

Report of the project:

**“Planning and Applying Mitigating
Measures to Green Transport
Infrastructure”**

in Myanmar and Thailand

January - March 2015

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Dedicated to Miklos

This work was the last field work of our colleague and best friend Dr. Miklos Puky. Last September we started together to plan and prepare the overall schedule of the project. His loss, due to heart attack, few weeks after our intense and extremely active presence in Myanmar and Thailand, makes us terribly sad while the deliverables and any kind of products of the project will be always uncompleted without him. We all miss the unique way of Miklos' point of view accompanied by his energetic smile.



The last road kill photo of Miklos on 6th February 2015, Kanchanaburi, Thailand.

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1. Introduction

Southeast Asia is facing rapid and extensive infrastructure development in the coming years (WWF 2014b). While there is an inevitable need for transport network improvement in the region to overcome current difficulties, at the same time this also poses a serious threat to wildlife (EARTH *et al.*, 2012). The construction and use of transport infrastructure entail significant habitat degradation and fragmentation and its impacts are recognized among the major threats to biodiversity and the natural capital worldwide (Mandl L. *et al.* 2014, OECD 2012, Sherwood B. *et al.* 2003). A highly important conflict area is the mountainous Tenasserim Region in Myanmar and Thailand, where the planned Dawei road and railway project will cross the last pristine and most intact forest areas in the Greater Mekong Region in which new species are still being discovered and furthermore the largest populations of tiger and elephant in southeast Asia exist (WCS *et al.* 2010, WWF 2013, WWF 2014a, Phoonjampa R., 2014, Lee Kien Foh, 2015). This makes it an area of importance to biodiversity on a worldwide scale.

A team of three Myanmar government officials, three Thai government officials, two WWF Thailand staff and one WWF Myanmar staff attended the IENE 2014 International Conference on Greener Transport Infrastructure in Malmö, Sweden from 16-19 September 2014. The participation at the conference was a good opportunity to learn more about road ecology, understand the challenges that both countries face in their different stages of infrastructure development and network with various green infrastructure experts. The conference was a first step towards providing support to both governments with regards to the Dawei road, in collaboration with the IENE network and the Austrian Ministry of Transport, Innovation and Technology. For this purpose the team met with the IENE Steering Committee to discuss opportunities for collaboration and support to Myanmar and Thailand for the construction of the Dawei road. As one outcome WWF invited IENE to assist in finding environmentally friendly solutions to problems that will result from road and railway development in this area.

A project was set up with the cooperation of WWF, IENE and the Austrian Ministry of Transport, Innovation and Technology with two purposes:

- a) To organize a systematic exchange knowledge and experiences on Green (ecologically adapted) Linear Transport Infrastructure with important stakeholders in national-ministerial, regional and local-social level.
- b) To evaluate the environmental impact on habitat fragmentation of the alignment of the trans-boundary high speed motorway between Bangkok in Thailand and Dawei in Myanmar and to propose a framework of recommendations for an appropriate design of the alignment.

To achieve the above goals the IENE team participated in the international GEGG Forum, meetings and special technical workshops as well as in special field visits on the planned

motorway alignment spots as well as in important protected areas and National Parks in Thailand.

2. Implementation

2.1. *Participation in meetings, workshops and conferences*

Aiming to exchange knowledge and experiences based on environmental principles for transport development in Europe, the IENE working team, in close cooperation with the members of WWF Myanmar and WWF Thailand, established a framework of presentations which covered a variety of important topics as:

1. The environmental strategy and policy in the European Union related with green linear transport infrastructure.
2. The legal framework with the appropriate legal tools existing and implemented in Europe on estimating, avoiding and mitigating the environmental impact of roads.
3. Introduction of the negative impacts on the environment in case of inappropriate design and construction of a road.
4. Introduction of the basic principles of the appropriate design and how to avoid, mitigate or compensate the environmental impact of a road construction.
5. Sharing best practices ranged from trans-boundary agreements to environmentally friendly road designing.
6. Sharing best practices from green transport infrastructure development including, connectivity and mitigation of negative impacts on wildlife migration from roads and railways construction, as well as the construction of wildlife passages and their effective monitoring.
7. Introduction of basic principles of ecosystem services and the values of roadless and low traffic areas.

