together with socio-economic and physical environmental data from the national authorities. The study area has experienced noticeable forest cover changes: both forest decreases and increases were unevenly distributed throughout the region. Logistic regression models were used to test relationships between forest cover decrease or increase and selected physical and socio-economic factors. Forest clearance was associated strongly with elevation, distance to main roads and shifting cultivation practices. Meanwhile, forest cover increase was more likely to correlate with rubber plantations. Native forest and shifting cultivation lands were vulnerable to being converted into rubber plantations. This research provides much-needed information on which to base forestry policy and decision making to minimize and prevent current deforestation, as well as manage potential risks in the future.

**Keywords:** Lao tropical deforestation; forest cover change; Landsat ETM+; elevation; socio-economic factors; logistic regression analysis

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## 1. Introduction

Lao People's Democratic Republic (PDR) was once one of the countries with the richest biodiversity in Southeast Asia. However, the country has undergone profound forest and land cover changes over the last few decades. Deforestation has become a crucial issue in the country. The deforestation rate has increased alarmingly since the 1980s (Robichaud et al., 2009 [1]). Forests covered nearly 50% of the country in 1982, but dropped to 41% in 2002, before gradually decreasing to 40% of the total land area by 2010 (Department of Forestry 2011 [2]; Vongsiharath 2011 [3]). This 40% of forest cover can be mixed with secondary forests, plantations and bamboo, as indicated by a rapid assessment in 2010 (Forest Carbon Partnership Facility 2014 [4]), and the share of primary forest within this estimation is unclear. To address this forest decline, the government of Laos has set an ambitious target to increase forest cover up to 70% by 2020 through afforestation, reforestation and stabilization of shifting cultivation (Ministry of Agriculture and Forestry 2005 [5]). Meanwhile, foreign direct investment in forestry and agriculture, along with land leases and concessions, has been promoted (The National Land Management Authority 2004 [6]). Despite this, the country has recently been experiencing forest and land use transformation to plantations, resulting in controversies about the decrease of native forests in the area. Phimmavong et al. (2009) [7] observed that between 1990 and 2007 the area of plantations, especially rubber plantations, increased dramatically from 1000 ha to over 200,000 ha. In addition, shifting cultivation practices or mountainous agriculture are considered as a critical environmental issue for forest resources. Approximately 6.5 million ha of forest were replaced by shifting cultivation during the 1990s (Messerli et al., 2009 [8]; Sovu et al., 2009 [9]).

There is growing concern over the depletion of the area of tropical forests in Laos. Its forests have been declining at an alarming rate, although the causes or factors associated with this depletion are poorly understood and the responses of tropical forests to environmental changes remain unknown. Both socio-economic and physical factors have important influences on forest depletion. Lao PDR has made rapid progress in its national socio-economic development (Asian Development Bank 2015 [10]; Organisation for Economic Cooperation and Development 2013 [11]); however, the relationship between this development and forest cover changes in the country is unclear. This has increased the nation's efforts to explain the causes of deforestation and conversion of forests to other land uses.

Understanding these spatial relationships and complexities can offer insight into the effective maintenance of forest resources. Identifying driving forces affecting forest cover changes is essential, as this would allow policy and decision makers to understand ongoing land use management and processes of deforestation, as well as their effects on the environment (Meyfroidt et al., 2013 [12]; Vu et al., 2014b [13]). Understanding the links between socio-economic and physical factors and forest cover changes at a national level is important to inform appropriately targeted policies, plans and strategies for combating deforestation Vu et al. (2014a) [14]. This research will provide key information on which to base forestry policy and decision making in Lao PDR to minimize and prevent deforestation, as well as manage potential risks in the future.

Worldwide, several studies have been undertaken to identify the drivers or associated factors of forest cover changes (Bhattarai et al., 2009 [15]; Casse et al., 2004 [16]; Pineda et al., 2010 [17]; Ryan et al., 2014 [18]; Scullion et al., 2014 [19]; Vu et al., 2014b [13]; Webb et al., 2014 [20]), and are useful in developing predictive deforestation models and suggesting implications for national forest and land management policy. The key factors in forest cover changes are often physical conditions, such as elevation and slope, as illustrated by studies by Mon et al. (2012) [21] and Bhattarai et al. (2009) [15]. In addition, socio-economic factors at local and national levels can also influence patterns of tropical deforestation. For example, it was found that deforestation in China was associated with infrastructural parameters such as the location of rivers, roads and settlements (Gao and Liu 2012 [22]; Du et al., 2014 [23]; Mon et al., 2012 [21]).

In Lao PDR, as in many developing countries, identifying and understanding the primary causes of these changes remains challenging. There is little evidence to understand the causes and underlying drivers of forest cover changes. Detailed and in-depth studies are still rare and the issue needs to be urgently investigated. Therefore, the primary objective of this research was to investigate the relationship between the changes in the spatial patterns of forest cover and physical and socio-economic factors that have taken place in the south of the Lao PDR. We investigated this relationship by analysing forest cover changes mapped from satellite imagery in relation to socio-economic and physical data from the Lao government. The south of Lao PDR was selected as a study area due to its recent intensive land cover change and rapid foreign investment and development. The study is an important step in understanding the relationship between socio-economic and physical characteristics and forest cover changes, particularly in Laos, and to illustrate the complex interaction between the human and natural environments at national level. The study provides better understandings of socio-economic and physical drivers of forest cover change at local and regional scales and demonstrates an approach which may be scaled up to national level.

## 2. Materials and Methods

### 2.1. Study Site

The study region is located in the south of Lao PDR, covering large areas of three provinces: Savannakhet, Salavan and Champasak (Figure 1). The area is approximately 23,500 km$^2$, including parts of the Annamite mountains (known as Xai Phou Luang) and borders Vietnam in the east. The study area covers nearly 10% of the country. The altitude within the area ranges from 20–1700 m above sea level, with an average elevation of 300 m.

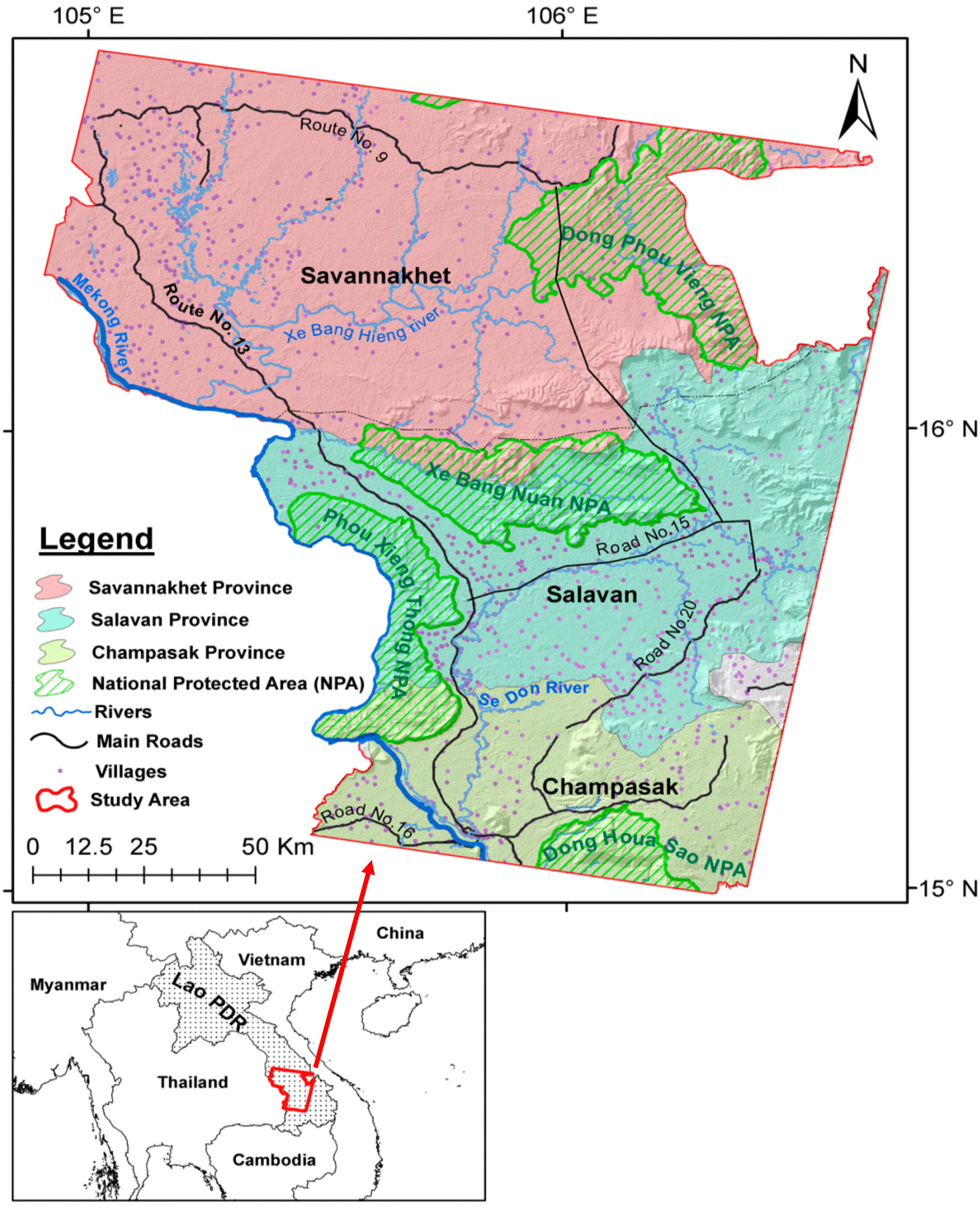


**Figure 1.** The location of the study area in the south of Lao People's Democratic Republic (PDR), showing provincial boundaries, national protected areas, rivers, roads and village locations.

The biggest river in the area is the Mekong River, which serves as a significant transport channel and essential food source for the Lao people. In addition, there are several other important rivers in this region including Xe Bang Fai, Xe Nou and Xe Bang Hieng in Savannakhet territory. The Se Don River flows through the Salavan province and eventually joins the Mekong River at Pakse, Champasak province.

The main road is Route No. 13, which connects the north to the south. There are also four important roads, including Routes 9, 15, 16 and 20, which cross the region from west to east. These connect within the provinces and extend to the Vietnam border. A large population is settled closely along the roads. There are a total of 1363 villages within the study area.

The study area covers four national protected areas (NPAs): Dong Phou Vieng, Xe Bang Nuan (located in Savannakhet and straddling the border with Salavan Province), Phou Xieng Thong (located between Salavan and Champasak), and Dong Houa Sao (situated in Champasak). These NPAs are rich in forest and wildlife species. The forests located in these areas are evergreen, dry dipterocarp and mixed deciduous and are important natural habitats for wildlife. However, much of the forest within the study area has been the target of heavy logging since the 1980s. After the investment policy on agriculture and forestry was promoted in 2004, the conversion of native forests to other land uses has become controversial, especially in the Southern part of Laos. In addition, this region is thought to have the most extensive illegal timber smuggling, with much illegal trade crossing the border between Laos and Vietnam.

### *2.2. Forest Cover Change between 2006 and 2012*

We used a map of forest cover changes between 2006 and 2012 presented in Phompila et al. (2014) [24]. This forest cover change map covered approximately 23,500 km$^2$ across 24 districts of three provinces: Savannakhet, Salavan and Champasak. The map was derived from Landsat ETM+ images in 2006 and 2012 using Principal Component Analysis (PCA) and was evaluated using high-resolution Google Earth$^{TM}$ images from the same years. The map identified areas of forest cover decrease and increase as well as areas where forest cover appeared unchanged. One principal component was interpreted as showing forest cover change between the two dates, and was classified into three classes (forest remains stable, forest increase and forest loss) using a standard threshold. The Landsat forest change classes were compared with a reference change map derived from digitization of vegetation cover classes in Google Earth images (2006 and 2012), and showed an overall accuracy of 87%, Kappa = 0.8 (Phompila et al., 2014 [24]).

### *2.3. Physical and Socio-Economic Factors*

We investigated a total of eight physical and socio-economic variables (Table 1), influenced by the availability of relevant data in our study area. Information on elevation and slope can provide an indication of access to forest and land use. Vu et al. (2014a) [14] suggested that forest areas located on steep slopes or high elevations can create difficulties in access for people utilizing forest resources or transforming land into agricultural areas. About 80% of Lao people live in rural areas and depend on forest resources. The shifting cultivation is a major source of food for farmers in upland areas. The cutting down and the burning of trees and grasses and basic slope cultivation without soil conservation practices have resulted in land degradation. This leads to more disturbances to native forests or further to land-use pattern changes. Thus, we investigated whether elevation and slope influence population pressure on the forest.

**Table 1.** A summary of the spatial data used to produce variables for our logistic regression models of factors associated with forest cover increase and decrease in the south of Lao People's Democratic Republic (PDR).

| Data | Source | Unit |
|---|---|---|
| **Dependent Variables** | | |
| Forest cover increase from 2006 to 2012 | Landsat ETM + (Phompila et al., 2014 [24]) | Categorical data (Yes = 1, No = 0) |
| Forest cover decrease from 2006 to 2012 | Landsat ETM + (Phompila et al., 2014 [24]) | Categorical data (Yes = 1, No = 0) |
| **Independent Variables** | | |
| Elevation | NASA GDEM | m |
| Slope | NASA GDEM | % |
| Distance to main roads | FFS | km |
| Distance to rivers | FFS | km |
| Distance to villages without rubber plantations or shifting cultivation | NSC | km |
| Distance to villages with rubber plantations | NSC | km |
| Distance to villages with shifting cultivation | NSC | km |
| Distance to protected areas | DOF | km |

Sources: NASA GDEM = National Aeronautics and Space Administration Global Digital Elevation Model; NGD = National Geographic Department; NSC = National Statistic Centre; DOF = Department of Forestry; FFS = Faculty of Forestry Sciences; National University of Laos.

Another key element to facilitate access to the forest resources is improved infrastructure development, such as road networks and river routes. Many studies have found that these factors can increase pressure on forest and land use (Du et al., 2014 [23]; Gao and Liu 2012 [22]). Therefore, we examined whether distances from main roads and rivers influence forest cover changes. The roads were limited to well-developed roads main only, such as paved roads which connect between provinces, districts or towns, and excluded unpaved roads or forest trails.

Conservation forest and protected forest areas are rich in biodiversity. Conservation forests are forests classified for the purposes of conserving nature, preserving plant and animal species, forest ecosystems and other valuable sites of natural, historical, cultural, tourism, environmental, educational and scientific research experiments. On the other hand, protected forests are forests with important ecosystem functions such as the protection of water resources, river banks, soil quality, natural disaster and preventing soil erosion, as well as strategic areas for national defense. The government of Laos has ambitious goals for preserving its forests, but achievements are negligible due to a lack of human and financial resources. Meanwhile, national economic development throughout land concessions, timber extraction, and large-scale mining and hydropower developments are priorities. Thus, achieving economic development growth and sustainable uses of forest resources is challenging. We assumed that the abandonment of forest resources without a strong protection mechanism could increase the risk of illegal forest timber exploitation. It is essential to examine whether this is a factor associated with deforestation. The location of villages is also important for assessing how people achieve access to forest resources (Bhattarai et al., 2009 [15]; Du et al., 2014 [23]; Getahun et al., 2013 [25]; Mon et al., 2012 [21]). Closer distances to the forest resources may increase the rate of deforestation. Thus, we hypothesized that the village locations would have some degree of correlation with a decrease in forest cover.

### 2.4. Elevation and Slope

Elevation data was obtained from the Global Digital Elevation Model (GDEM), derived from Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) images. This data is under the administration of the Ministry of Economy, Trade, and Industry (METI) Earth Remote Sensing Data Analysis Center (ERSDAC) in Japan and the National Aeronautics and Space Administration (NASA) in America. The data was downloaded from the NASA site in a Geo-referenced Tagged Image File Format (GeoTIFF) (http://earthexplorer.usgs.gov/). Slope data was generated from this GDEM data using the Spatial Analyst tool in ArcGIS 10.2 software (ArcGIS Desktop Help 10.2 Geostatistical Analyst, Environmental Systems Research Institute (ESRI), Redlands, CA, USA, 2014).

### 2.5. Distance to Main Roads, Rivers, Protected Areas and Villages

The road and river data was collected from the Research Division, Faculty of Forestry Sciences (FFS) at the National University of Laos. The locations of villages were derived from population census data, distributed by the Lao National Statistic Centre. The population survey was conducted in 2011/2012 by the Department of Forestry (DOF), Ministry of Agriculture and Forestry. Villages were categorized into three groups: villages without rubber plantations or shifting cultivation, villages with rubber plantations and villages with shifting cultivation. A protected area map was also obtained from the DOF. The distance of forest areas to main roads, rivers, protected areas and villages were measured using the "Near" tool, based on Euclidean distance in ArcGIS10.2 from four different GIS layers derived from this data: main roads, rivers, protected areas and village locations.

### 2.6. Sampling Procedure

We established a random sampling system within the study area using the Random Point tools in ArcGIS 10.2.1, producing a total of 5000 sample points. To ensure a better spatial distribution and minimize the effects of spatial autocorrelation, a minimum distance of 1 km between points was chosen as recommended by Linkie et al. (2004) [26], Mon et al. (2012) [21] and Vu et al. (2014a) [14]. Ultimately, 4998 sample points were used due to missing values from the elevation dataset. The attributes of both dependent and independent variables were extracted for each random sample and then analyzed using R scripts and packages in RStudio software (Version 1.0.136, Integrated Development for R. RStudio, Inc., Boston, MA, USA, 2016, URL http://www.rstudio.com).

### 2.7. Data Analysis

We applied logistic regression models to investigate the relationship between forest cover change and the chosen physical and socio-economic factors. Logistic regression allowed us to evaluate the probability of membership in one of the groups, based on the combination of the independent variables.

The logistic regression model assumes that the variables are normally distributed, so we tested for normality of our sampling data. Variable data was transformed by log10 and then tested for normality through a chi-squared test using the chisq.test () function in R.

Strong collinearity between the independent variables is undesirable when applying a logistic regression model as it can cause unstable estimates and inaccurate variances which affect the confidence intervals and hypothesis tests in statistical models (Hosmer and Lemeshow 2000 [27]; Midi et al., 2010 [28]; Mon et al., 2012 [21]; Vu et al., 2014a [14]). Thus, the collinearity between each independent variable was tested with Pearson's correlation coefficients using the cor () function in the R software. It has been suggested that the level of collinearity of the independent variables must be below an acceptable threshold of 0.7. Results of the paired independent variable correlation tests are shown in Table 2. In our case, none of our independent or explanatory variables exceeded this collinearity level. Only three pairs of variables showed a moderate degree of collinearity: elevation and distances to villages without rubber plantations or shifting cultivation ($r$ = 0.41), distance to main roads and distance to villages with shifting cultivation ($r$ = 0.40), and elevation and distance to rivers ($r$ = 0.32). Thus, all of the variables were considered to be acceptable for use in the logistic regression analysis.

