Thematic Paper #1

- **Smart Green Infrastructure**
- Conservation through Community Incentives
- Capacity-Building
- Landscape-Scale Management
- Addressing Competing Demands
- Innovative Finance
- Costing Tiger Conservation

GTI
Global Tiger Initiative

Smart Infrastructure in Tiger Conservation Landscapes: A Multi-Level Approach

The working report on tiger-friendly infrastructure in Tiger Range Countries.

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Acronyms

BBOP	Business and Biodiversity Offset Program
CBD	Convention on Biological Diversity
CDM	Clean Development Mechanism
CITES	Convention on International Trade in Endangered Species
EA	Environmental Assessment
EAP	East Asia and Pacific
EIA	Environmental Impact Assessment
EMS	Environmental Management System
ESIA	Environmental and Social Impact Assessment
FSC	Forest Stewardship Council
GIS	Geographic Information Systems
GTI	Global Tiger Initiative
GTF	Global Tiger Forum
ICDP	Integrated Conservation and Development Project
IUCN	International Union for Conservation of Nature
LEED-AP	Leadership in Energy and Environmental Design Accredited Professional
NGO	Non Governmental Organization
NTAP	National Tiger Action Plan
PA	Protected Area
PES	Payment for Ecosystem Services
REC	Renewable Energy Certificate
REDD	Reducing Emissions from Deforestation and Forest Degradation
SEA	Strategic Environmental Assessment
SEPA	State Environmental Protection Agency
SI	Smart Infrastructure
TCL	Tiger Conservation Landscape
TRC	Tiger Range Countries
WBI	World Bank Institute
WCS	Wildlife Conservation Society
WWF	World Wildlife Fund US

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Executive Summary

Tigers (*Panthera tigris*), are majestic symbols for many ancient and modern cultures. Unfortunately, they are on the brink of being extirpated from the wild due to poaching, illegal trade, habitat loss and fragmentation. In 2008, The World Bank, together with other stakeholders, established the Global Tiger Conservation Initiative (GTI)[1] "to assist the thirteen tiger-range countries (TRCs)[A] with their efforts in restoring wild tigers and their habitats." Early on, tiger experts identified infrastructure (transportation, mining and hydropower in particular)[2], as a major contributing factors in habitat degradation. Although the situation for wild tigers is critical and challenging, there are still excellent opportunities for financing agencies, governments, business owners/operators, engineers, and local communities to ensure that infrastructure is smart and tiger-friendly.

This study followed a multi-level approach at the international, national, sectoral, and project levels. It examined policy infrastructure challenges and opportunities, using lessons learned from case studies, along with regional and in-country analyses. While there are options for improvement for all countries, Russia, India, Bhutan, and Nepal have developed a good foundation of conservation, planning, and policy efforts. Best practice case studies from non-TRCs provide additional learning opportunities that could be benefit TRCs and tiger populations, but these are beyond the scope of this report and will be produced in early 2010 prior to the GTI meeting in Thailand.

At the national level, government officials have a range of regulatory policies, fiscal policies and incentive programs that can promote tiger-friendly infrastructure development. Regulatory options for controlling impacts to tigers and their habitats include land use and tiger corridor planning, infrastructure permitting, transfer mechanisms such as payment for ecosystem services schemes, and environmental impact assessments, along with strategic environmental assessments. Environmental Compensation policies and incentive programs can help drive investments in alternative livelihoods, as well as drive smart infrastructure and preserve key habitat areas. Avoiding Tiger Conservation Landscapes (TCLs) is the best and cheapest option available to governments to save wild tigers and to this extent we encourage a "game changing" commitment from TRC governments: designate core tiger population habitats as "no go" areas for infrastructure development. In addition, recovering wild tiger populations will not be possible without effective transboundary conservation efforts, expanding the network of protected areas, creating buffer zones, restoring connectivity between patches of actual habitat within landscapes, avoiding poaching, securing long term funding, and applying stringent infrastructure development policies that factor in poverty reduction and take projects from human-tiger conflict to communities that support co-habitation with tigers.

However, regardless of the national policy options adopted, sectoral planning must begin to explicitly consider tigers and related biodiversity considerations in their plans. Industry has numerous options within the mitigation hierarchy including having explicit tiger conservation goals, effective stakeholder engagement, environmental management systems, and biodiversity offsets. Emphasizing lower-impact forms of development, whether via run-of-river or railroad infrastructure, may assist tiger conservation. Overall, voluntary approaches at an industry level that demonstrate leadership can play a critical role in tiger conservation.

Lastly, on a project level, engineers have various options available to them to ensure that habitat loss, fragmentation, and induced impacts, such as poaching are minimized. In terms of road infrastructure design, the primary focus should be on open-span bridges / bridge extensions which are likely to be both cost-effective and preferred by both large cats and their prey. Minimizing paving and design that considers hydrological impacts is also important. Mining and hydroelectric

[A] Tiger Range Countries: Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Myanmar, Nepal, Russia, Thailand, & Vietnam.

infrastructure also has tiger-friendly options available throughout the project life cycle, and in particular, attention should be paid to limiting ancillary roads, settlements and establishing strict policies for workers with respect to hunting and poaching.

Beginning with the choices behind a project's location, smart, sustainable infrastructure uses careful design, friendly construction practices, community engagement, strong assessments, monitoring, and adaptive management to ensure that infrastructure does not interrupt natural ecological processes. In summary, while avoidance should be a primary focus of any effort, there is an array of policies and practices that can help ensure that there is a future for wild tigers.

1. Introduction & the Global Tiger Initiative

Over the years it has become apparent that public works — such as roads, hydroelectric dams, and mining operations — which support the way of life of millions of people in Asian countries, have contributed to the loss of the region's biodiversity. Of particular concern are Tigers. Tigers are important biologically to maintain the overall health of multiple ecosystem processes[3]. As a top predator of the food chain, tigers help keep prey populations in check. Large, familiar animals such as tigers are often considered wildlife ambassadors and therefore attract funding and wider conservation benefits. In addition, Tigers have symbolized beauty, power, religious beliefs, and fierceness for over 5,000 years[4]. Unfortunately, Tigers are considered endangered and listed under CITES Appendix I[5] and are part of the efforts of the Species Survival Commission/Cat Specialist Group of The International Union for the Conservation of Nature (IUCN).

Tigers are threatened primarily through a combination of a) poaching and wildlife trade and b) habitat fragmentation and loss. Both of these threats require different and immediate interventions as the rapid pace of infrastructure development, land use change, and poaching all continue unabated throughout Asia. The plight of the tiger in the face of these threats meant that in 2008, various stakeholders, in conjunction with the World Bank, established the Global Tiger Conservation Initiative (GTI)[6] "to assist the thirteen tiger-range countries (TRCs) with their efforts in restoring wild tigers and their habitats"[7]. The World Bank has been, and continues to be, active in development projects as well as specific integrated conservation and development projects (ICDPs) in or adjacent to Tiger Conservation Landscapes (TCLs)[8]. Accordingly, they share the challenge of tiger conservation along with various tiger range governments and non-governmental organizations.

In the report *A Future for Wild Tigers*[9] tiger experts identified infrastructure**,** noting transportation, mining and hydroelectric infrastructure in particular, as a major contributing factor in habitat fragmentation and conversion[B]. Having identified the need to generate so-called "tiger-friendly infrastructure" or "smart infrastructure", ***the purpose of this paper is to develop a set of multi-level tiger-friendly options (at a policy, sector planning, and engineering level) based on best practices for government officials, financing agencies, and project managers. These options will highlight the basic elements throughout a project's life cycle (including planning, optimal site selection, design, operations and construction) for roads, hydroelectric dams, and mining operations in TCLs.*** The ultimate goal is that options presented in this paper will form the basis for improved decision making and be incorporated into country-level tiger conservation plans, national conservation policies, sectoral planning, and the construction of local projects.

[B] At the World Conservation Congress in Amman, Jordan, on October 2000, the IUCN Tiger Conservation Resolution was passed by consensus inviting funding agencies, national, and local Governments to desist from making financial investments that adversely affected tiger habitats and heightened the priority given to tiger conservation within their policies.

2. Effects of infrastructure on tiger conservation

Tigers (*Panthera tigris*), are majestic symbols for many ancient and modern cultures, which various civil society groups have identified as being important to save from extinction[10]. Unfortunately, they are on the brink of being extirpated from the wild. The world's population of wild tigers has plummeted by 95% in just over a century, from an estimated 100,000 in 1900 to approximately 4,000 today. Tigers, having already disappeared from Central Asia, Java and Bali in Indonesia, occupy only 7 percent of their historic range. Regrettably, the tigers' range shrunk by an additional 40 percent in the last decade alone[11]. Tigers are divided into a series of subspecies including the Bengal (*Panthera tigris tigris*), Indochinese (*Panthera tigris corbetti*), Malayan (*Panthera tigris jacksoni*), Sumatran (*Panthera tigris sumatrae*), Siberian (*Panthera tigris altaica*) and South Chinese tiger (*Panthera tigris amoyensis*), along with three extinct subspecies: the Balinese tiger (*Panthera tigris balica*), the Javan tiger (*Panthera tigris sondaica*), and the Caspian tiger (*Panthera tigris virgata)*[C]. The South Chinese tiger is the most critically endangered of any of the living tiger subspecies, with a few 20 individuals remaining in the wild[12]. While the subspecies populations vary in size and health, significant conservation opportunities exist for most of the enduring subspecies. The remaining tiger habitat ranges across 13 countries and faces many challenges due to population growth and development pressures[13]. These pressures vary from country to country which entails that solutions must be customized for each country and region.

Tigers have been reduced in number throughout their range primarily due to a combination of hunting, loss of prey and habitat degradation[14]. While addressing the former two factors is critical to stop the immediate loss of tigers, the latter driver, habitat loss, is typically a result of either land use conversion (often for either agriculture or human settlement) or infrastructure development. Although the relative contribution of infrastructure development is less significant than poaching and land use conversion, its magnitude should not be underestimated. In fact, investments in both the urban and rural areas of Asia and the Pacific is estimated to reach US$ 4.7 trillion dollars over the next 10 years to sustain growth in the region with two-thirds of that amount required for new infrastructure[15]. As economic development, resource demand and population growth continues to increase, infrastructure expansion will attempt to meet these various transportation, mining and energy demands. Moreover, given the historical failure of efforts to avoid core tiger habitat degradation, it is imperative that decision makers consider long-term environmental and economic impacts and do not allow short-term political rationales to trump decisions relating to core tiger populations and infrastructure siting.

Fragmentation and deforestation are already occurring within TCLs where protected areas have become insular and often unable to support viable population of tigers[16]. Thus, the creation of effective corridors that connect protected areas, forest reserves, and large intact habitat blocks using optimal conservation landscape design approaches is essential in most TCLs. In 2007, in Asia and the Pacific, the terrestrial area designated as legally protected according to the laws was around 10 per cent of total land area, slightly lower than the global average[17]. Forests outside protected areas are also at risk in TRCs. During 1990-2005, more than half of the countries in Asia and the Pacific for which data are available reported net losses in forest cover.

Currently, only 30 percent of the land area is covered by forest – one of the lowest proportions among the global regions. Four countries accelerated their loss of cover between 1990 and 2005, Vietnam, Nepal, Indonesia, and Cambodia with Indonesia and Nepal reporting the greatest loss of over 20 percent of 1990 levels.

[C] According to a recent genetic study (Driscoll CA, Yamaguchi N, Bar-Gal GK, Roca AL, Luo S, et al. (2009) Mitochondrial Phylogeography Illuminates the Origin of the Extinct Caspian Tiger and Its Relationship to the Amur Tiger. PLoS ONE 4(1): e4125. doi:10.1371/journal.pone.0004125), the authors concluded that *P. t. virgata+P. t. altaica* should be taxonomically considered a single subspecies.

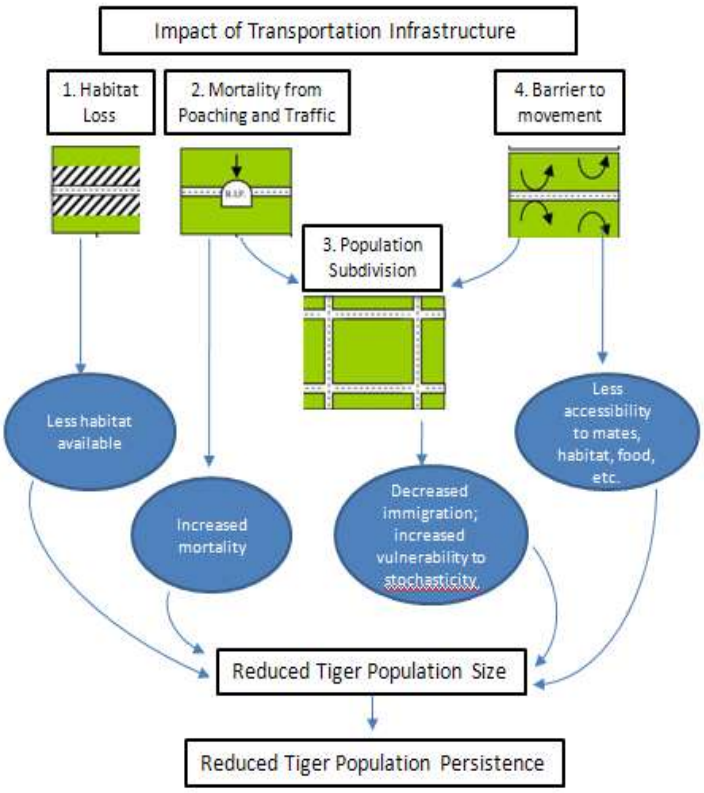


Figure 1: Impact of transportation infrastructure (adapted from Jaeger et al., 2005)[A]

The largest TCLs occur in Myanmar (249,389 km^2), Russia (241,868 km^2), India (197,199 km^2), Thailand (115,884 km^2), Indonesia (88,314 km^2), and Cambodia (74,749 km^2) where controlling land use change and habitat fragmentation have been identified as a critical issue[18].

Transportation infrastructure generates serious direct and cumulative impacts if poorly planned. Road density can impact faunal movement, cause population fragmentation and human access to wildlife areas[19], and these impacts increase with higher road density[20,21] (Figure 1). Roads often have downstream hydrological impacts. Perhaps most importantly, roads open up intact habitat and create opportunities for poachers to reach remote areas which currently provide refuge for tigers and their prey. Roads also provide the means for exporting tiger parts as most of the illegal tiger trade occurs by roads and trains[22]. While tiger populations may suffer few road casualties in an absolute sense, because of the small population sizes, the loss of even a few individuals might lead to their local extinction[23]. Roads often lead to induced impacts and these cumulative impacts can ultimately jeopardize tiger populations[24]. Despite these various impacts, well-designed infrastructure projects do have the potential to freeze and even reverse degradation of natural habitats and the loss of biodiversity[25]. For a more detailed discussion of the impacts of roads on tropical biodiversity, see Laurence et al. (2009)[26].

The current tiger population, infrastructure and fragmentation trends in Asia underscore the fact that project-level mitigation efforts to date have not properly included tiger recovery and protection programs. Moreover, it highlights the need for more comprehensive policies, regulations, and protocols to safeguard tiger populations and TCLs from poorly conceived infrastructure sector planning and investments. Beginning with the choices behind a project's location (see Appendix D), smart, sustainable infrastructure uses careful sector planning design, community engagement, strong assessments, monitoring, and adaptive management to ensure that infrastructure does not interrupt natural ecological processes. However, making infrastructure projects tiger friendly is only a part of the complexity of actions that need to be adopted to address the impacts from encroachment, land use conversion, poaching, and illegal trade. While the situation for tigers in the wild is critical and challenging, there are still excellent opportunities for government officials, business owners/operators, engineers, and local communities to ensure the development of "smart infrastructure": infrastructure that is avoids tiger habitats, minimizes and mitigates impacts through tiger-friendly design, and compensates for any remaining damage.

3. Multi-level options approach

Since traditional project-based mitigation approaches have proven insufficient to halt habitat fragmentation and tiger population declines, a multi-level approach is proposed here. Beginning with

international conventions and frameworks, tiger-friendly infrastructure must be driven and supported at the national policy level, the sectoral planning level and finally, at the project level.

All of the tiger-friendly infrastructure options presented below can be framed in the context of the mitigation hierarchy (Table 1): first avoid, then minimize, then rehabilitation/restore, and then finally, when all options are exhausted, compensate. In other words, *avoidance, which lies at the top of the mitigation hierarchy, should be the primary aim for any policy or program designed to save wild tigers*.

Table 1: The Mitigation Hierarchy[D]

***Avoidance**:* measures taken to avoid creating impacts from the outset, such as careful spatial or temporal placement of elements of infrastructure, in order to completely avoid impacts on certain components of biodiversity. This results in a change to a 'business as usual' approach.
Minimization: measures taken to reduce the duration, intensity and / or extent of impacts that cannot be completely avoided, as far as is practically feasible.
Rehabilitation/restoration: measures taken to rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to impacts that cannot be completely avoided and / or minimized.
Offset: measures taken to compensate for any residual significant, adverse impacts that cannot be avoided, minimized and / or rehabilitated or restored, in order to achieve no net loss or a net gain of biodiversity. Offsets can take the form of positive management interventions such as restoration of degraded habitat, arrested degradation or averted risk, protecting areas where there is imminent or projected loss of biodiversity.

With the mitigation hierarchy in mind, the remainder of this paper sets out various options at the policy, sectoral and project level.

4. International context and national policy level options

Tiger Range Country (TRC) governments are in the position to set the stage for tiger conservation when it comes to infrastructure development. With a mandate to drive the economic, social and environmental wellbeing of their respective countries, government policies can have a profound impact upon tiger conservation.