The IENE team participated in four meetings in the region:

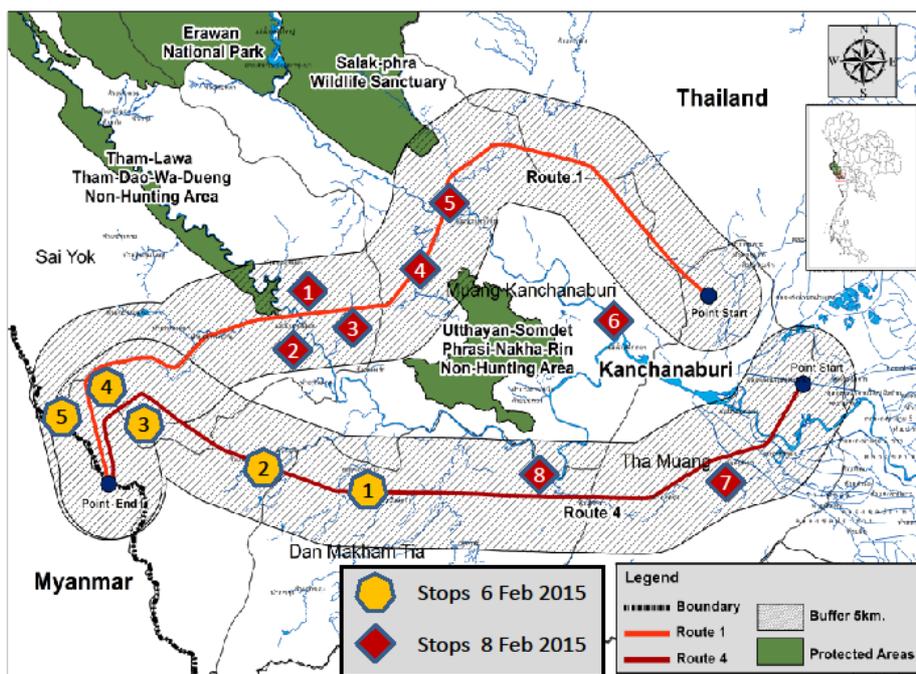
1. The highly international 4th “Green Economy, Green Growth” (GEGG) Forum with contributing to a special Parallel Session (3.1.2): “*Moving Forward: Developing Environmentally Sustainable Transport Infrastructure in Myanmar*” in Naw Pyi Taw, the capital of Myanmar, 3-4 February 2015.
2. A Thailand - Myanmar Trans-boundary “*Civil Society Introductory Meeting on Green Transport Infrastructure*” in Kanchanaburi with representatives from both Thailand and Myanmar, 9 February 2015.
3. A policy seminar on “*Green Transport Infrastructure*” attended by Thai and Malaysian experts, 11 February 2015, and

4. A technical workshop on “Green Transport Infrastructure” attended by engineers, lawyers and conservationists of relevant ministries in Bangkok, 12 February 2015, Thailand.

Unfortunately, the planned meetings with the national and the regional government in the region of Dawei as well as the field visit in Myanmar were cancelled due to administrative reasons. This led to a lack of personal interaction as well as the important introduction of the green infrastructure principles to regional government officials and the local stakeholders in the western part of the road area in Myanmar. However, government officials from the Ministry of Environmental Conservation and Forestry, Ministry of Construction and Ministry of Transport attended the green transport infrastructure session at the GEGG Forum in Nay Pyi Taw.

2.2. Field visits

Aiming to better understand the physical situation of the landscape, the character and the situation of the local natural habitats, as well as the land use by humans and the humans - nature intervention profile, the initial schedule included a field visit in both Myanmar and Thailand Dawei road alignment areas. Due to safety and administrative reasons, the fieldtrip schedule had to be modified, which finally resulted in the cancellation of the planned visit to the Dawei region in Myanmar, thus allowing more time for working on the Thai side of the impact area. The project working team visited the region between Kanchanaburi and the Myanmar – Thailand borders in Thailand giving a general approach of the two candidate routes alignments presented in Map 1.



Map 1. Kanchanaburi region with the two candidate routes alignments

The field visits included local investigation with the following schedule and stops indicated approximately in the Kanchanaburi Routes Map (Map 1):

Friday 6 February:

After traveling from Bangkok to Kanchanaburi by bus the IENE – WWF team made field visit to the Dawei road to the Thai – Myanmar borders at a level of the second half (western) of the South proposed route (Rout 4 at the Map 1).

The stops in approximate approach on the kilometers alignment according the provided document of TESCO Ltd. are the following:

- 1st: ~65+000 Klm. Agricultural area with water presence in the rice fields and important wetlands bird species presence and a road kill of a snake. Recorded as "Snake" stop.
- 2nd: ~70+000 Klm. Entrance in the mountain zone mixed with forest and agricultural use with stockbreeding (observation of goats). Recorded as "Goats" stop.
- 3rd: ~74+400Klm. Core area of mountain zone at the level of end of the elevated section of the road and the start of the proposed tunnel. A general view of the landscape with a mosaic status of forest and agricultural land use was possible. Recorded as "Landscape" stop.
- 4th: ~76+000 Klm. Core area of mountain zone at the level of end of the proposed tunnel with road widening works. Recorded as "Road widening works" stop.
- 5th: ~82+000 Klm. Core area of mountain zone and forest cover with agricultural land use close to villages. Recorded as "Border" stop.

