Integrating spatial modeling into strategic planning – SEA of the GMS North South Economic Corridor Strategy and Action Plan

By

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I GMS Development Context

The Greater Mekong Subregion (GMS) comprises six countries that are linked by the Mekong River – Cambodia, Lao PDR, Myanmar, Thailand, Viet Nam, and PR China (Yunnan Province and Guangxi Autonomous Region). The GMS has seen unprecedented economic growth in past decade, as part of its transformation into an integrated and robust economic zone.[2] However, the benefits of growth have not always been equitably distributed, with urban centers amassing most of the benefits while the rural poor remain largely disconnected and vulnerable to the negative impacts of development.

To counteract these increasing disparities and realize its goal of a *poverty-free and environmentally rich GMS*, the Asian Development Bank has formulated and coordinated strategies focused on the Economic Corridor model.[3] It aims to provide opportunities for livelihood improvements to the poor in remote and underdeveloped regions by developing infrastructural links and networks into major markets / business centers and establishing enabling policy and regulatory frameworks. Currently, the ADB plans four major corridors: NSEC (3 sections), EWEC, SEC, and SCC. The NSEC is the largest with regard to overall extent and country coverage.

II SEA rationale and frame

The ***North South Economic Corridor (NSEC)*** –Western Section passes through an area broadly known as the "Golden Quadrangle", the remote and relatively poor border region connecting PR China's Yunnan province, Myanmar, Lao PDR, and Thailand (Figure). The trans-boundary road (Route 3) passing through these areas improves the regions connectivity, and serves as a catalyst to stimulate trade and economic development that ultimately creates livelihood opportunities for poorer communities along the corridor.

To ensure the that corridor road is actually serving its catalyst function and develops into a full fledged economic corridor – including the desired livelihoods improvements –a ***NSEC Strategy and Action Plan (SAP)*** is being prepared for the NSEC. The NSEC is in its initial phase (Phase 1) of development during which its transition to a logistics corridor is to be achieved, in time for the ASEAN and ASEAN/China Free Trade Agreements. The NSEC Strategy and Action Plan (SAP) will help to consolidate related infrastructure decisions and aims to increase the efficiencies within the corridor through the construction of missing links, improving logistics and stimulating associated developmental clusters.

This Strategy and Action Plan is the main entry point for the ***Strategic Environmental Assessment of the NSEC SAP***[4]. It blends both ***ex-post*** and ***ex-ante*** features: an evaluation of past decisions on

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[2] From 1994-2004, gross domestic product (GDP) in the region grew at an average annual rate of %,, despite the 1997 Asian financial crisis, slowdown of the global and economics in 2001, outbreak of severe acute respiratory syndrome (SARS) in 2003, and thereafter the threat of the avian flu epidemic.

[3] The corridor concept has provided a holistic approach to the spatial development of the poorer areas of the GMS by focusing on investments in priority sectors (e.g., transport, energy, telecommunications, trade and investment, tourism and agro-industry).

[4] The SEA timeframes are linked closely to the SAP timetable with the ADB Core Environment Program (CEP) providing regular input into this process. The SEA commenced in early 2008 through the Asian Development's GMS Core Environment Program (see www.gms-eoc.org) to dovetail with the formulation of the SAP. The scope and impact assessment phases have been completed and the final report is expected in April 2009.

infrastructure (i.e. construction of Route 3) together with an assessment of predicted impacts of future measures on both hard and soft infrastructure associated with the economic corridor concept. Of particular interest in the SEA target area (**Figure 1**) is the focus on enhancing the productivity and efficiency of the agro-processing and secondary wood processing industries. The SEA aims to have a pre-emptive and anticipatory role in shaping these investments and broader sector strategies. It adopts an objectives-led approach wherein the potential impacts of the SAP are assessed against a series of objectives for sustainable development using a range of spatial modeling and decision support approaches.

