

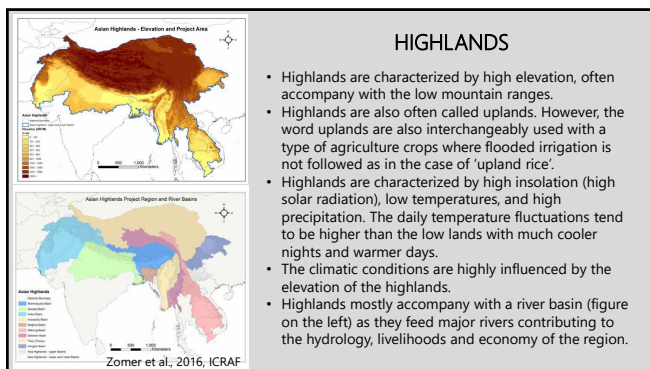
CLIMATE CHANGE VULNERABILITY ASSESSMENT IN HIGHLAND AGRICULTURE: CHALLENGES AND OPPORTUNITIES

S.V.R.K. Prabhakar, Principal Policy Researcher, IGES, Japan
Based on the baseline survey conducted by the project team

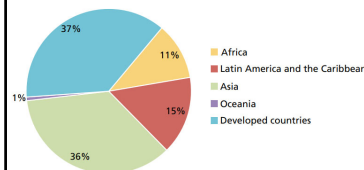
Presented at the ADB project training workshop "TA 9993-THA: Climate Change Adaptation in Agriculture for Enhanced Recovery and Sustainability of Highlands", July 4-5 2022, Nan Province, Thailand

OVERVIEW

- Overview on highlands
- Socio-economic complexities of highlands
- Climate change in highlands
- Agriculture in highlands
- Characteristics of the Nan province
 - Household survey results with vulnerability implications
- Conclusions
 - Challenges in highlands
 - Opportunities in highlands



Asia is the home of highlands and highland people



1. Asia is home to 36% of the global highlands (FAO 2015)
2. A large portion of Asia's highlands fall under the Class 6 of elevation classes of UNEP-WCMC.
3. Asian highlands accommodate nearly half of world mountain populations.
4. Southeast Asian highlands have third largest vulnerable populations in the world. Nearly 41% of mountain people in Southeast Asia are estimated as highly vulnerable to food insecurity.

SOCIO-ECONOMIC COMPLEXITIES OF ASIAN HIGHLANDS

- Poor overall development due to physical isolation, poor infrastructure development and employment opportunities.
- Highlands have one of the lowest urbanization in the world.
- Rapid migration to the plains seeking employment opportunities.
- Rapid environmental degradation also occur in many parts of Asian highlands.
- The rapid environmental degradation is related to deforestation, and other forms of resource extraction that local communities may not benefit from.
- As a result, highlands are slowly depleting the human resources, leaving behind aged and vulnerable populations.
- Poor institutional development often do not protect local populations depriving them of access to various services and facilities. Political and social marginalization is an important issue in most Asian highlands.

CLIMATE CHANGE AND HIGHLANDS

- Globally, highlands are rapidly changing their climatic characteristics than the low lands.
- The rapid changes were also observed in the Hindu Kush Himalayan (HKH) region which is reported to be warming three times faster than the global average with debilitating impacts on the region's glaciers, glacier-fed rivers, and dependent national and regional economies.
- Increasing water scarcity is a real threat for most highlands. A decline in agricultural productivity will have food security implications downstream in the river basins these highlands feed.
- Climate change impacts hydrology, biodiversity, and ecosystem services in highlands.
- Food insecure people in mountain areas rose 30 per cent over 12 years to nearly 330 million (FAO, 2015). This number could grow in the future due to climate change impacts in highlands.

CLIMATE CHANGE AND HIGHLANDS (CONT....)

- By 2050, mean annual temperatures for the Asian Highlands (averaged over all upper basins) are projected to increase from 2.5°C to 3.1°C.
- Highland plateau regions especially may face higher warming than other highlands (as in the case of HKH and Tibetan plateau)
- Slight to substantial increase in precipitation in major highlands in Asia on an average 39-48mm by 2050.
- At the same time, the average potential evapotranspiration (PET) and actual evapotranspiration (AET) increases as much as 11% by 2050 indicating a high water demand in highlands. Hence, an increase in the precipitation is compensated by the increased PET.
- Soil moisture content may be drastically affected, with an average decline by 5% due to increased PET and AET.
- A shift in bioclimatic zones was projected across Asian highlands.

(Zomer et al., 2016)

These changes will have compounding impact on the traditional agricultural systems followed in highlands.