Saturday 7th February:

On February 7th the working team visited specific north areas as the Sai York National Park. The visit in the Sai York National Park gave the team important knowledge about the wildlife presence in the area, the habitat types, the vegetation cover of the area, the National Park protection system in Thailand, the migration routes of the tigers to the Myanmar side and the importance of the area as cornerstone for conservation of the biodiversity in the Greater Mekong Region.

Sunday 8th February:

On February 8th, the working team field visit included sections of both North (1) and complementary visits of the South route (4) along the Dawei road alignment between

Kanchanaburi and the Myanmar – Thai borders. At the afternoon a visit to Salak-Phra Wildlife Sanctuary took place.

North route visits:

North route visits were focused at the eastern section of the alignment focusing the area between the protected areas in the North and the Utthayan – Sombet – Phrasi – Nakha - Rin Non Hunting Area.

Stops:

- 1st: Edge of the Tham – Lawa Tham – Dao – Wa – Dueng Non hunting area, at the north buffer zone of the North Route (1), characterized with agricultural landscape. Recorded as "Yellow trees" stop.
- 2nd: Edge of the Tham – Lawa Tham – Dao – Wa – Dueng Non hunting area, at the south buffer zone of North Route (1), characterized by agricultural landscape. Recorded as "Agricultural canal" stop.
- 3rd: Area with agricultural landscape with location of a single small culvert. Recorded as "Single Culvert" stop.
- 4th: Area with agricultural landscape between mountain ridges of the southern borders of Salak-Phra Wildlife Sanctuary and the northwestern edges of Utthayan - Somdet Phrasi – Nakha - Rin Non Hunting Area. Recorded as "Corridor west entrance" stop.
- 5th: Area with agricultural landscape between mountain ridges of the southeastern borders of Salak - Phra Wildlife Sanctuary and the northeastern borders of Utthayan - Somdet Phrasi – Nakha - Rin Non Hunting Area. Recorded as "Corridor east exit" stop (or 'Double Culvert' stop).
- 6th: River before the west entrance of the city of Kanchanaburi. Recorded as "Bridge" stop.

Complementary South Route visits:

Complementary South Route visits were focused at the eastern section of the alignment in the area south of Utthayan - Somdet Phrasi – Nakha - Rin Non Hunting Area with two stops.

Stops:

- 7th: Agricultural area with livestock activity, water presence in rice fields and important wetlands bird species presence. Recorded as "Buffalos" stop.
- 8th: A stop at a secondary river with small amount of water and dry banks. Recorded as "Viaduct" stop.

Visit at the Phra Wildlife Sanctuary

At the afternoon a visit to Salak-phra Wildlife Sanctuary took place giving the opportunity to get introduced to several important topics about the status and the management of this protected area. Interesting discussions with the Sanctuary staff took place about the forest management, the status of poaching and the special activities for important species and the cooperation with the local Livestock and Wildlife hospital.

Additionally and as a main topic the working team discussed about the habitat fragmentation due to the dam at the west zone of the Sanctuary, the barrier effect to primate species of the existing road especially when they approach the dam for drinking water. But, the most important discussion was related on the presentation of the use of electric fences in combination with the creation of ditches in special points to control the population of the wild elephants to minimize and solve the conflicts of approaching the local villages.

To examine the fragmentation problem for the primate species, it is very important to identify the areas that the animals use and, if it is possible, the specific spots that can be dangerous for road kills. For that observations of road crossings by primates have to be recorded systematically and based on that special mitigation measures as climbing overpasses for primates can be designed.

About the use of electric fences in combination with ditches for elephants control a special evaluation of the measure can be implemented with:

1. Collection of data about damage numbers before and after the installation of the electric fences.
2. Recording the numbers of different spots with the electric fence installation.
3. The length of the electric fence installation in each spot.
4. The cost of the installation, monitoring and maintenance of the measure.
5. Recording the cases that elephants are destroying the fences as weak point of the measure.
6. Detail description of the technical characteristics of ditches as depth, high, the angle of the slopes and the level of the electric fence installation.
7. Detailed description of the vegetation and the surrounding Landscape nearby

The effectiveness of the electric fence for such a purpose, as pioneer idea can be evaluated as a subject of concrete research projects and special discussion in the academic and scientific level. Exchange of similar experience and knowledge will be important and useful in a special scientific workshop or conference.