**Table 2.** Collinearity of the seven predicted variables used in the logistic regression analyses.

| Elevation | | | | | | |
|---|---|---|---|---|---|---|
| 0.24 | Slope | | | | | |
| 0.14 | 0.09 | Distance to main roads | | | | |
| 0.32 | 0.07 | −0.03 | Distance to rivers | | | |
| 0.41 | 0.17 | 0.21 | 0.20 | Distance to villages without rubber plantations or shifting cultivation | | |
| −0.09 | 0.02 | 0.15 | 0.00 | −0.04 | Distance to villages with rubber plantations | |
| 0.08 | 0.04 | 0.40 | −0.09 | 0.11 | 0.11 | Distance to villages with shifting cultivation |

Forest increase and decrease between 2006 and 2012 was used as two binary dependent variables, each expressed as two categories: change and no change. We used two separate regression models because we expected different factors contributing to forest clearance or increase. A total of seven socio-economic variables were used in the analysis including elevation, slope, distance to main roads, distance to rivers, distance to villages without rubber plantations or shifting cultivation, distance to villages with rubber plantations and distance to villages with shifting cultivation. The distance to protected areas variable was excluded due to its non-normal distribution. We noted if there were any outliers in our data because outliers can create statistical problems in logistic regression models (Mon et al., 2012 [21]). No outliers existed in our data. We examined the levels of statistical confidence in each independent variable in the results. We also used the receiver operating characteristic (ROC) statistics and the Hosmer and Lemeshow test to measure the goodness-of-fit of the logistic regression model, as suggested by Mon et al. (2012) [21] and Vu et al. (2014a) [14]. Our analysis was conducted using statistic R software.

## 3. Results

### 3.1. Distribution of Changes in Forest Cover between 2006 and 2012

Figure 2 is a map from the previous study by Phompila et al. (2014) [24] that shows forest cover changes between 2006 and 2012 within the study area. Overall, it appears that a large proportion of the forest cover areas remained stable between 2006 and 2012 (94.6%). However, forest cover in the study area decreased by 2.8% and increased by 2.6%. Forest cover increase is found in all three provinces: Savanakhet, Salavan and Champasak. The contribution to this increase in forest cover is from plantations: mostly rubber. A large proportion of mixed wooded/cleared land was transferred to plantations. Noticeable areas of increase are located in Phin, Sepon, Thapanthong and Bachiangchaleunsouk districts. This increase is close to the national protected areas (NPA): Dong Houa Soa and inside the Dong Phou Vieng and Xe Bang Nouan NPA. There are about 37 villages located inside the NPAs that contributed to the increase in forest cover, including 21 shifting cultivation villages. A majority of shifting cultivation areas in these two NPAs was transformed to rubber plantations, resulting in an increase of forest cover.

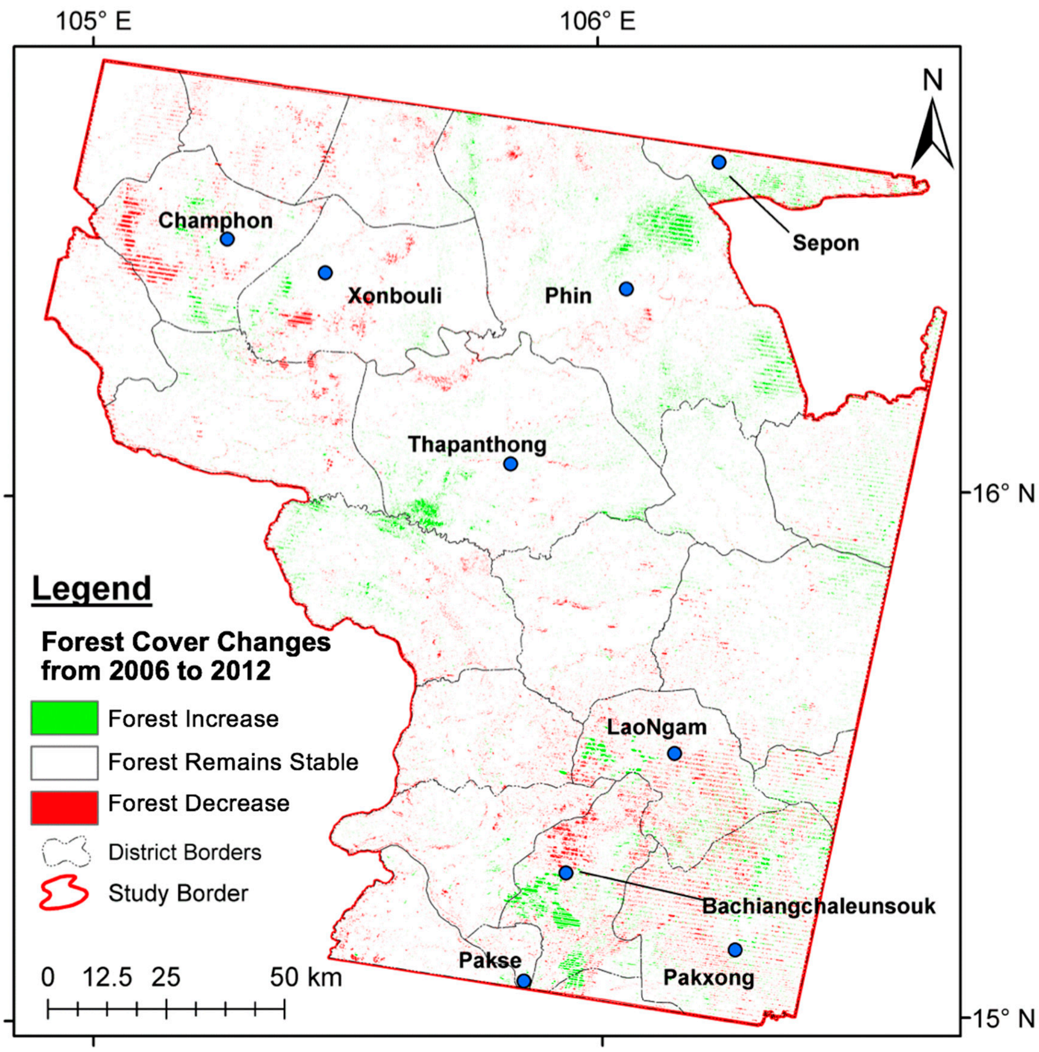


**Figure 2.** Forest cover changes from 2006 to 2012 derived from Landsat ETM+ images and evaluated by high-resolution Google Earth™ images (Phompila et al., 2014 [24]; Phompila et al., 2015 [29]). Forest that remains stable are areas that appear to exhibit little or no change between the images; forest cover increase indicates areas that show an increase in forest cover such as the transition from mixed wooded/cleared areas or bare land to plantation; forest cover decrease indicates the clearance or loss of forest, i.e., the transition of native forest to mixed wooded/cleared areas, shifting cultivation areas, or agricultural land.

However, forest cover decrease is notable in Champasak and Savanakhet provinces. The areas of most significant decrease appear in LaoNgam district, Salavan province andBachiangchaleunsouk, and Pakxong district near Pakse city centre and the north of Champasak province, as well as in Champhon and Xonbouli district, Savanakhet province.

Using high resolution Google images in 2006 and 2012, we found that forest increase appears to have resulted largely from the establishment of plantations, especially rubber: rubber plantations were recognized by their regular tree canopy patterns and spacing. Forest removal occurred around 2006 and was replaced by rubber and regrowth later (Figure 3a–d). Meanwhile, forest cover decrease was likely to have been derived from forest transformation into shifting cultivation lands or to rubber plantations.

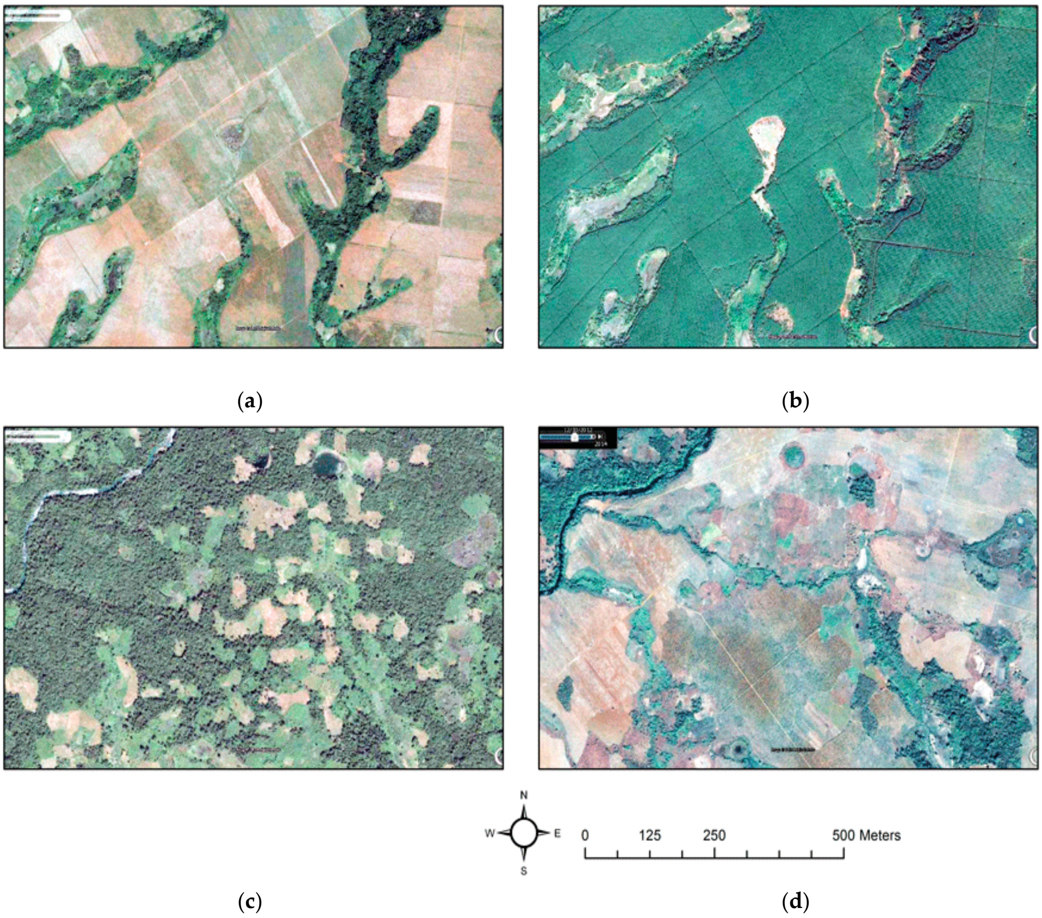


**Figure 3.** Google[TM] Images showing forest cover changes from 2006 to 2012 in two locations: (**a**) land preparation in 2006; (**b**) full canopy of rubber plantations in 2012; (**c**) forest and shifting cultivation areas in 2006; (**d**) massive forest and land clearances apparent in 2012.

### *3.2. Factors Associated with Forest Cover Changes*

Three physical and socio-economic variables have significant effects on the spatial extent of forest cover decrease, including elevation, distance to main roads, and distance to villages with shifting cultivation (Table 3). These were the most important predictors of forest cover decrease between 2006 and 2012. The logistic regression model showed that elevation was most significantly correlated with the likelihood of forest cover decrease in the study area ($p < 0.01$; and highest Wald value, Table 3). This positive correlation revealed that land at higher elevations was more likely to decrease in forest cover, especially in the south of the study area. The forest cover decrease was found to correlate negatively with distances to main roads ($p < 0.05$): there was more disturbance to native forests closer to roads. In addition, the distances to villages with shifting cultivation was the third strongest influential factor for forest depletion ($p < 0.05$). Forests located at a closer distance to these villages were more likely to be disturbed. However, other variables were not significant in the logistic regression analysis, including slope, distance to rivers, distance to villages without rubber plantations or shifting cultivation, and distance to villages with rubber plantations.

**Table 3.** Results of regression analyses for identifying associated factors of forest cover decrease between 2006 and 2012 in our study area.

| Variables | Coefficient | S.E | Z-Value | *p*-Value |
|---|---|---|---|---|
| Elevation | 3.578 | 0.917 | 3.903 | 0.000 |
| Slope | −2.209 | 1.954 | −1.130 | 0.258 |
| Distance to main roads | −0.781 | 0.374 | −2.086 | 0.037 |
| Distance to rivers | −0.623 | 0.432 | −1.443 | 0.149 |
| Distance to villages without rubber plantations or shifting cultivation | 0.142 | 0.671 | 0.212 | 0.833 |
| Distance to villages with shifting cultivation | −1.030 | 0.519 | −1.987 | 0.047 |
| Distance to villages with rubber plantations | 0.216 | 0.501 | 0.431 | 0.667 |
| (Intercept) | −4.265 | 3.824 | −1.115 | 0.265 |
| Null deviance = 260.76 on 4997 degrees of freedom | | | | |
| Residual deviance = 223.71 on 4990 degrees of freedom | | | | |
| Akaike Information Criterion (AIC) = 239.71 | | | | |
| n = 4998; B = coefficient; S.E. = standard error; *z*-value = Wald *z*-statistic | | | | |
| Nagelkerke $r^2 = 0.15$ | | | | |
| Hosmer and Lemeshow test = *X*-squared = 6.5256, df = 8, *p*-value = 0.589 | | | | |
| Area under Receiver Operating Curves (ROC) = 0.848 ($p < 0.001$) | | | | |

Note: In the logistic regression, the Wald value is normally used to determine whether a certain predictor dependent variable (X) is significant or not. We reject the null hypothesis if it is zero.

Both the Hosmer and Lemeshow and ROC tests indicate the results of the model are acceptable. The goodness-of-fit test statistics are acceptable, according to the criteria of Mon et al. (2012) [21] and Vu et al. (2014a) [14], whilst the Hosmer and Lemeshow test provides a non–significant value ($p = 0.589$). The area under the ROC curve (theoretically ranging from 0.5 to 1.0) was used as the basis for evaluating the model's performance (Vu et al., 2014a [14]). In our case, the area values of 0.848 ($p > 0.001$) demonstrate excellent performance.

The logistic regression model indicated that the probability of forest cover increase in the study area from 2006 to 2012 was significantly correlated to distances to villages with rubber plantations and distances to villages with shifting cultivation variables used in the regression model ($p < 0.05$ and $p < 0.1$, respectively; Table 4). We found that these variables were negatively associated with an increase in forest cover. A closer distance to these villages was related to a greater increase in forest cover. However, in our analysis, the following factors were not significantly associated with forest cover increase: elevation ($p = 0.369$), slope ($p = 0.929$), distance to main roads ($p = 0.369$), distance to rivers ($p = 0.929$), and distance to villages without rubber plantations or shifting cultivation ($p = 0.929$).

**Table 4.** Results of regression analyses for identifying associated factors of forest cover increase between 2006 and 2012 in our study area.

| Variables | B | S.E | *z*-Value | *p*-Value |
|---|---|---|---|---|
| Elevation | −0.820 | 0.915 | −0.896 | 0.370 |
| Slope | −0.161 | 1.950 | −0.082 | 0.934 |
| Distance to main roads | −0.051 | 0.427 | −0.119 | 0.905 |
| Distance to rivers | 0.670 | 0.521 | 1.285 | 0.199 |
| Distance to villages without rubber plantations or shifting cultivation | 1.055 | 0.708 | 1.491 | 0.136 |
| Distance to villages with shifting cultivation | −0.905 | 0.502 | −1.802 | 0.072 |
| Distance to villages with rubber plantations | −1.512 | 0.487 | −3.104 | 0.002 |
| (Intercept) | 0.025 | 3.595 | 0.007 | 0.995 |
| Null deviance = 293.43 on 4997 degrees of freedom | | | | |
| Residual deviance = 262.98 on 4990 degrees of freedom | | | | |
| Akaike Information Criterion (AIC) = 278.98 | | | | |
| *n* = 4998; B = coefficient; S.E. = standard error; *z*-value = Wald *z*-statistic | | | | |
| Nagelkerke $r^2 = 0.11$ | | | | |
| Hosmer and Lemeshow test = *X*-squared = 7.3362, df = 8, *p*-value = 0.5008 | | | | |
| Area under Receiver Operating Curves (ROC) = 0.817 ($p < 0.001$) | | | | |

The Wald statistics also indicated that distances to villages with rubber plantations was the most important variable (highest negative value) for forest increase in the study area during 2006–2012, followed by distances to villages with shifting cultivation. Similar to the logistic regression model for deforestation, the value of the Hosmer and Lemeshow test ($p$ = 0.50) and Area under ROC = 0.817 ($p$ < 0.001) indicated that the model fit was acceptable.

## 4. Discussion

The results indicate that the areas of forest cover decrease were associated with higher elevations, shifting cultivation and main roads within our study area. The flat areas had less deforestation whilst high elevation areas were more likely to suffer higher deforestation. Although there are a greater number of human settlements on the lower land when compared with those on high elevation mountainous areas, the impact of human activities was mainly found in high elevation areas. This finding differs from a number of studies, which suggest that the likelihood of forest cover decrease is greater at a low elevation in other worldwide countries (Fox et al., 2000 [30]; Gao and Liu 2012 [22]; Mas et al., 2004 [31]; Mon et al., 2012 [21]). In those cases, expansion of the cultivated land was associated with the distance to towns in low elevation areas which provide better accessibility and ease of access to markets. However, our analysis suggests that forest clearance in mountainous areas in southern Lao PDR was associated with shifting cultivation. The majority of shifting cultivation land is located in mountainous areas, whereas permanent agricultural lands are largely found in lowland areas. In these Lao low land areas, infrastructure is better developed and little forest remains to be cleared. Slash-and-burn agriculture or shifting cultivations are widely practiced and important food production systems for the minority ethnic groups in Lao upper lands (Inoue et al., 2010 [32]; Shi 2008 [33]; Sovu et al., 2009 [9]). Shifting cultivators rely completely on the availability of the upper farming land and forests for their income and self-subsistence due to their poverty. Thus, we infer that population increases can simultaneously lead to an increase in forest and land use, which, in turn, leads to expansion in forest clearance. The shifting cultivation practice is commonly recognized as a serious threat to biodiversity globally (Geist and Lambin 2002 [34]; Li et al., 2014 [35]; Rasul and Thapa 2003 [36]). In the case of Lao PDR, this practice is associated with land clearance, tree cutting and use of fire, and has been viewed as a direct cause of deforestation. This destructive farming practice tended to cause serious land degradation, soil erosion and loss of biodiversity (FAO 2015 [37]; Higashi 2015 [38]).