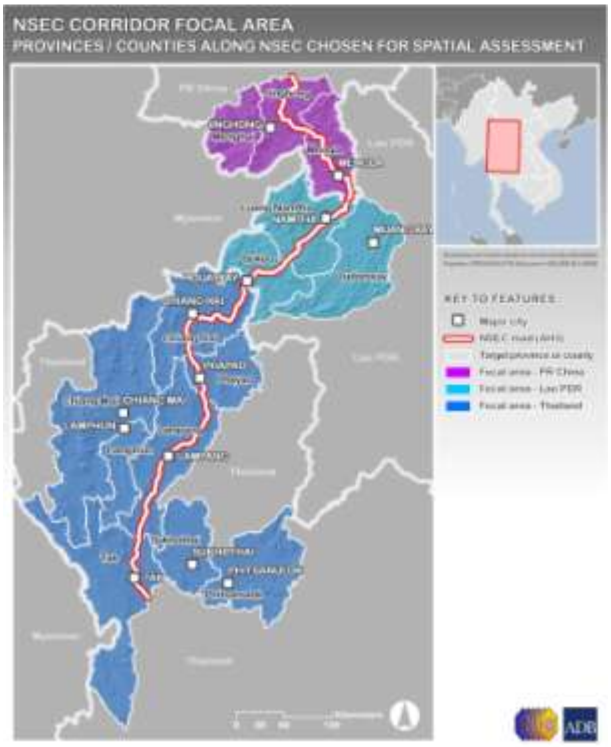

Figure 1: SEA of the NSEC SAP – Focus / target area for spatial modelling tools.

III Spatial Planning in the GMS – Challenges and Opportunities

Spatial planning tools are capable of integrating sector information – including future demands and visions – into one common, geographically explicit analytical framework.. It allows for the anticipation of geographic changes and their magnitude, information that is critically improving the valuation of options and the development of effective adaptation and mitigation measures.

While GMS governments are striving to develop and improve such expertise, there are still several critical challenges that need to be addressed to make spatial planning truly effective. The availability of precise and up-to-date spatial data is a binding constraint in most cases - while all GMS countries generally have national base datasets of 1:50.000 or 1:100.000 scale, the sheer speed of development in these countries requires all but terrain information to be updated on a regular base. With government organisations operating on tight budgets, continuous spatial data maintenance is often not in place. This problem is further aggravated by operational fragmentation - particularly on the national level - and a lack of clear data sharing regulations among ministries. Overlapping or unclear planning mandates of government agencies, particularly in the natural resources sectors often leads to competition between agencies and a duplication of efforts. Even within the same government agency vertical information sharing and synchronisation of methods and standards remains patchy, increasing the threat of parallel data collection and – ultimately – in different and incompatible databases. To tackle these challenges, dedicated and well trained national staff is needed that is capable of identifying the challenges, work towards solutions to improve the data infrastructure required for spatial planning, and use the data creatively to answer related analytical questions.

While considerable ODA resources have targeted increasing capacity of national staff, much of this has only resulted in capacity substitution and not long-term capacity development. Trained staff are also often lured away by the private sector and its higher incentives for skilled labourers. Projects with regional / transboundary focus face the additional challenge of a multiplication of these issues in the overall context of very different societal development stages.

Despite these challenges, there is no alternative to integrated spatial planning if the GMS countries are to achieve sustainable management of natural resources and development planning benefiting investors and local communities alike.

IV Spatial Planning Tools in the SEA of the NSEC SAP

The SEA of the NSEC SAP utilized a set of spatial tools ranging from basic spatial overlays to complex thematic and predictive modelling, each plugging into a specific stage of the SEA process. To achieve this, the SEA spatial work was split into 3 distinct components: a) baseline phase: ***overview of the present situation*** through map overlays, b) Assessment phase: facilitating better ***understanding of changes and impacts*** through predictive models, and c) Alternatives / mitigation phase: supporting the development ***of solutions*** through better targeting investments and mitigation measures using a spatially explicit decision / criteria framework.

IV.1 Thematic overlays

The ***baseline assessment*** took stock of the overall situation with respect to available resources and assets, and planned development directives. ***Thematic overlays of secondary data*** supported this fact finding process, covering and combining key environmental (forest cover, terrain, biodiversity values), socio-demographic (population density, poverty, type of livelihood) and infrastructural / economic variables (roads, railways, mining / forest / agricultural concessions, tourism industry). The maps produced from this information served two purposes: a) inform and guide the team about the spatial distribution, association and aggregation of key variables through visual interpretation, and b) document what datasets feed into the subsequent modelling applications.

IV.2 Scenario-based land allocation modelling

Based on the spatial information collected and reviewed during the baseline assessment, the ***assessment phase*** took the information a step further with regard to spatial integration. In order to identify and quantify future development and transformation pattern in the NSEC – and potential conflicts arising or increasing from them – a ***scenario-based land allocation model*** was utilized. The CLUE-s model – short for Conversion of Land Use and its Effects for small geographic areas – consists of four major components: 1) Land use requirements (land demand), 2) Land use type specific conversion settings, 3) Spatial restrictions, and 4) Location characteristics. While the first both are non-spatial “qualitative” components that lay out potential development trends and pathways in the target region, the latter are geographically specific, providing the “quantitative” dimension of the model.