International agreements often form the basis for national legislation. International expectations are usually harder for governments to ignore than local pressure. All TRCs are Parties to The Convention on Biological Diversity (CBD) and as signatories, they have legally binding responsibilities. These sorts of commitments set the stage for biodiversity conservation and theoretically require countries to create legislation to protect threatened species including tigers; however, protecting tiger habitat and populations is not an explicit obligation being enforced through the CBD. The Global Tiger Forum (GTF) recognizes that efforts by National Governments both individually and through multilateral agreements such as CITES require additional and complementary support to guarantee the survival of tigers in the wild. Furthermore, subsequent to the first general assembly of the Global Tiger Forum in 2000, all TRCs, with the exception of Laos, have developed, updated and/or approved National Tiger Action Plans (NTAPs)[E]. These NTAPs provide TRCs with an opportunity to develop innovative approaches and more effective actions addressing the multiple threats faced by tigers in the wild. A common approach for the implementation of NTAPs is essential. NTAPs need to not only

[D] Note: The World Bank also subscribes to the mitigation hierarchy via their safeguard policies including Operational Policy OP 4.04 Natural Habitats which looks to avoid habitat impacts and minimize / restore habitats. The Bank promotes and supports natural habitat conservation and Offsets. The Bank does not support projects that involve the degradation of critical natural habitats. Mitigation measures include, as appropriate, minimizing habitat loss (e.g., strategic habitat retention and post-development restoration) and establishing and maintaining an ecologically similar protected area.

[E] NTAPs in Bangladesh, India, Nepal, Russia, Thailand, and Vietnam are in the process of being updated.

identify the threats posed by infrastructure, but also should underscore the inclusion of tiger-friendly development policies as part of the planning of infrastructure projects near or within existing TCLs including adequate political support, financing, and legislation. To this extent, there are numerous policy options available to decision makers which, in some cases, can be tailored to be sector-specific.

Of particular note is a suggestion put forth by the GTI-SI team to develop "no go" areas. Given the critical state of wild tiger populations, it is suggested that all core tiger habitats that are acting as source populations be designated as "no go" areas for infrastructure development (see section 5.1 for more details). It is the GTI's hope that governments can signal their intentions to pursue tiger-friendly infrastructure through a commitment such as this at the Year-of-the-Tiger Summit,

In addition to such commitments, the following are highlights of some of the primary options and tools available to government officials (a more comprehensive list may be found in Appendix C):

- **Land Use Planning Policy/Framework**: A robust and systemic national land use planning policy is the foundation for avoiding impacts to TCLs. By concentrating development in lower-value habitats with existing human presence, higher biodiversity value areas, including core tiger areas, can be spared for tigers and provide critical ecosystem services. To this extent, fragmentation[F] analyses can be a useful tool to inform "no go" areas. Furthermore, Spatial Decision Support Systems (as illustrated in the NSEC SEA; see Appendix K) can provide an intuitive and accessible approach to delineate suitability layers for infrastructure investments, identify vulnerability zones and avoidance/mitigation measures for land use planning.
- **Tiger Corridor Identification**: National-level tiger corridor analyses, such as that for Terai Arc[27], are another valuable approach that can inform both the NTAPs, as well as tiger-friendly infrastructure planning. These analyses identify particularly important migratory corridors for tiger populations, and can help to ensure connectivity between source populations and habitats. Avoiding infrastructure development in these corridors should be a primary policy aim and should be a part of a comprehensive land use planning process.
- **Protected Area Networks**: Protected area (PA) networks form a critical part of tiger habitat conservation and should form a cornerstone of any NTAP and land use framework. Ensuring optimal overlap with TCLs, as well as connectivity between PAs should be an explicit policy goal. It should also be noted that infrastructure projects (via offsets which are noted below), can provide transfer funds for PA establishment and management. Tools such as MARXAN can be helpful in optimizing PA networks and informing land use planning.
- **Financial incentives:** Programs designed to provide incentives to avoid (and to a lesser extent minimize, rehabilitate and compensate) impacts on TCLs can be put into place. These can come in the form of expedited approvals, lower interest rates, taxation benefits, or direct cash subsidies. Encouraging the uptake of voluntary sectoral market certifications, such as Forest Stewardship Council (FSC) through various means (such as national marketing), can be an inexpensive means of improving tiger and biodiversity management within a given sector. Experience from around the world, particularly the industrialized countries, indicates that a combination of financial incentive programs, aggressive subsidy reforms, energy efficiency policies and renewable energy legislation can all be a powerful motivator for affecting development patterns. When the appropriate government institutions implement and enforce these sorts of policies in conjunction with private players and the domestic financial sector, it can go a long way in greening infrastructure. It is also worth noting that incentive schemes can also be put into place not only for developers, but also for local communities to help encourage tiger conservation (and thus not request further infrastructure development). While such integrated conservation and development projects (ICDPs) have met with mixed success, with improvement, these sorts of projects do have the

[F] Fragmentation is defined as a disruption of ecological interrelation between two locations and structurally as obstacles against the movement of animals (separating patches of habitat).

potential to help support and drive tiger conservation and target development away from key habitats. Developing such tiger projects would also potentially reduce human-tiger conflict.

- **Regulatory controls:** Legislation is always an option available to governments as a means of controlling infrastructure development. Whether through permitting processes, or environmental acts, the government can use legal penalties as a disincentive mechanism to prevent impacts to tigers. These regulatory controls are often sector specific and can include requirements such as EIAs, SEAs, financial sureties related to restoration, and legal measures around tiger poaching and prey hunting.
- **Environmental Impact Assessments:** Environmental Impact Assessments (EIAs) are of particular importance in mainstreaming environment and social issues into infrastructure development and merit additional consideration. National environmental regulations in most TRCs have references to EIAs, but only recently (past 10 years) have countries implemented formal regulations making EIAs mandatory for projects. The degree of maturity and quality of environmental assessment practices varies from country to country with implementation challenges existing almost everywhere. Some like China, India, and Indonesia have well laid out EIA policies while Bangladesh, Myanmar and Cambodia are at an earlier stage and trying to build their own basic capacity. Countries like Vietnam and Lao PDR are in between. Appendix B provides a full breakdown of EIA regulations throughout TRCs.
- **Strategic Environmental Assessments**: The Strategic Environmental Assessment (SEA) is an analytic and participatory approach that integrates environmental considerations into policies, plans and programs and evaluates the inter-linkages with economic and social considerations. SEA is a relatively new concept and only China and Vietnam currently have regulatory frameworks for conducting SEAs. SEAs are necessary in many cases because only a relatively small proportion of proposed actions and decisions are subject to EIA. Furthermore, EIAs are conducted at a later stage of the decision-making process after selections of major alternatives are finished. Since the greatest impact to tiger populations is through the cumulative impact of networks created by siting of the infrastructure, the EIA process is often too late to affect change. SEAs provide the opportunity to identify and avoid TCLs earlier in the development process saving money, time and tigers.
- **Biodiversity/Tiger Offsets**: Major infrastructure projects also offer unique opportunities to create and enhance the connectivity of critical habitats for tigers. Compensation actions have been described via numerous terms including 'biodiversity offsets', 'compensatory mitigation', 'compensatory conservation', 'net conservation benefits' and 'environmental enhancement', among other terms. However, offsets are a 'last resort', after all reasonable measures have been taken first to avoid and minimize the impact of a development project and then to restore biodiversity on-site[28]. The goal of biodiversity offsets is to achieve no net loss and preferably a net gain of biodiversity on the ground with respect to species composition, habitat structure, ecosystem function and people's use and cultural values associated with biodiversity[29].

Case Study: Brazilian Environmental Compensation Law. In 2000, Brazil passed an legal act, based on the "polluters-pay" principle requiring that development projects with a significant environmental impact (determined via an EIA) must compensate for biodiversity losses by paying a sum (the specific amount varies by the degree of the impact) which is at a minimum 0.5% of total project costs and over 6% in the case of sensitive rainforest. This money is paid to the National System of Protected Areas (locally known as SNUC) to set aside conservation & sustainable use units. While the project developer proposes how the money should be used, it is the environmental authority (national or regional) that makes the final choice with the money ultimately used to create and maintain only strictly protected areas.[30, 31]

There are various mechanisms for financing offsets including tax and subsidy shifts, protected area transfer funding, as well as payment for ecosystem services (PES) schemes. Of particular note are both adaptation efforts and the emerging market for carbon sequestration through reduction of emissions from deforestation and forest degradation (REDD). To date, TRCs have shown a strong interest in advancing and incorporating these instruments in their environmental portfolios. While the proposed REDD schemes do not

necessarily target high biodiversity value areas and core tiger habitats[32], there are opportunities to combine ecosystem-based mitigation (forest/soil carbon capture and sequestration), ecosystem-based adaptation (maintenance of habitat and ecosystem services), and tiger-habitat conservation.[33,34] Similar opportunities exist around the emerging discussion of biodiversity offsets within the Business and Biodiversity Offset Program (BBOP).

Lastly, but critically, in addition to the various policies, regulations, and fiscal measures noted above, dedicated and properly resourced institutions with strong governance mechanisms will be indispensable to create an enabling environment for greening infrastructure. Enforcement and ensuring compliance has often proven to be a challenge to tiger conservation in TRCs and should be a strong focus for all TRC governments to ensure the success of policy-based solutions.

Table 2: Summary of national policy options

Level	Project Life Cycle	Option
National Policy	Applicable to all stages	Land use planning framework (including strengthening property rights, restrictions, tiger corridor analysis)
		Designing protected area networks (new / strengthening existing PAs)
		Environmental Impact Assessments (EIAs) (including mandating stakeholder engagement and fragmentation analysis)
		Strategic Environmental Assessments (SEAs)
		Leveraging tiger/biodiversity funds from infrastructure project as compensation mechanism
		Payment for ecosystem services (PES) schemes including carbon (REDD), watershed-services, and biodiversity offsets
		Tiger-friendly construction permits
		Restrictions on ancillary infrastructure development
		Promoting and providing incentives for alternative livelihoods: eco-tourism/tiger viewing as integrated community development projects that support tiger conservation
		Strong compliance monitoring and enforcement via institutional strengthening
		Legal requirements regarding financial sureties
		Remediation and removal of ancillary infrastructure enforcement

5. Sectoral level options

Having indicated some of the governmental policy instruments that would make infrastructure tiger-friendly, the next step is to explore sectoral level options. Sectoral options must begin with the acknowledgement that developers and financial institutions have a significant role to play in wild tiger conservation when it comes to infrastructure development. While economic development is a highly desirable outcome, there is a general appreciation that it cannot come at a social and environmental cost. As developers have often learned, these costs carry significant risks from project delays and legal battles to bad publicity and mitigation costs. Invariably, finding solutions that meet the so-called "triple bottom line" (economic, social and environmental well-being) is in everyone's interests. With this premise in place, there are a number of actions that the private (and public sector, infrastructure mainly in public hands in TRCs) sector can put into place throughout the life-cycle of an infrastructure project (see Appendixes E, F, G, H).

At the forefront of sectoral options are sector-level plans and this report suggests that *all sectoral plans rooted in an SEA should include a fragmentation analysis, tiger-specific considerations about TCLs and core habitats, funding transfer mechanisms including PES, offset options, and minimization of cumulative, ancillary and induced impacts.* In addition to planning efforts, sectors can commit to

adopt voluntary best practices and seek out additional training and awareness for their workers. The remainder of this section will first assess the lessons learned at a sectoral level before exploring these various options.

5.1 Lessons learned and voluntary adoption of best practices

The loss of biodiversity, including tigers, has allowed researchers to learn a great deal about failures and success when it comes to human activity such as infrastructure development. Successful smart infrastructure projects designed to improve populations of large carnivores, often employ the following best practices:

- Commitments to entirely avoid large, intact habitat blocks with core tiger populations
- Identification and use of natural corridors to situate crossings
- Innovative and locally-customized engineering/design
- Environmentally friendly operations with environmental management systems that explicitly take biodiversity (such as tigers) into account when examining significant impacts.
- Explicit native habitat restoration goals and "net positive impact" compensation related to biodiversity. Efforts to establish new protected areas need to be started during project preparation when impacts are identified.
- Community-based environmental awareness/education programs
- Robust monitoring and evaluation plans that are implemented at an early stage
- Strong, independent environmental impact assessments conducted by accountable consultants
- Well defined terms of reference with explicit tiger (and other biodiversity) goals,
- Early involvement of stakeholders improves project design, operation, and management;
- Careful considerations related to construction including the timing of construction, rules for contractors (especially related to hunting/poaching), noise and dust abatement during construction, and restrictions around settlement and ancillary development. Induced effects of camp followers and boom towns that accompany large infrastructure projects in or near tiger areas should also be closely monitored and eradicated as part of the overall plan.
- Localized projects enable more in-depth, site-specific actions such us good EMP during construction and post project monitoring.[35]

Furthermore, studies suggest that EIAs in TRCs encompass different degrees of maturity both in terms of environmental and social impacts and their mitigation costs. Accordingly, lessons learned can be categorized as follows:

EIA Implementation: Timing issues are a common problem throughout the EAP region. Often the EIA starts when the decision on the project including design, site and construction preparation has already been made. The EIA/SEA is often implemented too late to have a meaningful impact.

Government Models: In many cases the environmental offices responsible for safeguarding the environment are under the authority responsible for the projects. It is hardly possible for them to make a truly professional or independent evaluation. Furthermore, biodiversity concerns (raised through EIA/SEA) can be perceived as costly issues with the potential to prevent foreign investment.

Enforcement & Penalties: Short-term economic benefits override longer term costs (including the degradation of ecosystem services) and become a main driver of *weak enforcement* of laws safeguarding biodiversity (such as the widely established legal statues of EIAs in the region). The recent "EIA storms" in China appropriately illustrates this problem. Thirty projects, mainly in the power sector and involving investment of US $1.3 billion in total, were suspended in 2005 by the State Environmental Protection Administration because they have been implemented without application or approval of EIAs[36]. In essence the penalties associated government regulations are too low to prevent violations.

Authority Channels and Agencies: Reduced coordination is happening at both local and central levels. The authority of the environmental agency in formulation and implementation of EIA guidelines is disregarded during the processes of evaluation and approval of EIA reports, especially when the projects are under the authority of the sector ministries. Effective coordination can become quite complicated for cross-agency projects and it is critical that political support exists for environmental agencies to ensure proper environmental procedure.

Public Consultation and Information Disclosure: Consultation is a typically evolving area in the implementation of EIA/SEA in the region. There are numerous possible explanations for this trend including historical top-down administrative traditions in many countries. Public consultation is also impeded by the reduced number of effective information channels to the public, and the limited time for members of the public to assess the information, understand the process and express their opinions, despite the fact that these principles are often stipulated in the regulations. Finally, in many cases there are no mandatory actions or decisions that must be taken in response to concerns and complaints raised by the public.

Resources: There is often modest funding to collect data. From the initial baseline data, to the follow up monitoring and activities, a lack of environmental information often affects the assessment and evaluation of infrastructure projects. For example, in Indonesia baseline research on ecological areas at the national scale, which is the precondition for regional EIAs, is far behind schedule because of a lack of resources. Conversely, extensive monitoring of highway modifications in Banff, Canada, has resulted in improved design, reduced cost and strong conservation results. This problem is further compounded by a paucity of qualified staff in governmental agencies. Ultimately, resource constraints result in deficient data sets, inadequate conservation science and poorly informed infrastructure development.

Growth Paradigms: The prevailing paradigm of profitability and development is via growth and economic expansion. At a sectoral level, businesses and government need to re-evaluate this approach in an effort to distinguish between "more" and "better". Approaches such as clustered development (transportation), demand management (water & energy), and recycling (mining) all present opportunities to increase profits and development ("better" development) whilst not incurring additional infrastructure in intact habitats ("more" development).

In light of these various lessons learned and the derived best practices, one of the first options available to sectoral leaders is to commit to voluntarily following best practices. Sectors have a long history of such commitments, ranging from the chemical industry and their Responsible Care voluntary commitment[37] to the industry-created Sustainable Forestry Initiative[38]. Developing an equivalent commitment related to tigers, or biodiversity more broadly, is one option available to sectors.

5.2 Strategic Environmental Assessments & Environmental Impact Assessments

A second option at the sectoral level, involves strategic planning including conducting Strategic Environment Assessments (SEAs) ought to take place as it is a proactive process carried out at the initial stages of the decision-making process. It serves as an early warning tool regarding the long term cumulative, induced and ancillary impacts of a policy, plan or program as compared to EIAs which are project specific taking place usually at the end of the decision making cycle. For example, an SEA of a land use plan can take account of tiger habitat fragmentation associated with proposed developments, or an SEA of a national road building program can address the implications for the whole TCL.

SEAs complement the environment and social impact assessment process by stream lining their scope and costs by ensuring that project proposals are set within a policy framework that has already been subject to environmental scrutiny[39].

The SEA process has to be rooted in legislation as an approach for sustainable development rather than to solely mitigate damage, or even as an end in itself[40]. The process has to link with other policy approaches, ensuring the sustainability of the outcomes and has to be integrated into all phases of the planning process from the earliest stage rather than applied as a separate procedure. Different levels of integration include[41]:

- *Vertical integration of assessments*, which are undertaken at different stages in the policy, planning and project cycle ('tiering' – see Figure 2);
- *horizontal integration of assessments*, i.e. bringing together different types of impacts – environmental, economic and social – into a single overall assessment at one or more stages in the planning cycle;
- *integration of assessments into decision-making,* i.e. integrating the assessment findings into decision-making at different stages in the planning cycle.

