Increased accessibility, landscape changes, rural transformations, and urbanization: Impacts of the east-west economic corridor from Da Nang, Vietnam, to Khon Kaen, Thailand

Progress Report

Principal Investigator: Stephen J. Leisz
Period of Report: December 1, 2014 – November 30, 2015 (Year 3)

Colorado State University
Fort Collins, CO 80523

Grant # NNX13AC51G

Abstract

The project investigates the impact that the 'East-West Economic Corridor' from Da Nang, Vietnam, to Khon Kaen, Thailand, is having on land-use and land-cover, and urban growth patterns in three different, yet contiguous, countries with different political histories and current policies. The project works at the intersection of physical and social science and makes use of a cross-section of remotely sensed data and social science data. In order to create a baseline of land-cover for the EWEC and to understand the land-use associated with this baseline land-cover, Landsat and SPOT data from 1982 through 1990 (the first time period) and 1990 to 2000 (the second time period) has been collected and has been analyzed. For the third time period, from 2000 to 2011, 16 day 250 m MODIS VI products over yearly time steps has been acquired and hypertemporal analysis of the EWEC corridor has been done. This analysis uses hypertemporal characteristics as identifiers of where change is taking. Post-2000 Landsat and SPOT data is being investigated to identify trends on a year-to-year basis. High resolution data (air photos and high resolution satellite imagery) is being used for ground truthing of hard to get to areas. Field-work has been done to ground truth satellite imagery. Recall data is being used to validate the baseline land-cover and land-use classifications done for the first two time periods. A geographic information system (GIS) with population data and other information about the study area has been created and is being used within the analysis of land-cover/use changes. As part of the ground-truthing, interviews have been carried out in the EWEC in each country to investigate the role that the EWEC is playing in the population's livelihood systems and movements within the corridor. The LCLUC, rural, urban, and peri-urban nature of the EWEC within each of the countries has been investigated by analyzing in tandem the remote sensing and social science data collected. The census and LCLUC data is being integrated to develop an index of urbanicity of the transportation corridor and to understand how the urbanicity of the corridor has changed from the baseline period to the present day and what roles the differing government policies have on these changes and on land cover/land use changes. Connections between land cover/land use changes, rural-urban transitions, and urban growth are being investigated using GIS and spatial statistics tools. Agent based modeling to illustrate changes in the rural areas is being investigated.

Summary
Fieldwork in two villages in rural Savannakhet, Laos, and two rural villages in Northeast Thailand was completed. It was not possible to meet with District officers in Laos during this year due to the MOU having only been approved at the University and Province level and not approved at the National level until October of 2015. Analysis of Landsat data for the EWEC in Vietnam is completed, revisions during the coming year will be done. Work on Landsat data for Laos and Northeast Thailand is ongoing. Draft of a Master's Thesis is completed, one project paper was published in a Vietnamese conference proceedings, five articles are in draft for international journals. A no-cost one year extension was applied for and granted.

Year Three Planned Activities and Objectives:

1. Complete fieldwork in Savannakhet, Laos, and Northeast Thailand
2. Continue remote sensing data acquisition as needed. Complete image processing and time series analysis.
3. Continue review of all data and integrative analysis.

Yearly planning meeting: Meetings were held with collaborators in Savannakhet, Laos, and at Khon Kaen University, Thailand, in February 2014 to plan the fieldwork for the coming year and to carry out some initial fieldwork. A skype meeting, with email follow-up, was carried out with the Co-I in Vietnam in January. The work plan was revised as follows to better reflect the planned fieldwork and analysis periods for the project in recognition of the hold up of the MOU in Laos.

Workplan and schedule	Project Year 2 (2014)				Project Year 3 (2015)				Project Year 4 (2016) (1-year extension)			
	Jan-Mar	Apr-Jun	Jul-Sept	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sept	Oct - Dec	Jan-Mar	Apr-Jun	Jul-Sept	Oct - Dec
Yearly planning meeting	x				x							
Remote Sensing												
- *data collection*	xxx	xxx							xxx			
- *initial data analysis (pre-fieldwork)*	xxx	xxx										
- *revised analysis (post fieldwork)*	xxx			xxx	xxx	xxx			xxx	xxx		
Socio-economic data												
- *data collection*	xxxx		xxx			xxx						
- *data analysis*	xxx				xxx		xxx		xxx	xxx		
Fieldwork												
- *data collection in field*	xxx	x	xx			xxx				x	x	
- *field data analysis*	xxx	xxx		xxx	xxx		x		xxx	xxx		
Integrative analysis												

Initial integrative analysis by country		xxx			xxx				xxx			
Comparison (cross-county) integrative analysis							xxx	xxx	xxx	xxx		
Final Report								xxx			xxx	

The changes in the schedule have been necessitated by the difficulty in finalizing the MOU in Laos at the national level. That has now been resolved and all fieldwork will be done by June of 2016.