3. Results and recommendations

As an overall result, the whole project with both the organization of meetings and field trips was very successful with engaged and committed participants from both Thailand and Myanmar. Based on the framework of the above implementation data and towards the double aim of the project, both about systematic exchange of knowledge and experiences and the creation of a framework of evaluating recommendations for an appropriate design of the alignment of the Dawei highway the following results are extracted and recommendations are proposed.

3.1. *Exchange of knowledge and experience on Green Transport Infrastructure*

The total overview of the implemented exchange of knowledge and experiences events were well organized and with important participations of audients. IENE talks attracted more than 220 participants, including ministerial decision-makers (e.g. general directors) in both countries. The talks focused on developing a sound legal framework to guide the development of projects and the need for both avoidance and mitigation measures in environmentally sensitive areas. The talks were well received by the authorities concerned, including the Union Minister for the Environment of the Republic of Myanmar during the 4th GEGG Forum. As a result the IENE team received invitations from both Myanmar and Thailand to come again to help develop guidelines and solutions that will minimize the negative environmental impacts of transport infrastructure.

At a detailed level with a more technical approach the participation and the discussions followed the specific presentations at the workshops and seminars gave a very positive interest to learn about environmental impacts of a road construction and how to mitigate them appropriately. In this sense the initial aim of an introduction of the general principals of road ecology and the presentation of lessons learned in Europe on green transport infrastructure shown to various stakeholders was achieved in a very satisfactory level.

Also the presentation of examples from other road projects as 304 Highway was instructive and opened the extremely interesting discussion on how to design linear infrastructure on a national level related with the minimizing of environmental impacts in protected areas of international level importance as Natural World Heritage Sites.

From the experience gained during the project and evaluating the organization of the overall political framework of WWF actions in the Greater Mekong Region as an absolute positive result the IENE team recommends to continue the multi-level approach from the high political level to more administrative and local level, the local civil society included especially in Myanmar where the technical meetings didn't take place.

The IENE team, based on the experience in Europe, more specifically, proposes eight general recommendations for the countries in the Greater Mekong Region as basic Green Transport Infrastructure Principles:

1. The legal structure for green infrastructure must be established and strengthened.
2. Strategic planning need to precede any major development projects.
3. Civil society has to be involved in the planning phase of linear infrastructure projects.
4. Establish multi-disciplinary cooperation among different professionals such as engineers and environmentalists.
5. The “Polluter pays” principle must be implemented by including concrete mitigation measures right from the beginning of the planning phase until the tendering and contracting phase.
6. Maintenance of mitigation measures must be included in the budget of the ordinary program for maintenance of the actual infrastructure.
7. Environmental supervision of technical features of the infrastructure and monitoring of the habitat and wildlife populations’ status should be required for all phase of the projects from design to full operation.
8. A culture of learning, must be established to build up and support continuous evaluation and exchange of knowledge and experience between the interested, relevant and authorized organisations and state services.

The legal structure

Concerning the legal structure for green transport infrastructure there are many directives and strategies released by the EU that are implemented into the legal systems of all member states, that can be used as an example for a strong legal framework emphasizing on green infrastructure (<http://europa.eu>). The directives on Strategic Environmental Assessment for plans and programs and Environmental Impact Assessment for projects build the framework for the approval process and the evaluation of impacts on humans and nature. The Aarhus-Convention determines the participation of civil society within the planning and approval process. The Espoo-Convention defines trans-boundary involvement in projects effecting neighboring countries. Directives concerning nature conservation are the Fauna-Flora-Habitat-Directive as well as the Birds-Directive; they determine the protection of species as well as the establishment of protected areas and their strict protection system including their coherence. Furthermore the EU has established strategies, as the Biodiversity Strategy and the Strategy on Green Infrastructure, to emphasize the importance of actions to stop further degradation of the biodiversity. The European experience underline that a strong legal framework is inevitable for the long term sustainable use of our environment.

To fulfill the legal obligations and use best practices and the state of the art many European countries have developed specific guidelines for different topics concerning the planning and

construction of transport infrastructure and the evaluation of the environmental impacts. The experience clearly shows that this helps a lot in fulfilling the legal needs by planning sustainable and environmentally compatible infrastructure.

Besides, trans-boundary conventions were developed in Europe dealing with the special requirements of certain regions. For example the Alpine Convention for the alpine region and the Carpathian Convention for the Carpathian mountain range (*Alpine Convention 1991, Carpathian Convention 2014*). These conventions include specific protocols for different subjects like sustainable development, traffic infrastructure or tourism. There are also examples of transboundary projects aiming to implement these conventions, like the Alpine-Carpathian-Corridor project which was carried out by Austria and Slovakia (*WWF Austria 2008*). It seems suitable to establish similar agreements for the Greater Mekong Region. Developing the legal framework has to be in national level in Myanmar and Thailand, but can also be developed on trans-boundary level at the Greater Mekong Region at a first phase and at an even wider Asian level at a second phase, especially for promoting green infrastructure on developing international linear tasks. This is depended of maturity of trans-boundary relationships between the countries.