The broadness and complexity of biodiversity issues require a participatory mechanism and biodiversity inclusive SEAs and EIAs can not only serve as platforms for public participation and transparent decision-making but also provide an operative framework through which ecosystem service valuation approaches can be practiced. Impact assessment should be adaptable to local planning processes and avoid being an 'add-on' assessment process. Although we have mainly focused on large scale sectoral plans, it is equally important to include biodiversity inclusive EIAs and "Tiger friendly filters" into small rural infrastructure (e.g., rural roads, water) projects in or near tiger core areas. These projects are usually carried out by rural development agencies and townships/municipalities with little control and without previous environmental planning increasing fragmentation of core habitats and the likelihood of additional encroachment and illegal tiger hunting and trade. Given the evolution and uneven degrees of maturity of EIAs in TRCs we propose both the strengthening of EIAs and the incorporation of SEAs throughout TRCs using adequate legislative and political channels. Both instruments can help conserve tiger populations assuming that tiger-friendly filters are mainstreamed into the planning, design, and construction of infrastructure projects regardless of the scale.

Figure 2: A tiered approach to SEA and project level EIA

5.3 Avoidance policy and land use planning in priority TCLs

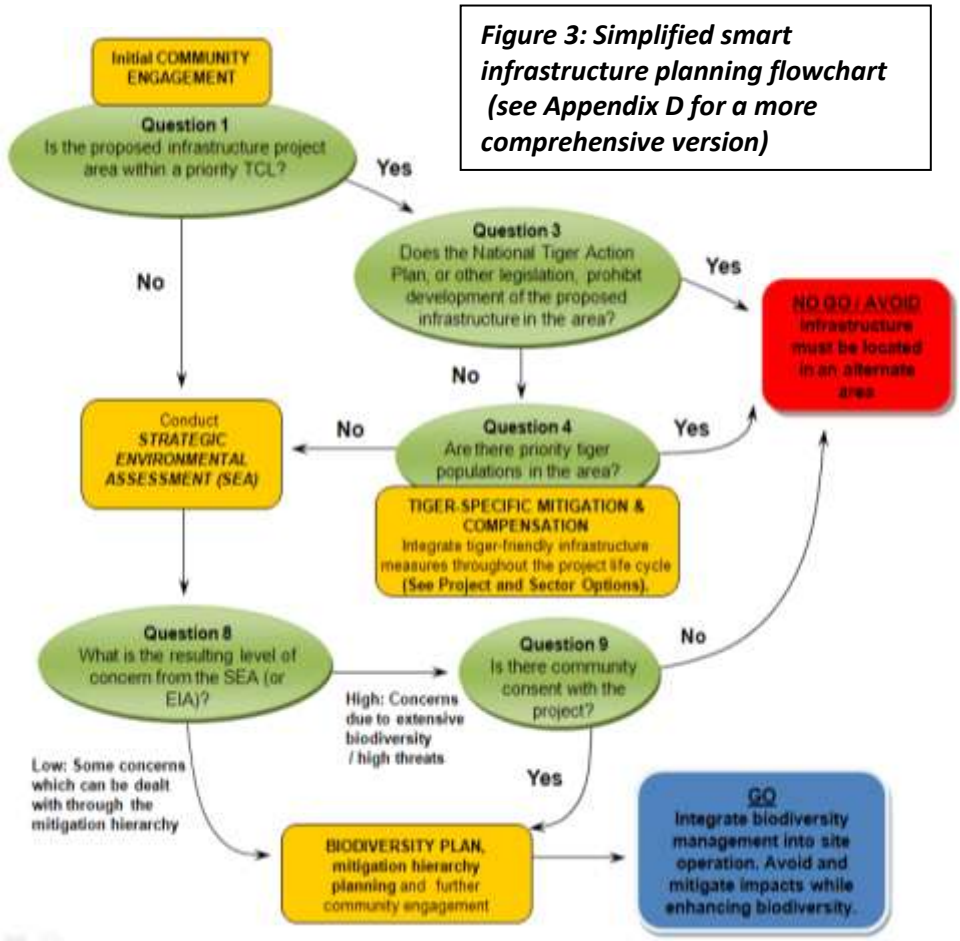
Outside of SEAs and EIAs, another sector-level option is to voluntarily commit to a tiger-friendly approach for land use planning that evaluates the consequences of potential land use change on core tiger populations and habitats. Here we present a framework, flowchart (Figure 3), and spatial methodology to help integrating tiger-friendly policies into land use decision making and on how to apply the avoidance principle in global priority TCLs.

A key step included in the more detailed flowchart of Appendix D involves the Application of GIS cost-surface analysis (see Appendix D, question 2a example). The cost-surface approach allows scoring various areas depending on tiger suitability; high and low cost areas could then be mapped against proposed infrastructure to evaluate thresholds for "go" or "no go." Such cost surfaces could also guide the degree/cost of mitigation/compensation. This approach could safeguard tiger populations from further infrastructure development in priority TCLs (Table 7 & map in Appendix J). It is recognized that the priority TCLs presented in Appendix J are clusters that need further refinement and prioritization, however they provide a useful framework for the tiger friendly policies presented here to be applied.

Research indicates that avoidance is the least costly environmental solution of any major infrastructure project in high biodiversity areas[42]. Linear infrastructure is frequently associated with economic development, but it is often implemented without consideration for its economic feasibility or efficiency in terms of all the costs, beyond planning and construction, associated to deforestation, habitat fragmentation, habitat degradation, and loss of ecosystem services within/near protected areas[43]. Unfortunately, it is not uncommon to see political discussions inclined towards approving economically inefficient projects. Frequently overlooked in road infrastructure development projects are environmental and longer-term social and economic costs of the project (see cost-benefit analysis for Madidi NP in Appendix K). Appendix K summarizes not only exemplary cases but also current challenges and potential policy options following the tiger friendly policies presented here.

Major cumulative impacts from infrastructure projects could easily occur in priority TCLs if the avoidance principle is disregarded (see Appendix I). TRCs like China, Vietnam, Lao PDR, and Thailand are already including avoidance and mitigation principles in major infrastructure projects (see Appendix K).

Figure 3: Simplified smart infrastructure planning flowchart (see Appendix D for a more comprehensive version)



Deciding where to site an infrastructure project

The site selection process should begin as early as possible in the Land use planning and project lifecycle. The flowchart depicted in Figure 3 aids to identify and prioritize the risks and benefits of working in a certain area and guide choices about whether to pursue specific infrastructure development opportunities within/near TCLs. The SI recommends evaluating impacts at all levels, encompassing the appropriate temporal and spatial scales of impacts on Priority TCLs. Basically Priority TCLs containing tiger populations, core habitats, and protected areas should be avoided provided that governments are unable to apply tiger friendly policies through a valid process. Even if the governments apply tiger friendly policies but cannot mitigate impacts adequately they should stop the project in the priority TCL area and perform Alternative analysis. An expanded and more detailed flowchart including specific planning steps and mitigation hierarchy requirements is presented in Appendix D.

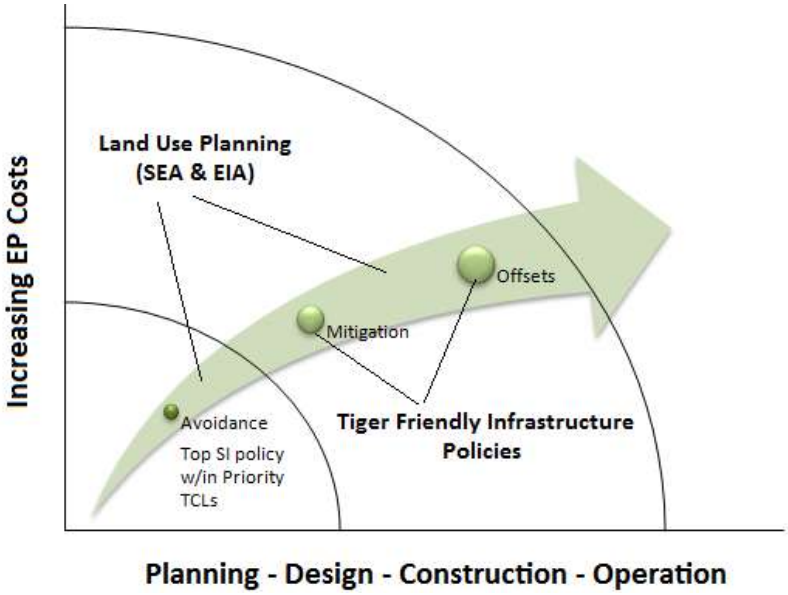


Figure 4: Relationship between environmental project costs, project cycle time line, priority TCLs, and land use planning

Successful Smart Infrastructure projects designed to improve populations of large carnivores, often depend on commitments to entirely avoid large, intact habitat blocks with core populations. Biodiversity-inclusive and tiger-friendly SEAs and EIAs can provide the operative framework to identify avoidance priorities and adequate mitigation activities during the project life cycle (see Figure 4).

5.3.1 Global priority TCLs and development restrictions

WWF, WCS, Smithsonian, and Save the Tiger Fund identified 76 Tiger Conservation Landscapes (TCLs) across the tiger's remaining habitat[44]. TCLs tend to be clustered, offering the potential of forming even larger landscapes if connectivity between them can be reestablished. For example, there is a cluster of TCLs in the Terai Arc of India and Nepal; another set in central India; and another in central Indochina, including Myanmar, Laos, and Thailand (see Appendix J). Such TCL clusters represent large expanses of suitable habitat interrupted by stretches of non-tiger habitat more than 4 km.

Several TCLs cross political boundaries, causing each mainland country of the TRCs to host a transboundary TCL. For example, the Northern Forest Complex - Namdapha- Royal Manas has within its boundaries six different biomes and crosses the boundaries of three countries (Bhutan/Myanmar/India). The Russia Far East bioregion contains two TCLs, including the world's largest, which is 270,000 km2. This TCL is primarily in Russia, but extends into northeast China, which has recently recorded tigers on its side of the border.

There are a total of 342 nature reserves (including all IUCN categories) representing 23.1% of the land area found within all TCLs[45]. Restricting those protected areas to IUCN Categories I through IV, TCLs comprise 12.5% of their land under protection[46]. More than 87% of major core tiger habitat is not protected in TRCs.

Scientists from the above institutions developed a method in which to prioritize the TCLs, with the assumption that tiger populations in larger habitat areas would be more resistant to future disturbances. They established three well defined priority levels for prioritizing TCLs:

- Global priorities for tiger conservation[G]
- Regional priorities for tiger conservation
- Long-term priorities for tiger conservation

[G] Global Priority TCLs are classified as Class I: landscapes that have habitat to support at least 100 tigers, evidence of breeding, minimal-moderate levels of threat, and conservation measures are in place.

In total, WWF identified 20 TCLs as "Global Priorities for Tiger Conservation" representing all the major biomes and bioregions where tigers occur[47]. Global Priority TCLs represent the best places to conserve tigers based on ecological, conservation, and threat criteria, and therefore form the framework for applying tiger friendly policies in terms of infrastructure development.

Critically important for global tiger conservation are two areas that represent no less than seven biomes between them: the Russian Far East and the Northern Forest Complex of Namdapha-Royal Manas. When combined with Corbett-Sonanadi, Tenasserims, Southern Annamites, and the Sundarbans, these six TCLs capture the largest areas of habitat within all the major biomes for tigers across their range. All these areas have breeding populations and some conservation measures in place.

A new genetic study found that Indian tigers have much higher genetic variation than wild tigers elsewhere. Despite having experienced recent demographic declines, extensive habitat loss, extant Indian wild tigers retain 76% of the mitochondrial diversity and 63% of the species' nuclear genetic diversity and are adapted to a greater diversity of habitats[48]. The study also identified a few protected landscapes in India with high tiger densities and potential connectivity. Conservation efforts must be focused in places such as the Western Ghats, Central India and the alluvial flood plains in the Himalayan foot hills that support high potential tiger densities, and relatively larger populations. Indian tigers are thus critically important from demographic, evolutionary and ecological perspectives for future survival and recovery of the species.

Accordingly, the SI team identified the following "no-go" areas (open for discussion) including global priority tiger habitats, presence of tiger populations, growing threats, high biodiversity values, and genetic variation criteria:

1. Russian Far East-Northeast China,
2. Terai Arc Landscape of India and Nepal,
3. Northern Forest Complex-Namdapha-Royal Manas (Bhutan/Myanmar/India) and
4. The Tenasserims Semi-Evergreen Rain Forests of Thailand and Myanmar.
5. Central Western Ghats (India)
6. Central Indian Landscape (India)
7. The Southern Annamites Montane Rain Forests of Lao PDR and Vietnam
8. Sumatran lowland rain forests (Sumatra)
9. Lower Mekong forests (Cambodia, Lao PDR, Vietnam, and Thailand)
10. Peninsular Malaysian rain forests (Malaysia and Thailand)

The above list could be further refined using a GIS and overlapping major ongoing and proposed infrastructure projects to the above areas; however, securing tiger populations and core habitat in the largest TCLs will be critical to meeting the goal of restoring tiger populations. This will not be possible without effective transboundary conservation efforts, expanding the network of protected areas, creating buffer zones, restoring connectivity between patches of actual habitat within landscapes, avoiding poaching, securing long term funding, and applying stringent infrastructure development policies that factor in poverty reduction and take projects from human-tiger conflict to communities that support co-habitation with tigers.

5.4 Professional tiger training and awareness

Finally, sectors have had a history of coming together to build professional training and certifications for their constituencies. From professional engineers and biologists, certification in such areas as green buildings (e.g. Leadership in Energy and Environmental Design Accredited Professional, or LEED AP[49]), sectors often offer training to their members to enhance credibility and ensure professional qualities are maintained. Moreover, the various sectors that develop infrastructure often have little experience dealing with biodiversity challenges, let alone the specifics of tigers.

Developing tiger-specific training for workers, from the on-the-ground construction workers, through the project managers, and right up to designers and engineers on how to build smart infrastructure would be very helpful.

To help facilitate this, the World Bank may want to consider some of its available instruments such as capacity building. Thus far, World Bank Institute has committed over $1 million dollars to build "a Conservation and Development Network that will train hundreds of rangers, foresters, and other habitat managers in the latest cutting-edge practices in biodiversity management, with a specific focus on preserving and increasing wild tiger populations."[50] Extending such programs to the sectoral level is an opportunity which could be pursued if supported by all parties that would have numerous benefits from sectoral planning to project design and implementation.

Table 3: Summary of voluntary sectoral options

Level	Project Life Cycle	Option
Sectoral planning	Applicable to all stages	Adopting best practices throughout the mitigation hierarchy, avoiding past mistakes and pursuing voluntary commitments (see 5.1)
	Applicable to all stages	Develop national sectoral plans that include: integration of land use planning (including fragmentation analysis and PA establishment), SEAs that include tiger-specific considerations, funding transfer mechanisms including PES (e.g. REDD), tiger-friendly project design and construction, compliance guarantees, considered construction rules and minimization of cumulative, ancillary and induced impacts (see 5.2).
	Siting & development	Specific avoidance or "no go" of the 10 priority tiger areas (see 5.3)
	Applicable to all stages	Professional training and awareness for workers on tiger conservation (see 5.4)

6. Project level options: mainstreaming tiger conservation into roads, mining, and hydro projects

In the cases where infrastructure development will occur within TCLs, there are still ways in which traditional infrastructure impacts can be mitigated through ecological engineering design[51]. At the project level, planners and engineers have a number of options available throughout the project life cycle to help to ensure that infrastructure is both tiger and biodiversity friendly. In some cases were existing infrastructure is going to be expanded or improved the same principles can be applied. Drawing upon both the lessons learned, as well as best practices for infrastructure projects taken from throughout the world, we present various cost-effective options available to sectoral decision makers when it comes to project planning and development. An overarching principle to good design is that it should meet the needs of multiple stakeholders, species, and be resilient to impacts such as climate change and seismic activity. While there has been very little infrastructure design work applied directly to tigers, India has developed useful academic studies in terms of roads, spatial analysis and landscapes, and wildlife [52,53,54]. Our recommendations stem from the best practices available in case studies from selected countries. These case studies are designed to illustrate the various options in practice, such as leveraging funds from infrastructure projects to benefit biodiversity conservation efforts using the offsets approach[55] (Appendix A).

All of the following options are predicated once again upon the mitigation hierarchy with an emphasis on avoidance. To this extent, we explored both a so-called "tiger filter" (Appendix D) as well as various infrastructure life-cycle options (Appendix E). In order to evaluate the applicability of the tiger filter and the options presented, we will be developing an in-depth case study, not included here, but set to be released before the January 2010 GTI meetings in Thailand.

6.1 Transportation infrastructure / roads

Tigers have been shown to be drawn to roads, which has an impact upon the type of infrastructure selected[56]. With respect to roads, engineers have an array of construction options available to help ensure minimal impacts. These infrastructure modifications should be designed at the start and funded at the beginning before the project gets underway. Some researchers have also suggested avoiding roads altogether and working with railroads instead which have shown to result in lower ancillary impacts than road infrastructure[57].

While ideally large intact habitat blocks will have been avoided to lower the risk of poaching and impacts to connectivity[58], there may still be a need for "micro-siting"; determining the exact location of where to locate the infrastructure and when to apply tiger filters during the entire process (see Figure 5). Biologists, planners and engineers can assist in the mitigation of impacts to tigers by identifying and avoiding tiger corridors[59]. The inverse is that in situations in which infrastructure location is set to coincide with a TCL, tiger crossings should be properly planned and engineered to help facilitate tiger connectivity. Appropriate mitigation of the barrier effect caused by transportation infrastructure should be customized for tigers including behavioral patterns associated to fragmented and modified habitats caused by roads, fences, overpasses, and underpasses. There is a major need to monitor both the initial fragmentation effects on tigers, as well as the effectiveness of project-level mitigation efforts.

To help identify the exact location of these tiger corridors ("connectivity planning"), a number of methods can be used including: aerial photography, vegetation maps, topographic maps, wildlife habitat maps, road kill information, interviews with locals and/or rangers (if applicable), footprint/scat trails, poaching information, and ideally (if available) photographs from camera traps. The wildlife crossing options listed in Appendix F are largely derived from a recommendation report developed for carnivore crossings in North America[60].