AGRICULTURE IN HIGHLANDS

- **Unlike lowlands and plains, the highlands are characterized by high heterogeneity in vertical and horizontal planes in terms of microclimate, geographical, and other factors that determine the nature of agriculture practiced.**
- **Highland agriculture is distinctly characterized compared to the lowland agriculture due to its distinct weather and climate patterns and different socio-economic conditions.**
- **Shallow soils, depletion of nutrients due to runoff and leaching makes them poor in fertility.**
- **Landholding sizes are often smaller due to small areas possible to cultivate on slopes.**
- **Often low input intensification compared to the lowlands, characterized by low per capita fertilizer and pesticide use.**

Agriculture in Highlands (Cont....)

- Due to physical isolation, access to markets is often challenging and long distance transportation under difficult conditions contributes to high marketing costs.
- These factors make highlands often unsuitable for mass and commercial agricultural production.
- High reliance on animal husbandry makes highland agriculture suitable for resource circulation models.
- The traditional highland agriculture is slowly changing and this can be detrimental to the local ecosystems. Due to the fragile nature of mountain ecosystems, one has to preserve the traditional and low-input agriculture systems.
- We need to strengthen institutions in highlands to adapt highland agriculture to rapid climate change in highlands.
- Climate change also provides new opportunities in highlands due to warming that provides a potential for growing new crops. We need to identify these new opportunities, new crops, and prepare well in time.

Thai Highlands: Challenges

1. The **Thai highlands** is a mountainous natural region in the north of Thailand. The region of the Thai Highlands encompasses the nine administrative provinces of northern Thailand, based on the six region system, as well as parts of Tak and Sukhothai Provinces.
2. Expansion of upland maize cultivation is believed to have played a key role in deforestation and environmental problems in these highland areas.
3. Unsustainable farming practices and over-exploitation of natural resources in the area has led to severe resource degradation, low productivity, adverse health impacts, and unstable incomes.



(ADB, 2021)

Thai Highlands (Cont....)

1. Key challenges facing highland agriculture in Thailand:
 - Severe soil degradation and erosion
 - Chemical contamination in the environment
 - Climate change
 - Food quality and safety
2. Climate change, manifested through rising temperatures and a greater frequency of extreme weather events such as droughts, is exacerbating these problems.
3. 1.4 to 1.8°C increase in mean annual temperature by the 2060's, and 3.0 to 3.8°C increase by the 2090's
4. 19,461 ha. primary forest lost in highland provinces between 2002–2020. The lost forest areas were converted to maize monocropping.

Nan highlands: More of the same

1. Increase in maize cultivation in Nan highlands is significantly correlated with increased deforestation
2. Deteriorating soils and soil erosion and the extensive application and subsequent leaching of agri-chemicals, contaminating critical water sources
3. Monoculture farm practices, especially maize production, have led to increased household debt burdens, as indicated by the income-to-debt ratio reaching to 0.89 by 2032
4. The deterioration of soil fertility and soil health is leading to increased and chronic debt
5. All the above factors are increasing economic burden on the households and the environmental burden on the Nan highlands

(ADB, 2022)

Household Survey in Bua Yai subdistrict

Population and sample characteristics in the subdistrict

Village	n	Sample population (n=1051)		Mean HH size	Main respondent gender (n=520)				
		Male	Female		n	row%	n	row%	
V1 B. Oi	40	62	75	137	3.4	16	40%	24	60%
V2 B. Mai Mongkol	40	65	80	145	3.6	13	33%	27	67%
V3 B. Na Haen	40	63	63	126	3.2	11	28%	29	72%
V4 B. Tabman	40	65	62	127	3.2	8	20%	32	80%
V5 B. Nakai	40	54	69	123	3.1	13	33%	27	67%
V6 B. Tong Muang	40	62	63	125	3.1	11	28%	29	72%
V7 B. San Payom	40	59	63	122	3.1	10	25%	30	75%
V8 B. Nong Ha	40	68	78	146	3.7	8	20%	32	80%
Total	320	498	553	1051	3.3	90	28%	230	72%

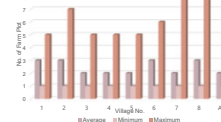


Sample location

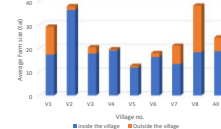
1. A total of 320 household samples were collected.
2. The survey was conducted using digital tablet-based face to face interviews
3. The draft questionnaire was formulated and tested
4. The survey interviews were conducted in the Thai language
5. Pilot testing was done to assess the questionnaire
6. Eight enumerators were trained for two days prior to implementation
7. The average household size was 3.3
8. The sample consists of predominant male population

Landholding size

No of units of land per household



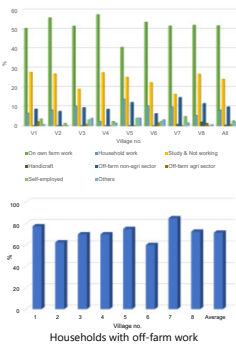
Area of land per household



1. The landholding is highly fragmented. Number of plots owned by each family range between 1-8. The highest difference between the max and min number of plots was in B Nong Ha and the least was in Na Haen, Tabman, and Nakai.
2. In terms of the land holding size, the highest landholding size was reported in the B Mai Mongkol and the least was in Nakai.
3. Most owned the land and a very negligible farmers leased in the land. **High land ownership is an important capacity factor.**
4. However, the **large variation in the landholding size** indicates a wide economic disparity among the villages. It can pose challenges in terms of technology adoption as different land holding sizes may allow different kinds of technologies to be employed.