For each national section of the NSEC target area, two land demand scenarios were developed: one “business as usual”, focusing on maximised economic development, and one “environmentally / social sound”, putting more emphasis on keeping the natural resource base – and dependent livelihoods – intact. Land use type specific conversion tables were developed for each individual land cover dataset in consultation with national stakeholders and international experts. Each land demand scenario was run once with protected areas as spatial restrictions (no conversion allowed in these areas), and once without (simulating lack of law enforcement). Present land use distribution was tested for correlation with a set of underlying “explaining” factors: elevation, slope, aspect, distance to stream, distance to main road, distance to minor road, population density, and distance to settlement. If a specific land use type shows a strong correlation with one or more of these factors, they are used to guide the future allocation process.

Results of this model show continuing and intensifying conversion processes in all three national sections of the NSEC. With larger valleys already being developed for agriculture and commercial plantations increased demand starts transforming smaller, previously not utilized valleys, confirming that infrastructural development is a key catalyst for land conversion processes (**Figure 2**). Without law enforcement, protected areas close to infrastructure and development areas face significant land conversion too (e.g. Nabanhe and Mangao in Xishuangbanna; Mae Paem, Doi Luang and Tham Pathai in Thailand). On the positive side, more benign development scenarios could show that, especially in Thailand, even without law enforcement protected areas do not see much land conversion. In Xishuangbanna, past trends show that the increase in rubber plantations is coupled with a decrease in agricultural land, a linkages that – if it can be confirmed – significantly reduces the pressure on pristine forest resources (**Figure 3**).

In a last step, future land use change related information is feeding into the GLOBIO biodiversity pressure model that uses spatial information on land cover changes, infrastructural development, and ecosystem fragmentation as a proxy to estimate the relative loss of biodiversity compared to the pristine state of the respective ecosystem.