Our study suggests that roads are also a very important factor associated with forest cover decrease during 2006–2012 in the southern part of Laos. The area of greatest deforestation is found where the land is easily accessible with good road systems nearby. Logging activities frequently happen when markets and timber saw factories are easily accessible. The improved road networks create greater ease for travel: this can lead to a relative increase in the transportation of timber. As a result, forests located at close distances to roads are more likely to be disturbed. This was similar to several studies, which report that deforestation has a link with distance to roads (Ali et al., 2005 [39]; Bhattarai et al., 2009 [15]; Du et al., 2014 [23]; Etter et al., 2006 [40]; Gao and Liu 2012 [22]). However, other studies suggest that there is no link between deforestation and ease of road access (Deng et al., 2011 [41]).

Our results also reveal that distances to villages with rubber plantations are an important factor related to an increase in forest cover. We observe that most of the forest increase is a result of the establishment of rubber plantations in these villages (nearly 65% of forest increase). In recent decades, investment in rubber plantations had been promoted by the Lao Government, which aims to stimulate greater foreign investment in the country in order to reduce poverty, while managing natural forest resources and land use (Phimmavong et al., 2009 [7]; Shi 2008 [33]). However, this can potentially increase rates of forest and land use change, due to massive land preparation and clearance, when governance is ineffective and monitoring systems are insufficient. There are a number of concerns related to rubber investment promotions, including the destabilization of rubber prices in the international market, and environmental issues due to large areas of natural forest being converted to rubber plantations, which leads to a loss of biodiversity and wildlife displacement (Beukema et al., 2007 [42]; Sirirak et al., 2006 [43]; Yi et al., 2014 [44]). Furthermore, another factor associated with forest increase was distance to villages with shifting cultivation areas. There are two potential hypotheses for this: firstly, it was assumed that, after a harvest, the cultivated area would be left untouched, which would create an opportunity for forest recovery. Secondly, shifting cultivation areas in these villages were converted into rubber plantations due to high demand for rubber products in this region.

## 5. Conclusions

In this research, we investigated the relationship between the physical and socio-economic factors in terms of forest cover decrease and increase from 2006 to 2012 in the south of Lao PDR. We used forest cover change maps derived from a classification of Landsat ETM+ imagery and analysed the relationships with possible physical and socio-economic drivers using a logistic regression model. There are noticeable changes in forest cover within the study area, with regional and local patterns of forest cover decrease and increase. Key findings in this research showed that forest cover decrease was associated with both physical and socio-economic factors, including elevation, access to roads and shifting cultivation practices. Meanwhile, forest cover increase was more likely to be linked with rubber plantation investments in the southern region. Native forest and shifting cultivation lands were vulnerable to transformation into rubber plantations when rubber prices were booming. The goals of poverty alleviation and eradication of shifting cultivation through foreign investments requires more attention in order to reduce potential pressures on forest and land use. Our study should be useful in providing a greater understanding of socio-economic and physical drivers of forest cover change at a local level. This should also be helpful in ensuring the effectiveness of the land management policies being implemented on uplands, especially where such policies are created in response to the natural and socio-economic conditions of this region. Policies for sustainable forest and land use planning should be introduced to ensure a long-term nutrition and food security for upland communities, capacity building programs for local people should be provided to ensure the improvement of their livelihoods, and finally alternative livelihood development options or financial assistance should be available and supported to create a better opportunity for local people to improve their livelihood and avoid deforestation.

Our results provide better understanding of socio-economic and physical drivers of forest cover change at a local level, which is useful for policy makers to ensure the effective management of land use and forest resources. However, expanding the social and environmental factors (e.g., income and timber species) included could improve the analysis and provide deeper understanding of factors driving forest clearance, but is dependent on availability of suitable data. Additionally, there is scope to apply this model in different geographic areas in Laos, which may provide insights into the underlying causes of deforestation in contrasting locations and populations. This is desirable for further research.

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**Author Contributions:** Chittana Phompila designed the research, collected satellite data and socio-economic data used and implemented data analysis. Megan Lewis assisted in the research design, data analysis and interpreting results, especially regression outputs. Kenneth Clarke and Bertram Ostendorf assisted in interpreting R statistical analysis result and land use mapping. All of the authors worked on the interpretation of results, manuscript writing and revisions.

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# Rush for cash crops and forest protection: Neither land sparing nor land sharing

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ABSTRACT

In many countries with large tracts of tropical forests, there is a dual focus on enhancing forest protection and increasing commercial agriculture for economic development. Laos is a case in point for this development as the Government of Laos (GoL) has a strong commitment to economic growth, which rural farmers in part help realize through a rush for cash crop production destined to be sold in neighboring countries. Maize cultivation, for example, is rapidly expanding and grown under a contract-farming system for Vietnamese markets. At the same time, GoL attempts to increase nationwide forest cover and prepares for REDD+ (reducing deforestation and forest degradation). This paper explores how the recent boom in cash crops is impacting land use and livelihoods of local communities, as well as affecting forest conservation in Hua Meuang District of Huaphan Province in northeastern Laos. We also examine how local authorities react to these changes and navigate the contradicting policies. Furthermore, the paper analyzes to what extent the land sparing intention of land- and forest-land allocation policies are fulfilled. We found that the production of maize has rapidly expanded in Hua Meuang District since the mid-2000s as a result of high demands for maize in Vietnam and because local authorities see the crop as a way to reduce rural poverty and reduce traditional subsistence shifting cultivation practices. Communities have increased the areas that they dedicate to maize cultivation and have achieved an increase in both income and household assets. Maize has replaced upland rice cultivation as well as primary and secondary forests. Although the government policies aim to spare land for forest conservation by intensifying agriculture, the result is rapid agricultural expansion and no spared forest. Moreover, the traditional land-sharing landscapes with forest, fallows, and fields are being transformed, creating landscapes that are increasingly dominated by agriculture. This may still be in line with economic development policies, but it is at odds with forest conservation policies, REDD+ policies, and the GoL target of increasing forest cover in the country.



## 1. Introduction

In many countries that still have large tracts of tropical forests, there is a dual focus on enhancing forest protection while at the same time developing the economy by increased production of cash crops. Both targets are, of course, highly relevant for countries with high levels of poverty. As natural forests are becoming increasingly commoditized, e.g., through the proposed REDD+ mechanism (Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries), there is potential scope for forest protection to contribute more directly to economic transfers to high-poverty rural areas. Linkages between conservation and land-use intensification have been studied both in theory and by using local case studies, and these are, for example, outlined in the debates on land sparing (divided landscapes with totally protected forests and intensified agriculture on surrounding lands) versus land sharing (multi-

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functional landscapes serving both conservation and agricultural purposes).

This approach to understanding landscape management was launched by Green et al. (2005) and has sparked a rather polarized debate. Some conservationists have been strongly favoring the sparing approach in which land use policies should ensure that primary forest areas are left untouched in order to conserve specialist species that only thrive in such habitats (Gibson et al., 2011; Phalan et al., 2011). Other scholars, however, have pointed out that biodiversity can be just as high or higher in the shared landscapes that are often the outcome of traditional agricultural systems such as shifting cultivation (Rerkasem et al., 2009; Xu et al., 2009; Berry et al., 2010). Moreover, it has been shown that intensification processes may lead to further agricultural expansion as opportunity costs of agricultural production increase, thus not leading to any spared land for conservation (Rudel et al., 2009; Lambin and Meyfroidt, 2011). In recent years, more balanced views emphasiz that there should be room for both types of landscapes to benefit from a broad range of ecosystem services (not just biodiversity conservation) (Grau et al., 2013; Fischer et al., 2014). In addition, the need to ensure optimization of conservation and food production objectives may need elements of both sharing and sparing and in any case the best choices are always highly context specific (Butsic and Kuemmerle, 2015; Law and Wilson, 2015). Thus, it appears that this debate is rather quickly changing from polarized to reconciling views.

Such scientific debates can be highly useful in guiding policy on land-use planning, but the question remains as to whether they are reaching the appropriate policy-makers. For this to be achieved, agricultural and environmental policies must be coordinated to make the right choices between forest protection and land-use intensification. In many countries, policy-makers responsible for agricultural development and poverty reduction are disconnected from those responsible for environmental conservation (DeFries and Rosenzweig, 2010). Moreover, the land sparing and land sharing debate has had a somewhat restricted application in the scientific debate as there are numerous case studies that, without relating their results to land sharing and land sparing, actually show that neither is occurring. This is especially the case in many developing countries where rapid conversion of forest lands to annual cash crop production and industrial plantations is taking place (Galford et al., 2010; Brown, 2012) and where attempts at increased agricultural production appear in the guise of a land-sparing approach, but in reality these often serve neither forest conservation nor poverty reduction (Barrett et al., 2011; Ferraro et al., 2011).

There are many examples of agricultural intensification efforts that are justified by their assumed effect on both poverty reduction and, by default, forest protection. These include a study from Madagascar indicating that the expansion of intensified cash crop production such as maize has been one of the major causes of deforestation (Scales, 2011), and it has been argued that concessions and expansion of biofuel feedstock plantations lead to dispossession of land and increased poverty in Ghana, Cambodia, and Laos (Schoneveld et al., 2011; Hought et al., 2012; Kenney-Lazar, 2012; Neef et al., 2013). In Sarawak, several waves of large-scale oil palm expansions have led to questionable outcomes for local people (Ngidang, 2002; Cramb et al., 2009; Fox et al., 2009). More recently, smallholders in some of these areas now reject the large land development schemes and grow their own oil palm, benefitting from the infrastructure of the large schemes (McCarthy and Cramb, 2009; Mertz et al., 2013). Many of these agricultural development schemes argue that they indirectly aim at protecting remaining forests, but in reality, besides their questionable effect on poverty reduction, they have little, if any, connection to forest-protection efforts, which increasingly are limited to small 'islands' of old-growth forest (Curran et al., 2004; Fitzherbert et al., 2008). Similarly, forest protection efforts rarely link to land-development policies (Brussaard et al., 2010) even though expansion of cash crops is often identified as a driver of deforestation (Lambin et al., 2001; Haberl et al., 2014) and therefore could be used as an argument for stronger enforcement of forest protection. Consequently, policies aiming at either 'forest conservation' or 'economic development' are working towards different goals that, from a spatial point of view, are mutually exclusive. From a land sparing-land sharing perspective, we hypothesize that this may actually result in not achieving the beneficial goals that would be expected from either land sparing or land sharing. What appears to happen is that unenforced land sparing policies and new economic opportunities make people abandon traditional land sharing approaches and the result may be wholesale conversion of the landscapes to more or less intensive agriculture with very little forest left. This perspective has – to the best of our knowledge – not been discussed in the literature.

Laos provides an interesting case for examining this situation, since the Government of Laos' (GoL) efforts regarding land use planning can best be characterized as land sparing. The national Land and Forest Allocation (LFA) program – implemented since the mid-1990s – epitomizes this with its focus on containing traditional agricultural activities by local communities in limited areas in order to spare forests for regrowth (Lestrelin and Giordano, 2007; Fujita and Phanvilay, 2008; Lestrelin et al., 2012; Castella et al., 2013). However, a range of different drivers of land use change (outlined in more detail in the next section – including the LFA itself) have led to continuing declining forest cover (Tong, 2009; DoF, 2012), agricultural expansion (Thongmanivong and Fujita, 2006) and pressure on protected areas (Rao et al., 2014), none of which testify to the intended outcomes of the LFA. In this paper, we therefore analyze various land-use planning processes aimed at forest conservation (such as the proposed REDD+ mechanism) and agricultural intensification (such as cultivation of hybrid maize – hereafter maize – for the Vietnamese market) and their interplay with the LFA to understand the effects on land use, livelihoods of local communities, and forest protection. Moreover, we discuss whether the approach and outcomes of policy implementation can be characterized as land sparing or land sharing, or whether none of the two characterize the land use change pathways in Laos. First, however, to set the scene for the analysis, we outline the main drivers of land use change in Laos.

## 2. Drivers of cash-crop expansion and forest protection in Laos

The multiple and complex drivers of forest and land-use change observed on a global level (Lambin et al., 2003) are also found in Laos. According to the GoL, these drivers include traditional shifting cultivation and population growth (GoL, 2005), whereas scholarly studies also identify government policies on land reform—such as the LFA itself—as drivers of land-use change (Thongmanivong and Fujita, 2006; Fujita and Phanvilay, 2008; Broegaard et al., in review). The LFA had been implemented in an estimated 7130 villages by 2005 (GoL, 2005), and besides sparing forests, it also has a stated goal to reduce poverty through agricultural intensification. The rate of the poor in the shifting-cultivation landscape is about 46.5%, while the national poverty rate is 34.7% (Messerli et al., 2008; Heinimann et al., 2013), but this is partly because shifting cultivation is practiced in upland areas in the northeast and the south, where there is little access to services and employment, and where it is difficult to practice intensive agriculture due to the rugged character of the terrain (Epprecht et al., 2008). Nevertheless, it has become a major discourse in the LFA that shifting cultivation needs

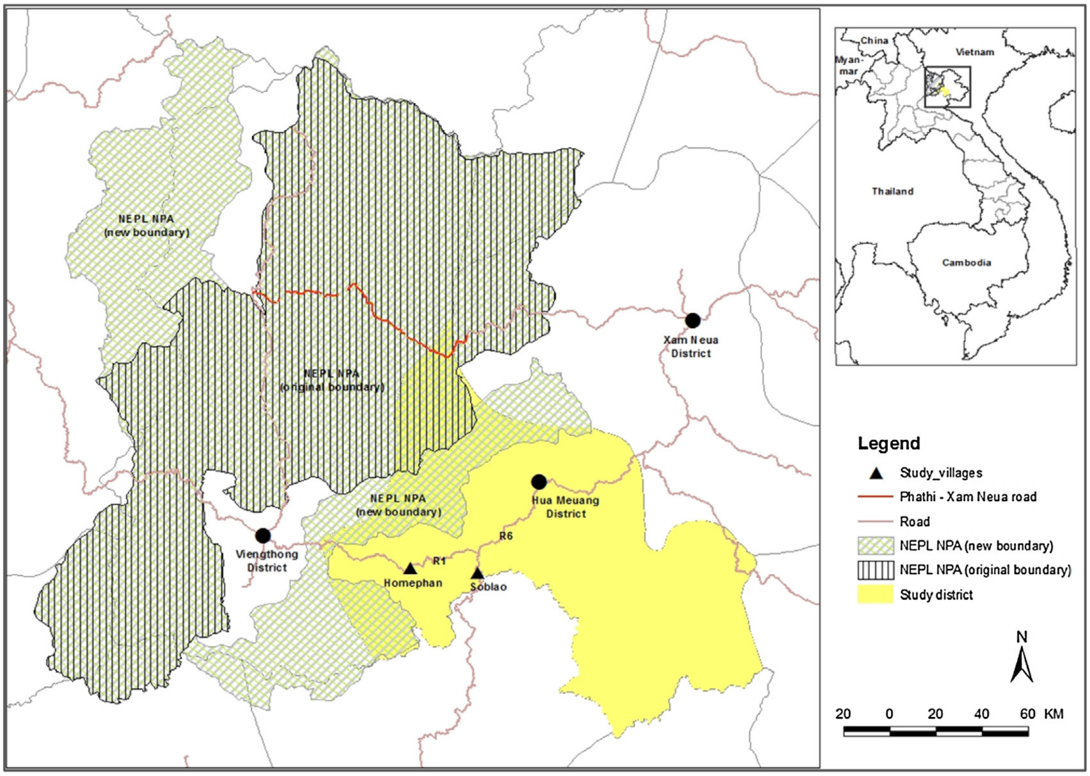


**Fig. 1.** Study sites in Laos—small map on the right indicates the location of Huaphan Province in Laos.

to be halted, and this has led to peculiar definitions of the system. For example, shifting cultivation of upland rice with 3–4 years fallow is allowed, but is now called rotational agriculture. Similarly, when rice is replaced by commercial maize, it is no longer considered shifting cultivation by technical staff at the provincial and district levels or by the villagers even if fallowing is still used (Vongvisouk et al., 2014). Moreover, the LFA has also been shown to create social inequity as rural households with greater social and economic power can bargain to obtain larger land areas than other households, effectively upholding existing differences in land and resource access (Lestrelin et al., 2011).

The LFA has led to a decline in shifting cultivation areas as well as a reduction of fallow periods (Thongmanivong and Fujita, 2006; Lestrelin and Giordano, 2007). However, logging and illegal trade of forest products also affect forests in Laos (Robichaud et al., 2009; Barney and Canby, 2011) as does expansion of commercial agriculture with rubber, maize, and sugarcane (Thongmanivong and Fujita, 2006; Thongmanivong and Vongvisouk, 2006; Kenney-Lazar, 2010). The increase in commercial crops is partly a result of the market-liberalization policy – the New Economic Mechanism – from the mid-1980s that initiated the promotion of private-sector activities. The GoL also encouraged populations in remote upland areas to move to lowland areas close to roads and other public services, where there was better access to land suitable for permanent agriculture (Fox, 2009). As a result, land use and forest resources in the lowland areas close to roads are more exposed to increased pressure from land-policy implementation than isolated upland areas, as people in the lowland areas convert their former shifting-cultivation areas into cash crop cultivation (Thanichanon et al., 2013).

The GoL also aims to increase nationwide forest cover as stipulated in 2005 in the National Forestry Strategy for 2020 and with the establishment of 18 National Protected Areas in 1993 that cover 2.8 million hectares or approximately 12% of the total country's land area (GoL, 2005). Nonetheless, forest cover in Laos has continuously declined: from 47.2% of the country's land area in 1992 to 41.5% in 2002 and 40.3% in 2010 (Tong, 2009; DoF, 2012). Still, Laos remains one of the countries with the highest percentage of forest cover in Southeast Asia (FAO, 2011), although the continuous forest decline provides little evidence that the GoL's goal of 70% forest cover by 2020 is likely to be achieved.