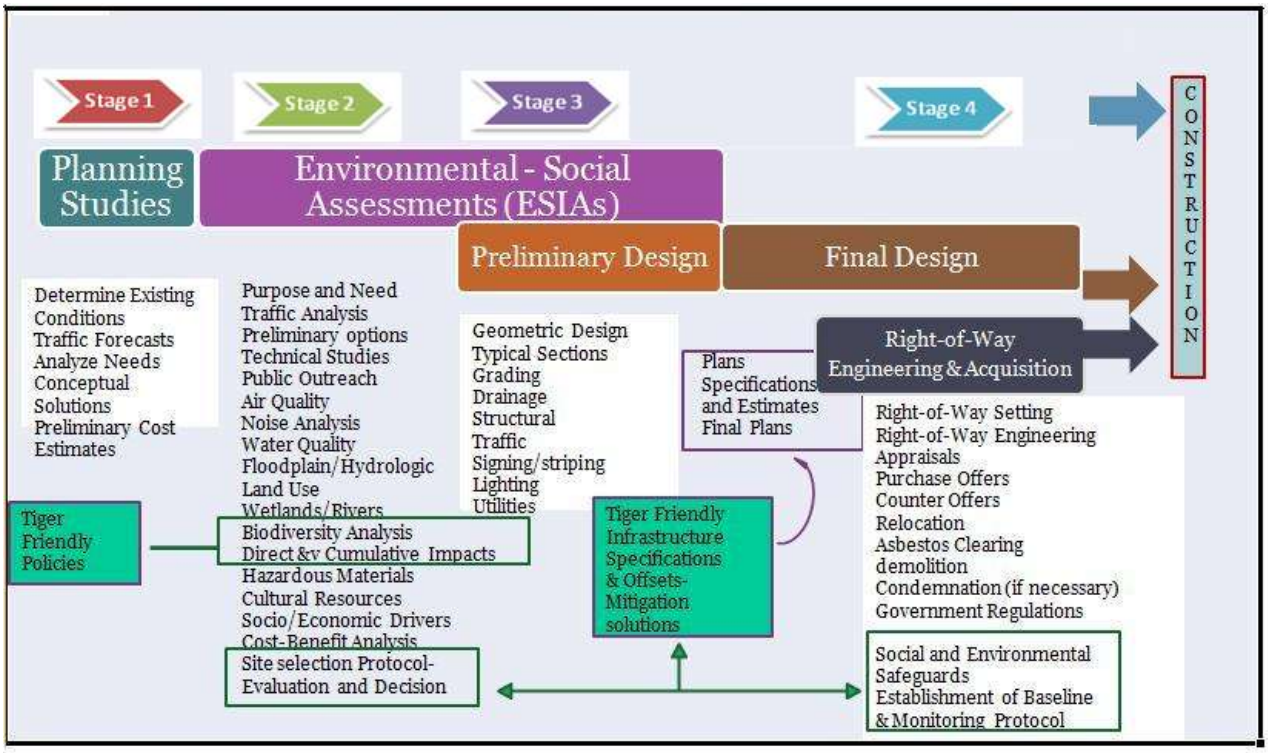


Figure 5: Tiger-friendly road project and planning timeline

Appendix F provides a breakdown of options to help make transportation infrastructure tiger-friendly. Overall, however, research suggests that open-span bridges and bridge extensions are the form of infrastructure recommended for mitigating road impacts to tigers, and should also work for other species, including prey and other large mammals such as elephants[61].

The entrance to the wildlife crossing should be natural with gradients and curves (rather than edges and lines). Shielding the tigers from the view of potential poachers is critical. Discordant, non-natural features should be removed from the vicinity of the crossing, and the ground should be similar to the surrounding area. For all of the structures noted above, it is helpful to have a full line of sight across the crossing. Lastly, fencing has been decisive to the effectiveness of crossing structures in North America. It is of note that Elephants, which co-occur throughout many TCLs, are not always amenable to fencing solutions and thus this is an area which will require further research and monitoring, in particular to identify whether migratory routes and general movement corridors for both species overlap or are separate. Should fencing prove to be an option in select areas, research for cougars suggests that it should be at least 8 feet high (preferably higher) and should attach to the top of the crossing (versus the base). Furthermore the fencing should run for longer than half a mile (>800m) and it may be desirable to fully fence in certain areas to serve the dual purpose of keeping tigers in, and poachers out of, crossing areas.

No matter which crossing structures are used, monitoring systems are critical to evaluate effectiveness, which in turn will enable managers to adapt plans. The camera systems may also potentially serve secondary roles of tracking tiger and prey populations and monitoring poaching.

6.2 Mining

Mining has the potential to affect TCLs and tigers throughout the life cycle of a project, both directly and indirectly. Impacts from mining can result from any activity that involves land clearance (e.g. access road construction, exploration drilling, overburden stripping or tailings impoundment construction) or direct discharges to water bodies (e.g. riverine tailings disposal, tailings impoundment releases, or unintended acid rock drainage), land (e.g. overburden dumping) and air (e.g. dust or smelter emissions).

The potential for significant impacts to tigers is greater when mining occurs within or near TCLs. Due to the continuing demand for minerals, the depletion of resources in readily accessible areas and changing legislation, fiscal and regulatory reforms, technologies, and economics in the mining sector, mining is increasingly being proposed in remote and biodiversity-rich ecosystems that were previously unexplored and undeveloped for minerals. Despite the significant potential for negative impacts on tiger populations and TCLs from mining operations, there is a great deal that companies can do to minimize or prevent such impacts in areas identified as being appropriate for mining. There are also many opportunities for companies to enhance biodiversity conservation within their areas of operations. Appendix G presents a set of recommendations based on best practices.

We recommend that in TCLs, it is essential the these practical realities are factored into the design of mitigation hierarchy measures, into the allocation of responsibilities for implementing these measures and into construction supervision to ensure that adequate protection is afforded to tigers, TCLs, and affected stakeholders.

6.3 Dams and Hydropower

The electric power and water demands of TRCs are growing rapidly. Most of the countries already have multi-year development plans where dams will be constructed near or within TCLs. In addition to huge social impacts, large dams directly impact rivers in a variety of physical and biological ways. The most significant is the alteration of a river's flow, which affects downstream ecosystems and the landscape through which the river flows. Riverbeds downstream of dams are typically eroded by several meters within the decade of first closing a dam; the damage can extend for tens

or even hundreds of kilometers below a dam. During the flooding phase large tracts of forest are impacted directly and major tiger habitats could be loss irreversibly.

Since the majority of river basins within TCLs are noted as being at a high or very high risk of cumulative impact, there is a strong need for integrated, precautionary approaches to hydropower planning and design including avoidance of critical habitats. The same notions also apply to other forms of water-based infrastructure, such as pipelines. A strategic package of avoidance, protection and offset policies near TCLs should include:

a) avoidance of core tiger habitats and trans-basin/river water transfers to prevent introduction of exotic species;
b) protection of high-value or un-/under-represented low-land tiger habitats especially in watersheds that remain largely in their natural state (supported by clustering of hydropower projects or their concentration in particular basins or parts of basins);
c) maintaining minimum downstream environmental flows (quality and quantity of water)
d) provision for equivalent or nearest comparable offsets for all critical habitat loss or deterioration; and
e) fair valuation of losses and payments for maintenance of ecosystem services such as enhanced watershed protection.

These principles can be augmented by many of those presented in the two previous sections on transportation and mining infrastructure, as well as hydropower specific recommendations (Appendix H).

The hydropower sector usually deals with a set of strategic issues at the policy, plan, and program level of analysis which require different instruments (see Table 4 below):

Table 4: Environmental issues in the hydroelectric planning process

Level of Analysis	Strategic issue	Instrument
Policy	Trade-offs: hydroelectric development vs. greenhouse emissions Loss of biodiversity	SEA for energy matrix
	Water allocation priorities Water efficiency Inter basin transfers "No-development" basins	SEA for National Water Resources Strategy
Plan	Environmental criteria for hydroelectric project selection Including critical natural habitats (tiger landscapes)	SEA for 10-yr Hydroelectric Plan
	Water allocation tradeoffs in watershed Ware use conflicts Environmental flows in watershed	SEA for Watershed Water Resources Plan
Program	Cumulative impacts on biodiversity in watershed Regional environmental programs for mitigating/compensating cumulative impacts on biodiversity	SEA for Watershed Hydroelectric Development Program

As a general frame of reference, the principles of the mitigation hierarchy provide a good practice guide to managing the impacts and risks of current and proposed hydropower development at all levels. In addition to a high quality EIA, applying a SEA to hydropower, road, and mining plans and projects (where they impact TCLs and tiger populations) needs to be included into regional and project plans. In addition, it should always be considered the major impacts that come from ancillary infrastructure: access roads, transmission lines, boom towns. Often, EIAs do not pay enough attention to these ancillary impacts. Furthermore, strategic decommissioning should also be considered on infrastructure that is causing great harm to tiger areas (e.g. old forest roads).

In summary, despite a track record of poor Tiger conservation success, infrastructure projects do have numerous options available to help drive wild tiger conservation. These options, organized within the project life cycle, are summarized below:

Table 5: Summary of project level options

Level	Project Life Cycle	Option
Project	Exploration, Planning & Design	Early stakeholder engagement (including benefit sharing agreements and informed consent)
		Tiger/large intact habitat block avoidance (includes screening & "no go" commitments)
		Conduct baseline studies & monitoring
		Legal compliance with all regulatory requirements throughout project lifecycle (including both EIAs and SEAs even if they are not compulsory)
		Tiger-friendly design & engineering (emphasis on open-span bridges / bridge arches for roads)
	Construction	Minimizing ancillary infrastructure development & clustering development
		HR-based construction protocols (relating to workers, noise, dust, and induced development)
	Operations	Embedding tiger conservation performance objectives into Environmental Management Systems
		Community tiger education programs
		Ongoing monitoring of tigers, tiger habitats, and crossing structure use (by various species)
		Ongoing reporting and disclosure of information to stakeholders
		Tiger patrols & poaching/hunting restrictions on workers
	Closure & Remediation	Post-project reporting and communication of learning

7. Priority actions

Over the current and coming year, the GTI has a series of meetings planned starting from Kathmandu in October 2009 to Thailand in January 2010 and finally the final Tiger Summit in September of 2010. Here is a set of priority actions that would facilitate activities before and during the Tiger Summit (see also *Appendix C* for long term policy recommendations):

7.1 Funding agencies

1. Developing capacity for building tiger-friendly policies into sectoral planning.
2. Initiating a policy of information sharing and open access to basic infrastructure development information among government agencies and preferably, among other key partners to assist in SEA and EIA, help interagency coordination and promote integrated planning.
3. The need to mainstream environmental/biodiversity considerations into the design, construction, and operation of infrastructure projects through application of SEA at a sectoral level, preparation of sector wide tiger-friendly environmental safeguards including environmental protection commitments, and dissemination of best practices.
4. Strengthening environmental policy and governance oriented to TCLs.
5. Ensure safeguards are operationalized and made to be tiger-friendly.
6. Maximizing the use of non-financial instruments such as advisory services, grants, and capacity development.

7.2 Governments

1. Publicly commit to a "no go" policy for infrastructure development within priority TCLs.
2. Policy analysis and debate about appropriate options for tiger and TCL protection instruments.
3. Review and update national tiger action plans including tiger-friendly policies.
4. Review land use planning policy especially in and around priority populations/habitats to avoid TCLs. In cases where these habitats are transboundary, conduct bilateral work.

Protected area networks should also be reviewed to determine whether TCLs can receive additional support.
5. Discuss possible regulatory policy, fiscal policy, and incentive program options presented here with appropriate agencies.
6. Prepare specific actions for discussion and proposal for Thailand.
7. Consider and discuss inter-country commitments.
8. Preparing updated policies and guidelines for presentation in Thailand.
9. Stipulating a tiger-friendly policy into their EIA/SEA systems.
10. Ensure institutions responsible for tiger conservation and general habitat protection are strengthened adequately to perform monitoring and enforcement of policy.

7.3 Business and industry

1. Reviewing corporate environmental/biodiversity policies to incorporate tiger-specific actions. Policies should ensure that a strong mitigation hierarchy is in place along with biodiversity (tiger) specific elements.
2. Reviewing planned and existing infrastructure projects located within TCLs to incorporate tiger-friendly actions. Of particular note is ensuring that there are explicit tiger conservation goals and strong community engagement. Conservation planning tools for this sort of work, available from NGOs, may be used to assist.
3. Researching and reviewing engineering guidelines for tiger crossings that are customized for application to tigers in Asia, along with performance monitoring for learning.

8. Conclusion

The fate of wild tigers hangs in the balance. Decision makers who have the ability to guide infrastructure development throughout Southeast Asia will have a major say in whether tigers disappear from the wild within our lifetimes or not. While the challenges are complex, there are options available at various levels from national policies to business practices and project design.

Research indicates that avoidance is by far and away the best, and cheapest, solution and should be pursued as the primary choice. *A "no go" commitment at the Tiger Summit*, along with various options (Table 6) can help to drive avoidance from regulatory policies including protected areas legislation, through fiscal policies and various incentive schemes such as payment for ecosystem services and biodiversity funds. Sectoral-level policies can also pro-actively avoid such areas on a voluntary basis to minimize risk and avoid costly delays. There are also a number of cost/effective options around stakeholder engagement, education programs, offsets and explicit incorporation of tiger conservation goals into infrastructure projects (including through EMS processes) that can help drive tiger conservation. Lastly, should it come to it, there are project-level design elements that can minimize disruption to tiger (and prey) movement, monitor performance and help to reduce habitat loss. The mitigation hierarchy can act as a useful framework for these various options (see Appendix I).

With joint uptake of these types of efforts, humanity may still enjoy a world in which economic and social wealth is created in part because of strong biodiversity conservation. By committing to, supporting, and promoting smart infrastructure, wild tigers will continue to inspire future generations for years to come.

Table 6: Full summary of multi-level options

Level	Project Life Cycle	Option
National Policy	Applicable to all stages	Land use planning framework (including strengthening property rights, restrictions, tiger corridor analysis & TCL construction permits)
		Designing protected area networks (new / strengthening existing PAs)
		Environmental Impact Assessments (EIAs) (including mandating stakeholder engagement and fragmentation analysis)
		Strategic Environmental Assessments (SEAs)
		Leveraging tiger/biodiversity funds from infrastructure project as compensation mechanism
		Payment for ecosystem services (PES) schemes including carbon, watershed-services, and biodiversity offsets
		Tiger-friendly construction permits
		Restrictions on ancillary infrastructure development
		Promoting and providing incentives for alternative livelihoods: eco-tourism/tiger viewing as integrated community development projects that support tiger conservation
		Strong compliance monitoring and enforcement via institutional strengthening
		Legal requirements regarding financial sureties
		Remediation and removal of ancillary infrastructure enforcement
Sectoral	Applicable to all stages	Adopting best practices throughout the mitigation hierarchy, avoiding past mistakes and pursuing voluntary commitments
	Applicable to all stages	Develop national sectoral plans that include: integration of land use planning (including fragmentation analysis and PA establishment), SEAs that include tiger-specific considerations, funding transfer mechanisms including PES (e.g. REDD), tiger-friendly project design and construction, compliance guarantees, considered construction rules and minimization of cumulative, ancillary and induced impacts
	Siting & development	Specific avoidance or “no go” of the 10 priority tiger areas
	Applicable to all stages	Professional training and awareness for workers on tiger conservation
Project	Exploration, siting & development	Early stakeholder engagement processes (including benefit sharing agreements and informed consent)
		Tiger/large intact habitat block avoidance (includes screening & "no go" commitments)
		Conduct baseline studies & monitoring
		Legal compliance with all regulatory requirements throughout project lifecycle (including both EIAs and SEAs even if they are not compulsory)
		Tiger-friendly design & engineering (emphasis on open-span bridges and bridge arches for roads & tigers)
	Construction	Minimizing ancillary infrastructure development & clustering development
		HR-based construction protocols (relating to workers, noise, dust, and induced development)
	Operations	Embedding tiger conservation performance objectives into Environmental Management Systems
		Community tiger education programs
		Ongoing monitoring of tigers, tiger habitats, and crossing structure use (by various species)
		Ongoing reporting and disclosure of information to stakeholders
		Tiger patrols & poaching/hunting restrictions on workers
	Closure & remediation	Post-project reporting and communication of learning

Appendices (Tables, Case studies)

Appendix A: Sectoral case studies - best practices and offsets

Project Description	Offset, or other Contribution to Biodiversity Conservation	Offset Strategy
Roads		
The Banff Wildlife Crossings Project		
In 1996, Parks Canada contracted for long-term research to monitor the Banff highway mitigation measures. Researchers have employed a variety of methods to monitor animal use of the wildlife crossings, such as regularly raking the track beds clean, deploying infrared-operated cameras, and checking the structures every three days year-round. Moreover, the research is being performed in an area that leads the world in the planning, design, and performance assessment of wildlife crossings.	Banff National Park and its environs in Alberta, Canada, are among the world's best testing sites for innovative passageways to mitigate the effects of roads on wildlife. The major commercial Trans-Canada Highway (TCH) bisects the park, but a range of engineered mitigation measures—including a variety of wildlife underpasses and overpasses—has helped maintain large mammal populations for the past 25 years and has allowed the gathering of valuable data.	The TCH reconstruction included 24 wildlife crossings—22 underpasses and 2 overpasses—to ensure wildlife connectivity. Monitoring the track pads has shown that 10 species of large mammals have used Banff's 24 crossings more than 84,000 times as of January 2007. The research suggests that the animals experience a learning curve—they need time to locate the wildlife crossings and to feel secure using the structures before crossing regularly.
San Francisco – Mocoa Road Construction and Improvement , Putumayo Department, Colombia		
The project involves the construction of 45.6 km from San Francisco to Mocoa in the southern portion of Colombia to replace the existing road from Pasto-Mocoa 145 km long within the Forest Reserve of the Mocoa River.	The National Institute of Roads (INVIAS) of Colombia developed an updated EA project in 2007. The EIA designed special measures that minimized impacts within the forest reserve. A basic environmental and social plan was developed as part of a larger regional environmental evaluation of the major road Pasto-Mocoa. The plan included: 1. Land planning for the region 2. Conservation and sustainable development of the Protected Areas 3. Integration of local communities into the Protected areas 4. Design and sustainable construction of the road 5. Control and Vigilance**.**	The strategy included the creation of : a conservation corridor by expanding the forest reserve from 34,600 ha to 65,289 ha; the creation of an integrated management area (50,656 ha) that connects the reserve with the Churumbelos National Park; a buffer area of multiple uses (5,770 ha) where the local communities are. In toal a new area of 121,715 ha was created connecting the southern portion of the Colombia mountain range with the Amazonia region.
Honduras Road Reconstruction and Improvement Project: safeguarding an endemic biodiversity hotspot		
	A conservation action plan was formulated to conserve critical thorn forest habitat for the endemic endangered Honduran Emerald hummingbird, *Amazilia luciae*, as well as 11 endemic plant species. To date, some 1,200	A study to assess the hummingbird's habitat showed that dry thorn forest was essential not only for the hummingbird's survival but also for at least 11 endemic plant species, all either threatened or endangered; this