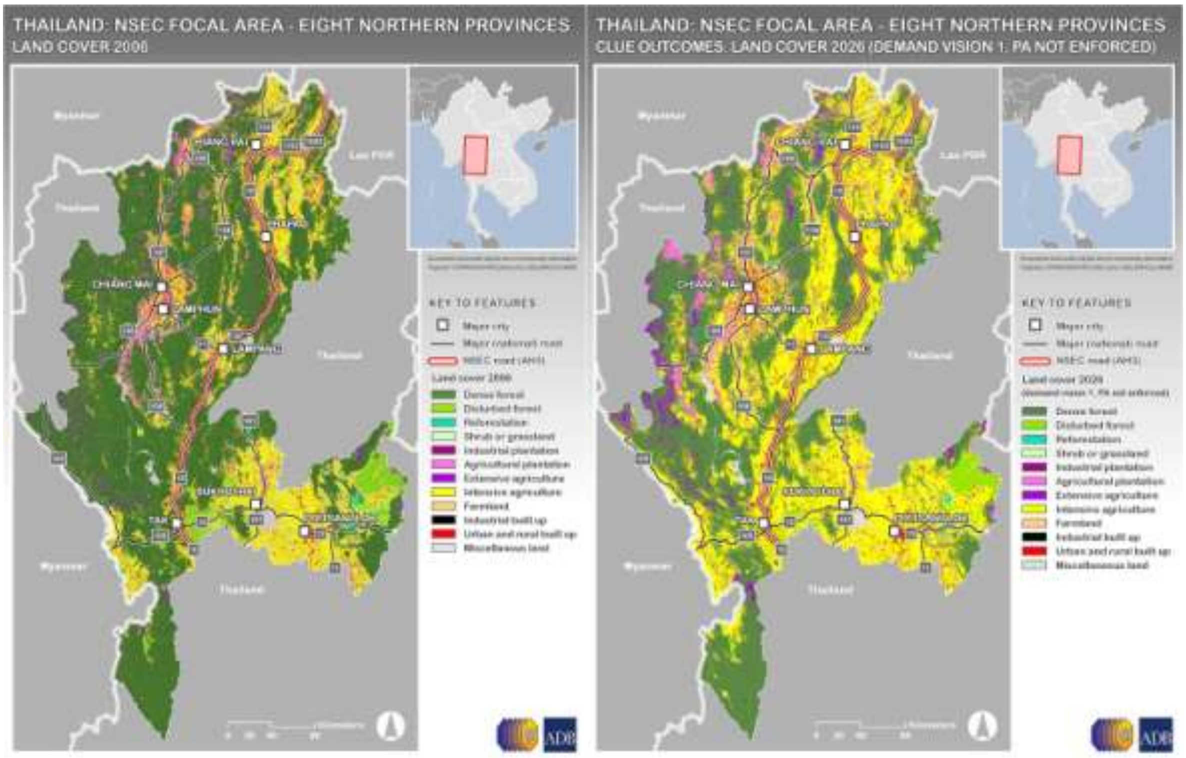

Figure 2: Estimating land conversion in Northern Thailand based on a "business as usual" (economically optimized) scenario. Present land cover on the left side, land cover in 2026 on the right side (based on scenario 1: 100% each increase in industrial plantation and intensive agriculture, 200% increase in industrial built up, 50% in agricultural plantations, 20% each in extensive agriculture [shifting cultivation] and farmland. Law is not enforced for protected areas.

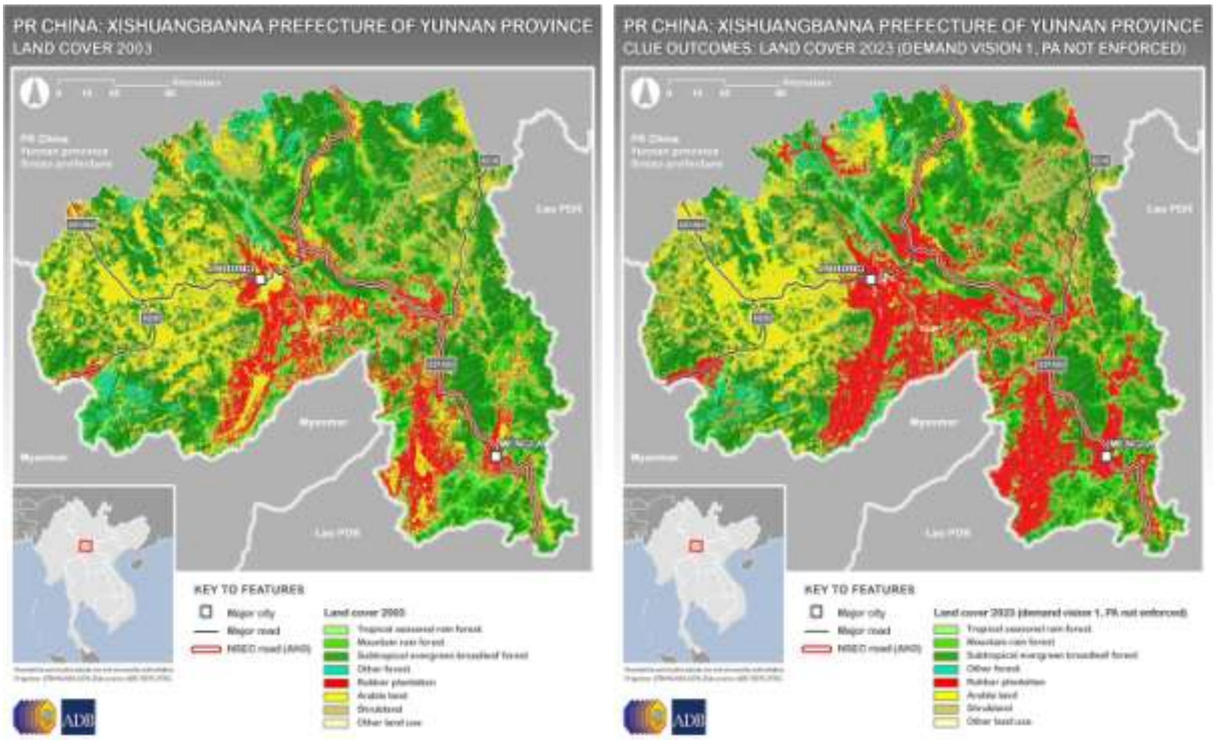

Figure 3: Estimating land conversion in Xishuangbanna, Yunnan / PRC based on a "business as usual" (economically optimized) scenario. Present land cover on the left side, land cover in 2023 on the right side (based on scenario 1: 80% increase in rubber plantations; 20% decrease in arable land). Law is not enforced for protected areas.

IV.3 Spatial Multi-Criteria Assessment

After the assessment phase identified and raised awareness about the potential geographic implications and related impacts of planned developments, the ***alternatives / mitigation phase*** introduced a tool that allows for the integration of these findings before the actual development process, thus helping to avoid the negative impacts previously forecast in the assessment phase.