Policies encouraging private-sector and foreign direct investment in cash-crop production, hydropower, mining, and forestry all stand in the way of this goal as they have turned Laos into an important resource frontier for transnational capital and large-scale land and natural-resource investment (Lestrelin et al., 2013). Thus, one of the drivers of the forest decline is the GoL land development policy slogan of '*turning land into capital*' (meaning activating the land capital in terms of investment) (Dwyer, 2007). Rubber plantations, for example, have boomed in the northwest and the south of the country under contract farming and land-concession/lease systems (Manivong and Cramb, 2008; Shi, 2008; Kenney-Lazar, 2010; Khamphone and Sato, 2011; Sturgeon, 2013). This fits well with the GoL aims to use the land for co-investment or joint ventures with domestic and foreign investors and to channel land tax, rental fees, and profits into the state revenue system (Dwyer, 2007), but it tallies less well with the land sparing approach of the LFA as concessions take over community land that would otherwise have been set aside for forest protection and regrowth (Kenney-Lazar, 2010; Baird, 2011). Geographically, commercial crop production is expanding fastest in the areas bordering China, Thailand, and Vietnam, as traditionally there are good connections with private investors (and markets) in neighboring countries. For instance, during the 1990s and early 2000s, the rubber boom was driven by Chinese and Vietnamese investments (Manivong and Cramb, 2008; Shi, 2008; Kenney-Lazar, 2010; Kenney-Lazar, 2012) and various agricultural products are generally sold to the neighboring countries close to the production sites (Manorom et al., 2011). The maize boom in Huaphan Province, which is of particular interest as a case

**Table 1**
Interviewed institutions.

| No. | Institutions | Office/division/section/unit/representative |
|---|---|---|
| Institutions at the national level | | |
| *Ministry of Agriculture and Forestry (MAF)* | | |
| 1 | Department of Forestry (DoF) | Office of Greenhouse Gas Emission Reduction from Deforestation |
| 2 | Department of Forest Inspection (DoFI) | Division of International Relations |
| 3 | National Agriculture and Forestry Research Institute (NAFRI) | Socio-Economic Research Center |
| *Ministry of Natural Resources and Environment (MoNRE)* | | |
| 4 | Department of Forest Resource Management | Conservation Forest Management Division<br>Division of Emission from Deforestation Management |
| *Ministry of Planning and Investment (MPI)* | | |
| 5 | Department of Investment | International Investment Division |
| Institutions in Huaphan Province | | |
| 6 | Provincial Agriculture and Forestry Office (PAFO) | A provincial REDD+ coordinator<br>Agricultural Land Management Division<br>Cabinet Division |
| 7 | Provincial Office of Natural Resources and Environment (PoNRE) | Forestry Division<br>National Protected Area and Protection Unit<br>Division of Land Management<br>Division of Land Development and Planning<br>Head Cabinet Division (former head of Nam Et-Phou Loey National Protected Area)<br>Nam Et-Phou Loey National Protected Area (NAPL NPA) Office in Hiem District |
| 8 | Provincial Planning and Investment Office | Division of International Investment<br>Division of Domestic Investment |
| Institutions in Hua Meuang District | | |
| 9 | District Agriculture and Forestry Office (DAFO) | Land-Use Planning Unit<br>Agricultural Extension Unit<br>Forestry Unit |
| 10 | District Office of Natural Resources and Environment (DoNRE) | Head of the office<br>Land-Use Planning Unit |
| 11 | District Planning and Investment Office | Planning and Investment Unit<br>Statistic Information Management Unit |
| 12 | District Finance Office | Finance Management Unit<br>Taxation Unit |
| Non-Governmental Organizations (NGOs) | | |
| 13 | German Society for International Cooperation (GIZ) | Climate Protection through Avoided Deforestation (CliPAD)<br>Northern Uplands Development Program (NUDP) |
| 14 | Wildlife Conservation Society (WCS) | WCS's Headquarter Office in Vientiane Capital<br>Tiger Conservation Project in NEPL NPA<br>Ecotourism Project in NEPL NPA |
| 15 | Netherland Development Organization (SNV) | SNV's Headquarter Office in Vientiane Capital<br>Provincial REDD+ Coordinator in Huaphan Province<br>Bamboo Development Project in Huaphan Province |
| 16 | Village Focus International (VFI) | The Rights-Link Lao Project |
| 17 | Lao Biodiversity Association (LBA) | The directors and a technical staff |
| 18 | Land Issue Working Group (LIWG) | The coordinator and a technical staff |
| Private Companies | | |
| 19 | Sisouphan Company: Contract-farming for maize | |
| 20 | Chaleun Xam Company: Contract-farming for maize | |
| 21 | Phetkhamxay Chaleun Company: Contract-farming for maize | |
| 22 | Saengchan Agricultural Development Company: Contract-farming for Job's tear | |
| 23 | Wuhan Kaidii: Biofuel plantation investment | |

study in this paper, started in the early 2000s and was also partly due to the proximity to the Vietnamese market (Willi, 2011).

## 3. Case area setting

The present study focuses on Huaphan Province in northern Laos (Fig. 1), an area that epitomizes the current developments in the country. Huaphan Province has been identified as having the highest potential natural forest regeneration in Laos (DoF, 2012), but private sector investment in commercial crops is rapidly expanding. Maize is one of the main crops drawing in investments, while other crops such as Job's tear and various types of biofuel and industrial tree plantations are also being promoted by district and provincial authorities. At the same time, Huaphan Province harbors the majority of the Nam Et-Phou Loey National Protected Area (NEPL NPA), which is a high-profile area for tiger conservation. Nonetheless, NEPL NPA is being encroached by maize cultivation and by the construction of a new military road from Phathi Village to Xam Neua (the capital of Huaphan Province) – passing right through the core-zone of the protected area. A REDD+ feasibility study in the NEPL NPA and its buffer zones concluded that REDD+ was not economically feasible due to historically low levels of deforestation (Moore et al., 2012), but this only shows that history is a poor predictor of the future: the high market demand for maize may lead farmers to expand maize cultivation further into the NEPL NPA and the military road may also facilitate future encroachment.

In this paper, we focus on two villages in Hua Meuang District of Huaphan Province, namely Homephan and Soblao (Fig. 1). These villages have mixed ethnicities and are located close to the buffer zone of the NEPL NPA. Originally, both villages were located inside the NEPL NPA within the administrative boundary of Hua Meuang District, but they were moved to their current locations in the mid-1980s (Soblao) and early 1990s (Homephan). Homephan is dominated by Khmu, who traditionally practice shifting cultivation for household subsistence; however, once they settled in this village, they received paddy (wet rice) fields abandoned by the former inhabitants in the area who moved out for security reasons during the 1980s. People in Soblao are dominated by

Lowland Lao (*Lao Loum*), who traditionally practice both paddy and shifting cultivation. The locations of the two villages have different economic development opportunities. Homephan is located along the national road number 1 (R1) from Hiem District to the capital of Huaphan Province (Xam Neua District), and people in this village mainly rely on farming activities. Soblao is located along the national road number 6 (R6) connecting Huaphan and Xiengkhuang provinces (and onwards to Vientiane Capital and the south of the country), where commercial or trading activities abound. In addition, Soblao is also one of the focal socio-economic development villages (*sarm sang*) in Hua Meuang District under the GoL's socio-economic development project.

Land-use planning (e.g. LFA) is implemented in the district (Broegaard et al., in review) and in both villages, and as elsewhere in Laos it is aimed at reducing shifting cultivation areas, increasing forest conservation, and promoting permanent agricultural practices. Moreover, Hua Meuang District has been appointed a 'REDD+ district' in Huaphan Province, and the German Society for International Cooperation (GIZ) funded 'Climate Protection through Avoided Deforestation Progam' (CliPAD) is assisting the province in setting up a jurisdictional REDD+ approach and creating demonstration activities for REDD+ (GIZ, 2014). While this potentially could be an important driver of land use change in the future, REDD+ activities have so far had very little impact locally in Laos.

The villages thus represent typical northern Laos communities that have been moved from a protected area, have undergone land use planning exercises restricting their land use, and also engaged in various cash crop schemes.

## 4. Methods

This paper is based on two field visits conducted in April-May and November-December 2013 using multiple materials and methods. These methods included a household questionnaire survey, semi-structured interviews, secondary data collection, and spatial analysis of satellite images. The survey included 50 households in Homephan and 52 in Soblao. The surveyed households were randomly selected from a list containing all households in each village and represent all household statuses, occupations, and ethnicities in the study villages. A few households (three in Homephan and five in Soblao) were unavailable and these were replaced with other households selected randomly from the remaining households.

We carried out semi-structured interviews with representatives of different governmental institutions at different administrative levels (national, province and district), Non-Governmental Organizations (NGOs) and projects, as well as private companies. Governmental organizations included relevant departments, divisions, sections and offices under the Ministry of Agriculture and Forestry (MAF), the Ministries of Natural Resources and Environment (MoNRE), and the Ministry of Planning and Investment (MPI). Authorities of the two selected villages were key-informants at village level. The NGOs and donor organizations included only organizations working on land-use planning, forest conservation, and livelihood development. In total, we interviewed 23 institutions (Table 1) and representatives from the two study villages. Interviews were carried out in Lao and immediately translated to and from English by one of the researchers and interview notes were taken in English—sometimes backed up with tape recordings—and these notes were then coded according to key aspects of the research questions and analyzed using NVivo-software, version 8.

We also collected documentation from various institutions. These included official reports and local data on land use and land-use planning (both the LFA and Participatory Land-Use Planning (PLUP)), regulations, investment agreements between governmental authorities (mainly provincial and district levels)


**Fig. 2.** Photo of sign stating that shifting cultivation has been stopped. The sign states that Homephan Village in Hua Meuang District, Huaphan Province has stopped traditional shifting cultivation practices as of 13.06.2013–or literally: "*have ended the cutting of forest for the purpose of planting upland rice*".

Source: Photo taken by Thoumthone Vongvisouk in 2014.

and investment companies, contract-farming agreements, statistics of agricultural production, infrastructure development, project reports, etc. This information was triangulated with the information from the household survey and semi-structured interviews.

Finally, a spatial analysis was carried out using Rapid-Eye satellite images from November 2010 and 2012 using the remote sensing software "ERDAS IMAGINE" and then mapped by ArcGIS10.2. We first classified the land cover into seven classes: primary forest, secondary forest, older fallow, young fallow, active cropping area (crop land), built-up area, and water. However, since it is difficult to distinguish the differences between secondary forest and old fallow, as well as between young fallow and crop land, we finally grouped land cover into five classes: primary, secondary forest (fallow), crop land (including actively cultivated area and young fallow), built-up area, and water.

## 5. Results

The two study villages in Huaphan province have been negotiating a complex path between conservation of the NEPL NPA at or within their village boundaries, restrictions on shifting cultivation by the LFA, as well as new opportunities for agricultural intensification through cash cropping of hybrid maize and other forms of contract farming. Here we first outline some of the 'boundary conditions' related to the NEPL NPA and the LFA and then move on to discussing the agricultural intensification.

The NEPL NPA was established in 1993, but management was not actively enforced until the 2000s, at which time the International Union for Conservation of Nature (IUCN) began to provide financial and technical support followed by continuous support from the Wildlife Conservation Society (WCS) until today (Moore et al., 2012). One important aspect of the enforcement relates to the boundaries of villages located close to the NPAs. The authorities of one of our study villages were concerned that they had lost agricultural land to the NEPL NPA when the NPA staff re-defined its boundary in 2010. Although the authorities of the village referred to an LFA map from 2002 to claim their village boundary, the NPA staff disregarded the LFA. They argued that it was not geo-referenced and therefore inaccurate regarding the boundary of the NPA.

Forest conservation thus overrules the LFA, but the LFA remains the legal document when it comes to restricting agricultural activities within village lands. Officially, the villages have stopped shifting cultivation of upland rice in accordance with the LFA and Homephan village even received an approval sign stating this (Fig. 2). In fact, shifting cultivation of both upland rice and maize

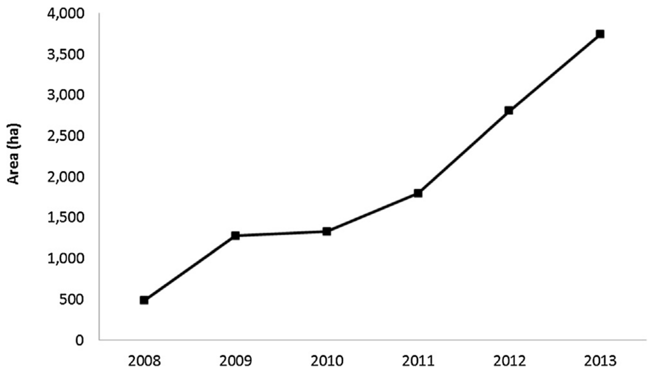


**Fig. 3.** Total maize cultivation area in Hua Meuang District.
Source: DAFO in Hua Meuang, 2013.

is still practiced in the village: rotation of shifting cultivation for maize is often 2–4 years (although some maize fields are intensively cultivated for several years without fallow), while the rotation for upland rice is seven years or more. The local re-interpretation of the LFA in which maize cultivation is not called shifting cultivation, coupled with the provincial and district authorities' support of maize cultivation as a means of poverty reduction, gives local legitimacy to the expansion of maize cultivation areas and associated deforestation. A technical staff member from the District Agriculture and Forestry Office (DAFO) in a neighboring district expressed that "*...we know that local people in some villages expand their maize cultivation areas by encroaching forests, but as technical staff, we cannot do anything to stop them because maize is a cash crop supported by the district and provincial authorities for rural poverty reduction*". This indicates that although the LFA had been implemented in the village in order to allocate land for agriculture and spare land for forest conservation, government authorities acknowledge that poverty reduction is best achieved by not following a land sparing strategy.

Overall, our interviews with institutions at both provincial and district levels and with private companies indicate that the authorities have warmly welcomed agribusiness investment by private investors in the province as a means of supporting poverty reduction. As a result of the promotion of commercial-crop cultivation, the size of the maize cultivation areas in Hua Meuang District increased from 488 ha in 2008 to 3745 ha in 2013 according to data collected from DAFO (Fig. 3). The district authorities (especially DAFO) are encouraging villagers to replace shifting cultivation of upland rice with maize cultivation and this has indeed led to a reduction in upland rice areas. However, villagers typically spare some fallow-plots in isolated areas, inaccessible by vehicle, for upland rice cultivation, whereas the maize cultivation is mainly found close to roads and villages. The expansion of maize is clearly contradicting the LFA policy on forest conservation as local people convert fallow and forest land into maize fields, areas that should have been set aside for regrowth.

At village level, information from household surveys indicates that villagers have increased their agricultural land since maize cultivation began in the mid-2000s. They have increased the areas used for maize cultivation and fallows, while areas for upland rice cultivation have decreased (Fig. 4). Two different sources of data were used to estimate the development of the area used for maize cultivation: (1) household surveys, in which villagers were asked about the size and location of their fields at different points in time, and (2) records of the seeds of maize received by villagers and recorded into the notebooks of the village tax collectors in both villages. In one of the villages, data were furthermore triangulated with information from one of the three maize companies working in the village. The amount of maize seeds has been converted into cultivation area based on the information provided by the villagers and technical staff at DAFO in Hua Meuang. An estimated 18–20 kg of seeds are used per hectare and we thus used an average of 19 kg of seeds per hectare to calculate the area. Although some seeds may not have been planted during the planting season, we trust the much stronger increase in maize cultivation areas obtained from the notebooks *(dotted red line)* more than the data from households *(solid red line)*. This is partly because the interviewed households are unfamiliar with the area measurements and often consider one plot as 'one hectare' (and might add: 'a large one' or 'a small one'). Moreover, there could be an incentive to under-report if land expansion is not in line with the LFA. This means that their estimation of agricultural land is probably an underestimate, except for paddy rice fields, which have been measured for tax collection purposes – paddy area reported in household surveys coincided with figures recorded in the village tax collectors' notebooks.

As a consequence of the maize boom, people in Homephan and Soblao have increased household income and assets since they started cultivating maize in the mid-2000s. There is an especially steep increase in transportation and communication tools (Fig. 5). Villagers use these tools mainly for facilitating their agricultural production, e.g. by using trucks and tractors to transport agricultural products from field to home and onwards to markets. Many households spend cash income (at least partly from maize) to buy motorbikes for their children to travel to school and return home from school quickly so that they have time to participate in agricultural work. Cell phones are frequently used for communication with agricultural investors and traders or with children studying in the provincial or national capital. As income from maize is also frequently used to finance education, for hiring labor and for increasing mechanization such as plowing, villagers perceive that they have reduced poverty by increasing maize cultivation areas. In addition to helping themselves out of poverty, the villagers find that they in this way contribute to developing the country by achieving national goals of rural poverty reduction.

Other income sources are less important in Homephan village, where the majority of people are farmers and earn their income predominantly from on-farm work. This is different in Soblao where, thanks to its location on a main road, trading is the predominant source of income, alongside other off-farm occupations. According to interviews with authorities of Soblao Village, more than half of the households in the village are engaged in commerce—and this is one of the reasons why the village is selected as a *sarm sang* village. Only Khmu families, who moved to the village after 1990, still heavily rely on shifting cultivation for upland rice cultivation.

Local governmental authorities expect to gain multiple benefits from the agricultural investment, including infrastructure development. Along with the boom in maize, the investment companies draw up contracts with villagers to construct agricultural feeder roads in order to facilitate their access to the maize fields and ease the transport of products. This road construction is financed by the investor, but ultimately paid for by the villagers. According to the District Public Works and Transportation Office in Hua Meuang, the growth of agricultural feeder roads in the district has rapidly increased since 2010 (Fig. 6). However, not all feeder roads have been officially approved by or reported to this office. We do not have aggregate data on this, but Homephan Village provides a telling example: only one feeder road 1.2 kilometers long has been officially approved by the office and included in official statistics, but interviews and field visits revealed that a total of five feeder roads with a combined length of 7.5 kilometers have already been constructed by two investment companies in the Homephan village territory. In principle, the District Public Works and Transportation Office requires the investment companies to submit their feeder-road construction proposals in order to obtain permission; however, no fines have been given for any of the roads constructed

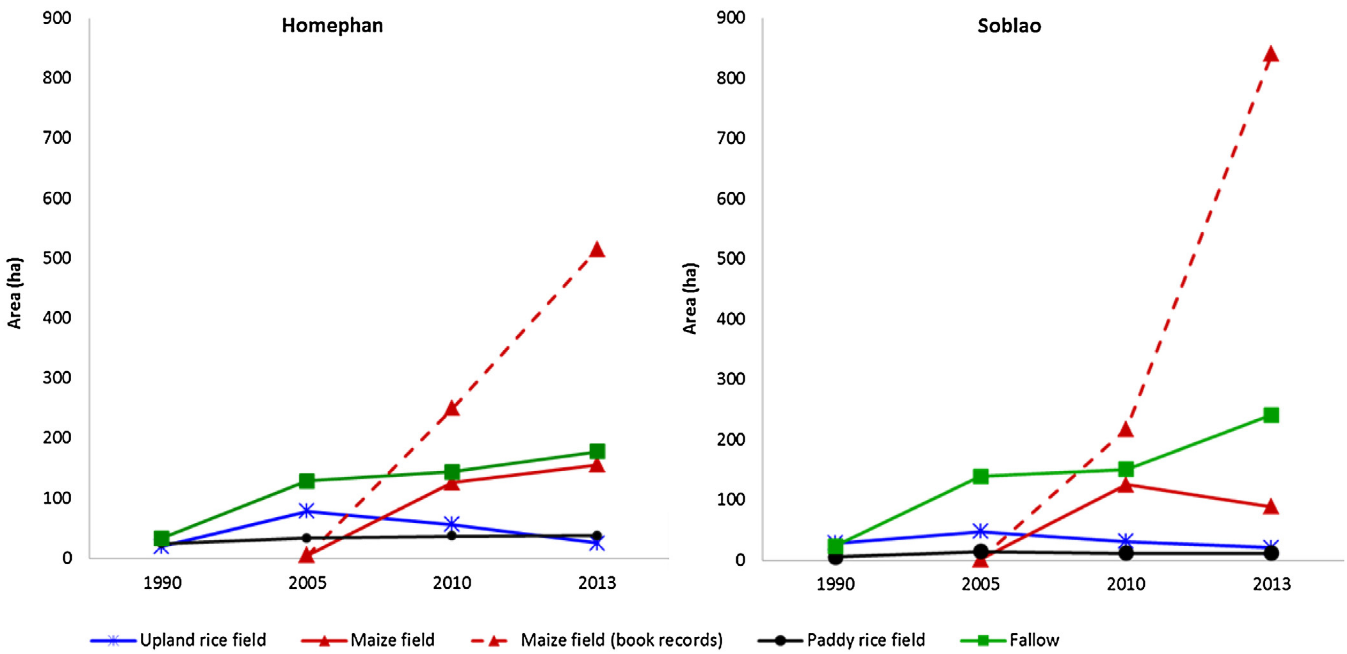


**Fig. 4.** Total claimed agricultural land by households in Homephan and Soblao villages.
Source: household survey and village book records.