Year Three Accomplishments

Fieldwork (year three planned activity 1)

Savannakhet, Laos

Originally, the plan for fieldwork in Savannakhet involved meeting with District officials first to understand their perspective on the impact of the EWEC in their district and then visit three villages of varying distances from the main highway in the corridor. However, due to the slowness in getting the memorandum of understanding between Savannakhet University and Colorado State University approved at the national level the fieldwork plans had to be changed. Colleagues at Savannakhet University believed that I could still participate in their fieldwork at the village level, but that I could not participate in any visits to interview district officials. Therefore, we decided to place on hold all district level meetings until the MOU was approved at the national level and to proceed with as many village visits as we could. Training for Savannakhet University staff in field interviewing techniques was held and then two week long field trips to two villages in Sepon District were undertaken. During these village level visits focus group, semi-structured, and structured questionnaire oriented interviews were done of purposively chosen villagers (for focus group and semi-structured interviews) and randomly chosen villagers (for structured questionnaires). Transects were walked and ground truth points collected. All collected data was organized in a database. The MOU was finally signed in October. District level visits and interviews will now be done in 2016 as well as fieldwork in at least one more village.

Khon Kaen, Thailand

Follow-up fieldwork and interviews were carried out in July along the EWEC between Khon Kaen and Mukdahan, Thailand. Two villages were visited, semi-structured interviews were carried out and participatory mapping of the village land cover was carried out. Targeted interviews of villagers involved in land management were also carried out. Household interviews focusing on land-use changes were carried out in two other villages within the EWEC. Data is organized and currently being analyzed.

Da Nang, Hue, and Quang Tri, Vietnam

Follow-up information gathering in Da Nang, Hue, and Quang Tri was carried out during this year. Collaborators from Vietnam National Agriculture University (previously Hanoi University of Agriculture) were in contact with officials in Hue and Quang Tri to ask follow-up questions

based on findings from our fieldwork in rural areas of Quang Tri Province and Savannakhet, Laos. Meetings were also held with Vietnamese colleagues who have been working on urban issues in Da Nang and Hue Cities in June and July. In March, May, and July project researchers in Vietnam met to jointly analyze data and draft results. One paper has been published in Vietnam from this effort and a second one is in draft for a Vietnamese journal.

Remote Sensing (year three planned activity 2)

Analysis of the hypertemporal MODIS imagery was initially done in year two. In year three we started revising the analysis. We are continuing to modify the classification of the MODIS data. Landsat TM data for the study villages has been analyzed to document how cultivated land patterns are changing. Further detailed work on the Landsat TM data for urban areas was done.

Integrative analysis and findings to date (year three planned activity 3)

Urban Changes

In Vietnam analysis of the Landsat TM data in conjunction with the interview data clearly detail the way that infilling is taking place in all three cities in the corridor in Vietnam as well as the geographical direction the change is following in areas where the urban growth is extending beyond the previous built up areas. The drivers found from interviews during the second year were confirmed and two new, previously unknown drivers were identified, (1) the real estate market and (2) City rank by central government. The real estate market as driver works as follows: government clears the land and sells it into the private market in order to derive funds for local government use; the private companies who buy the land then develop and resell it. This driver is not evident from talking with government officials, but comes out clearing when talking with local individuals. City rank as driver: The local governments also have incentive to infill areas and extend the urban cores' infrastructure because of central government regulations. Cities are ranked in Vietnam into hierarchical categories, the higher the rank of the city the more money devoted to the city from the central government. Cities move up in rank based on their size (population) and the built infrastructure of the city. City leaders want to increase the ranking of their city by expanding boundaries and importantly expanding and building new infrastructure. When cities move up in rank the prestige of the city increases, and the money directed to the city from the central government increases, leading to more funds for urban development and more funds for government salaries.