Strategic planning

Strategic plans for the development of infrastructure is important for sustainable development in a country. General national traffic plans that define the main traffic corridors to fulfill the needs for transportation of people and goods as well as environmental needs must be developed right in the beginning of every development. National, regional and local spatial plans help to define the development of traffic routes, industrial zones and settlements. Consequent and effective spatial planning is inevitable for creating sustainable coexistence of humans, economic development and nature. Protected natural areas and important wildlife corridors for migrating species need to be kept clear of human land use to secure functioning natural environment. Mitigation measures like crossing structures for wildlife can only function in a long term perspective if the surroundings are incorporated and secured by binding spatial plans.

Public Participation

The Civil society needs to be involved in the planning process of all infrastructure projects. In Europe the above mentioned Aarhus-Convention determines the right of local people to be informed in the planning process and to be able to comment on the plans and to raise their concerns. Everybody has the possibility to comment on project plans, public hearings are held where the affected population is allowed to discuss their concerns with the infrastructure company as well as with the approving administration. European experiences showed that this improved the acceptance of projects in the population and that public awareness for nature concerns is raised.

Supporting public participation can be achieved through:

1. Announcement of the availability of project study for public comments in reasonable time (1-2 months) on media as website, newspapers, technical magazines and radio stations.
2. Immediate communication with special target groups as, special social federations and organizations, NGOs, experts and professional Unions.
3. Organizing special presentations and deliberation events.
4. Holding public hearing before project approval to incorporate questions and suggestion by affected neighbors.

Multi-disciplinary cooperation

The experience in Europe (*Iuell B. et al 2003, Jackowiak B. et al 2007, Jedrzejewski W. et al 2009, European Commission 2012, <http://www.iene.info>*) also showed that the multi-disciplinary collaboration between experts of all involved professions is extremely necessary to find good and sustainable solutions for infrastructure development. The overall aim of every single infrastructure project must be to find the route and design which produce the least impact on humans and nature and the greatest benefit for the greatest number of interests. In the beginning this is a hard way as the ways of thinking and working of different professions as well as the viewpoints and the perspectives differ a lot from each other. That was one of the reasons the IENE network was established and it seems that a fruitful collaboration is inevitable for good, cost-effective and sustainable results. IENE experience also showed that international collaboration in expert networks helps a lot to exchange experience, knowledge and best practices.

Designing environmentally friendly transport infrastructure means reducing negative impacts on the environment and should always follow the order of avoidance – mitigation – ecological compensation. Avoidance can only be successful in early planning phases, as the main goal is avoiding valuable areas by not touching them with the alignment of the infrastructure. For defining suitable mitigation measures the conflict point of the planned infrastructure with the adjacent ecosystems need to be defined and specific and suitable solutions must be designed. If the negative impacts cannot be completely mitigated ecological compensation by creating, restoring or enhancing nature qualities needs to be considered to reduce the negative impact on the environment.

Another lesson learned is that the early consideration of possible impacts of infrastructure development on the environment leads to better and cheaper solutions. Therefore ecological expertise should be involved starting at an early stage and continuing throughout the whole planning and construction process. The evaluation of habitat fragmentation in very early stages can significantly save costs and mitigation measures are more likely to be more effective. In the beginning of the planning process the routes of transport infrastructure can be

planned in a way to minimize the impacts on the environment within the constraints of cost and engineering. In an early planning phase it is possible to find the route and design which produce the least impact on the environment and the greatest benefit for the greatest number of interests. The first goal in finding the route alignment should always be the avoidance of highly valuable and sensitive areas. Only if avoiding is not possible the mitigation of impacts must be considered.

The “polluter pays” principle

Objectives and targets of the project must embrace environment including ecology. Since new roads inevitably mean severe negative impact on ecosystem and fauna populations, mitigation measures need to be included in planning as well as in tendering and contracting. Mitigation measures need to be incorporated in the project as a necessary and inevitable part of the project. In Europe the so called “Polluter pays principle” makes it necessary to mitigate the caused impacts on the environment and the related cost has to be included in the overall project budget. The setup, as well as the range of the procurement, can vary almost infinitely in different mixtures. A single procurement can cover everything from the initial physical road planning to maintenance for certain years after the built road is taken into operation, where the procurements are only described as expected function’s (functional demands). Or the setup of procurement can be divided into many well defined steps where the expected result and/or the process are specified in expected results and/or technical demands. Commonly the procurement is divided into one or two planning steps and one or two construction steps, usually defined by specified and measurable demands of outcome.