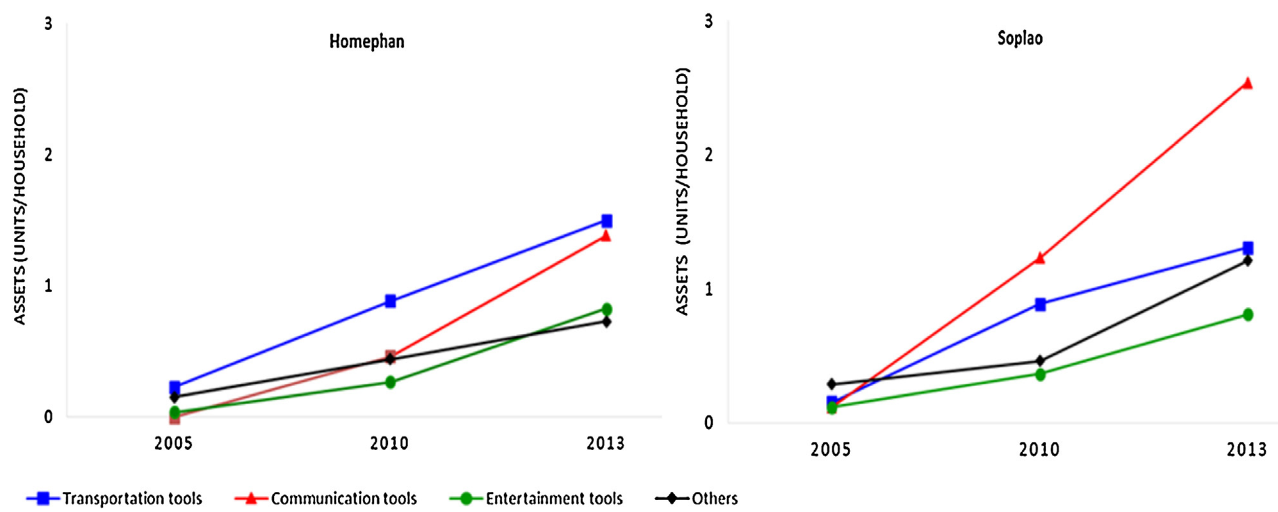


**Fig. 5.** Household assets in Homephan and Soblao villages.
Source: household survey, 2013.

without permission. The only real concern by the Public Work and Transportation officials seems to be that no agricultural feeder road enters the NEPL NPA territory. Based on interviews and field observations, the actual length of agricultural feeder roads constructed in Hua Meuang district is estimated to be several times higher than that suggested by the official data.

## 6. Land sparing or land sharing?

The change detection analysis indicates that primary forest areas in both study villages have dramatically decreased, while at the same time crop land has increased during 2010–2012 (Fig. 7). This indicates that people have converted not only fallows and former shifting-cultivation areas but also primary forest into maize-cultivation areas. However, secondary forest (fallows) also decreased from 2010 to 2012, while information from the household survey indicates that fallows have increased since the mid-2000s. This is probably due to the recent intensification of the system whereby some maize is grown without fallow.

Fig. 7 shows that fallows in 2010 in the area close to the villages have been converted into crop land in 2012. This supports our information from the household surveys and field observations that local villagers convert former upland rice cultivation and fallows located close to the roads and the villages to maize cultivation areas. The greenest part in the north of Homephan Village is located in the so-called 'village protection forest' area, but even though it is a protection forest, it is also disturbed—probably by expansion of maize—as forest cover in the area has changed from primary forest in 2010 to fallow (classified as "secondary forest" in Fig. 7) in 2012. Therefore, while villagers claim to have lost agricultural land to the NEPL NPA in 2010, it appears that they have also expanded their agricultural land into village protection forest that they manage

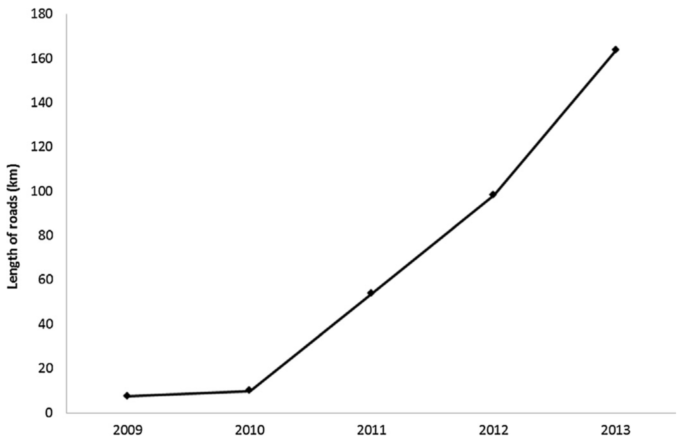


**Fig. 6.** Change in agricultural feeder roads in Hua Meuang District based on official data.
Source: District Public Works and Road Construction Office in Hua Meuang District, 2013.

themselves. Fig. 7 also testifies to our assumption that book records of maize expansion were more correct than household statements as the cropland increase between 2010 and 2012 corresponds well to the increase in maize area recorded in Fig. 4.

This was confirmed in a group discussion with villagers where, again, a local re-interpretation of land and forest allocation was invoked: "*We understood that the village's utilization forest can be used for whatever the villagers would obtain benefits (products) from. Thus, this year we decided that households who do not have enough fallows can clear our village's utilization forest for maize cultivation. As it is termed 'village utilization forest', we have to utilize it*". Such 'free' interpretations are not unique to the village level. Policies, laws, and regulations are also frequently misinterpreted or re-interpreted at higher administrative levels in order to justify why policies are implemented a certain way, possibly not as intended by policy-makers. This is typical of a policy environment, which is driven, but not necessarily well-coordinated, from the top, and the reality of which provincial, district, and village authorities have to deal with as best they can.

Moreover, the expansion of feeder roads to maize fields is an example of how a mismatch between officially recognized data and reality is largely ignored. This may be because the feeder roads are needed for maize production and as district and provincial government support maize production and development in their area in general, perhaps they are lenient towards 'offenders' that make roads without permission. It could also be a reluctance to punish the construction of small roads when the government itself is building the much larger military road through the NEPL NPA. In any case, road constructions are clearly important for intensifying agricultural production as shown elsewhere in Laos (Thanichanon et al., 2013).

These (re-)interpretations of (contradicting) policies have immediate and short-term implications. If maize is continuously supported by local authorities to respond to market demand and for poverty reduction, then forests—at least within the village's boundaries—will undoubtedly continue to decline. Moreover, as land for agriculture becomes scarce and maize production becomes

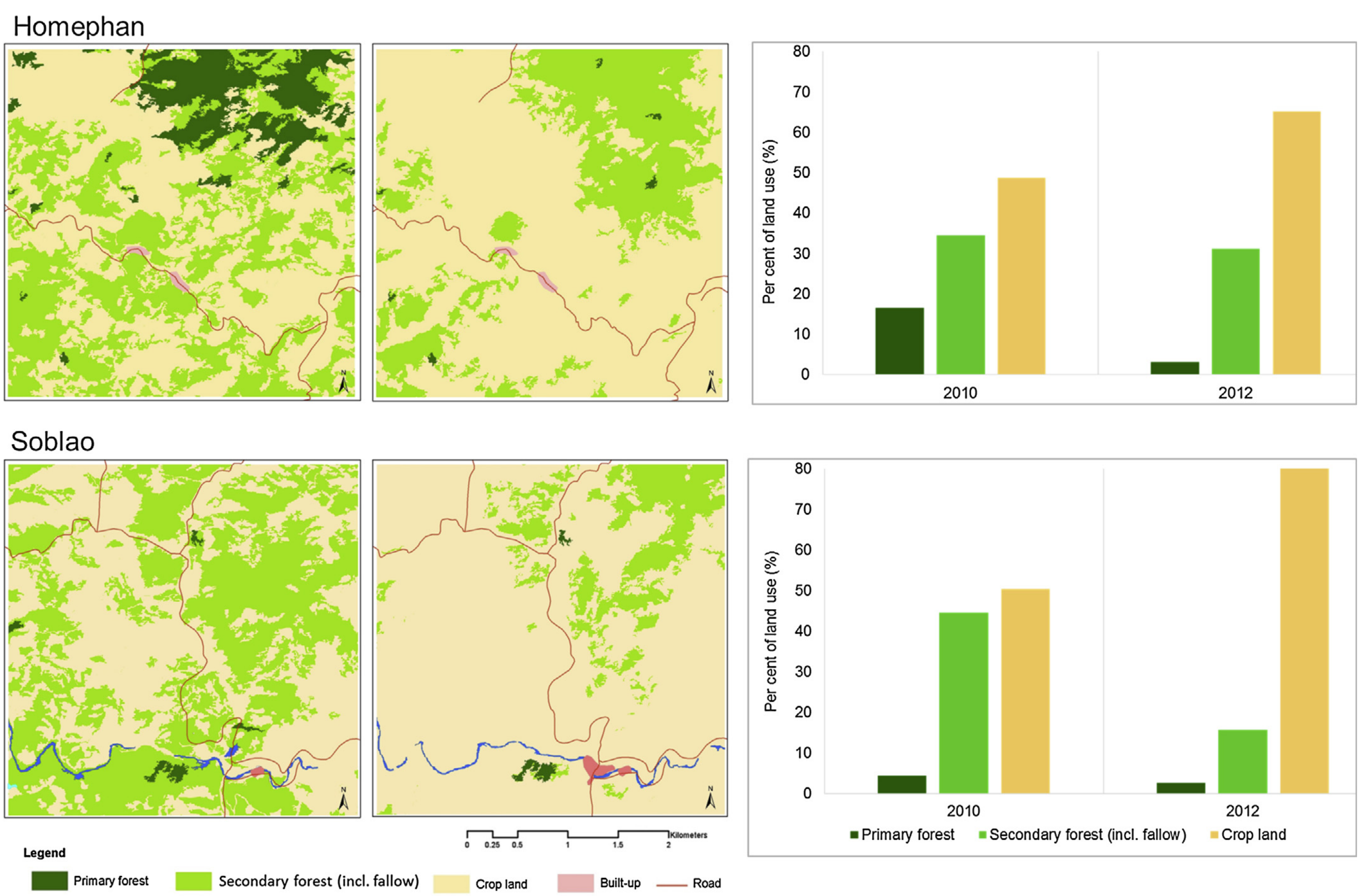


**Fig. 7.** Land-use change in Homephan and Soblao villages during 2010–2012.
Source: Interpreted from Rapid-Eye satellite images taken in November 2010 and 2012

increasingly profitable, this will provide additional fuel for the increase in maize cultivation, at least as long as the market continues to expand as is currently the case.

This fits well with the 'turning land into capital' policy for economic development. However, it is taking place at the expense of the forest – or at least the forest that could potentially regenerate – and, as such, it contradicts forestry policies and government aims to increase forest cover and could compromise engagement in REDD+. It also defies the intentions of the LFA to spare land for forest protection by intensifying crop production – essentially no land is spared as expansion continues unchecked. Moreover, the traditional land-sharing landscapes with shifting cultivation that integrate forests, fallows, and fields are decreasing as fallows are very short in maize production and sometimes not employed at all. Accordingly, what appears to be happening in northern Laos is that well-intended land-sparing policies are not actually resulting in land sparing and they are, at the same time, contributing to the abandonment of traditional land sharing approaches by expediting the conversion of mosaic landscapes with forest and agriculture into pure agricultural landscapes. This case therefore supports the argument by Angelsen (2010) that future agricultural development will result in the expansion of production areas rather than reducing deforestation and also that of Rudel et al. (2009) who pointed to the lacking correlation between agriculture intensification and reduced rates of agricultural expansion. Essentially these authors argue that intensified agriculture (in terms of higher agricultural output per area unit, such as the conversion from upland rice to maize in the case study in Laos) will make agriculture more profitable, and expansion to new areas is also likely to occur either because more people move in or because people see returns on agriculture increase and therefore invest more. It is for others to judge whether the situation of neither land sparing nor land sharing in Laos is good or bad, but there is no doubt that economic development is a clear winner over forest-protection measures, especially those not linked to high-profile conservation initiatives such as the protection of large mammals. Poverty in terms of income and assets has been reduced – at least in the short run – for households engaging in maize production, and while we were unable to establish specific links between the LFA and poverty levels, other studies have stressed that it increases vulnerability as communities are forced to reduce the diversity of livelihoods (Castella et al., 2013). This confirms the questionable link between land sparing and poverty reduction observed elsewhere (Barrett et al., 2011; Ferraro et al., 2011).

The question is whether these policies and development outcomes are intended or coincidental. In their study of hydropower decision-making and power in Laos, Suhardiman and Giordano (2014) identify multiple inconsistencies between co-existing polices as well as multiple, conflicting legal orders, and propose that "inconsistent policies and institutional discrepancies" should not be understood as gaps but rather as reflections of the existing power structure (p. 980). Based on their interviews and analysis they argue that the GoL uses the legal plurality as a means to achieve its development goals, focused on high economic growth (Suhardiman and Giordano, 2014, p. 976). We cannot conclude whether the discrepancies between forest conservation policies and policies promoting cash crop investments and conversion from shifting cultivation towards (more intensified) cash crop cultivation observed in our study are coincidental or purposefully created by the State actors. There could be signs in both directions: the stopping of shifting cultivation of upland rice (see Fig. 2) does not explicitly say that shifting cultivation of maize should be stopped and this could be taken as a government blessing of cropland expansion as long as it is a cash crop. On the other hand, there is no doubt that the contradictions between coexisting policies allow the actors at all levels to choose the forum (or policy) that best supports their main interest (cf. von Benda-Beeckman (1981) analysis of "forum shopping"). Furthermore, there were no signs in our field work data that the policy contradictions are a matter of much concern or something that is actively opposed at any administrative level.

## 7. Conclusion

Through contract farming, the production of cash crops such as maize can help increase economic incomes for rural communities, at least in the short term. In order to support agricultural development and reduce poverty, authorities at both district and provincial levels strongly encourage rural communities in Hua Meuang District to cultivate these commercial crops. They do so by actively reducing tax levels in order to attract investment companies and by choosing not to monitor the contraction between this income-generating activity and forest conservation. Although maize is a commercial crop intended to replace shifting cultivation of upland rice, it encroaches more into the forested areas than shifting cultivation of rice. Consequently, the recent boom in maize production has not reduced the area under shifting cultivation simply because it employs shifting cultivation practices similar to upland rice cultivation with shorter or no rotation.

The intentions of policies on agricultural development and forest conservation in Laos, as seen clearly in the LFA, favor a land-sparing trajectory of the landscape, whereby pristine forest areas are to be preserved for biodiversity and conservation of other ecosystem services. Agricultural land is restricted by the LFA, which promotes more intensive land uses in the allocated agricultural areas and reduces shifting cultivation. However, the actual implementation of the policies leads to an expansion of more intensive agriculture into natural forests and fallow areas that could be destined for regeneration. As a result, while the traditional shifting-cultivation practices favored a land-sharing landscape, the new development appears to favor neither sparing nor sharing as intensive agriculture is simply taking over forested land earmarked for protection and conservation, but not subjected to enforcement. The NEPL NPA remains to a large extent protected, but even here new road construction is likely to be a driver of further deforestation. The prospects for stopping deforestation and reducing forest degradation in this scenario are bleak as the degraded forests that would be eligible for protection and regrowth under a REDD+ mechanism are now disappearing fast.

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# Financial returns from collaborative investment models of *Eucalyptus* agroforestry plantations in Lao PDR

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ABSTRACT

Global demand for forest products is increasing and plantation forests are supplying a growing proportion of wood to industry. Plantation expansion has however slowed and the location and management of plantations to meet future timber needs is uncertain. In South East Asia, population pressure and land tenure arrangements will challenge broad scale plantation establishment. Companies and government are looking to plantation models that integrate local community or conservation needs but there has been little financial analysis of integrated production systems that can inform investment decisions by corporations or smallholder tree growers. Lao PDR has at least four million hectares of degraded forest land that could potentially be used for production and conservation purposes. The Lao 2020 Forestry Strategy aims to increase forest cover across the country, particularly on degraded lands, to enhance rural livelihoods and natural capital. This includes the most recent target of 1.2 million ha. The strategy envisaged that, in part, forest cover would be increased through the establishment of commercial tree plantations by local farmers, and by domestic and foreign investors, to provide wood exports and domestic timber products. Realising this target has been challenging. Foreign investors have been allocated concessions but have not been able to achieve area targets due to community resistance. There is a need to explore timber production investment models that engage local growers and address community needs for food, but there has been little analysis of these integrated approaches. This paper presents financial analyses of three plantation models: a 'collaborative investment model' with *Eucalyptus* intercropped with rice by landholders for the first year of the rotation, *Eucalyptus* intercropped with cassava by the forestry company, and a *Eucalyptus* monoculture. Results indicated that all models were highly profitable with positive NPV under a 12% interest rate, and Internal Rates of Return (IRR) ranging from 17% to 20%. The *Eucalyptus*-rice model generated the highest returns, with 21% of the NPV going to the local rice farmer. *Eucalyptus* monoculture was more profitable than when intercropped with cassava. Results are compared with those from other plantations in the region. Adoption of timber plantation models that integrate local food production can avoid potential conflicts over land allocation for plantations, build local engagement and support enhanced food security. The implications for forest and land use policy in Lao PDR are discussed.

## 1. Introduction

Global demand for forest products is increasing, forest plantations are supplying a growing proportion of wood to industry and the area of plantation may need to double to meet future wood needs (Barua et al., 2014). While the global area of forest declined between 1990 and 2015, the area of planted forest increased (Keenan et al., 2015). However, the rate of increase slowed between 2010 and 2015 and there are signals that future expansion of broad-scale plantations will be more limited than the rates seen in the past (Payn et al., 2015). This raises these questions: where will future plantations be located, who will manage them, and how will they be managed to meet future wood demand?