Rural Changes and drivers of land change

Seven village case studies have been investigated in the uplands of Quang Tri Province, Vietnam, Sepon District, Savannakhet Province, Laos, and Kalasin Province, Thailand. The villages in Vietnam and Laos are populated by the same ethnic group and are relatively close to each other, separated only by the border between the two countries, and these villages (in Vietnam and Laos) have recently experienced an improvement in their road access. The villages in Thailand have long had good road access and access to markets, however increased traffic along the roads which are part of the East-West Economic Corridor, are introducing a new variable to the local systems. There is evidence that each village studied is undergoing land use and land cover changes, varying in direction of change and magnitude of change. Synopses of the initial analyses of these cases follow:

Vietnam Village 1, Da Krong District, Quang Tri Province
This village has been located near the main highway for many years. Its livelihood revolves around swidden / fallow rice production with, until recently, some small production for the market. Even though it was on a main highway, access to markets was not good until recently. In 2007 road access improved. A few years later a starch factory opened in Dong Ha City, Quang Tri Province, and representatives from the starch factory came to the district and village promoting hybrid cassava for production with the understanding that the starch factory would buy the harvest. The villagers have started growing large amounts of hybrid cassava near the newly improved road, and appear to at the same time have decreased the cultivation of upland areas farther from the road that were previously cultivated for upland rice. Concurrent with the upgrading of the road district forestry agents started coming to the village and promoting the planting of acacia trees in the upland areas. The villagers also integrated these trees into their fallow rotation. Initial indications from the analysis of the TM imagery for the village is that tree and bush cover is recovering away from the road and there is more tree cover in the hinterlands of the village now than before the road was upgraded. However, areas near the road have been cleared for growing hybrid cassava.

Vietnam Village 2, Da Krong District, Quang Tri Province
This village is located around 5 kilometers from the Ho Chi Minh Highway in Quang Tri Province, and within 10 km of the first village. Before the Ho Chi Minh Highway was constructed between 2000 and 2007, and secondary roads between the Ho Chi Minh highway and the village completed in 2010, the village was very isolated. Its livelihood revolved around swidden / fallow rice production, some small areas of maize production, and some small areas of irrigated rice. Cultivated fields were found in the small areas of flatland near the stream that runs through the village and in scattered swidden fields on sloping land. In 2010 access to the village improved due to the road construction already noted. Concurrent with this a starch factory opened up in Dong Ha City, Quang Tri Province, and representatives from the starch factory came to the district and village promoting a hybrid cassava for production that the factory would buy. The villagers started growing large amounts of the hybrid cassava near the new roads in the village. Unlike the first previous village (Vietnam Village 1), though, at the same time the village increased the cultivation of upland areas farther from the road and expanded their upland rice and maize cultivation. Initial indications from analysis of the Landsat TM imagery for the village is that there has been increased clearing of bush and trees to create cultivated fields since the period before the roads were built.

Vietnam Village 3, Da Krong District, Quang Tri Province
This village is been located on a secondary road about 10 km from Highway 9 in Quang Tri Province and within 20 km of the first village. Until 2010 the village was on a paved road, but cut off from Highway 9 due to the lack of a bridge over the river that runs between the village and the district town. However, the village was connected to Quang Tri Town, in the lowlands, via the river and there was some trade that occurred via river traffic. The village's livelihood system revolved around irrigated rice in the lowland area, and some production from upland swidden fields. In 2010 access to the village improved due to the construction of a bridge over the river that created a direct connection to the district town and National Highway 9. Concurrent with this a starch factory opened in Dong Ha City, Quang Tri Province, and

representatives from the starch factory came to the district and village to promote a hybrid cassava for production that the factory would buy. The villagers started growing some cassava for the market in their swidden areas after this. Concurrent with the bridge opening, district forestry agents started coming to the village and to promote the planting of acacia trees in the upland areas. The villagers also integrated these trees into their fallow rotation. Similar to Vietnam Village1 initial indications from the analysis of the TM imagery for the village is that there has been increased tree cover in the village's upland areas that are furthest from the road.

Laos Village 1, Sepon District, Savannakhet Province

This village is located along National Highway 9, within 10 km of the border with Vietnam. It is 40 km from the first village studied in Vietnam. The village has been in its present location since the late 1970s. It's livelihood, until recently revolved around swidden/fallow cultivation of rice and some minor crops. The national highway (also called Highway 9 in Laos) that runs through the middle of the village is a continuation of Highway 9 from Vietnam and was built in colonial times. Until the implementation of the EWEC and the upgrading of the road in 2007 the road was little more than an unpaved track. In 2007 the road was paved and upgraded and the border crossing protocols simplified to encourage cross-border trade between 2007 and 2010. In 2010 demand from the starch factory in Dong Ha City, Quang Tri, Vietnam, and at the food processing factories in the Vietnam duty free industrial zone led to the increased growing of hybrid cassava (the same variety that has been promoted in Vietnam) and bananas. These two crops have been integrated into the local farming system. Land cover in the area has correspondingly changed, but it is not yet clear if land-use patterns have also changed. In the past two years a new cassava starch factory (owned by a Vietnamese company) has been built just to the west of the village.