For this purpose special steps can be established, as:

1. At the tender, specific measures have to be proposed and described technically for the mitigation of a concrete fragmentation problem.
2. The concrete mitigation measures have to be part of the technical obligations to the contract and the final deliverable product.
3. Costs have to be addressed as all the technical needs costs of the road.

In outline this means:

1. Set objectives and targets for the project.
2. Find indicators and measures to follow up objectives and targets.
3. Decide range and setup for the procurement that fits best with the follow up possibilities resulting from decided objectives and targets and practicable indicators and measures.
4. Express demands for the procurement following of the chosen range and setup. Meaning functional demands, technical demands, a mixture or other and how to measure if the demands are completed by the contractor.

5. Decide suitable occasions for inspection and the procedure for this during the realization and after.

Maintenance of mitigation measures

Mitigation measure have to serve the movements of animals on individual level from one side to the other of a road or a railway in daily or seasonal basis for migratory species and finally to support the establishment of genetic communication constantly in future perspective. In many cases maintenance is a mean to achieve the expected design or function of a mitigation measure, for example to develop the expected vegetation on an ecoduct which may take several years after the construction phase is ended. Therefore, to achieve or to maintain a good ecological function over time, maintenance of mitigation measures must be included in the budget of the ordinary program for maintenance of the actual infrastructure as long as the road or the railway is in operation. To achieve this in infrastructure planning, building and permanent operation completed procedure, pre-studies and follow-up studies must be standardized and the results need to be evaluated for continuous improvement of the mitigation measures.

Environmental supervision

Environmental supervision of technical features of the infrastructure and monitoring the habitat and wildlife populations' status before the construction, during the construction and after construction / during operation should be required as absolute necessity of the procedure of procurement. Environmental supervision, although often not done, needs to have stated objectives and concrete targets for the project defined in a way that makes it possible to determine if they are achieved in an objective way. That means they must be measurable with objectives specified in targets, increasingly and step by step specified in a way that makes it possible through indicators or directly to measure the actual procurement comprises adapted to the step in the planning or construction chain. In the procurement certain opportunities for inspection must be built in. It is said from experience that *“you will get what you inspect, not what you expect”*, from a contractor. This enforces to recognize technical mistakes and update solutions in practice. In this occasion it needs to be discussed if suggested solutions will fulfill expected results and targets.

Culture of learning

A baseline of knowledge regarding ecological adaptation of infrastructure is available from many countries worldwide. But still, further development is often necessary to find the most cost-effective and best adapted solutions to the actual local or regional conditions. The composition of species differ from region to region, climate likewise, soil and geology also, etc. It is therefore important to build up a culture of learning within the interested, relevant and authorized organisations and state services. The support of continuous evaluation and

exchange of knowledge where results of best practices and mistakes, can be used for improving planning and performance of mitigation measures has to be enforced.

In a parallel way, scientific investigations and the update of knowledge about the status and distributions of important and protected species are extremely crucial for their survival through:

1. The systematic update of the National Red Data Books.
2. The implementation of the National Action Plans for important species of the Biodiversity activated according the IUCN guidelines and
3. The special trans-boundary agreements or conventions as the Hua Hin Declaration on Tiger Conservation, at the first Asia Ministerial Conference on Tiger Conservation January 29, 2010 (Department of National Parks, Wildlife and Plant Conservation, et all 2013).

In all the above or similar official national and international level texts, habitat fragmentation and genetic isolation due to linear transport infrastructure constructions has to be recognized and evaluated as real or potential threat.

3.2. Dawei highway alignment

From:

- ✓ the evaluation of all available data from WWF about the proposed road routes that would go west through Kanchanaburi to the Myanmar border,
- ✓ the completion of the field trips and the sampling visits at the 13 mentioned specific spots,
- ✓ the consideration of the high level of Biodiversity Value of the Tenasserim Area and
- ✓ not having the real view as well as a candidate alignment of the Dawei road on Myanmar side,

the IENE working team recommends the follow suggestions needed for the sustainable design, construction and operation of the motorway:

General recommendations:

1. A Strategic Environmental Assessment including all planned infrastructure development projects has to be performed for the region. This must include the deep-sea port in Dawei, the motorway and the high-speed rail connecting the port with Bangkok. This assessment has to include the comparison of different alignments and development leves (e.g. how many lanes) in terms of fulfilling traffic needs, economic feasibility and - especially important - evaluation of the expected environmental and social impact on the region. By this, the alignment can be adjusted to **avoid** impacts in highly valuable and sensitive areas.