For this purpose, the SEA of the NSEC SAP piloted a ***Spatial Multi-Criteria Assessment (SCMA)***. At the heart of this method is the development of a criterion tree. It hierarchically lists all spatial factors defining the suitability for a specific investment – in the SEA of the NSEC SAP transport infrastructure development was used as a pilot example. The criterion tree included a range of economic factors such as construction costs and value of assets to be connected, however, it also included environmental and social factors such as biodiversity, water resources, livelihood and health / security related spatial layers – all factors that add indirect costs if the targeted investment is not harmonised with them. National counterparts then assigned individual weights to these factors, creating "visions" prioritising either economic, environmental or socio-demographic components.

The resulting suitability layer alone is already a useful input into the SEA as it identifies areas of high suitability for a desired investment. At the same time the SMCA outcome was used to identify areas of low suitability that are synonymous for vulnerable areas where the respective investments would come with considerably increased costs.

The suitability map produced by the SMCA is also an ideal input into a least-cost path calculation, which can be used to find an optimal routing. Other than a digital elevation (terrain) model which is usually the base for such a calculation, a suitability layer does not only contain terrain information but integrates a whole range of other factors related to both construction and maintenance costs into one spatial layer. In the SEA of the NSEC SAP, this was done to identify potential railroad alignments (**Figure 4**).

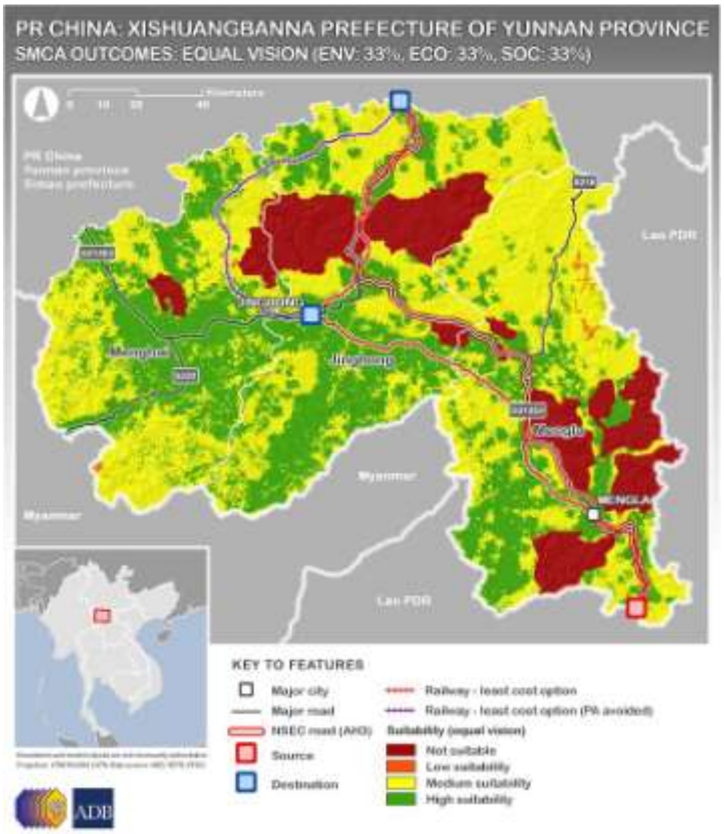

Figure 4: SMCA suitability layer and outcomes of a least-cost-path calculation based on such a layer. Two options for railroad were calculated: least cost routing with passage through protected areas allowed (red line), and alternative railroad routing avoiding protected areas (purple line).

IV Conclusions and lessons learned

Future changes in land use pattern are closely aligned to existing infrastructure and population distribution, making road development a key driver for land transformation. The CLUE-s and GLOBIO models were able to show the spatial changes in land cover and biodiversity under different land demand scenarios defined in the SEA, for each NSEC country, providing guidance for the SEA valuation, options and development of alternatives. The subsequent spatial multi criteria assessment was building on the outcomes of the predictive models and translated the findings into safeguards and suitability criteria that were used to find suitable locations for future infrastructure development while avoiding further disruption and fragmentation of vulnerable areas within the NSEC. Building on the experience of the SEA, integrated spatial planning approaches are being deployed in other economic corridors in the GMS.

While the SEA piloted a set of sophisticated spatial modelling approaches and produced a useful set of results, challenges remain. Setting up and using a spatial planning system of this complexity requires investment in human capital, hardware and data resources. Data availability and sharing is an ongoing challenge and needs to be considerably improved if spatial modelling is to produce results that are reliable enough to support strategic planning processes.