A shift from net forest loss to net forest gain through natural regeneration or planted forests is described as a 'forest transition' (Meyfroidt et al., 2018). Rudel et al. (2005) described two possible pathways for such transitions: the 'economic development' pathway with higher wages and increasing urbanization leading to increased costs for agriculture, less forest clearing and total or partial abandonment of agricultural land; or the 'forest scarcity pathway' where demand for forest products and environmental services increases with

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agricultural expansion and reduced forest cover, leading to increased investment in forests. A third, 'smallholder, tree-based intensification' pathway can result from dynamics at a small farm scale (Pokorny and Jong, 2015), with trees incorporated into farms resulting in a "tree cover transition" that extends beyond what is usually defined as forests (van Noordwijk et al., 2014). Different types of forest expansion can make a significant contribution to economic development as well as a wide range of biodiversity and conservation outcomes, when these plantations are well managed (Silva et al., 2018). Sustainable management of production landscapes can also build resilience in the commercial forestry sector (CISL, 2017).

Byerlee (2014) suggests that, in the early stages of development of agricultural plantations in Asia, economic fundamentals related to processing methods and pioneering costs and risks favoured large-scale plantation investors but that, over time, there has been a transition to smallholder-dominated production. More recently, policy biases and development paradigms often favoured plantation investors and discriminated against smallholders, with government provision of land and access to cheaper labour favouring investors in some countries. In studies of teak timber plantations in Laos, Cramb et al. (2017) and Maraseni et al. (2018) concluded that smallholder tree production can be a viable and inclusive livelihood strategy, as it can be easily established and can require little household labour to grow and harvest. Such plantations have been used to secure claims to 'surplus' land while accumulating wealth for emergency needs and/or long-term investment. However, this favours better-off smallholders and outside investors, and creates a 'backwash' effect on poorer households who are more likely to sell their teak stands early and push farther into marginal land to meet their subsistence needs. Others have pointed to the wider role of smallholder tree growers in the region (Midgley et al., 2017). While these studies indicate the potential future role of planted forests in timber supply, there has been little analysis of their financial outcomes.

In South and South East Asia, population density and climate change are putting pressure on expansion of planted forests (Payn et al., 2015). Lao PDR is classified by the World Bank[1] as a low-income country, with a Gross National Income (GNI) per capita of approximately US$2150 in 2016. It has transformed through development, from the pre-colonial and colonial eras through the Indo-China war period, to independence in 1975 and increasing exposure to regional and global trends and opportunities (Phimmavong et al., 2009). While the economy has grown relatively rapidly, this has largely been through hydro-power and mining development and the benefits of growth have been unevenly distributed (OECD, 2013, 2017). Approximately 80% of the Lao population live in rural areas and are heavily dependent on forest resources. Agriculture and forestry collectively accounted for 23.7% of total GDP in 2014-15. Food security remains a problem for much of the population, which is still primarily rural and subsistence agriculture predominates.

Forest policy has evolved from an initial focus on subsistence use and local trade in forest products, through increased industrial development based on exploitation of natural forests and government revenue from log exports, to a focus on forest conservation and restoration, and poverty alleviation. These latest goals have been supported through forest land allocation to villages and smallholders, forest restoration activities and encouragement of foreign investment in tree plantations. Plantations have been established in Lao PDR for well over a century. *Eucalyptus* plantations were introduced in the late 1960s and planted on a small scale, mainly for experimental purposes. Small woodlots of *Eucalyptus* were planted by the Lao-Australian Reforestation Project in the early 1973 (Midgley, 1976) and harvested for poles and construction. Many of these early plantations provided a knowledge base for agency staff to identify the best species, provenances, and establishment methods. The most promising species planted were *Eucalyptus tereticornis* and *Eucalyptus camaldulensis*.

Latest estimates indicate that forest area (with a tree canopy cover > 20%) in Laos increased from 40.3 to 47% of the land area between 2010 and 2015 (18.8 million ha) (DOF, 2015). An estimated area of 4.6 million ha is temporarily unstocked and could be used for a mix of production and conservation purposes. Restoring forest by integrating production plantations can reduce pressure on natural forests, support domestic industry development and improve landscape ecosystem services. The Lao 2020 Forestry Strategy aims to increase forest cover on degraded lands and enhance rural livelihoods and natural capital. This is to be achieved, in part, through planting 500,000 ha of high-value or fast-growing trees by smallholders and corporate investors to provide wood exports and domestic timber products (Phimmavong et al., 2009). Forest policy in Laos therefore incorporates industrial development and contributions to local livelihoods through foreign investment and smallholder timber production.

While smallholder teak plantations in northern Laos were the dominant form of plantation development in the 1980s and 1990s, private companies have driven investment since the early 2000s (Phimmavong et al., 2009). About 446 000 ha of tree plantations has been established, with the bulk of these being for rubber production. An estimated 70,000 ha has been planted for timber production, primarily *Eucalyptus* by foreign companies in central and southern Lao PDR (Phimmavong, 2012). The Lao Government has recently expanded the plantation target to about 1.2 million hectares, or about 700,000 ha of new plantations, by 2030.[2]

Despite low population density and large areas of degraded land, foreign investors in plantations have experienced problems securing their target land area for conventional plantation models, often due to negative reaction from local communities to plantation investment proposals or wider concerns about the benefits of plantations (Smith et al., 2017). Some companies began to focus on meeting community needs in their production systems, by providing for integration of food with timber production.[3] Integrating trees and agricultural production in agroforestry systems may be more profitable than either tree or crop monocultures (Coe et al., 2014; Grossman, 2015; Ota et al., 2018) and agroforestry has been promoted as an alternative land use strategy that could be both profitable and able to mitigate environmental problems associated with farming (Bannister and Nair, 2003; Hernández-Morcillo et al., 2018; Martinelli et al., 2019). Despite the widespread planting of *Eucalyptus* on farms around the world, and the use of *Eucalyptus* products by larger-scale investors and smallholders, there has been little analysis of financial returns from agroforestry based on *Eucalyptus* plantations. Plantations and agroforestry systems are a key issue for the development of sustainable land use in Lao PDR and such financial analyses are required to inform policy or investment decisions.

This paper aimed to investigate the financial returns that accrue to a tree investor and to farmers in three models of *Eucalyptus* plantation: *Eucalyptus* timber monoculture and two agroforestry models (*Eucalyptus* intercropped with rice and *Eucalyptus* intercropped with cassava). Data for the study were collected on sites developed by the Burapha Agroforestry Company Limited (BAFCO). The company receives the proceeds from the timber, timber- cassava. In the timber-rice model, the farmers own the rice which is analysed in this paper.

[1] The World Bank dataset at http://data.worldbank.org/country/lao-pdr (accessed on 04 October 2018)

[2] According to the Technical Workshop on Legal Framework for Tree Plantations organised by the Lao Department of Forestry, and the Department of Forest Inspection, Ministry of Agriculture and Forestry in Vientiane, Laos from 3-4 October 2018, the government of Laos plans to expand about 700,000 hectares of new plantations, most of which were identified in Production Forest Areas (650,000 hectares).

[3] See reference from the "Outreach" newsletter COP21 at https://outreach.stakeholderforum.org/index.php/previous-editions/cop-21-paris/edition-3-forests-food-and-agriculture.

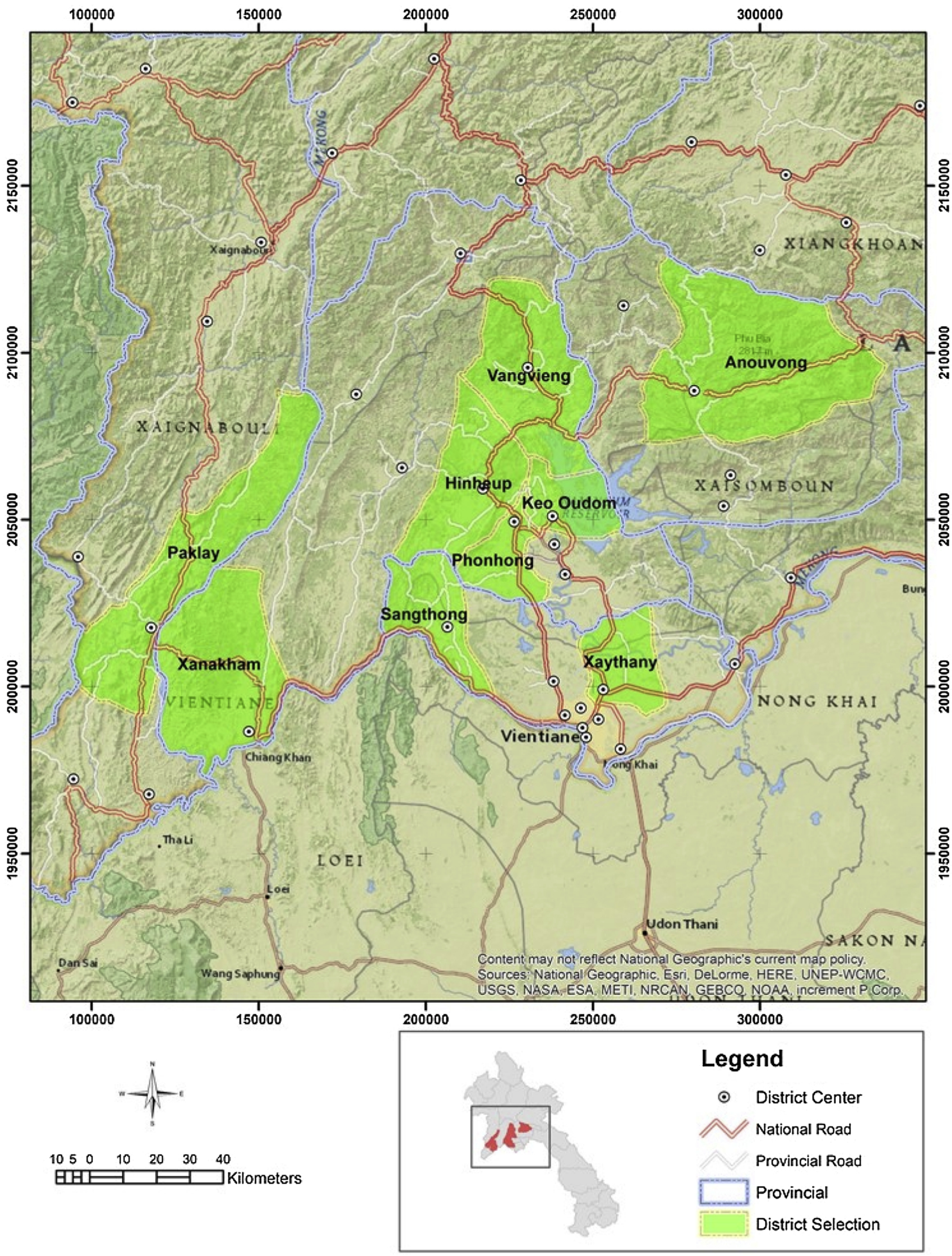


**Fig. 1.** Map showing all districts of BAFCO plantation sites in the study province.

## 2. Methodology

### *2.1. Study area and agroforestry plantation model*

The plantation sites are situated in four Provinces of Lao PDR: Vientiane Prefecture, Vientiane Province, Xayyabouly Province, and Saisomboun Province (Fig. 1). The climate of these regions is dominated by tropical monsoons with pronounced wet and dry season. There are two seasons in Lao PDR: rainy (May to September) and dry (October to April).

In Vientiane Prefecture (around the city), the landscape is quite flat, while Vientiane Province varies from flat, fertile sedimentary plains in the Nam Ngum River Valley, to rugged limestone mountains in the northern and western part of the Province. Saisomboun and Xayyabouly Provinces are moderately mountainous with steep valleys, and flood plains. In Xayyabouly Province, the Mekong river runs through the landscape. Most soils in these areas are siliceous sedimentary formations, mainly Acrisols and Cambisols. Due to long-term traditional, shifting agriculture, soils have become more acidic with relatively low nutrient concentration in some places.

The Burapha Agroforestry Company (BAFCO) is a Swedish company that has invested in plantation forestry and processing in Laos since the late 1990s. It has a goal of establishing sufficient trees to develop a veneer and plywood processing facility and, to date, has received approval to plant approximately 7960 ha of land for up to 30 years. It has, so far, planted about 4100 ha comprising primarily commercial *Eucalyptus* hybrid *E. camaldulensis* x *E. deglupta* with smaller areas of other hybrid *Eucalyptus* clones and some pilot plantings of clones of *Acacia auriculiformis* x *A. mangium*. The company uses the Free Prior and Informed Consent (FPIC) principle to acquire land. The company proposal and policies are presented to villagers. If they clearly understand and agree with what will happen under the proposal, the company develops a legal agreement and proceeds with land acquisition. BAFCO has several different forms of land-use agreements to suit varying situations. Land is also accessed through concession from local or provincial governments, but always after confirming the right to land with local farmers and communities.[4]

Table 1 shows different types of BAFCO's land lease agreements which are acquired from individuals, village lands, and the Government of Laos. BAFCO has acquired the land from the village and individuals and is based upon a 30-year concession agreement with a 20-year extension while the concession with the Government of Laos is a 50-year concession with 25 year extension.

In this study we collected data on three tree-crop systems being tested by the company: *Eucalyptus* monoculture, *Eucalyptus* and cassava and *Eucalyptus*-rice. In the *Eucalyptus*-rice system, villagers can grow rice between the trees. This usually only occurs for the first year of the 7-year tree rotation. Villagers are also employed to plant, tend the trees during the rotation and harvest the trees. For *Eucalyptus*-cassava, the company planted the cassava for the first year of the plantation cycle and collects revenue from the sale. In this model, local villagers receive wages for preparing and clearing land, planting, fertilising, weeding, pruning, thinning (if undertaken), and harvesting.

The spacing for intercropping with cassava is either 9 m × 1 m or 6 m × 1.5 m while those for rice are 9 m × 1 m, 6 m × 1.5 m, and 4.5 m × 2 m. In areas far from villages and available labour, the company has planted monocultures with a spacing of 3 m x 3 m. All models offered initial tree stockings of 1100 stems/ha, this being a regulatory requirement to obtain land tax exemption for planted lands.

In the *Eucalyptus*-rice model, farmers harvest rice for their own consumption or sale (Table 2). The company leases land from villages, which is allocated by the village head, in consultation with the communities and local authorities. Individuals are given the first right to grow agricultural crops on the land leased to the company. At planting, BAFCO contributes the following payments[5] to local authorities and the State: development funds for village cooperation and concessions which is a single, one-off payment to cover the whole 30 year concession period. This development funds comprise: a Village Development Fund (LAK 1–3 million $ha^{-1}$); Khum (village cluster) Development Fund (LAK 40,000 $ha^{-1}$); and District Development Fund (LAK 80,000 $ha^{-1}$), in addition to concession payments according to laws and regulations of Lao PDR. These costs are included in the overhead costs in Table 3.

### 2.2. Data collection

The data used in analysis were derived from company sources and field investigation in Vientiane Province. Data on costs of plantation establishment, management and other inputs were collected from the enterprise and from households through interviews by a team of researchers from the Faculty of Forest Science, National University of Lao PDR with the help of the local staff of Provincial Agriculture and Forestry Office. We made several visits to plantation sites to confirm information given in the interview notes and company documents. All costs were recorded in Lao Kip and converted to US dollars to enable comparison with other studies.

The company provided growth and yield data based on well-maintained trials. Mean annual volume increment (MAI) for both *Eucalyptus* monoculture and *Eucalyptus* intercropped with rice plantation was 28.6 $m^3$ $ha^{-1}$ $year^{-1}$ and *Eucalyptus* with cassava was 26 $m^3$ $ha^{-1}$ $year^{-1}$. These are high growth rates relative to those observed in other parts of the region, but the figures have been corroborated using data from company permanent sample plots (which indicate even higher growth rates, on average, than those used in this analysis). High growth rates are due to the quality of soils, favourable climatic conditions, plantation management and limited incidences of pest & disease. These *Eucalyptus* plantations are some of the best performing in South East Asia, where MAI in volume is typically between 15 and 24 $m^3$ $ha^{-1}$ $year^{-1}$ (Harwood and Nambiar, 2013). More recent plantings (2016 & 2017 age-classes) are much higher (33 $m^3$ $ha^{-1}$ $year^{-1}$)[6] than those assessed in this study, due to further improvements to silviculture and plantation management.

The expected average price of timber at farm gate of US$48/$m^3$ was obtained from the company (in 2016). This did not include the cost of transportation (from the point of harvesting to the market or factory). A discount rate of 12% was based on the interest rate on borrowings from the Agriculture Promotion Bank, the only state bank in Lao PDR which gives loans to agriculture and forestry investment.

The greatest cost component in all three models was land preparation and planting (Table 3), which included: land clearing (US$270), road construction (US$50), pre-plant manual herbicide application (US $49), seedling and delivery, staking, hole digging, phosphate application and refilling (US$259). Most of the land clearing was done manually by local villagers at a cost of about US$189 $ha^{-1}$ (70% of the total land clearing costs), while tractor, bulldozer and excavator costs accounted for 30% of the total land clearing costs.

Land cost and overhead costs are important factors in plantation investment. For this project, land is contributed in return for lease payments and contributions to Village Development Funds. The land cost includes the lease payments of US$50 $ha^{-1}$ $year^{-1}$ and an overhead cost of US$180 $ha^{-1}$ $year^{-1}$. The overhead costs include costs associated with sales, administration, marketing, resources and general company operations. These costs are based current plantation area and the unit-based overheads are likely to decrease when larger areas of plantations are established.

In the *Eucalyptus*-rice model, the company owns the trees and the farmers own the rice. For cassava mixed with *Eucalyptus*, the company owns both trees and cassava. The cost of cassava production includes operational labour, inputs, tractor cultivation, transport and loading. Operational labour and input costs were estimated to be US$308 $ha^{-1}$ and consist of cassava stumps and delivery, cutting and bundling, stump cutting, ploughing and mounding, planting cassava, pre-planting chemicals, manual weeding and singling, chemical weeding, and fertilizing (2 times). The mechanical lifting labour and tractors cost approximately

[4] The sources of BAFCO practices are based on standard operating procedures for land acquisition from Burapha Information Handbook (Laity, 2014).

[5] Exchange Rate: 1 US$ = 8,265 LAK (Banque Pour Le Commerce Exterior Lao Public (BCEL) on 05.10.2018)

[6] This MAI was used in a recent World Bank analysis (World Bank, 2018).