2. After the Strategic Environmental Assessment for all projects in the region, specific Environmental Impact Assessments should be done for each project. Preferably the EIA should include the Myanmar as well as the Thailand side of the project. Examples and experiences of transboundary transport infrastructure projects can be found in other countries, as for example the “Brenner Basis Tunnel”, a large railway tunnel between Austria and Italy. This should include the evaluation of all expected significant effects on *human beings, fauna and flora, soil, water, air, climate and the landscape, material asset and the cultural heritage and the interaction between these factors*. A real EIA process ensures a detailed assessment of adverse and beneficial environmental effects. Cumulative effects with other projects in the region need to be evaluated seriously. This process vouches for proper **adaption** and **mitigation** of the planned infrastructure. It also chisels out if ecological **compensation** needs to be a part of the solution.
3. In the expected case that a railway will be constructed as well, a special evaluation of complementary environmental impacts of the coexistence of two linear infrastructures in the same zone is needed. The bundling of two linear infrastructures close by has advantages but also disadvantages. To create an ecologically sustainable development the impact evaluation as well as the development of mitigation measures must include both infrastructures.
4. The development of an overall strategic plan concerning land use and spatial planning should build the framework for the desired development of the administrative regions at both two sides of the borders, guide secondary development and avoid unplanned developments, which can negatively impact peoples living areas and the environment.
5. Ecosystem services and all provided benefits have to be evaluated of a linear infrastructure project area. Ecosystems provide a variety of services for mankind including:
 - Provisioning services such as food, water and timber.
 - Regulating services which regulate environmental functions such as water purification and flood risk reduction.
 - Supporting services which are the ecological functions such as nutrient cycling and soil formation.
 - Cultural services such as recreational and educational activities as cornerstone for development of ecotourism which has positive influence on local economical and social activities.

There is a need for looking at these services and evaluate their benefits at a finer scale to give more precise estimates and provide a new tool for decision-makers how spatial planning could best be made to keep the vital services as high as possible and keep human disturbance to the environment at the lowest possible level. Special mitigation measures can be taken on preserving the ecosystems services as special forestry management plans for protecting timber and water purification, soil erosion protection on points without vegetation (special nets and cover material), establishing water

management system on the overall watershed level with recording and evaluating floods risks.

6. To increase the benefits of the road and reduce the negative impacts on the environment it is important to consider the expected impacts right from the beginning. Multi-disciplinary cooperation in all planning phases secures the best results for the greatest number of interests.
7. Civil society and local people should be involved and informed about the planning process, by this public awareness is raised as has been described above (§3.10) on Public Participation.
8. Special consideration has to be put on preventing soil erosion on the infrastructure slopes, which are highly vulnerable especially in climates with intensive rainy seasons. Examples for cost-effective slope stabilization measures by soil bio-engineering techniques can be found in other Asian countries with similar climatic conditions (e.g. Nepal, India). Soil erosion does not only harm the surrounding environment it also endangers the transport infrastructure itself to be temporarily interrupted or even destroyed by floods or mudflow. (Clark J.E. et al 1992, Gray D.H. et al 1996, Howell J.H. 1999, Maskay M.L. 1997, Spindler E. 2001).

Specific recommendations concerning wildlife:

1. Support of systematic research and field work as a priority for the establishment of a permanent wildlife monitoring system including the evaluation of the natural capital status and ecosystem services of the region.
2. The candidate route no.3 which is foreseen to pass through Uthayan - Somdet Phrasi – Nakha - Rin non hunting area is proposed to be avoided at least in the section inside of the important natural area.
3. Special zones have to be recognized as “Natural Corridors” and special actions have to be implemented to support the movement of wild fauna species including the construction of mitigation measures and key species protection and monitoring. Such a natural corridor can be the area between the mountains ridges of southern borders of Salak - Phra Wildlife Sanctuary and northern edges of Uthayan - Somdet Phrasi – Nakha - Rin Non Hunting Area. In such a case a special study for both the construction of the mitigation measures and the operation of the natural corridor has to be implemented.
4. In the area of mitigation measures and their close surroundings the land use for human purposes need to be avoided (e.g. construction of local road on a tunnel or a green bridge). Concerning conflicts between humans and wildlife special policies of human – wildlife coexistence have to be established.
5. Large scale mitigation measures as elevated road sections, tunnels and viaducts are needed for elephants and tigers. Elephants and tigers can play a role of umbrella species

covering the need of estimating the impacts of the road constructions on habitat fragmentation on a large scale. Aids available to find best cost effective locations and measures, are for example Circuitscape (McRae, B.H., och Shah, V.B. 2011) and Zonation

(http://www.helsinki.fi/bioscience/consplan/software/Zonation/References_new.html).