The project sought to rehabilitate or upgrade main and rural roads throughout Honduras. However, standard environmental screening of the project found that one of the roads to be upgraded ran through the Aguan Valley, a known habitat of the endangered, endemic Honduran emerald hummingbird, *Amazilia luciae*.	hectares of natural vegetation (of which 600 ha comprise Honduran Emerald habitat) are under permanent protection within the Poligono Habitat Management Area established in 2005. During project implementation, the scope of the project changed, and the planned civil works along the road segment passing through critical habitats for the Emerald hummingbird were not implemented. A planned Payments for Environmental Services (PES) scheme, if successfully implemented, will lead to the long-term protection of an additional 1,000–2,000 ha on private lands This, in turn, would address the main environmental concern associated with the proposed future paving of the Olanchito-San Lorenzo road.	fact placed the dry thorn forest at the top of Honduran ecosystems with high endemic biodiversity. The 3,300 ha of remaining thorn forest lies mostly within privately owned lands. Interviews showed that landholders intended to convert the rest of their land to cattle ranching as soon as it was financially possible. Upgrading the road would increase land values, consequently favoring an increase in the deforestation rate upon road completion. The impending land conversion and the rich endemic biodiversity called for an Action Plan to conserve the dry thorn forest in the Aguan Valley. The Conservation Action Plan was designed to ensure that adequate environmental measures were in place before road construction began
Tocantins Sustainable Regional Development Project: conservation as desired land use (Brazil)		
A road network (Tocantins State) in a regional development project based on land management and ecological-economic zoning (EEZ) about 6,000 km of municipal roads will be selected in a participatory manner and improved to all-weather conditions.	One of the outcomes of the AEZ was the identification of areas that should be protected. Eleven potential new conservation units totaling 917,000 ha are currently under evaluation; the six deemed most urgent will be implemented under the project, adding some 214,000 to 762,000 ha (5–20 percent) to the current system. This portion of the project is carried out in coordination with the Programa Nacional de Biodiversidade funded by the GEF.	The EEZ process has been designed around five goals: avoid critical habitats; match type and amount of natural resources to economic activities and levels of use; improve land-use and water resources management and monitoring; improve the institutional framework for environmental conservation; and prioritize municipal agendas, taking into consideration the communities' expectations.

Project Description	Offset, or other Contribution to Biodiversity Conservation	Offset Strategy
Hydropower		
Nam Theun 2 Hydropower Project, Lao People's Democratic Republic, Asia ('NT2') [Nam Theun 2 Power Company]		
A trans-basin hydropower facility in the Khammouane and Bolikhamxay provinces, central Lao PDR.	The company will contribute a total of US$31.5 million (US$6.6 million up front, US$1 million per annum thereafter) to the Watershed Management and Protection Authority, a government organization. The funds are to be used for the management and conservation of the Nakai-Nam Theun Biodiversity Conservation Area (NBCA) and two associated corridor areas (a total of 393,618 ha), and for sustainable livelihood development opportunities for the estimated 5,700 villagers living in the area. An estimated 98,020 ha of habitat would be directly impacted and 32,568 ha indirectly impacted by the project.	A Natural Habitats Accounting approach was applied to the impact and compensatory conservation area, after the latter area had been selected. This approach quantified the hectares and quality of each habitat type directly impacted by the project, and evaluated the significance of habitat in terms of either its national or subnational conservation value. The area of each habitat type lost as a result of the development was then compared with the area of each habitat type in the existing Nakai Nam Theun Biodiversity Conservation Area (NBCA), to determine the extent to which habitats 'lost' would be represented within the NBCA.

Bujagali Energy Limited: Hydropower project and transmission line, Uganda, Africa ('Bujagali') [Bujagali Energy Limited]		
A hydropower plant on the Victoria Nile, and associated electricity transmission line.	The impact on the Bujagali Falls and Jinja Wildlife Sanctuary would be compensated by enhanced protection of the Kalagala Falls and Nile Bank Forest Reserves, with tree planting in disturbed areas. Loss of forest habitat and associated biodiversity in Mabira would be compensated by monies equivalent to the Total Economic Value of lost forest resources, allocated to support initiatives by the National Forestry Agency. Communities would receive 'compensatory benefits' for lost biodiversity related LIVELIHOODS. Approximately 70 ha of three Central Forest Reserves (CFRs) would be converted by the transmission line component of the project. In the initial impact assessment, two properties of 234 ha and 162 ha next to Mabira CFR were evaluated as a potential offset for these impacts.	BASELINE STUDIES focused on species. The evaluation of potential compensatory conservation measures involved the consideration of social, economic and conservation values of affected natural areas. To compensate for impacts of the hydropower facility on the Bujagali Falls and nearby Jinja Wildlife Sanctuary, the Kalagala Falls area and contiguous smaller forest reserves were identified in both the 2001 and 2006 impact assessments as being "appropriate for maintaining an ecologically similar protected area"9. HABITAT TYPE and condition, land use and proximity to the impacted area were the key criteria used to compare options for compensating the impacts on the Mabira CFR in the 2001 study. No explicit loss-gain measures were used. In the later 2006 study, the 'on the ground' actions to compensate for impacts on the three CFRs were not considered further. Rather, the value of biodiversity (primarily related to use value) was converted to monetary values and compensation was paid to the department responsible for managing protected areas.
Amoya Hydroelectric Project, Colombia		
The Amoya Project, an 80 MW run-of-river hydropower generation unit will be built using the stream of the Amoya River fed by moorlands of Las Hermosas; located in the central range of the Andes, above 3,500 m. It includes a bottom intake on the Amoya river, an 8.6 km pressure tunnel, an underground power station and a discharge tunnel of 2.9 km. The project will generate 510 GWh/year.	The Amoya plant is expected to displace thermal generation in the region and will sell the resulting carbon emission reductions to the World Bank. The project will invest 10 percent of the expected carbon revenues (about E$ 2 million over the next 14years) in programs designed to ensure sustainable water supply through the conservation of the Las Hermosas National park. Specifically, the carbon revenues generated by the operation of Amoya will be ear-marked for activities that would document changes in the ecosystem and formulate and implement adaptation programs. The activities supported under Amoya include: (a) characterization, planning, and conservation of the soil cover in the moor-lands; (b) water cycle study in the mountains; (c) monitoring and conservation program for endangered megafauna; and (d) support for sustainable agriculture at lower altitudes. The Las Hermosas Mooreland is considered the most humid one in Colombia, whoae altitudinal range and plentiful water have conspired to create a unique, rich biodiversity of	In addition to the carbon revenues, the project will also transfer resources to the conservation of the watershed and community development as required by Colombian Law. 6% of the annual gross electricity sales are transferred to municipalities and watershed agencies. Through these funds the project will support: (i) rural sanitation: (ii) protection of micro-watersheds; (iii) reforestation and forest cover maintenance in the watershed; and (iv) water and soil conservation. By linking carbon revenues to activities to conserve the ecosystem that regulates and provides the water for power generation, the project has a positive sustainability cycle. The project also constitutes one pioneering example of combined mitigation-adaptation efforts for climate change, as well as payment for ecological services and benefit sharing for local communities.

	unparalleled scenic beauty and valuable environmental services. All of this is being threatened by anticipated warming of the mountains	
Yacyretá Hydroelectric Project II: raising environmental standards in started projects		
The Yacyretá hydroelectric facility is a joint venture between Argentina and Paraguay. It is also among the largest dams in Latin America. The project is based on the exploitation of the hydroelectric potential of the portion of the Paraná River that runs along the border between these countries. At full capacity, the reservoir level will be 83 masl, generating 3,100 MW of electricity.	A revision of the project's environmental management to finally fill and operate the dam at partial capacity resulted in new and extended compensating measures to ensure adequate environmental standards. The measures were extensive, and comprised: a network of 12 new compensatory protected areas; landscape reconfiguration of borrow pits; increased water flow on the Aña Cuá branch to maintain a nearly natural state year-round; a fish elevator to maintain the gene pool in upstream fish populations; ex situ conservation of endemic snails; fish regulations to avoid overexploitation of stock aggregations below the dam; water monitoring to ensure good water quality in the lake; and a program to find, protect, and maintain suitable habitats for the endangered saffron-cowled blackbird. The project shows that even interventions at an advanced stage can contribute substantially to the conservation of natural habitats.	Because the site had already been selected, the ecological compensation program was designed to match the inundated area with similar protected habitats A network of protected areas covering 161,000 ha will be implemented when the dam operates at full capacity (83 masl). The area protected surpasses that of the inundated lands. The network will comprise nine protected areas located in Argentina, and three in Paraguay. The process was speedier and easier in Argentina, because the land was already owned by the government. In Paraguay the land can be managed as a protected area in cooperation with landowners.

Project Description	Offset, or other Contribution to Biodiversity Conservation	Offset Strategy
Mining		
Strongman Mine – New Zealand. Solid Energy New Zealand Limited		
Underground mining began in 1939 and continued. Mining was completed in early 2005. The site has since been the subject of significant REHABILITATION work including landform development, surfacing with growth media and revegetating. The mine site and associated access road is the focus of the Strongman Mine BBOP Pilot Project.	This biodiversity offset pilot project is being undertaken in retrospect rather than as part of the development and design of a new project. The pilot project only began in 2008, by which time most of the negative impacts from the three stages of mining had already been incurred. The critical implications here are: (i) the window of opportunity to avoid and minimize impacts had largely closed (albeit not the opportunity to rehabilitate /restore) and therefore the project could not strictly adhere to the MITIGATION HIERARCHY, as enshrined in the BBOP PRINCIPLES; (ii) because the	A range of potential offset projects has been identified including threatened species, like-for-like and 'not-forlike' ecosystem enhancement projects. Several small MITIGATION projects have been running for several years and the expectation is that these will continue. Solid Energy is supporting a potentially substantial social mitigation project, the South Paparoa Walkway. The priority for an offset project is therefore to provide ecosystem offsets, and projects that can be readily expanded may be preferable. Like-for-like ecosystem offsets and great spotted kiwi offsets are best gained by

	residual impacts had already taken place, they could be measured rather than predicted (as is the case for several other BBOP pilots)	ecosystem enhancements, through controlling a range of introduced pests including predators (to achieve kiwi and native bird success criteria) and herbivore and / or weed removal to achieve forest health criteria.
Akyem Gold Mining Project Eastern Region, Ghana Newmont Mining Corporation (Newmont)		
The proposed Akyem Project would include development of an open pit mine construction of a waste rock disposal facility, tailing storage facility, ore processing plant, water storage dam and reservoir, water transmission pipeline, sediment control structures and diversion channels, haul and access roads, and support facilities.	Biodiversity components subject to residual impacts following mining and reclamation (30 years) chiefly include density of large trees and IUCN Vulnerable plants. To achieve NO NET LOSS in biodiversity, an offset area of 80 HABITAT HECTARES of gain is necessary within a 250-hectare offset site located within the Mamang River Forest Reserve. In addition to conservation of habitat and species involves, the primary benefit of the offset to local communities could be the provision of medicinal plants. 1,428 hectares of disturbance including 74 hectares in Ajenjua Bepo Forest Reserve; all but 162 hectares will be reclaimed. Approximately 1,331 persons in 242 households live within the project FOOTPRINT.	Design and management of the offset are planned to go beyond NO NET LOSS of biodiversity by achieving a NET GAIN of biodiversity through plantings of native species and protection of forest communities from non-sustainable, extractive uses. Compensation for socioeconomic impacts associated with development of the offset would include payments for land that is taken out of production consistent with programmes committed to in the EIS for other affected cropland. Priorities in management include enhancement of native populations of plants and animals, increased efficiency in crop production, and development of additional protein sources though aquaculture and raising locally adapted animals valued by local residents (e.g., giant snails, poultry and grasscutters).
Brisas Gold and Copper Project, Venezuela ('Brisas') [Gold Reserve Inc.]		
An open pit mine in Eastern Venezuela's Orinoco River basin	A portfolio of compensatory conservation activities comprising the creation and expansion of a protected buffer zone adjacent to the Canaima National Park upstream of the Brisas mine site, tree-planting, a number of agro-forestry and ECOTOURISM projects based on traditional livelihoods, and the establishment of a biodiversity research station The total footprint of the mining area is about 3,100 ha of mainly forest habitat within the Imataca Forest Reserve. The mine site is located in a landscape impacted by artisanal and small-scale mining. Biodiversity information was gathered and evaluated within a regional and landscape context.	Areas were selected for conservation activities using the following criteria: 1. Equivalent or comparable biodiversity; 2. Expected support for the offset by key STAKEHOLDERS; 3. Likely sustainability of the offset; and 4. Opportunities for partnerships. A range of possible options was considered, from rehabilitation, assistance with sustainable agro-forestry, to more conventional measures aimed at strengthening existing pristine or protected areas.
Cerrejón Open Pit Charcoal Mine, Colombia [Carbones del Cerrejón Limited]		
Cerrejón is the largest Open Pit Charcoal operation in the World. It has been in operation since 1986 generating more than 31 million tons of carbon annually. The charcoal is being exported to the Americas, Europe and other countries. The mine is localized in the Guajira Peninsula, Northeastern Colombia.	The Environmental portfolio comprises programs about preservation, education, and monitoring of the water, soil, forest, and fauna on the 69,000 ha occupied by the mine. The program also includes a marine component at the port area, dispersion of solid particles project, air quality, watershed studies, and inventory of future forested areas for the mine. The programs were established as a result of an EIA study in 1980.	The Company allocated a total of US $39.8 million to its environmental programs during 2008. It has invested so far $US 194.7 million since the program started. A major approached have been habitat restoration including the rehabilitation of the soil, vegetation cover, and reforestation with native species including commercial woods and total protection of native forest. So far they have included 2,580 ha, planting more than one million of native trees. Recently the Cerrejón Group created an

		Offset program with Conservation International to protect 8.484 ha at the Los Montes de Oca Forest Reserve and properly manage the watershed of the Ranchería River.
Kennecott Utah Copper Mine, North America ('Kennecott') [Kennecott Utah Copper Corporation]		
Expansion of the tailings area of a copper mine, Utah.	An area of 1,011 ha less than 1 km from the project site was restored as wetland habitat; the so-called Inland Sea Shorebird Reserve. This area comprised a Mitigation Site and a Bank component to compensate for future impacts on wetlands in the catchment. About 427 ha were impacted by the tailings expansion.	A Habitats Evaluation Procedure, using a Habitat Suitability Index model, was used to determine the number of Habitat Units for different species at both the impacted and mitigation sites. In discussion with the relevant authority, it was determined that a 1:1 ratio of Habitat Units of 'mitigation wetland' to impacted wetland, would be required; in this instance the ratio coincided with a 1:1 ha ratio. The mitigation site required was 427 ha, the same size as the impacted area.