**Table 1**
BAFCO's land lease agreements.
Source: Earth Systems (2015)

| Type | Description |
|---|---|
| Perpetual land use rights | Land with land use rights in a Lao shareholder's name. |
| Cooperation agreement with village | Cooperation agreements made with villages on land that is state land will be forwarded to relevant government authorities for establishment of concession agreements (30 + 20 years). |
| Cooperation agreement with individuals | Cooperation agreements made with individuals on land for which the individual can prove that their land use rights (30 + 20 years). |
| Concession agreement | Concession agreement with the Government of Laos (50 + 25 years). |
| Joint Venture Agreement | Joint Ventures can be made with such entities that can prove that their land use rights and related documents are fully in accordance with Government of Laos' laws rules and regulation. A Joint Venture operation shall, in all aspects, follow the same policies and standards that are applied to the Company's own operations. |

**Table 2**
*Eucalyptus* Agroforestry model used by BAFCO.

| Year | Plantation activity | Workforce | Intercropping |
|---|---|---|---|
| 1 | - Bush clearing<br>- Staking and hole digging and planting<br>- Fertilizing x2<br>- Weeding and guarding<br>- Pruning | - Manual clearing by casual workforce, controlled burning, or mechanical clearing by company staff<br>- Fertilizing, weeding and guarding and pruning undertaken by farmers who own rice | - Rice (owned and managed by individuals). From planting through to harvest.<br>- Cassava (owned by BAFCO, with casual workforce employed to plant, maintain, and harvest). Harvesting activities include labour for cutting shoots and branches, and harvesting. |
| 2 | - Weeding and guarding | - Local farmers who own rice | |
| 3-4 | - Weeding and guarding<br>- Thinning<br>- Pruning | - Local Farmers | |
| 5-6 | - Weeding and guarding | -Local Farmers | |
| 7 | - Harvesting | - Likely to be locally-recruited company employees | |

**Table 3**
Comparison of costs and revenue over a seven-year rotation for monoculture, rice- *Eucalyptus* mixture and cassava- *Eucalyptus* mixture grown in Vientiane Province, Lao PDR.
Source: Burapha Agro-Forestry Co. Ltd, 2018

| Activities | | Monoculture *Eucalyptus* | | Rice mixed with *Eucalyptus* | | Cassava mixed with *Eucalyptus* | |
|---|---|---|---|---|---|---|---|
| | | Costs (US\$ $ha^{-1}$) | Revenue (US\$ $ha^{-1}$) | Costs (US\$ $ha^{-1}$) | Revenue (US\$ $ha^{-1}$) | Costs (US\$ $ha^{-1}$) | Revenue (US\$ $ha^{-1}$) |
| Year 1 | Land Preparation and Planting | 628 | | 628 | | 628 | |
| | Weeding and fertilisation | 533 | | 533 | | 533 | |
| | 1st lift pruning | 15 | | 15 | | 15 | |
| | Crop production | | | 147 | 333 | 906 | 1045 |
| Year 2 | 2nd full weeding | 120 | | 120 | | 96 | |
| Year 3 | 3rd full weeding | | | | | 120 | |
| | 2nd lift pruning | 25 | | 25 | | 25 | |
| Year 4 | Thinning | 248 | 300 | 248 | 300 | 248 | 300 |
| | 4th full weeding | 17 | | 17 | | 120 | |
| | 3rd lift pruning | | | | | 30 | |
| Year 5 | 1st interrow firebreak weeding | 17 | | 17 | | 17 | |
| Year 6 | 2nd interrow firebreak weeding | 17 | | 17 | | 17 | |
| Year 7 | 3rd interrow firebreak weeding | 17 | | 17 | | 17 | |
| | Final timber harvest | 3300 | | 3300 | | 2755 | |
| | Gross timber sales | | 9600 | | 9600 | | 8750 |
| Year 1-7 | Land cost | 350 | | 350 | | 350 | |
| Year 1-7 | Overhead cost | 1260 | | 1260 | | 1260 | |

US\$33 $ha^{-1}$ while transportation and loading are about US\$17 $ha^{-1}$. The total costs of producing fresh cassava are estimated at approximately US\$906 $ha^{-1}$ while the total income received by the company for the sale of fresh cassava at the mill gate is \$1045 $ha^{-1}$. For *Eucalyptus* intercropped with rice, local farmers spend a total of 22 man-days of their labour per hectare for planting and harvesting rice. With the wage rate of just over US\$6 per day, the total cost for producing rice per hectare including cost of seed is US\$147.[7] The rice yield observed from farmers' rice harvest at the field site is on average 1176 kg $ha^{-1}$ for 2016 and the unhusked rice price is about US\$0.3 $kg^{-1}$, resulting in a total revenue equivalent in the first year of approximately US\$333 $ha^{-1}$. This does not usually enter the market because the farmer retains the rice for use by the family.

For the timber trees, at the end of the 7-year rotation, mono-culture and rice intercropping systems are projected to have similar log yields of 200 $m^3$ $ha^{-1}$. The trees intercropped with cassava are projected to be less productive with yields of 182 $m^3$ $ha^{-1}$. Therefore, both the monoculture and intercropping with rice models each have a gross tree revenue of US\$9600 $ha^{-1}$ while the tree revenue from intercropping with cassava would yield only US\$8750 $ha^{-1}$.

The data on costs and benefit for the current analysis have been

[7] The costs and benefit of rice cultivation integrated with *Eucalyptus* plantation were collected from a field investigation. A group discussion was made with 15 randomly selected farmers in Phonmuang Village, Hinheub District. The data on rice yield were collected at the time of harvesting rice in 2016.

provided by the company. Weeding is only three times for both monoculture and rice intercropping systems whereas for *Eucalyptus* with Cassava plantation it is done 4 times from year 1 to year 4. Weeding is not necessary for either *Eucalyptus* monoculture or the *Eucalyptus*-rice model in the second year. The Cassava mixed with *Eucalyptus* model was essentially an experimental pilot operation which has been recently discontinued. The weeding cost for this model remains high for year 3 and year 4 because of the experimental nature of the model. There is a need of research investigating variations in weeding costs of different models in the future.

### 2.3. Financial analysis

There are several approaches to compare financial returns from timber plantations. Selecting a suitable technique depends on the purpose of the study, and the results may be misleading unless the correct indicators are used. One of the most common capital budgeting measures is NPV, the present value of future revenues minus the present value of costs. Land expectation value (LEV) is the present value of the projected costs and benefits over an infinite time horizon and it provides an estimate of the value of land in perpetual timber production. The internal rate of return (IRR) is a rate of return or profit expected from investment projects and it is the discount rate at which NPV is equal to zero. NPV is suitable for evaluating short rotation plantations of 5–20 years while LEV is better for the long term where there are investments of unequal time lengths (Cubbage et al., 2014). Annual equivalent value (AEV) is NPV expressed as an annuity over the rotation length, calculated at the discount rate, using a simple formula. Multiplying LEV by the interest rate gives the Annual Equivalent Value (AEV). AEV is also useful for comparing investments of unequal length and is frequently employed to compare investments with periodic cashflow (namely forestry) to investments with annual returns, such as annual agricultural crops.

NPV, LEV and AEV are appropriate when land is the most limiting factor of production. IRR is often used in practice, even though it is not as theoretically appropriate as NPV for producers with limited land and relatively high access to capital. It has intuitive appeal and appropriate when investor does not have a set discount rate. Where labour is limiting, Discounted Returns per Workday (DRW, the ratio of the discounted net revenues to discounted wages, expressed in dollars per workday) is an appropriate indicator (Mercer et al., 2014). Smallholder decisions in investment of their limited capital, land and time are also commonly driven by endogenous preferences such as leisure, non-market values, time, risk, and uncertainty (Baker et al., 2017).

NPV, LEV, AEV and IRR were chosen for this study, as they have been widely used to evaluate forestry investments, including in Lao PDR (Manivong and Cramb, 2008; Maraseni et al., 2018; Phimmavong, 2004; Xayvongsa, 2001). To compare financial returns from the three models we assumed that all costs are borne, and benefits received, by the company. Sensitivity analysis was used to assess the impact of variation in stumpage price and timber yields.

The timber yields were similar in the trees only model and the agroforestry models. The timber yields and returns were assumed to accrue to the company. Differences in the financial indicators between the systems were therefore assumed to be due to the returns from the agricultural crops (rice and cassava).

## 3. Results

### 3.1. Comparing financial returns from three models of Eucalyptus plantations

Combining the returns to the company and to the farmer revealed that all models resulted in positive total NPVs at a discount rate of 12%. IRRs range from 16.7% for *Eucalyptus*-cassava to 20.1% for the *Eucalyptus*-rice intercropping model (Fig. 2). Total LEV for the *Eucalyptus* monoculture and *Eucalyptus*-cassava was similar ($1156 ha$^{-1}$ and $1190 ha$^{-1}$, respectively) but higher for the *Eucalyptus*-rice intercropping ($1459 ha$^{-1}$). AEVs ranged from US $103 ha$^{-1}$ in the *Eucalyptus*-cassava to US$175 ha$^{-1}$ in the *Eucalyptus*-rice system. The NPV of the *Eucalyptus*-cassava mix is lower due to the higher costs of cassava inputs and planting. As mentioned in Section 2.2, the net revenue from rice production is about US$186 ha$^{-1}$ in the timber-rice intercropping model. All this value accrues to the farmer in the first year.

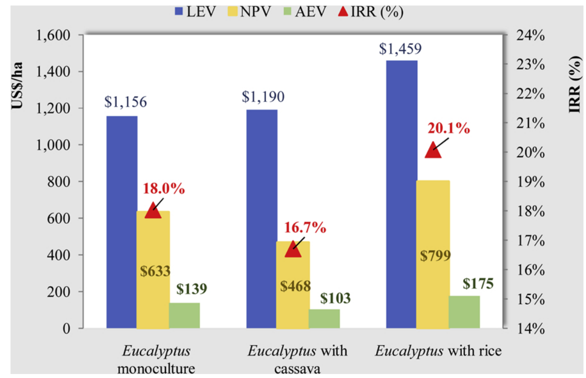


**Fig. 2.** LEV, NPV and IRRs for three models of *Eucalyptus* plantations.

### 3.2. Partitioning of benefits from the Eucalyptus-rice model between the company, the farmer and the village

This *Eucalyptus*-rice model results in value from the plantation investment being shared between the company as an investor, the farmers providing labor and growing crops, and the village providing land and receiving benefits from investment in the village development fund (Fig. 3). The total investment by the company over the 7 year rotation is $1884. Comparing the NPV of the value received by different parties at 12% interest rate, the farmer receives nearly 62% of the total for their labor and rice value, because their wages income is mostly in the first year and therefore not heavily discounted. The company receives about 28% because their returns are discounted over 7 years, and the village and district about 10% for payments associated with the land. This distribution would change with different discount rates.

### 3.3. Sensitivity analyses of plantation investment

#### 3.3.1. Impact of discount rate

As expected, all plantation models are relatively sensitive to variations in discount rate. With a discount rate of 12%, the LEV of the *Eucalyptus* monoculture is US$1156 ha$^{-1}$ compared to US$2393 ha$^{-1}$ (2 times higher) using a discount rate of 9% (Fig. 4).

Using a discount rate of 15%, LEV is almost 40% ($448) of the LEV with 12% applied. Furthermore, the use of a discount rate of 8% has enabled useful comparisons to be made with current World Bank analysis (Table 4) showing that the LEV remains highly profitable when compared internationally (US$3026 ha$^{-1}$).

#### 3.3.2. Sensitivity to variation in timber yield

Responses to yield change were highly elastic. Increasing the plantation yield increases the LEV significantly for all three plantation models (Fig. 5). For instance, increasing or decreasing the growth rate for *Eucalyptus* monoculture by 10% above the baseline will increase or decrease the LEV by more than 68% (from US$1156 ha$^{-1}$ to US $1949 ha$^{-1}$) and (US$1156 to US$363 ha$^{-1}$, respectively).

As expected, a higher tree growth rate for agroforestry models results in higher LEV. Increasing or decreasing the growth rate by 10%, results in an increase or decrease in LEV for *Eucalyptus*-rice of 54% (to

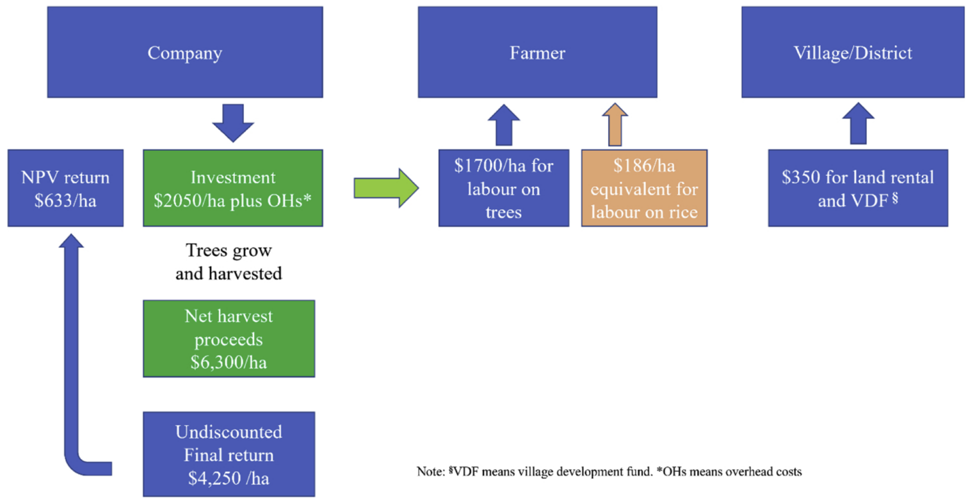


**Fig. 3.** Partitioning of benefits flow of the *Eucalyptus*-rice model between the company, the farmer and the village.

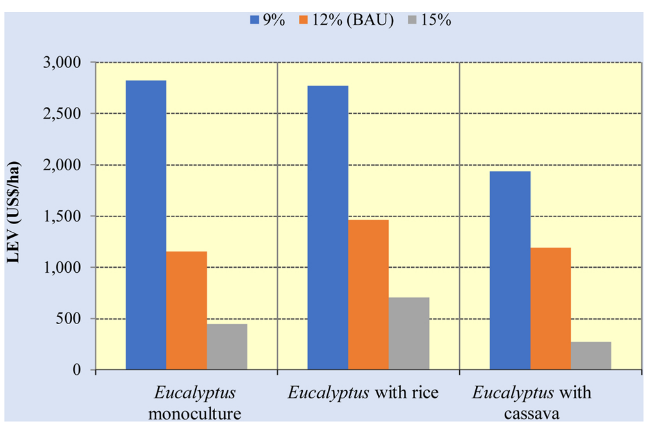


**Fig. 4.** Sensitivity of LEV to the discount rate of three plantation models.

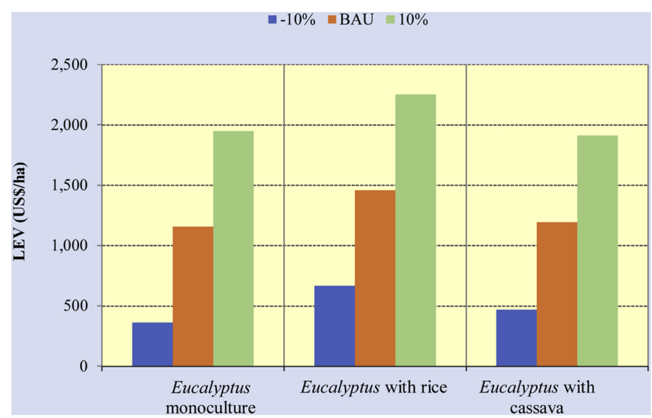


**Fig. 5.** Sensitivity of LEV of three plantation models to changes in timber growth rate.

US\$2252 $ha^{-1}$ and to US\$666 $ha^{-1}$, respectively). The impact on profitability of modest increases in productivity can influence investment decision-making and suggests the potential importance of high-quality germplasm, improved silviculture and plantation management. Smallholder access to best germplasm and silvicultural knowledge are crucial (Harwood and Nambiar, 2013) and with proper investments, their woodlots can be more productive and profitable and offer a pathway away from rural poverty.

### 3.3.3. Sensitivity to change in timber prices

When the timber price increases by 10% above BAU (Business as Usual), the financial LEV of *Eucalyptus* monoculture increases by almost 70% from US\$1156 to US\$1949 $ha^{-1}$. When the price decreases by 10% LEV drops by almost 70% to US\$363 $ha^{-1}$ (Fig. 6).

## 4. Discussion

These results indicate that all three models are comparably profitable from the standpoint of the company. The monoculture system and the *Eucalyptus* agroforestry system with rice have similar cost structure and have similar profitability in terms for returns from trees (NPV of US \$633/ha). *Eucalyptus* and cassava (NPV of US\$468/ha) compares less favourably due to higher input costs for cassava that were not met by returns. At the time of writing this paper, BAFCO had just decided to cease to employ *Eucalyptus* intercropped with cassava. This is because this intercropping model needs more intensive silviculture and management techniques and does give less direct benefit to farmers compared to the *Eucalyptus*-rice model. The returns from rice generated from *Eucalyptus* with rice go to the farmers. They also get returns from

**Table 4**
Comparison of returns for *Eucalyptus* plantations in Lao PDR to those of selected other countries around the world. 8% discount rate, 2015 US\$.
Source: Laos from authors; other countries from Frey et al. (2018) and Cubbage et al. (2014)

| Country | Species | Site Prep. Cost (US $/ha) | Planting cost (US $/ha) | MAI (m3/ha/yr) | Rotation length (years) | NPV (US $/ha) | LEV (US$/ha) | IRR (%) |
|---|---|---|---|---|---|---|---|---|
| Laos (monoculture) | *Eucalyptus* spp. | 369 | 259 | 29 | 7 | 1260 | 3026 | 18 |
| Vietnam (smallholder) | *Acacia* hybrid | 120 | 670 | 21 | 5 | 1,274 | 3,989 | 22.7 |
| Vietnam (SFE) | *Acacia* hybrid | 610 | 575 | 11 | 7 | –29 | –69 | 7.7 |
| Brazil | *E. grandis* | 170 | 330 | 30 | 16 | 7,712 | 10,891 | 27.9 |
| China | *Eucalyptus* spp. | 608 | 260 | 30 | 7 | 6,723 | 16,142 | 33.6 |
| Uruguay | *E. globulus* | 300 | 350 | 22 | 9 | 1,281 | 2 563 | 17.9 |
| Venezuela | *E. urophylla* | 156 | 2,066 | 25 | 7 | 560 | 1 343 | 10.4 |

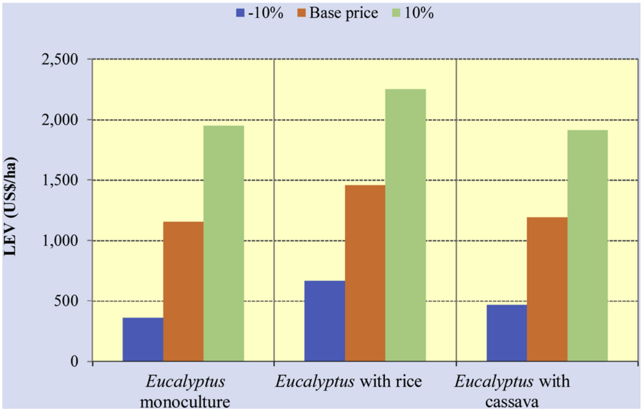


**Fig. 6.** Sensitivity of LEV of three plantation models to changes in timber prices.

their labour for establishing and planting the trees and income through the plantation rotation for weeding and thinning, and potentially harvesting. In most cases the rice is consumed by the growers' families and therefore realised as a subsistence benefit.[8]

There has been surprisingly little financial analysis of mixed tree crop systems with which to compare this analysis (Franzel, 2004; Guo et al., 2006; Jain and Singh, 2000). Agroforestry is more complex than traditional agriculture or plantation forestry, with varying input-output mixes of annuals or perennials or techniques such as contour hedgerows, alley cropping or enriched fallows (Dhakal et al., 2012; Mercer et al., 2014). Trees are often incorporated into agriculture for shade, shelter or nutritional benefits to animals or crops, or for environmental and catchment management outcomes beyond the farm. In these cases, the direct financial benefits of integrating trees and crops are difficult to assess.