6. For assessment of midscale and small-scale impact other species or groups of species are recommended to be used. Amphibians are often very useful on a small scale basis and often carnivores of midsize have proved to be useful on a midscale basis. Ungulates are another group of species often used as indicator species on large-scale or midscale levels around the world. It is important to take into consideration the relation between home range size and dispersal when selecting species useful as indicators (*Bissonette and, Adair 2008*).
7. At pristine mountain landscape elevated sections of the motorway have to be continued with tunnels, cut and covers, overpasses or green bridges.
8. In unspoilt landscapes noise probably have to be regarded as a serious impact on bird populations (*McClure et al. 2013*) with special anti noise disturbance structures (screens or sheets) adapted at the local needs.
9. At great valleys, elevated sections of the motorway are recommended as planned in the south route of the road and have planed of other roads in Asia (*Ghose, D. et al 2014*).
10. At the level of mosaic presence of semi-mountain and agriculture landscape and especially with the presence of small valleys, large underpasses for medium and large size animals have to be constructed instead of simple small water culverts.
11. For small creeks both with permanent or temporal water presence culverts have to secure the movements of fish, amphibians, reptiles and small size animals.
12. At the crossing of the motorway with rivers, viaducts with open and free banks have to be constructed to secure the movement of the terrestrial species and support rivers zones to function as natural corridors but also to give protection in cases of floods.
13. In agricultural landscape with water presence as dams, marshes, swamps and especially in rice cultivations special measures as leading structures of high (>5m) and dense bushes or trees have to be established for preventing birds from flying on low altitude over the motorway as well as appropriate underpasses for fish, amphibian, reptiles and small size animals.
14. Roadless and low traffic areas have to be recognized and to be supported with minimum or non-human presence as an ecological compensation practice in the direction of promoting the natural values and support local livelihood and ecotourism.
15. A road kill observatory has to be established to evaluate the most dangerous road spots and as a result being able to set appropriate measures.

16. Cooperation with local stakeholders has to be established in a framework of improving the communication, the exchange of opinions and knowledge and finally to take common agreed decisions and plans as a local Action Plan for a specific topic. Such a network in the Kanchanaburi Region with the creation of a Road Kill Observatory can be a first aim and can include:

- ✓ The National Parks, the Wildlife Sanctuaries and the Non Hunting Areas Management Authorities.
- ✓ The Local Road, the Environmental and the Forestry Services.
- ✓ The Livestock and Wildlife Hospital in Sai York Area.
- ✓ A Local University, etc.

Data of treatment of wildlife in the local hospital can give a first evaluation of existing cases of road kills or injuries.

17. Finally special mitigation solutions for keeping wild elephants away from highways have to be evaluated on a systematic and scientific way based on the experience of the use of ditches and electric fences to keep elephants away from fields, settlements and roads. This was an important outcome during the consulting discussions with local experts from the Salak Phra Wildlife Sanctuary who have been experimenting with ditches and electric fences to control the approaching of elephants to crops and villages. This recommendation also goes along with the final decision of the WWF and IENE to focus at a next step cooperation on exploring possibilities for organizing an international meeting on elephant crossings, connectivity and land use planning either in Myanmar or Thailand in order to gather best practices and lessons learned from Africa and wider Asia.

The above recommendations are based on the knowledge obtained from the field visits at two mentioned routes the North Route, number 1 and the South Route, number 4. From the other routes, according the available data the most important is number 3, which - as mentioned - is proposed to avoid at least the section passing through the Utthayan - Somdet Phrasi – Nakha - Rin non hunting area. The above recommendations can be kept in a general level and in any case of large scale changes of the alignment probably have to be updated.

4. Epilogue

IENE as European network of organizations, NGOs, institutions, academic authorities and experts has implemented a variety of activities in Europe supporting wildlife and biodiversity conservation through the sustainable implementation of linear infrastructure tasks or supporting defragmentation projects. The currently implemented project on “Planning and Applying Mitigating Measures to Green Transport Infrastructure” in Myanmar and Thailand is a pioneer step for the development of IENE cooperation in an international level and WWF has made that achievement possible. Estimating the results of the project according to the

working team presences in Myanmar and Thailand and the fruitful cooperation with WWF colleagues, IENE is sure that the lessons that were transferred to the Greater Mekong Region from Europe will be a start for the development of Green Policy in the transport infrastructure sector in Asia.

IENE is looking forward to establish a permanent framework of cooperation especially as a concrete goal of an international meeting on elephant mitigation measures has already been discussed and IENE will be ready for such a new challenge.

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Annexes

- I. Agenda of the meetings
- II. PP presentations list (PDF)
- III. Abstract of presentation of the project to ICOET conference
- IV. Photos