Sources: Quintero, JD (2007) Mainstreaming Conservation in Infrastructure Projects: Case Studies from Latin America. Washington, D.C.: The World Bank. Greater Mekong Sub-region Nam Theun 2 Hydroelectric Project Asian Development Bank and The World Bank Reports. Business and Biodiversity Offsets Programme (BBOP) Compensatory Conservation Case Studies. 2009. Case study Akyem pilot BBOP. Akyem Gold Mining Project Eastern Region, Ghana. 2009. Strongman Mine – New Zealand BBOP Pilot Project Case Study.2009. The Bhutan Hydropower Sector Study: Opportunities and Strategic Options. ESMAP Technical Paper 119.2007

Appendix B: Analysis of Environmental Impact Assessment Regulations in Tiger Range Countries

Country	Law/Regulation	Year Issued	Oversight Institution	Alternatives Study	Public Participation	Certification of consultants	Environment Clearance*	Project Monitoring	EIA System**	SEA Regulation
Bangladesh	Environment Conservation Rules	1997	Ministry of Environment and Forests	Not required	Not mandatory	Not required	Required	Not required	Weak. Regulations are concerned with pollution control	No legal framework
Bhutan	Environment Assessment Act & Regulation for Envi. Clearance	2000 2002	National Environment Commission	Required	Stated in the regulation	Not required	Required	Required	Well laid out. Implementation challenges exist	Regulation on SEA acts as a broad guideline
Cambodia	EIA Sub-decree	1999	Ministry of Environment	Not required	General statement	Not required	Not required	Stated in regulation	Weak.	No legal framework
China	EIA Law	2002	Ministry of Environmental Protection	Stipulated in technology guidance	Stated in the regulation	Yes	Not required	Required	Good. Public participation is weak.	Yes
India	EIA Notification	2006	Ministry of Environment and Forests	Stipulated in regulation	Strict requirement	Voluntary certification being formalized	Required	Required	Good. Implementation challenges exist.	No legal framework
Indonesia	Governmental Regulation No.27/1999	1999	Ministry of Environment & Envi. Impact Management Agency	Stipulated in regulation	Strict requirement	Yes	Not required	Required	Good. Implementation challenges exist.	No legal framework
Lao PDR	EIA Decree 1170	2000	Science, Technology and Environment Agency	Stipulated in regulation	Strict requirement	Not required	Required	Required	Well laid out but implementation challenges exist.	No legal framework
Malaysia	Environmental Quality Act	1974 (amended 1985)	Ministry of Natural Resources and Environment	Required	Limited	Registration Required	Not required	Required	Laid out but not robust. Implementation challenges exist.	Regulation require EIA integrated into plan formulation

Country	Law/Regulation	Year Issued	Oversight Institution	Alternatives Study	Public Participation	Certification of consultants	Environment Clearance*	Project Monitoring	EIA System**	SEA Regulation
										processes
Myanmar	No formal EIA requirement		National Commission for Environmental Affairs is tasked with environmental protection							No legal framework
Nepal	Environment Protection Act & Environment Protection Regulation	1997	Ministry of Environment Science and Technology	Required	Stated in the regulation	Not required	Not required	Required	Well laid out but implementation challenges exist.	No legal framework
Russia	Regulations for EIA	2000	Ministry of Natural Resources	Required	General statement	Not required	In certain cases	Required	Implementation challenges exist.	Plans are subject to State review
Thailand	National Environmental Quality Act	1992	Ministry of Natural Resources and Environment	Stipulated in technical guidance	General statement	Required	Not required	Not required	Weak. Public participation is limited and implementation challenges exist	No legal framework but SEA is recommend ed and guidelines exist
Vietnam	Decree 175/CP	1994	Ministry of Science Technology & Environment	Stipulated in regulation	General statement	Not required	Not required	Not required	Weak. Stakeholder involvement is limited and implementation challenges exist.	Yes

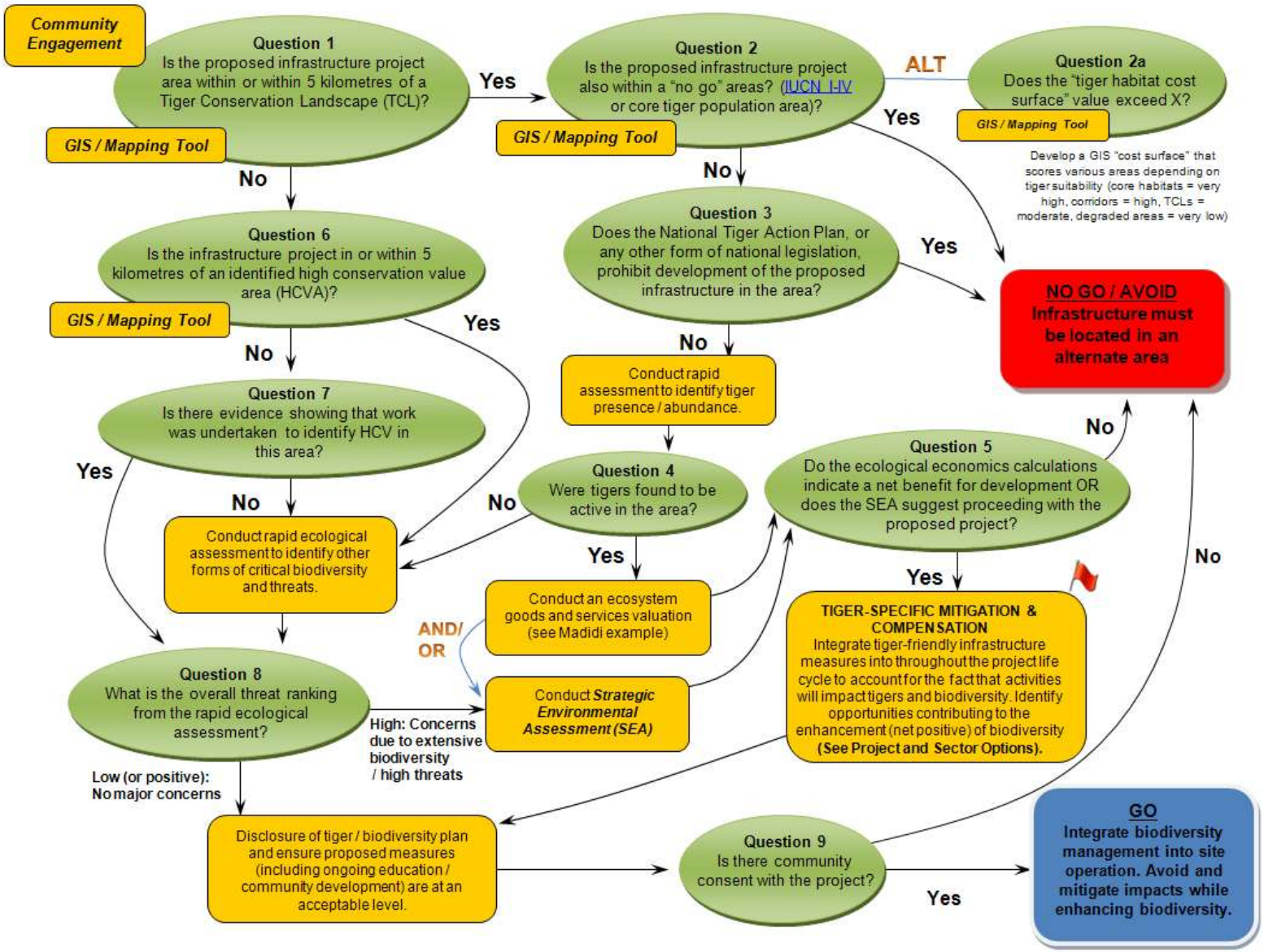
* Environmental clearance refers to an additional no objection certificate required from a relevant authority clearing the project.
** The rating of the EIA systems is based on a comparison between the 13 TRS and has not been compared to EIA systems in other parts of the world.
Adapted from World Bank. (2006). Environment impact Assessment regulations and strategic environmental assessment requirements: practices and lessons learnt in East and Southeast Asia.

Appendix C: A description of smart infrastructure options

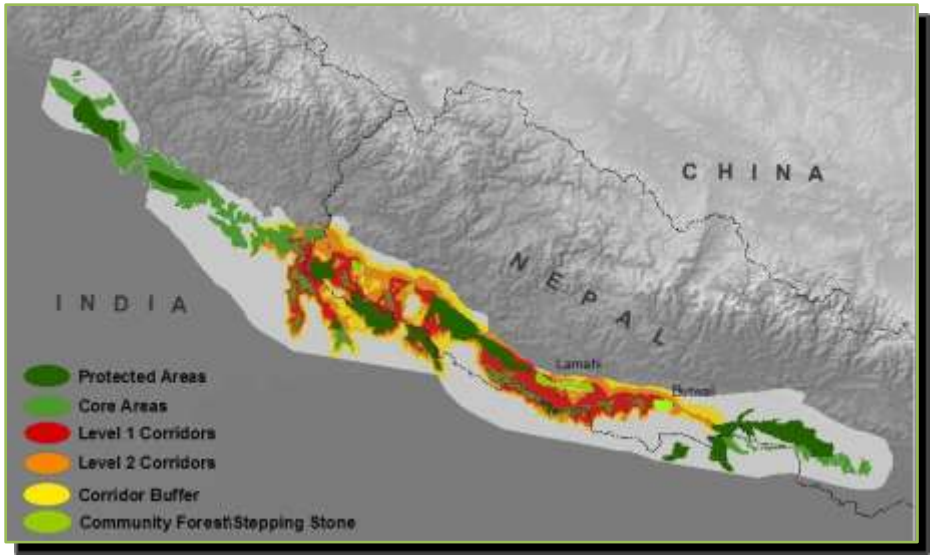
Regulatory Policies and Enforcement	***Description***
Designing Protected Area Networks (new/strengthening existing PAs)	Protected area networks that incorporate TCLs are a cornerstone to an effective national tiger plan. Effective and adequate funded enforcement is required to ensure tiger poaching does not destroy tiger populations. There are habitat types that are currently underrepresented in terms of tiger conservation. The majority of protected areas within TCLs are located in montane and pre-montane habitats despite studies in Russia and Sumatra that observe and predict higher numbers of tigers in lower altitudes areas. Accordingly protecting low-altitude TCLs should be considered a priority. Furthermore, research from Linkie et al. indicates that lowland areas in Sumatra are experiencing the greatest human pressure from oil palm, commercial and illegal logging, mining, and agriculture. Research also indicates that riparian habitat zones should also be protected, even in degraded habitat areas, to maintain movement corridors and retain tiger habitat.
Land Use Restrictions	Placing restrictions upon land uses in and around infrastructure can be helpful for land use planning. It is important to ensure that TCLs remain in land uses that are compatible with tigers and their prey. These legal restrictions are well served when complemented by incentive systems such as land easements.
Tiger-friendly Permits	Typically any form of major infrastructure requires a permit for construction. Governments have an opportunity, through such applications, to help ensure infrastructure is tiger-friendly. Appendix C provides an example of a decision tree filter that could be used to assess infrastructure development proposals. This sort of permitting restrictions also works well in conjunction with other regulatory and fiscal policies.
Funding Regulatory Policies	While regulatory policies can be very powerful, it is also very important to ensure that both new and existing legislation has the funding necessary to ensure effective implementation and enforcement. This includes areas such as land-use planning and, in particular protected areas and poaching enforcement.
Infrastructure location Regulations	Research on the impacts of infrastructure on wild tiger populations supports the concept that infrastructure would better support tiger conservation if it occurred in areas outside TCLs . In essence, the vast majority of the impact to tigers occurs in the decision regarding where to locate the infrastructure. Since often this decision is one of the least expensive to change, and since it has the greatest impact, it should be the primary focus for governments to create regulatory policies for TCLs so business and industry minimize their impacts upon tigers and TCls. Once this decision has been made, the remaining decisions in terms of ecological engineering (highlighted in the next section), are of greater financial cost and of lesser value to tigers.
Environmental and Social Impact Assessments	
Tiger-friendly SEAs & EIAs	Environmental Impact Assessments (EIAs) as well as Strategic Environmental Assessments (SEAs) have been shown to be a major factor in well planned infrastructure projects when it comes to biodiversity. Traditional EIAs do not always cover the induced and cumulative impacts that are brought with infrastructure projects (to which tigers are particularly sensitive) and thus SEAs can play a key role in informing the range of factors to consider in advance of construction. Mandating SEAs that evaluate tiger impacts specifically within TCLs would form a strong basis for smart infrastructure development. Appendix provides a breakdown of EIA regulations throughout tiger range countries.
Environmental Management Systems	An environmental management system (EMS), such as ISO 14001, is designed to manage environmental concerns. Within this context, biodiversity and specifically tigers, can be included when there is overlap with a TCL. By including tigers within the EMS framework, it ensures continual improvement of infrastructure management with respect to tigers. One particular element that should surface within the context of an EMS relates to human-tiger conflict.

	Therefore in known areas where humans and tigers are likely to interact in proximity to infrastructure, strategies to mitigate conflict are important to consider.
Incentive Programs	
Leveraging Tiger/biodiversity funds from infrastructure project	Siphoning off 1-3% of the total funds allocated for development and using these funds to fund tiger and biodiversity conservation efforts in the area of the project has been found to be an effective approach in other countries (see case studies). Such an approach can provide needed capital and operating funds for such measures as tiger patrols that would help mitigate the impacts of tiger poaching due to increased human access.
Payment for Ecosystem Services (PES) schemes including carbon/watershed	A more recent approach that has been adopted in numerous countries, such as Costa Rica, is the notion of payment for ecosystem services (PES). Typically PES schemes require the beneficiaries of ecosystem services to pay to ensure these services continue. For example, global carbon markets paying to set aside forests within a TCL (which acts as both a tiger habitat, but also a carbon store).
Alternative Livelihoods - Eco-tourism/tiger viewing	In numerous countries, there are examples of using federal funds to spur the development of industry. The development of tiger-viewing eco-tourism programs could help to both link a sustainable livelihood for local communities to tigers, but also offset some of the opportunities lost by relocating infrastructure outside of TCLs.
Stakeholder Engagement	
Early stakeholder engagement processes	Stakeholder buy-in to an infrastructure project is often a key determinant of success and has been identified as a best practice. By engaging local and broader stakeholders early in the design process, including building and communicating the explicit tiger conservation goals, it will help to lay a foundation for long term success. Research suggests that community support for tiger conservation has a major role to play in ensuring that tiger poaching is minimized. Once the project is completed, local communities not only reap the benefits, but also ensure the continued success of both the economic development and environmental benefit. Providing local communities with an understanding, in the right language, of tigers, habitat connectivity, mortality impacts and habitat loss is key for all parties. With the right understanding and incentives, engineers, officials and members of the public can often develop strong solutions. This communication may require different approaches for each stakeholder group (e.g. explain the requirements to engineers in terms of impacts on cost, timelines and safety). Discussions should include an explanation of conservation efforts, benefit sharing, agreement upon “conflict”, and understanding/clear delineation of PAs and buffer zones.

Appendix D: Smart infrastructure planning flowchart



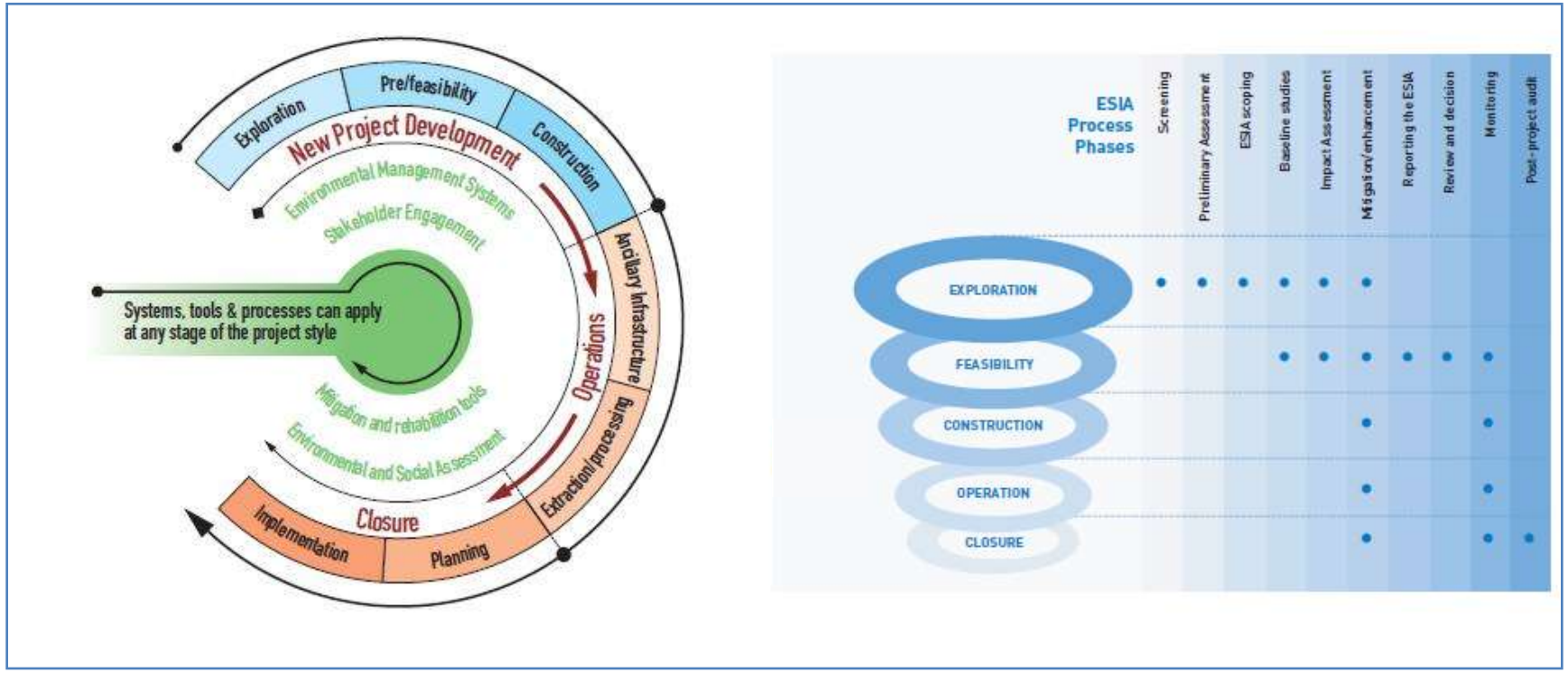
Example of Question 2a & GIS Spatial Mapping



Example of a "cost surface" (red = high cost; grey = low cost). Such cost surfaces could also guide the degree/cost of mitigation/compensation

This "cost surface" could then be mapped against proposed infrastructure to evaluate thresholds for "go" or "no go". SOURCE: WWF-US

Appendix E: Integrating tiger-friendly filters into the mining project life cycle



Adapted from: Good Practice Guidance for Mining and Biodiversity. 2006. Published by International Council on Mining and Metals (ICMM), London, UK. Available from: ICMM, www.icmm.com, info@icmm.com

Appendix F: Tiger-friendly transportation infrastructure options

- ***Road Signs***: While signs indicating the presence of tigers are a cost-effective means of lowering road strikes, which have been recorded with tigers, they could also be problematic as they could act as a magnet for poachers. Since poaching is such a large threat to tigers, it is therefore recommended that road signs indicating tiger crossings not be used.
- ***Round Culvert***: Culverts have been shown to be adequate for some large cat species such as cougars if they are of sufficient size (>10 ft./3m in height and >20 ft./6m in width). They may also be adequate for smaller prey species, but are only considered adequate (not ideal) for ungulates.
- ***Multi-plate Arches***: Multi-plate arches are tunnels that are put in below roads, often using large metallic culverts in combination with concrete arches. These are lower cost than some other options, but have also been shown to be less effective than bridges and overpasses. Nevertheless, so long as they are at least 20 ft. (6m) in width and 10 ft. (3m) in height, they should prove adequate for both tigers and their prey.
- ***Open Span Bridges and Bridge Extensions***: Open spans and bridge extensions are likely the best solution for tigers and road infrastructure. These solutions often take advantage of natural topography such as streams, valleys, wooded corridors and other landforms to enable tigers to pass underneath roadways. Since these bridges are often required for the road itself, they are often very cost effective as they require only moderate modification to make them "tiger-friendly". Not only have these been shown to be the best solution for large cats, but are also ideal for ungulate species. Open span bridges and bridge extensions are the form of infrastructure recommended for mitigating road impacts to tigers.
- ***Wildlife Overpasses***: Overpasses are full bridges that enable wildlife to go over transportation infrastructure. These are the most expensive forms of mitigating infrastructure and while they will be used by large cats, and are highly effective for ungulates (especially if twinned), other forms of infrastructure are preferential for large cats (notably bridges – open span / extensions), especially given the high costs of overpasses.