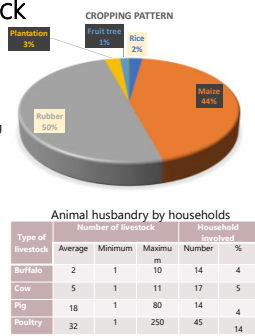
Livelihood diversification

1. Livelihood diversification is an important capacity factor. Lesser the diversity of livelihoods higher the vulnerability of farm households to economic shocks from climatic vagaries.
2. There is no optimum number of livelihoods a family can have, it depends on the local conditions.
3. We have noticed a relatively moderate degree of livelihood diversification in the region. Most livelihoods are relatively highly dependent on agriculture and related activities. This indicates high degree of vulnerability to agriculture related economic shocks to households.
4. Though the graph on the right indicates number of livelihoods in terms of % of respondents, it doesn't indicate how many livelihoods each household has or how much percent of non-agriculture income each household earns.
5. On an average, only **10% of households** reported non-agricultural livelihood options.



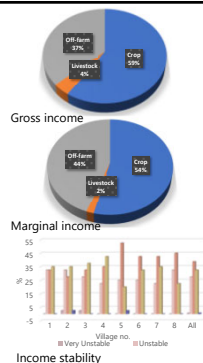
Cropping Pattern and Livestock

1. A very narrow cropping pattern could be found in the region highly dominated by rubber and maize. This indicates a presence of monocropping.
2. This also indicates the absence of ability to take advantage of wide varied environments in the region to adopt diverse cropping pattern.
3. Income potential seems to drive the cropping pattern in the region as against the environmental sustainability and this could pose serious long term consequences for the natural resources.
4. At the same time, the adoption of animal husbandry appears to be poor since only 14% of households raise poultry and less than 5% of households own buffaloes and pig.
5. The poor adoption of livestock can have important resilience implications against climatic and economic shocks as households already have less non-farm income diversification.



Household Income

1. Household income is an important indicator of the capacity of the household to provide quality of life to its members. While the amount of income is important indicator, even more important is the proportion of income coming from diversified sources.
2. Though households reported fewer non-agricultural income sources, the off-farm income appears to be relatively high, on an average 37% of gross income comes from off-farm sources while only 4% income comes from animal husbandry.
3. It is not clear how animal husbandry is complementing the nutritional security of households, though very few households reported following some kind of animal husbandry.
4. 33% households reported stable income (in the past 10 years) and 80% reported sufficient income, while 28% reported unstable income with highest unstable income reported in Oi, Moi Mongkol, and Nong Ha.



Challenges in Vulnerability Assessments in Highlands

1. High spatial variability in local characteristics of highlands means the need to have high granular/high resolution and quality data on all bio-physical and socio-economic conditions which is largely lacking in highlands.
2. There is a scarcity of homogenous and disaggregated data in most highlands. This pushes researchers to make assumptions that drive the analysis and interpretation of the analysis a challenging one to the local conditions.
3. Most vulnerability studies are focused on lowlands and plains. Vulnerability indicators are often location specific and hence the available literature on highland vulnerabilities and related indicators is scarce. In addition, since vulnerability studies are also focused on hazard-specific conditions, the nature and degree of difference between hazards of highlands and lowlands often means the limited suitability for application in highland conditions.
4. Even within the highlands, spatial extrapolation of vulnerabilities is faced with a challenge due to high heterogeneity in highlands.

Opportunities for Vulnerability reduction in Highlands

1. High dependency on natural resources for social resilience and the role of biodiversity and ecosystem services provides us with an important opportunity to understand highland natural resources and ecosystem services.
2. Animal husbandry needs to be promoted to strengthen resource circulation/closed-loop agricultural systems in highlands that can improve the agricultural resilience.
3. Highlands also provide greater opportunity for crop diversification due to vertical warming.
4. The traditional farming practices that evolved over the ages in accordance with local ecosystems in highlands can help conserve the local ecosystems.

What challenges and opportunities do you see in your highlands? Please provide your inputs!

Important references

1. Mapping the vulnerability of mountain peoples to food insecurity. FAO, 2015.
2. Projected Climate Change Impact on Hydrology, Bioclimatic Conditions, and Terrestrial Ecosystems in the Asian Highlands. Robert Zomer, Antonio Trabucco, Mingcheng Wang, Jianchu Xu. ICRAF Working Paper 222.
3. ADB TA 9993-THA documentation
4. Baseline survey conducted by the project team (TA 9993-THA: Climate Change Adaptation in Agriculture for Enhanced Recovery and Sustainability of Highlands)



THANK YOU!