Higher NPV for the mixed system was achieved because there was no trade-off between tree growth and rice yield. This is not common in agroforestry, where there is often a production frontier (Mercer et al., 2014). The system developed by the company allows for rice or cassava to be grown only in the first year of the tree rotation. Farmers avoid a rice production trade-off as the trees grow larger by moving to a different location to plant the next rice crop. The company's plan is to incorporate this movement into their rotational system to enable a continuous production of rice that would mimic the traditional shifting cultivation model for upland farming in this region. By limiting rice growing to the first year of tree production, this system avoids the usual competition effects of incorporating trees and light demanding annual crops, such as upland rice. These results suggest a benefit from agroforestry, but such benefit may be specific to these sites and this production system, and assumes that the company's goal of a rotational system is of interest to and supported by, the villagers.

In an analysis comparing agroforestry systems with agriculture and conventional forestry in the lower Mississippi region in the USA, Mercer et al. (2014) found that, in the absence of incentive payments, landowners are more likely to adopt agroforestry than conventional forestry on moderately marginal land. On the most marginal land the returns for agroforestry and forestry are similar. However, LEVs for agroforestry were much lower than for agriculture, suggesting little financial benefit to changing in these systems. On the other hand, analysis of an agroforestry trial in eastern Panama (Paul et al., 2015) concluded that the agroforestry model is a better investment than monoculture trees or pure agriculture. Intercropping teak trees with maize-beans-maize and pigeon pea using a discount rate of 6%, resulted in a 50% higher NPV compared to monoculture teak because of lower costs for pest management in the agroforestry system. The agroforestry system also contributed to improving food security in rural areas, as also noted in this study.

The estimated NPV for the *Eucalyptus* monoculture in our study (US $633/ha) on a 7-year rotation was lower than for other short rotation monoculture plantations in the greater region. For example, in a study of *Acacia* plantations in Quang Tri Province, Vietnam, the NPV using the same discount rate was US$1148/ha for a 5-year rotation and US $1221/ha for a 6-year rotation. NPV was considerably higher for a 10-year rotation (US$2972/ha) due the higher proportion of more valuable, larger-sized logs from the longer rotation (Maraseni et al., 2017).[9] Boulay et al. (2013) found that average NPV using a discount rates of 10% for a single rotation of *Eucalyptus* for growers supplying a pulp mills in northern Thailand was similar to our study - US$693/ha for contract growers and US$822/ha for independent growers. In the Vietnam *Acacia* study, LEVs for the 5-year, 6-year and 10-year rotations were $3998/ha, $5402/ha and $9895/ha, respectively, considerably higher than the LEVs for 7-year rotation in this study ($1156 - $1459/ha). This was primarily due to lower labor and input costs and higher wood prices in Vietnam.

Comparing returns from other crops, (Manivong and Cramb, 2008) undertook an analysis of smallholder rubber plantations in Luang Namtha Province, Northern Laos. Their analysis indicated that these plantations can be profitable at discount rates up to 13% when prices are high. Using a discount rate of 8%, a wage rate of 17,000 Kip per day, and the rubber market price at that time (7800 Kip/kg) NPV was $847 ha$^{-1}$. The NPV of a labour unit per person-day was approximately 29,000 Kip, much higher than standard wage of 25,000 Kip/person-day. While the NPV for rubber was higher than that for *Eucalyptus*-rice in our study ($799 ha$^{-1}$), the price of rubber has decreased dramatically since 2011 and the NPV for rubber investments has therefore declined. Many rubber growers are not tapping their trees (Lu, 2017) and some have converted rubber to banana plantations. This indicates one of the challenges with price volatility and the need to identify timber commodities for smallholder growers with few substitutes, and alternative market options, to reduce price fluctuations in a single market.

Costs and financial returns for monoculture timber plantations from our study were compared with those from a study by Cubbage et al. (2014) (Table 4). The growth rates of timber plantations of BAFCO in Laos were among the fastest amongst the comparators. While IRRs were competitive with other regions, LEVs were relatively low. One point of difference was that Cubbage et al. (2014) analysed financial returns without land costs, while our study included land acquisition costs and lease payments. All plantations, except for State Forest Enterprise (SFE) plantations in Vietnam, have positive NPVs and LEVs. While these SFE plantations produced a negative LEV and relatively low IRR of 7.7 percent, smallholders in Vietnam produced a high LEV of almost US $4000 per ha with an IRR of 22.7%. SFEs in Vietnam have high costs of site preparation and planting (US$1185 per ha) and weed control (US $600 per ha), but smallholders spend less on these activities. Growth in smallholder plantations is also much higher than SFE plantations (Frey et al., 2018). Land preparation and planting costs in our study were slightly lower than for smallholders in Vietnam, but much lower (almost half) for SFE plantations in Vietnam. These costs are lowest in Brazil (US$500 per ha), where these activities are mechanised, and highest in Venezuela (US$2222). Land preparation and management costs in Lao PDR could also be lower in subsequent rotations as company processes become more efficient.

Markets and infrastructure are keys driver of industry investment.

[8] In practice, integrating rice with *Eucalyptus* plantation into Year 2 is difficult since any use of fire to remove peeling bark and falling *Eucalyptus* leaves that litter on plantation floor would damage the trees. In addition, competition with the trees for light, nutrient, and moisture could potentially reduce rice yield.

[9] Maraseni et al (2017) did not compare the returns from a 10-year rotation with those from 2 x 5 year rotations.

As an example, in Vietnam, there is strong demand for plantation wood with increasing prices for woodchip from China and Japan and increasing demand for larger logs for furniture production. Vietnam also has easy access to ports and good roads in much of the country. Given these conditions, timber production has boomed in Vietnam over recent decades and the area planted by smallholders has increased. In Lao PDR, the wood industry is developing slowly and timber markets are poorly developed. Many other factors constrain tree plantation investment in Laos (Smith et al., 2017). Plantation regulations are highly bureaucratic with approvals required to establish, manage, sell and transport plantation timber being major obstacles to the development of industrial tree plantations. These impose direct payments and hold-up costs. In addition, Laos is a land-locked country which limits access to regional and global markets. A large proportion of plantation wood is currently exported to neighbouring countries.

This study shows the potential for a forest transition in Lao PDR from net forest loss to net forest gain, partly achieved through planted forests as markets for wood fibre develop. This transition is occurring through the 'forest scarcity pathway'. Under this pathway, over-exploitation of natural forests and decline in timber supply generally leads to increased demand for forest products and increased investment in new forests. Often this is corporate-investment-driven, larger-scale plantation. However, the 'smallholder, tree-based intensification' pathway has proven very successful in Vietnam (Pokorny and Jong, 2015).

The production model presented in our study represents an option between these two alternatives. The 'collaborative investment model' maintains and enhances opportunities for local food production, provides a timber resource for new regional industries, and returns for investors. In the process, local people receive income from employment and develop skills and experience with tree growing. In this model, trees are incorporated into rural land uses to support a "tree cover transition" (van Noordwijk et al., 2014) that results in trees beyond what is usually defined as forests. These skills can also transfer to the development of more independent outgrower arrangements in future.

Principles for value and revenue sharing in these types of arrangements differ, reflecting different types of business models. A business model is the way in which a company structures its resources, partnerships and customer relationships to create and capture value (Fielt, 2013). Business models are collaborative when they involve close working partnerships and share value, for example with local landholders and suppliers. Collaborative business models between industry and landowners include: contract farming schemes, joint ventures, management contracts and supply chain relationships (Vermeulen and Cotula, 2010). The model presented here, with the company and the farmer sharing the land and providing labour and the village or the government receiving lease payments, does not fit easily into these standard models. Sharing value is not just about sharing financial returns and business models need to consider: ownership rights to different business assets such as land, trees or processing facilities; the level of control over key business decisions, rights to information on market prices and costs, and arrangements for review and grievance; responsibilities for key activities in the model; how relationships developed and supported for the long-term; who bears different risks, including commercial risks, or wider political and reputational risks; as well as financial costs and benefits, including price setting and finance arrangements, and profit-sharing arrangements (Vermeulen and Cotula, 2010).

Tree growing in Lao PDR may therefore be following two pathways. The first is the production system for teak described by Cramb et al. (2017), where smallholder use trees to secure claims to land and accumulate wealth for emergency needs and/or long-term investment. Trees are sold off in small lots for periodic income requirements like school fees, health expenses or weddings. This tends to favour better-off smallholders and outside investors but disadvantages poorer households who are more likely to sell their teak early and push farther into marginal land to meet their subsistence needs. On the other hand, tree growers focused on *Eucalyptus* plantations are following the path of development of agricultural plantations described by Byerlee (2014). In this path, current requirements for processing methods and investment, and pioneering costs and risks, favour large-scale corporate plantation investors. These investors have operated in different parts of Laos with limited success.

By adopting a collaborative investment model that integrates food production with tree crops, BAFCO are addressing investment needs and managing production risks to profitably produce timber and provide new economic opportunities for local people. However, they are also contributing to local food security and providing some of the social benefits of maintaining traditional crop production (Dressler et al., 2017). As skills and experience with tree growing develops in the communities, there may be growth in smallholder timber production, along the path described by Byerlee (2014). Another Scandinavian company is also adopting this collaborative model in Central Laos with the additional benefit of removing unexploded bombs (UXOs) in part of the country that was heavily bombed during the American War in the region (Stora Enso Ltd).[10] These types of models can avoid the conflict and controversy associated with larger-scale plantation production (Malkamäki et al., 2018; Schirmer et al., 2015). The extent to which rice production is maintained in the long term will depend on relative returns to labour of growing rice versus trees and the price of rice in the market. Moreover, it depends on farmers' ability to access the plantations in the first year of establishment, which may be more difficult if the planted land is remote from the village.

The results from the financial analysis are based on three models of *Eucalyptus* planting and two food crops. Future studies could explore more combinations suited to different types of site or local community requirements. In neighbouring countries, Thailand, Vietnam and China, current markets for plantation timber are very strong and timber production is expanding rapidly. Regional demand for products from wood fibre is increasing and this is unlikely to slow down with hardwood wood chip markets facing substantial shortfalls of 3.5 million BDMT by 2023 and adjustments will be necessary (Flynn, 2018). In Lao PDR, forest policies have targets for plantation development, but much of the targets have been met through a wave of foreign and local investment in rubber during the late 1990s and 2000s. Under current prices, rubber is providing limited benefits to growers. The area of timber plantation is well below the current target of 500,000 ha and it is unclear how government plans to achieve an expanded target of 1.2 million ha. Allocating concessions to larger-scale foreign investors has led to unsatisfactory outcomes due to local policy impediments and community conflict over land allocation (Smith et al., 2017). The Government of Laos needs to consider policies to support new plantation models, such as that presented here, that integrate local needs with those of investors seeking to develop new timber resources. Smallholder farmers across the region might benefit from a more effective engagement with industry to build stronger value chains that provide farmers with the opportunity to receive more direct benefits from selling their plantation timbers while giving companies some measure of control over wood resources.

Recently, Sun Paper Holdings (Lao)[11] established a 300,000 tonne/year bleached hardwood Kraft (BHK) pulp mill in Sepon District, Savannakhet Province, Laos (Phimmavong et al., 2019) This mill will require approximately 1.2 million green tonnes of wood (*Eucalyptus* and *Acacia*) per year. At present, approximately 200,000 green tonnes per

[10] see https://www.storaenso.com/en/newsroom/news/2015/1/trees-food-and-bombs-in-laos

[11] Sun Paper Holding Laos Co., Ltd. is member of the Sun Paper Group; China's largest privately owned and managed paper business. The company also manufactures paper pulp, poles, and hard cardboard. The company was founded in 2010 and is headquartered in Savannakhet, Laos.

year are available in Laos and 1,000,000 green tonne are imported from Thailand (*Eucalyptus*) and Vietnam (*Acacia*). The demand and price for raw materials for paper production has therefore been increasing. The price of debarked *Eucalyptus* wood increased from 200,000 to 250,000 Kip (US$24 to 30) per gmt at the mill gate to 300,000–350,000 Kip (US $36 to 42) in October 2018 and to 400,000 Kip in January 2019. The Global Trade Atlas reports that in 2018, about 315,000 bdmt of *Acacia* wood chips were exported from Vietnam to Laos (RISI, pers comm). In addition, substantial quantities of *Eucalyptus* chips have been imported from Thailand (40,000 bdmt in 2018 and 26,000 bdmt in January 2019).

Greater attention might also be given to the obvious (and substantial) benefits presented in this study that accrue from increased productivity. The importance of increased productivity has been highlighted by the Bill and Melinda Gates Foundation: two of the prime strategic goals of their Agricultural Development Program are to increase agricultural productivity for smallholder farmers and increase smallholder farmer household income (BMGF, 2011). This is based on the evidence that productivity growth has been shown to drive rural poverty reduction through increased efficiency, employment, and income generation.

## 5. Conclusions

This paper investigated the financial returns from three models of *Eucalyptus* plantations in Lao PDR, including two models which intercrop with food crops in the first year. The *Eucalyptus*-rice system is a novel ‘collaborative investment model’ with foreign corporate investment in trees and local labour input to grow rice, with the value and benefits of the system being shared between the company and the participating villagers. Given current costs and projected future prices, returns from these intercropping systems are positive and competitive with those from fast grown trees in other parts of the world. The agroforestry systems, integrating food and trees has the potential to bring economic benefits for rural development of Laos and supply plantation wood to domestic and export markets. Under current prices and growth rates, these fast-growing plantation tree species can be more profitable than teak or rubber plantations. The Government of Lao PDR needs to develop the supporting legal and institutional frameworks for these new types of plantation investment models and support public private partnerships.

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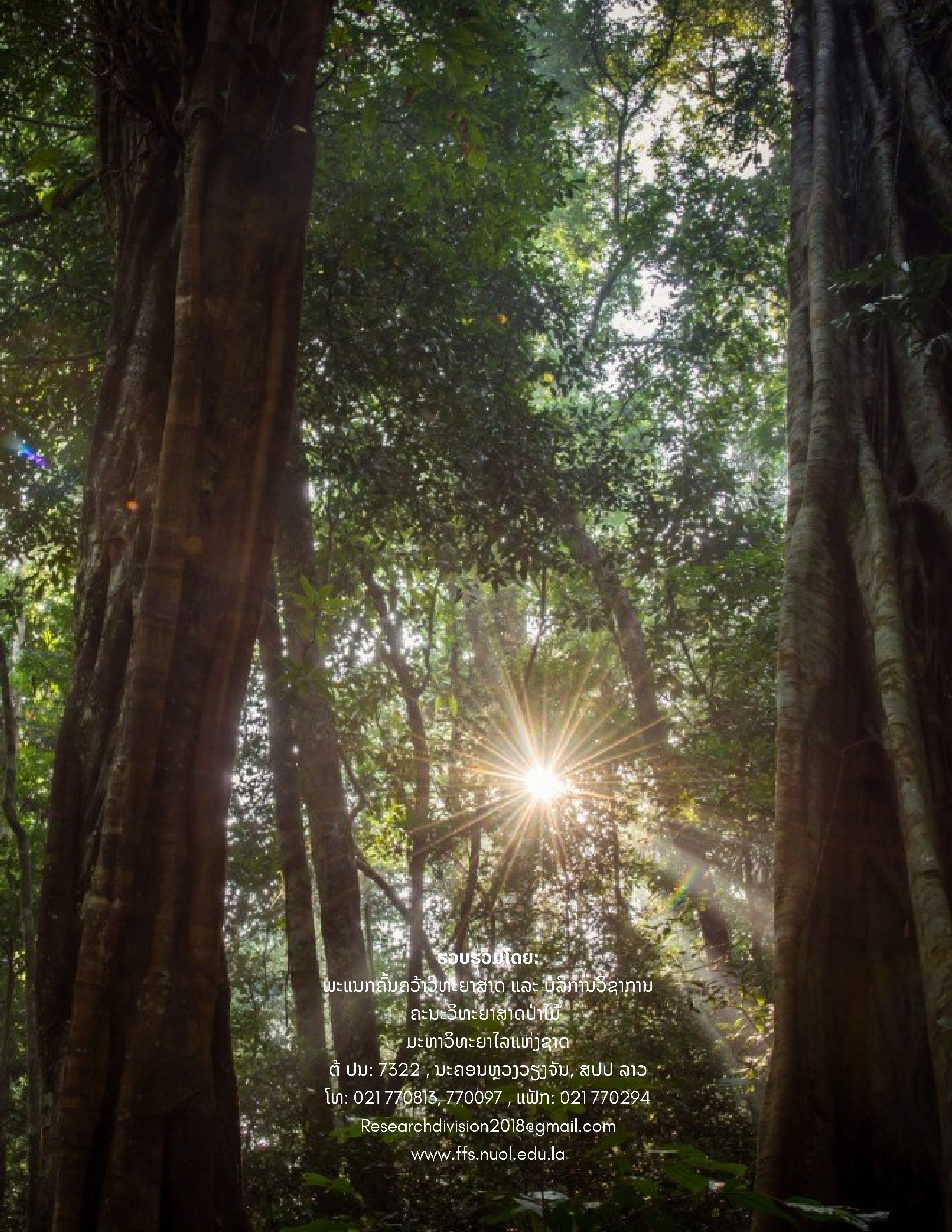


**ຮວບຮວມໂດຍ:**

ພະແນກຄົ້ນຄວ້າວິທະຍາສາດ ແລະ ບໍລິການວິຊາການ

ຄະນະວິທະຍາສາດປ່າໄມ້

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