Appendix G: Recommendations for mining infrastructure & tigers

Exploration: • Complete avoidance of certain areas, such as known and protected tiger source areas, via "no-go" commitments; • limiting land clearing by using technologies and mining practices that minimize habitat disturbance; • avoiding road building wherever possible by using helicopters or existing tracks. If roads are to be constructed, use existing corridors and build away from steep slopes or waterways; • using lighter and more efficient equipment to reduce impacts on biodiversity; • positioning drill holes and trenches away from sensitive areas; • capping or plugging of drill holes to prevent small mammals from becoming trapped; • removing and reclaiming roads and tracks that are no longer needed; and • using native vegetation to re-vegetate land cleared during exploration.• details of the exploration project and potential impacts should be made available, in culturally appropriate forms, to affected communities and area residents in an appropriate language and format, and should be made accessible to the public – especially to marginal stakeholders. • to cover the lasting environmental impacts of the exploration phase, companies should provide adequate financial guarantees to pay for prompt cleanup, reclamation, and long-term monitoring and maintenance. • Companies should obtain the free, prior, and informed consent of indigenous peoples before exploration begins and prior to each subsequent phase of mining and post-mining operations. • Companies should enter into binding contracts with communities that specify the terms under which a particular phase of a mining project may proceed. Such agreements should be mutually agreed upon and enforceable through the national court system in the country of operation or through mutually acceptable arbitration procedures.
Pre-feasibility – ESIAs: • identification of TCLs and Tiger core habitats, whether protected or not, and the status of protected areas and Tiger populations; • fund and conduct tiger/biodiversity adequate baseline research. • an initial review of possible mining options (underground versus open-pit, for example), processing options and likely waste products, water demands, options for waste rock or tailings storage and so on and consideration of the merits of each from a technical, economic, environmental (including biodiversity) and social perspective; and • preliminary assessment of potential impacts, taking into consideration possible timeframes for development. •Stakeholders should be given adequate notification, time, financial support to pay for technical resources, and access to supporting information, so that participation in the EIA process is effective. • Environmental costs, including those associated with regulatory oversight, reclamation, closure, and post-closure monitoring and maintenance should be included in the environmental impact assessment. • Environmental assessment should include worst-case scenarios and analyses of off-site impacts. Companies should work with potentially affected communities to identify potential worst-case emergency scenarios and to develop appropriate response strategies. • Companies should conduct adequate pre-mining and operational mine sampling and analysis for acid-producing minerals, based on accepted practices and appropriately documented, site-specific professional judgment. Sampling and analysis should be conducted in accordance with the best available practices and techniques.
Feasibility stage: • confirmation of the implications of legal provisions, protected areas and species and any interfaces with the mining project; • results of baseline studies and evaluation of the importance of tigers (from a technical perspective and based on in-depth consultations with a range of stakeholders) and a discussion of current threats to TCLs; • an assessment of the proposed mining projects' impacts on TCLs and tigers (direct, indirect and induced) and on the users of biodiversity; • a discussion of avoidance and mitigation measures (from construction through to closure), the prospects for successful implementation and residual impacts on TCLs and tigers and related stakeholders; and • a discussion of options for Tiger conservation or habitat enhancement including PES and biodiversity offset schemes. The mitigation measures to address potential impacts on tigers would be included in an EMP
Construction: During this phase thousands of temporary workers or contractors' staff, along with related infrastructure, can have significant impacts on TCLs. Of particular concern in ecologically sensitive areas is the likelihood of more permanent immigration following the construction period. This can result in significantly increased pressures on the natural resource base in general and on tigers in particular. One solution is to accommodate temporary workers in construction work camps, but these present their own problems for biodiversity (along with a range of associated social impacts). For example, workers may engage in hunting or make other demands on natural resources (for temporary gardens, for example, or fuelwood).To control the impacts on biodiversity during construction, some companies have adopted strict policies of no firearms or no hunting or fishing where violators are immediately fired.

• clustering construction and development as close to existing infrastructure, in lower-quality/degraded tiger habitat
• continuing on-going tiger/biodiversity monitoring
• strict no hunting/poaching HR policies
• establishing anti-poaching patrols
• Tailings impoundments should be built with liners if seepage would result in groundwater contamination, as well as monitoring systems
• Maximum noise level requirements should be implemented at the project boundary.

Operation:

Whereas the focus of efforts during new project development is almost exclusively on impact prediction and mitigation, the operational phase often provides opportunities for biodiversity protection and enhancement. Biodiversity may also be affected by maintenance activities on linear infrastructure, particularly weed and invasive species control and the transport of hazardous chemicals and waste materials. This can be minimized by implementing an integrated pest management and a hazard and risk assessment plan. Poaching and hunting policies are strongly recommended, along with ongoing biodiversity monitoring and ideally, tiger patrols which would help to minimize both poaching and human-tiger conflict.

• release data on tiger impacts (direct and induced) as well as mine discharge data to the public
• Mine dewatering should be minimized to prevent all undesirable impacts on ground and surface waters, including seeps and springs.
• Water bodies (rivers, lakes, etc.) should not be used for tailings disposal (including shallow-water waste disposal) or mine waste
• Acid-generating materials should be isolated and treated on site.
• Communities should have the right to establish independent monitoring and oversight of the performance of the mine.

Closure implementation: Rehabilitation and pollution prevention

This commits the company to implementing good practice rehabilitation aimed at reestablishing pre-existing conservation values, but acknowledges that some aspects may be unavoidable. In the case of TCLs national policies should enforce both legal requirement for restoration of the pre-mining land use, and post-mining uses with the regulatory authorities or with a broader set of stakeholders. Progress towards achieving this objective can be measured by comparing biodiversity parameters in the rehabilitated area with those in selected un-mined reference sites. Other objectives may address more specific aspects, such as the provision of habitat for tigers. Of particular note is eliminating road access and restoring habitat connectivity. Reclamation plans should be developed before operations begin with detailed cost estimates. All disturbed areas should be re-contoured and stabilized with quantitative targets in place for both stabilization and re-vegetation. Mines should be backfilled wherever possible assuming that groundwater contamination via acid-generating materials is not a concern. Finally, financial sureties, which guarantee funds available for reclamation, should be placed in escrow, reviewed regularly (including by the public), and be independently guaranteed. These sureties should not be released until reclamation and closure are complete and audited by an independent, 3rd party reviewer.

Appendix H: Options for tiger-friendly hydropower infrastructure

Planning

In this case, all of the strategic and project specific mitigation measures apply, especially:

- Reappraising the investment risks of the aggregate scale and regional distribution of hydro development and the policy options for addressing these, such as demand management, supply mix and project scheduling and sequencing;
- Relocation of dams/infrastructure to avoid impacting important habitats, to reduce fragmentation, or to minimize increased access;
- National environmental and biodiversity protection policies, such as maintenance of minimum downstream flows and avoidance of trans-basin water transfers to prevent introduction of exotic species and other impacts on biodiversity; and
- Guidelines for impact zoning in river basin planning and hydro-project design that implement the mitigation hierarchy (avoid, minimize and compensate). For example, low impact site criteria for reservoirs, infrastructure and resettlement zones that avoids, wherever possible, Critical Natural Habitats for tigers and areas of karst and peat swamp or concentrates development at low altitudes (particularly below 300 m).

Construction

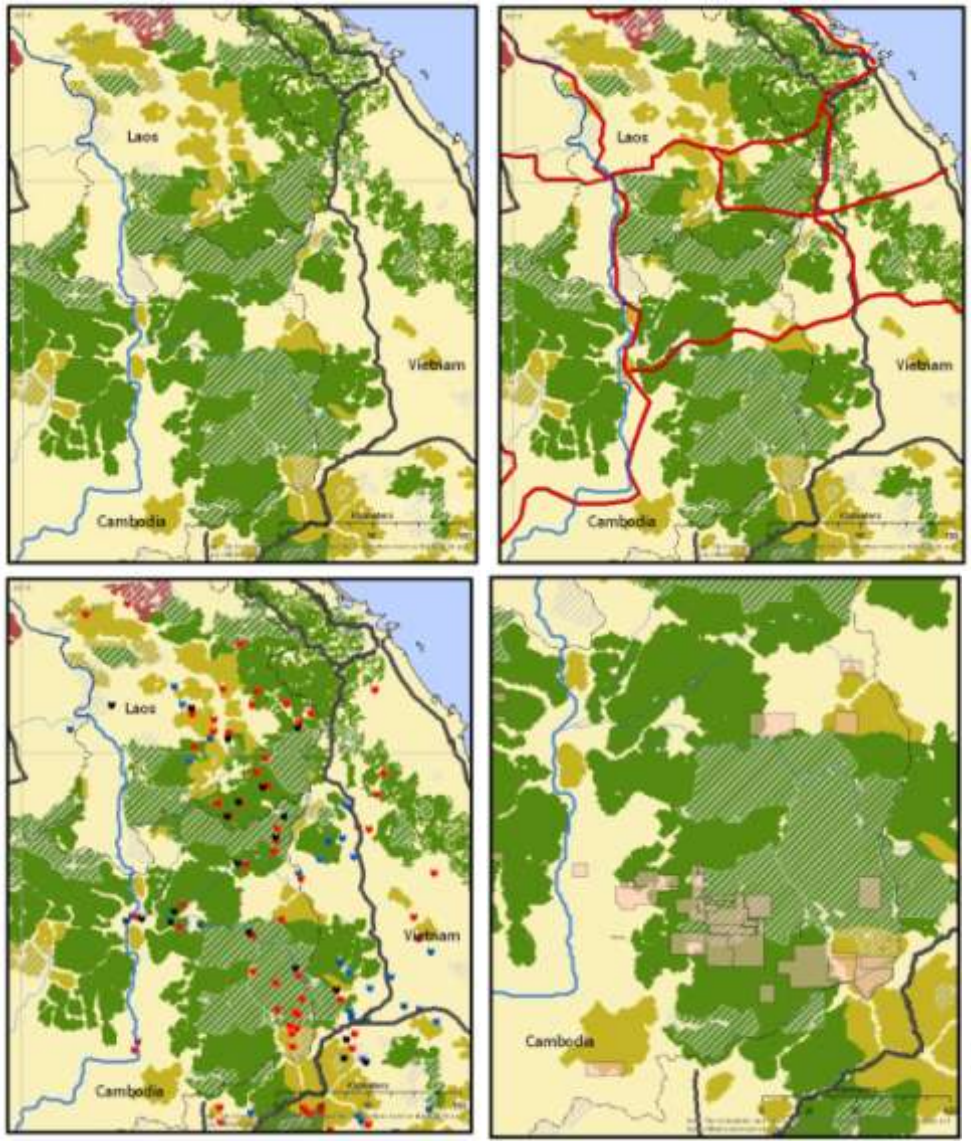
If construction is still at an early stage and TCLs have not yet been impacted, the following options could be considered:

- For projects with high potential biodiversity impacts, rescheduling or relocation of development; and
- For all type of impact categories, assuming there is still time, modifications to project design and construction scheduling through measures such as a) inclusion of a regulation dam; b) operation of the main dam for continuous natural flow through construction and inundation stages; c) treatment of released water (to ensure a natural range of salinity, turbidity, temperature, oxygenation, etc); and d) various controls on access, hunting etc and low-impact siting of resettlement areas, workforce camps.

Operation

In this case, direct impacts on biodiversity have occurred already and indirect impacts have been initiated. However, options to compensate for direct impacts or mitigate indirect impacts include: a) reducing, realigning or rehabilitating the aggregate footprint of project infrastructure; b) identifying Tiger friendly offsets and compensatory opportunities for areas of high biodiversity value; c) supporting resettled people to achieve sustainable livelihoods; and d) development schemes for communities which are dependent on altered or affected resources.

Appendix I: Cumulative Impacts from Infrastructure in Priority TCLs (Lao PDR-Vietnam-Cambodia)



South East Asia has extensive infrastructure planned for the coming years. As can be seen in this example, the planned infrastructure fragments existing tiger conservation landscapes. Furthermore, where hydroelectric and mining projects are developed, additional ancillary road infrastructure will further compound habitat degradation and increase access to remote areas for poaching of tigers and hunting of prey. Below is a set of exemplary actions that could be taken at various levels to address the infrastructure seen in this example.

AVOIDANCE: National policy to prevent infrastructure in core tiger population habitats as well as IUCN I-IV protected areas that occur within TCLs; laws around mandatory SEAs & PES transfer schemes.

MINIMIZATION: SEA that identifies means to reduce cumulative impacts; land zoning around infrastructure to prevent settlement and land clearance; hunting/poaching HR policies for construction workers; bridge extensions in tiger corridors

RESTORATION: Re-planting native vegetation along roads, ancillary road removal

COMPENSATION: Transfer mechanism to provide $ for national parks, & anti-poaching patrols

By combining strong national policy that re-directs incentives, along with systemic sectoral planning, and designing tiger-friendly infrastructure at the project level, wild tigers do stand a chance.

Legend

- Existing National Road

Hydropower

STATUS

- Operating
- Construction
- Feasibility
- Unknown
- Protected Areas
- Tiger Conservation Landscapes
- Restoration Landscapes
- Survey Landscapes
- GMS Mining Area
- Proposed National Road

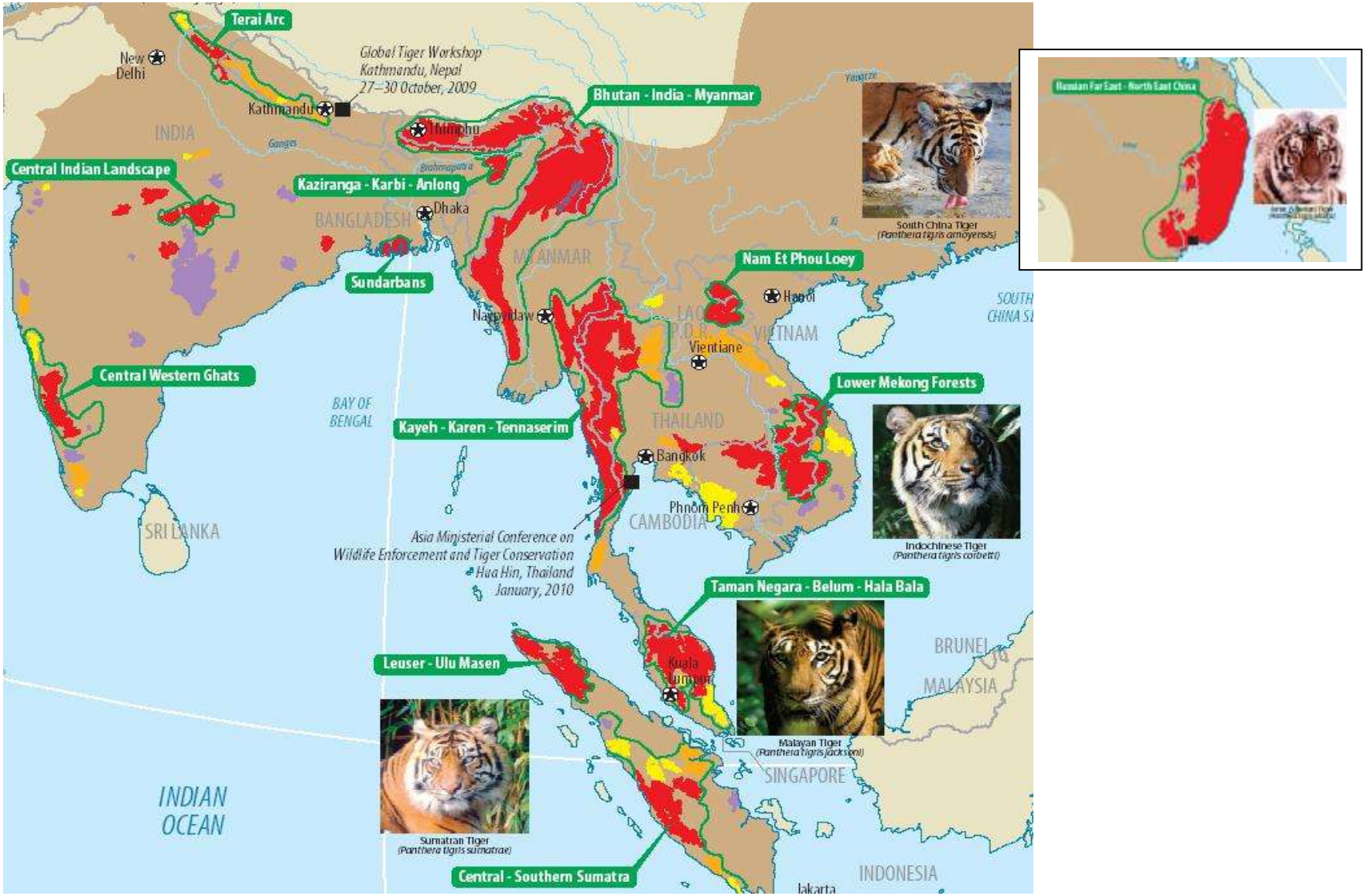
Map source: WWF-US

Appendix J: TCL Global Priority Areas (NO-GO Areas)