Laos Village 2, Sepon District, Savannakhet Province

This village is located seven kilometers from National Highway 9, about 35 kilometers from Laos Village 1 and within 40 km of the border with Vietnam. The village has been in its present location since the late 1970s. Its livelihood revolves around the cultivation of swidden/fallow rice and irrigated rice. A secondary road runs through the village in a north-south direction and connects the village with Highway 9. This road was unpaved until 2010/11when it was expanded and paved as part of a second phase of road construction under the EWEC project. Concurrent with this second phase of road construction a bridge was built across the major river in the village connecting a previously little used road that runs east-west directly to Vietnam and crosses the border at an informal border crossing with the north-south running secondary road. These road upgrades and bridge construction are directly tied to the village connecting with the national and international market. Since the construction of the bridge Vietnamese cattle traders have been visiting the village on a yearly (and some report twice yearly) time frame and purchasing local cattle, which they drive to Vietnam and cross the border at the informal crossing, and then sell in the lowland markets in Vietnam. Over the past two years cassava starch factory representatives have visited the village and promoted the introduction of hybrid cassava, which some farmers are starting to grow.

Thailand Village 1, Kalasin Province, Thailand

Unlike Quang Tri, Vietnam, and Savannakhet, Thailand, the Northeast of Thailand has long enjoyed a very developed and extensive road system. Thus, the villages studies in Thailand are

not experiencing increased connectivity with the improvements of the EWEC. Also, factory work and the extension of industrial crops such as cassava is not new in this area, as food processing factories have been located in the Northeast of Thailand since the 1970s and 1980s. Thailand Village 1 has livelihood system that is based on rice production for local use and hybrid cassava production which is sold to local cassava starch factories, as well as household members employed by local factories, or emigrating for work in larger cities in Thailand and abroad. This livelihood system does not appear to have been strongly impacted by the improvements associated with the EWEC. However there has been a change in land-cover within the village. A dynamic not predicted when this project was developed is the purchasing of land within the village by outside investors, from urban areas, who have come to the village to develop road side shops. This village is located near a cross-road between two major roads in the province, one which runs directly towards the Laos border (and is considered part of the EWEC system) and the other which runs towards, the largest city in the province. The villagers interviewed suggest that the investors are reacting to the perceived (and real) increase in traffic through the corridor. As a result local villagers have sold large tracts of land to outside investors and the investors have turned some of this land into shops, and converted the other purchased land from agriculture fields to tree plantations of eucalyptus. Growing trees on the purchased land allows the absentee owner to put the land into 'use' and protects the land from infringement by locals. An assessment of high resolution imagery for the village shows that tree cover has increased from 10% of the village before the EWEC was implemented (e.g. before 2007) to 30% of the village since the EWEC project was implemented.

Thailand Village 2, Kalasin Province, Thailand
This village has a livelihood system that is similar to the Thailand Village 1, it is based on rice production for own use and cassava production which is sold to local cassava starch factories, as well as household members employed by local factories, or emigrating for work in larger cities in Thailand and abroad. This village's livelihood system has also not been strongly impacted by the improvements associated with the EWEC. Unlike the previous village, interviews of local people assert, and an assessment of high resolution imagery for the village shows that tree cover has not increased, nor decreased since the EWEC project was implemented. The possible reason for this is that this village is very close to a major starch factory, which employs some of the villages inhabitants, villagers grow large amounts of cassava for sale to the factory, and the village is not located near cross-roads, and is thus in a different geographical setting than Thailand Village 1.

Success in meeting goals/objectives

1. Complete fieldwork in Savannakhet, Laos, and Northeast Thailand

Fieldwork in two of three villages in Savannakhet, Laos, was completed. It was not possible to visit District offices. The slowness in completing the fieldwork in Laos corresponds to the difficulty in getting the MOU approved at the national level. Because of this our collaborators in Savannakhet University were at first reluctant to do the village level fieldwork. After verbal indications that the MOU would be signed were received, we were able to carry out fieldwork in two rural villages. We ran out of time to do the third village. Fieldwork in a third village as well as district level interviews of officials has been rescheduled for 2016.

