Identification of erosion prone cropping systems in Northwest Vietnam to inform potential agroforestry interventions

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BACKGROUND

Socio-economic context

Making agricultural production more sustainable is critically important in Northwest Vietnam. The area has seen a 20% increase in the population between 2000-2014 alongside considerable deforestation to enable agricultural expansion (approximately 70% of the population are highly dependent upon agriculture, primarily wheat production). Many of these farmers are from ethnic groups such as the Hmong and Thai. Traditionally these groups would have practiced shifting cultivation but initiatives let by the Ministry of Environment & Natural Resources (MONRE) have now banned this practice. However, this has brought new problems to the area, primarily a significant increase in erosion.

Biophysical condition

- Sloping land (>15º): Accounts for 75% -90% of total land area
- Low tree cover (despite being designated as forest land)
- High erosion & land degradation potential
- Decline of water quality, quantity & biodiversity

Figure 1: Upland in Northwest region of Vietnam before maize cultivation season

Objectives

Mapping cropland on slopes (high soil erosion potential) *to inform* **Suitable tree species and tree combination options** & **Potential areas for tree integration for soil conservation**

Problems & Challenges

- Cropland area is underestimated in the government land use map
- Location of annual crop area in the land use map does not match Google Earth image
- No tree suitability analyses at landscape level for upscaling tree-based options

STUDY AREA

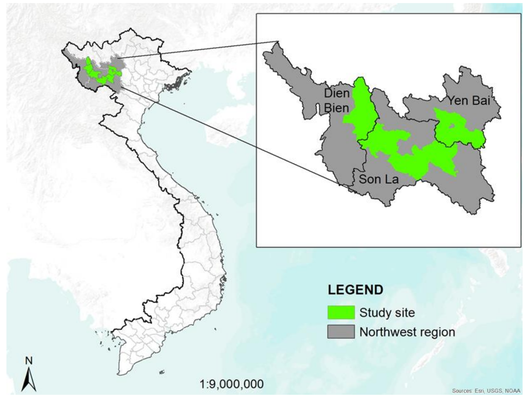

Figure 2: Map of study site in Northwest region and Vietnam country

METHODS

Remote sensing & classification model

- Apply Random forest model for cropland prevalence mapping
- Convert Landsat DN values to ground reflectance (N=12,222 points)
- Model calibration & validation: 70% of N for calibration, 30% of N for validation
- Produce cropland map at 80% of probability of cropland prevalence

Suitability mapping

- **GIS:** Overlay six layers of biophysical variables (assumed that all variables have the same weight)
- **Suitability analysis**: adapted from suitability ranking of FAO suitability analysis

Ranking	Condition
Suitable	All variables (elevation, slope, rainfall, temperature, soil type, soil layer thickness) meet the suitable condition
Not suitable	Any of six variables is not suitable

RESULTS

- Random Forest classification suggests 50% increase in area of erosion prone cropland (slope > 15º) in North West Vietnam in comparison to cropland map from Ministry of Environment & Natural Resources

Slope class (degree)	Natural area by slope class (ha)	Area of Landsat-based cropland by slope class (ha)	Percent of Landsat-based cropland/natural area by slope class (%)	Area of MONRE cropland by slope class (ha)	Percent of MONRE cropland/natural area by slope class (%)
0-15	208,840	66,669	32	75,953	36
15-25	264,669	72,128	27	60,303	23
25-35	214,524	46,621	22	24,072	11
Above 35	104,492	13,983	13	4,762	5

- 30% of cropland (equivalent to 63,000 ha) lies within the forest designation defined in MONRE land use map. Our work suggests that forest cover was over estimated by 15% by MONRE.
- Biophysical suitability analysis (based on elevation, slope, soil type, soil layer thickness, elevation, rainfall) suggested a range of agroforestry options were appropriate for 85% of total area of vulnerable cropland.

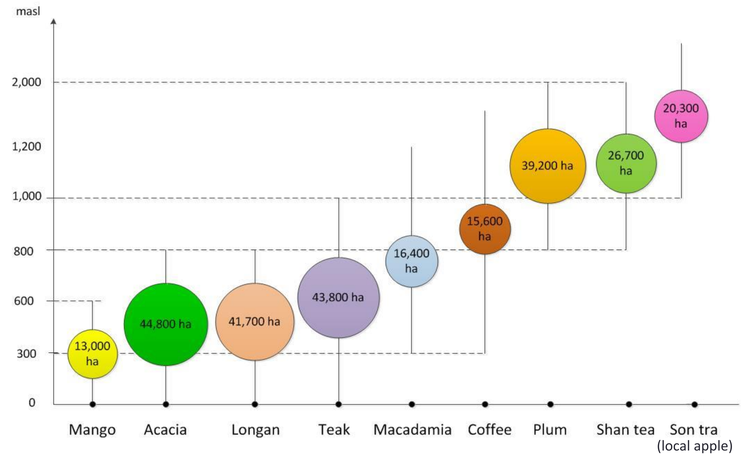

Figure 3: Potential expansion area of tree species on sloping cropland above 15◦, by elevation gradient

DISCUSSION

- These cultivated areas are after deforestation and under shifting cultivation practice for long time. It is difficult to encourage farmers to convert from crops to forest because maize is their only income source and it is still quite profitable. Therefore, these are potential areas for agroforestry interventions to increase tree cover while maintain food security and short term income for small holders. However, agroforestry adoption is challenging due to low educational level (mostly H'mong group), low quality road network and limited access to information and social credit.
- The next step for the study will be to explore interactions between socio-economic opportunities associated with agroforestry and their environmental impacts
- To put these ideas into practice, communication with policy makers, land use planners, scientists and small holders is required through workshops and FGDs at provincial and local levels.
- This study contributes to increase awareness/understanding suitable tree species and possibility of agroforestry intervention in the region and link to government land use policy with linkage to market development.

CONCLUSIONS

- Applying these methods : Actual areas of cropland on slopes (above 15◦) increased by 40%, doubled on steep slopes (above 25 ◦)
- High opportunity for planting trees: ~85% of total area within an elevation range of 100 – 3,000 m
- At high elevation zones (above 1,000 m) where son tra, plum and shan tea are suitable
- Building climate resilience: Son tra was the only tree surviving after the snow falling 2016.

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