Table 7. Global Priority Clusters of TCLs

India	
	Central Western Ghats
	Central Indian Landscape
	Kaziranga-Karbi-Anlong
	Sundarbans
Nepal	
	Terai Arc
Bhutan- India-Myanmar	**Bhutan- India-Myanmar TCLs**
Thailand	
	Kayeh-Karen-Tennaserim
Lao PDR - Vietnam	
	Nam Et Phou Loey
Cambodia	
	Lower Mekong Forest
Malaysia	
	Taman Negara –Belum-Hala Bala
Indonesia	
	Leuser – Ulu Masen
	Central- Southern Sumatra
Russia- China	
	Russian Far East- North East China

Sources: WWF, WCS, Save the Tiger Fund, and Smithsonian National Zoological Park. TCLs, Tiger Historic range, and Remaining Habitat: Sanderson et al. 2006, Dinerstein et al. 2007


Terai Arc
New Delhi
Global Tiger Workshop
Kathmandu, Nepal
27–30 October, 2009
Kathmandu
Thimphu
Bhutan - India - Myanmar
INDIA
Ganges
Brahmaputra
Central Indian Landscape
Kaziranga - Karbi - Anlong
Dhaka
BANGLADESH
Sundarbans
MYANMAR
Nam Et Phou Loey
Hanoi
Naypyidaw
LAO P.D.R.
VIETNAM
Vientiane
SOUTH CHINA SEA
Central Western Ghats
Lower Mekong Forests
BAY OF BENGAL
Kayeh - Karen - Tennaserim
THAILAND
Bangkok
Phnom Penh
CAMBODIA
SRI LANKA
Asia Ministerial Conference on
Wildlife Enforcement and Tiger Conservation
Hua Hin, Thailand
January, 2010
Taman Negara - Belum - Hala Bala
Kuala Lumpur
BRUNEI
MALAYSIA
Leuser - Ulu Masen
Malayan Tiger
(Panthera tigris jacksoni)
SINGAPORE
INDIAN OCEAN
Sumatran Tiger
(Panthera tigris sumatrae)
Central - Southern Sumatra
INDONESIA
Jakarta
South China Tiger
(Panthera tigris amoyensis)
Russian Far East - North East China
Indochinese Tiger
(Panthera tigris corbetti)

Appendix K: Case studies involving Land use planning and Mitigation Hierarchy and Policy options

Madidi Nationa Park & Integrated Management Area - Bolivia		
Project Description	**Land Use Planning and Conservation Challenges**	**Mitigation Hierarchy and Policy Options**
Apolo-Ixiamas road in Northwest Bolivia. This road would bisect the Madidi National Park & Natural Integrated Management Area, opening vast inaccessible tropical forest areas to illegal colonization and resource extraction. Madidi is widely recognized as one of the most important protected areas in the world.	**Cost-benefit Analysis:** Construction of the Apolo-Ixiamas road would result in a net loss to Bolivian society of $16.31 million, before considering environmental costs associated with deforestation. The very high cost of building a road in the rough terrain of the Madidi protected area simply cannot be recovered due to the extremely low local demand for transport. Adding in the cost of carbon emissions from an estimated 30,000 ha. of deforestation induced by the road brings losses to a total of $61.71 million. This project passes neither efficiency nor equity tests. It has a negative NPV and transfers wealth to a very small group, consisting of a mix of poor rural people, logging company owners, land speculators, design and EIA consultants and construction firms.	The larger goal of this project is to facilitate transportation between the highlands (altiplano) and lowlands of La Paz. For travel anywhere but Apolo and its nearest neighbors, the existing route is the lower cost option for travelers of all kinds. The sensible investment alternative would therefore be to upgrade the existing route. The Cost-benefit analysis showed that increasing maintenance from once every four months to once every two months would yield net benefits of $3.56 million.
KAZIRANGA NATIONAL PARK – Assam, India		
Kaziranga is one of the oldest protected areas in the world. It was decreed a forest reserve in 1905. The park harbors a variety of endangered species including rhino, elephant, tiger, wild buffalo and swamp deer. The park currently covers 430km2 although there are proposals to add an area of 454.50 km2 by including the Brahmaputra River to the north and part of the Miker Hills to the south. The park was designated as a natural World Heritage site in 1985 on the basis of its *outstanding universal value.* The 54 km length of the National Highway (NH) 37 along the southern boundary of the park have become a serious conservation issue due to the direct and cumulative impacts on the local wildlife. Plans are underway to convert the existing NH-37 to a six lane expressway.	The main challenges come from outside, particularly regional pressures at a landscape scale as a result of both Assam government development priorities and more diffuse pressures caused by rising population and higher economic expectations. Future success will depend on a the Government of Assam's commitment to adopting a landscape approach to conservation. The National Highway (NH) 37 running parallel to Kaziranga National Park, between Bokakhat to Ghorakati range divides the landscape between the low-lying grasslands in the north and the elevated Karbi Anglong hills in the south. During rainy season when flooding in Kaziranga National Park forces the wild animals to move southwards to elevated grounds, many wild animals are killed by vehicles while attempting to cross NH-37.	There is an urgent need to conduct a comprehensive EIA study and develop appropriate mitigation options. Options may include, avoidance by re-aligning the expressway through Nagaon-Silghat-Tezpur-Lakhimpur-Jorhat to protect the ecological integrity of this World Heritage Site. The Kaziranga-Meghalaya region is one of the priority tiger conservation habitats in India. The application of a landscape approach for Kaziranga will require evaluation of current and future pressures (including strategic impact assessment), development of different scenarios, agreement on the optimal way forward and a series of strategic interventions, carefully monitored so that adaptive management can be applied as necessary.

The Guiguang Railway Project in China		
The Guiguang Railway line crosses 8 nature reserves of various levels in the project corridor. The railway to be constructed will cross Shoucheng Natural Reserves mainly by tunnels	The final design of The Guiguang Railway in China avoided 7 out of 8 reserves by at least 300 m. but has to cross the Shoucheng Nature Reserve (provincial level) through a tunnel-bridge-tunnel scheme. This crossing has received special attention during project design. The railway to be constructed will cross Shoucheng Natural Reserves mainly by tunnels (15.264km) and only a 1036m long railway line will be exposed between the exit of Tiaopingshan Tunnel and the entrance to the Jiangjiashan Tunnel, joined by 4 bridges (668.4m long total), with the height from the rail foot in the bridges to the tunnel bottom of more than 8.5m with a maximum. of 23m, to ensure free passages of animals. No irreversible impacts will be generated on habitats over the tunnels, and the proposed railway line will not fragment habitats in the reserve.	An innovative three-fold approach to minimize environmental and social impacts in sensitive areas has been developed in the Guiguang Railway: (1) **Avoidance**: Alternative analysis has been regarded as one of the most important mitigation measures to minimize potential adverse environmental and social impact. (2) **Sound Engineering**: The project has been designed with state-of-the art engineering. Using tunnel-bridge-tunnel schemes avoid most sensitive issues. In some projects, close to 76% of the line comprise tunnels and bridges as shown below for the Guiguang railway line: currently under construction in southern China in which over 75% of this 100-km railway line is comprised by tunnels and bridges. (3) **Comprehensive Mitigation plans**: detailed environmental design plans (green corridors and landscaping) environmental management plans, resettlement action plans, and ethnic minority plans have been prepared in order to minimize unavoidable impacts from the project.
Trung Son Hydroelectric project in Vietnam		
Trung Song Hydropower Project is located on Ma River in the Middle part of Ma River, the tale of reservoir is 9.5km far from Laos border. The dam site is located in Trung Son village – Quang Hoa district – Thanh Hoa province, North Central Vietnam. The project is located on Ma River, about 0,7 km downstream of its confluence with Quang brook, in the Trung Son commune, Quan Hoa district, Thanh Hoa province (Vietnam), at about 195 km northwest of Thanh Hoa city. The reservoir tail is ca. 9, 5 km from the Vietnam - Laos's border.	The Trung Son Hydro-Power Project (TSHPP) is a multi-purpose task which includes 1) electricity generation, with an installed capacity of 260 MW that generates a total annual of 1,06 GWh which will be devoted to supply energy to the national grid; 2) flood control for the downstream stretch, by using 112 million m3 of the reservoir; 3) water supplement during the dry season; and 4) alternative energy resource for global green house gases (GHG) emission reduction. Although the direct impacts on natural terrestrial ecosystems due to reservoir inundation are expected to be minor (no area of the reserves wil be floded) , the additional pressures on natural resources in the area of the dam are expected to be significant	Overall this analysis should address the following issues: · Analysis of effects on terrestrial animal and plant species. These pressures will stem from: (i) the opening of good quality roads into remote areas; (ii) the presence of a considerable work force (3,000 to 4,000) in and near protected areas; (iii) in-migration due to increased economic opportunities from the project activities; and, (iii) the resettlement of local communities to different areas near the protected areas. As a result of these pressures, the natural reserves could see a progressive deterioration of vegetation cover (bamboo and natural forests) from increased slash and burn agriculture and illegal hunting of wild animals for food supply in restaurants and camps, and commercial uses. · Design of a plan to strengthen the protection of the natural reserves. This plan should be based on the existing management plan and the capabilities in the Reserve Management Authorities.

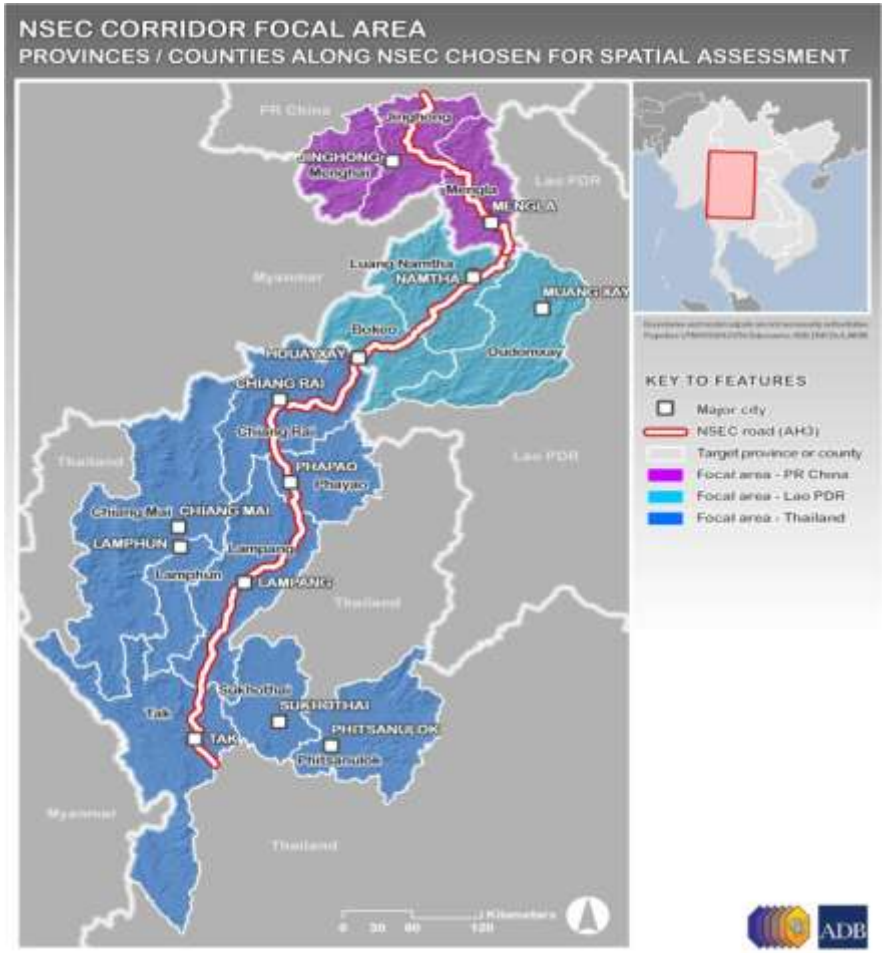
The North South Economic Transport Corridor (NSEC) in the Greater Mekong Sub-region (GMS)		
	The GMS NSEC is one of three priority corridors targeted for infrastructure development under the GMS Economic Cooperation Program (see NSEC map A in appendix L). The NSEC will link important economic hubs: (i) the Kunming- Chiang Rai-Bangkok via Lao PDR and Myanmar route; and (ii) the Kunming-Hanoi-Haiphong route through Yunnan province and entering Vietnam at Lao Cai, and more recently through a second route in the Guangxi Zhuang autonomous region that passes through the capital of that region, Nanning, and enters Vietnam through Lang Son. A number of major infrastructure investments are already being undertaken by GMS countries in the NSEC and more are planned. The cumulative impacts of the improved connectivity and trade along the corridor, and the sensitivity of the areas along the corridor, highlighted the need for wide-scale planning and environmental assessment to evaluate indirect/induced impacts on corridor natural assets and ecosystem services as well as on poor and vulnerable populations. A Strategic Environmental Assessment was carried out.	A *Spatial Multi-Criteria Assessment (SCMA) tool was utilized to integrate a wide range of 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. The SEA utilized a set of spatial tools ranging from basic spatial overlays to complex thematic and predictive modelling, which provided inputs to a specific stage of the SEA process. The 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. . Using map overlays resulted in a "suitability" map which 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, such as a potential railroad alignment in the corridor (see map B in Appendix L).

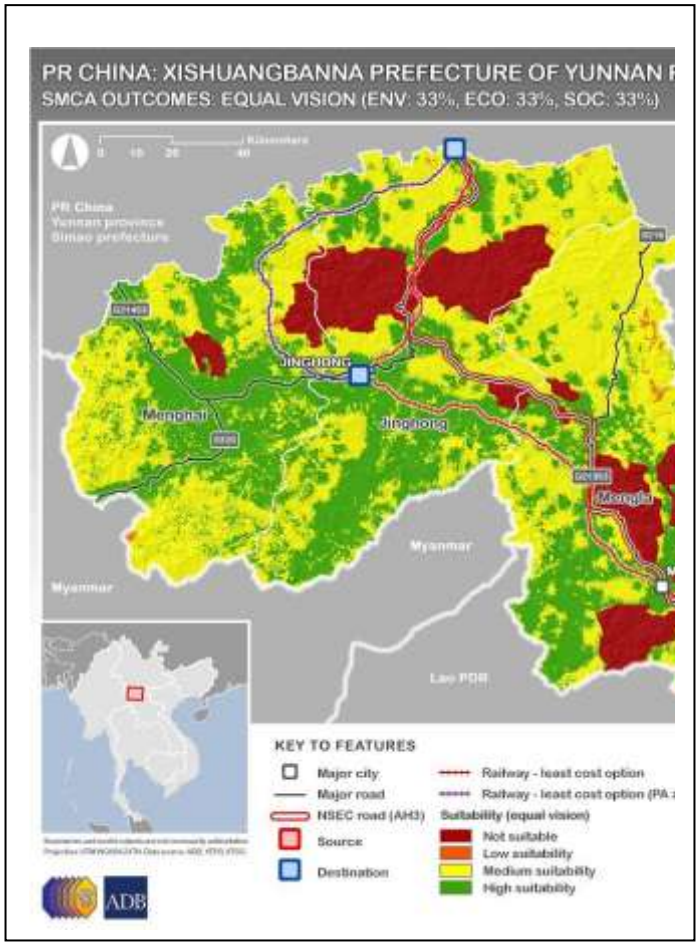
Sources: Fleck, L.C., Painter, L., Reid, J., Amend, M. (2006) A road through Madidi: An environmental-economic analysis. Conservation Strategy Fund. Technical Series No. 6. V.B. Mathur, Ashok Verma, Nigel Dudley, Sue Stolton, Marc Hockings, and Robyn James. Opportunities and challenges for Kaziranga national park, Assam over the next fifty years. (2005). Unf-unesco Enhancing Our Heritage Project Team. EIA Trung Son Hydroelectric Project. 2009. Trung Son Project Management Board. the North South Economic Transport Corridor (NSEC) in the Greater Mekong Sub-region (GMS)

Appendix L: The North South Economic Transport Corridor (NSEC) in the Greater Mekong Sub-region (GMS)

Map A

Map B


NSEC CORRIDOR FOCAL AREA
PROVINCES / COUNTIES ALONG NSEC CHOSEN FOR SPATIAL ASSESSMENT
PR China
JINGHONG
Menghai
Mengla
MENGLA
Lao PDR
Luang Namtha
NAMTHA
Myanmar
MUANG KAY
Bokeo
Oudomxay
HOUAYXAY
CHIANG RAI
Chiang Rai
PHAYAO
Phayao
Thailand
Chiang Mai
CHIANG MAI
LAMPHUN
Lamphun
Lampang
LAMPANG
Sukhothai
SUKHOTHAI
Tak
TAK
PHITSANULOK
Phitsanulok
KEY TO FEATURES
Major city
NSEC road (AH3)
Target province or county
Focal area - PR China
Focal area - Lao PDR
Focal area - Thailand
ADB


PR CHINA: XISHUANGBANNA PREFECTURE OF YUNNAN
SMCA OUTCOMES: EQUAL VISION (ENV: 33%, ECO: 33%, SOC: 33%)
PR China
Yunnan province
Simao prefecture
JINGHONG
Menghai
Jinghong
Mengla
Myanmar
Lao PDR
KEY TO FEATURES
Major city
Major road
NSEC road (AH3)
Source
Destination
Railway - least cost option
Suitability (equal vision)
Not suitable
Low suitability
Medium suitability
High suitability
ADB

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