2. Continue remote sensing data acquisition as needed. Complete image processing and time series analysis.

Most of the Landsat TM and ETM+ analysis was completed for the areas where village based studies have been done (which covers most of the EWEC from Dong Ha to Khon Kaen). The hypertemporal analysis was finished during year two. We have revisited this analysis to try to update it. That work is ongoing. The high resolution imagery has been visually interpreted to provide additional ground truth data for areas where village studies have been done.

3. Continue review of all data and integrative analysis.
This aspect is ongoing. As detailed above, data have been analyzed for village level studies and some of the urban areas that have been studied. These results are being integrated into comparative studies that seek to analyze the findings across the corridor. The results are currently being written up in a number of articles. The results for Vietnam village case studies were presented via the NASA LCLUC webinar and an expansion of this analysis was presented at the Vietnam Conference on Environment in Hanoi, Vietnam, in September by Co-I Dr. Ngo The An. Initial cross-border analysis was presented at the Southeast Asian Studies in Asia Conference in Kyoto, Japan, in December.

Publications/Presentations

Presentations:

11-12 December 2015. Stephen J. Leisz "Urban-rural teleconnections in Vietnam, Laos, and Northeast Thailand: are urban/rural boundaries still evident?" Southeast Asian Studies in Asia Conference, Kyoto, Japan.

29-30 September 2015. Ngo The An, "The Influence of the East-West Economic Corridor on Land-Use and Land-Cover", Vietnam National Conference on Environment, Hanoi, Vietnam.

26 May 2015. Stephen J. Leisz, "Increased Accessibility, Landscape Changes, Rural Transformations, and Urbanization: Impacts of the East-West Economic Corridor from Da Nang, Vietnam, to Khon Kaen, Thailand", NASA/ LCLUC Webinar.

16 March 2015 Stephen J. Leisz, "Teleconnections and rural and urban land-cover changes in Central Vietnam, Southern Laos, and Northeast Thailand", GSE Seminar Series, South Dakota State University.

Publications:

Leisz, Stephen J., and Ngo The An (2015) TÁC ĐỘNG CỦA HÀNH LANG KINH TẾ ĐÔNG TÂY ĐẾN BIẾN ĐỘNG SỬ DỤNG ĐẤT VÀ CHE PHỦ ĐẤT (Influence of the East-West Economic Corridor on Land-Use and Land-Cover), Proceedings of the Vietnam National Conference on Environment, Ministry of Natural Resources and Environment, Hanoi, Vietnam.

In preparation:

Rounds, Eric, **Stephen Leisz** (in preparation). Teleconnections and land-cover changes in Central Vietnam: the role of roads and industrial crops. (Target: Land Use Policy)

Leisz, Stephen J., Eric Rounds (in preparation) Hypertemporal Analysis of MODIS EVI data to identify agricutlure land-cover transitions in the East-West Economic Corridor of Vietnam. (target: Remote Sensing of Environment)

Leisz, Stephen (in preparation). Rethinking the connection between roads and land-cover change: evidence from Southeast Asia. (target: Global Environmental Change)

Leisz, Stephen (in preparation). Urban – rural teleconnections and land-use/cover changes across borders: the East-West Economic Corridor in Southeast Asia. (target: Journal of Land Use Science)

Nguyen Thi Bich Yen (draft) Sự thay đổi hệ thống cây trồng thích ứng với phát triển cơ sở hạ tầng và điều kiện khí hậu: trường hợp nghiên cứu ở thôn Tà Lang, xã Hải Phúc, huyện Đakrông, tỉnh Quảng Trị (Changeing cropping systems as a function of the development of infrastructure and: case studies in the village of Ta Lang, Hai Phuc, Đakrông district, Quang Tri province)

Year four planned activities (No-cost extension continuation of project)

1. Complete fieldwork in one rural village in Savannakhet, Laos. Complete interviews at district level offices in Savannakhet, Laos.

2. Extend fieldwork in Kalasin, Thailand, to include two more village level studies. Follow-up interviews in Mukdahan, Thailand, to investigate the cross-border dynamics of urban growth better.

3. Complete all image analysis for the corridor.

4. Complete integrative analysis and carryout writing workshops in Hanoi, Vietnam, Savannakhet, Laos, and Khon Kaen, Thailand, with project partners in May/June 2016.

5. Submit all papers for publication.

Subject Inventions/Reportable Items Interim Summary Report
No subject inventions or reportable items

Utilization of Subject Invention/Reportable Items
No subject inventions or reportable items