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SUMMARY REPORT

GREENING CHINA'S BELT & ROAD INITIATIVE IN MYANMAR

RAPID ASSESSMENT OF OPPORTUNITIES & RISKS FOR MYANMAR'S NATURAL CAPITAL FROM CHINA'S BELT & ROAD INITIATIVE

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EXECUTIVE SUMMARY

Road projects proposed as part of the One Belt One Road Initiative (BRI) in Myanmar would provide transport infrastructure to areas of the Ayeyarwady River Basin and surrounding mountain areas — home to approximately 25 million people.

These people rely on natural capital—including forests, rivers, land, and biodiversity—for a range of benefits, including clean drinking water and protection from natural disasters.

There is a risk that the benefits of BRI road projects could be undermined by substantial social, environmental and economic costs, if roads are constructed in ways that fragment ecosystems, endanger wildlife, or contribute to deforestation, landslides, flooding and pollution.

Through better road planning and design, there is a great opportunity for the benefits of the BRI to become much more far reaching.

KEY FINDINGS

SIGNIFICANT DEVELOPMENT OPPORTUNITIES FOR MYANMAR

Roads and road construction in the BRI's East–West and North–South corridors (see Figure 3) could make significant contributions to Myanmar's social, economic and infrastructure development. Roads in these corridors would connect cities and communities across Myanmar, with major population centres and markets in Bangladesh, China and India. Experience in other developing countries highlights the potential of BRI road projects in Myanmar to improve access to jobs, education and health; increase economic productivity; raise incomes; reduce trade costs and barriers; and catalyse growth of agricultural and industrial clusters.

SUBSTANTIAL RISKS TO NATURAL CAPITAL & MYANMAR'S SUSTAINABLE DEVELOPMENT

The analysis presented in this report highlights the significant extent to which BRI road infrastructure could impact on natural capital assets and associated benefits (ecosystem services) that people obtain from natural capital, including lower risk of landslides, flooding and water pollution. The report also shows how the resilience and durability of the BRI road infrastructure would potentially depend on ecosystems services, in particular flood and erosion risk reduction provided by natural ecosystems. The BRI road corridors cut through areas of the Ayeyarwady River Basin, and surrounding mountain areas that are home to approximately 24 million people (see Figure 5). These people rely on natural capital located in those areas to filter drinking water, maintain dry-season water flows, reduce risks from natural disasters, and provide other critical ecosystem services. There is a risk that benefits of BRI road projects could be offset by substantial social, environmental and economic costs, which would occur if roads are constructed in ways that fragment ecosystems, endanger wildlife, or contribute to deforestation, landslides, and pollution of land and rivers.

KEY RECOMMENDATIONS

FOR THE GOVERNMENT OF MYANMAR

NATIONAL SUSTAINABLE INFRASTRUCTURE PLAN. Undertake infrastructure planning at the national scale to help identify no-go areas, and evaluate alternative placements of broader infrastructure corridors as well as BRI road corridors. Avoid critical areas, including areas important for biodiversity and providing ecosystem services.

SUSTAINABLE INFRASTRUCTURE GUIDELINES. Consider developing guidelines or criteria or applying existing global sustainability standards, such as the SuRe® – The Standard for Sustainable and Resilient Infrastructure, to guide sustainable infrastructure planning, finance and design in Myanmar, including for the BRI.

COST BENEFIT ASSESSMENTS. Develop more detailed versions of the cost benefit assessments and risk areas highlighted in this report, and gradually incorporate these into planning processes for BRI development.

STRATEGIC ENVIRONMENTAL ASSESSMENT. Undertake a Strategic Environmental Assessment for the entire BRI to better assess economic, social and environmental risks and policies and plans required to avoid and minimize these risks.

FOR INVESTORS AND COMPANIES

BEST STANDARDS. Adopt and comply with best standards in accordance with the "*Guidance on the Building of the Green Belt and Road*" (published by Ministry of Environmental Protection of China). Consider using the SuRe® – the Standard for Sustainable and Resilient Infrastructure and other global sustainability standards and investor safeguards.

NATURAL CAPITAL ASSESSMENT. Undertake a more comprehensive assessment of natural capital and biodiversity (beyond the 3 services and 4 conservation datasets but based on highlighted risk areas included in this report) to enable robust decision-making to ensure that natural capital impacts and risks are properly considered and mitigated.

AVOIDANCE. Avoid critical areas, including areas important for biodiversity and providing ecosystem services, when deciding location of road corridors.

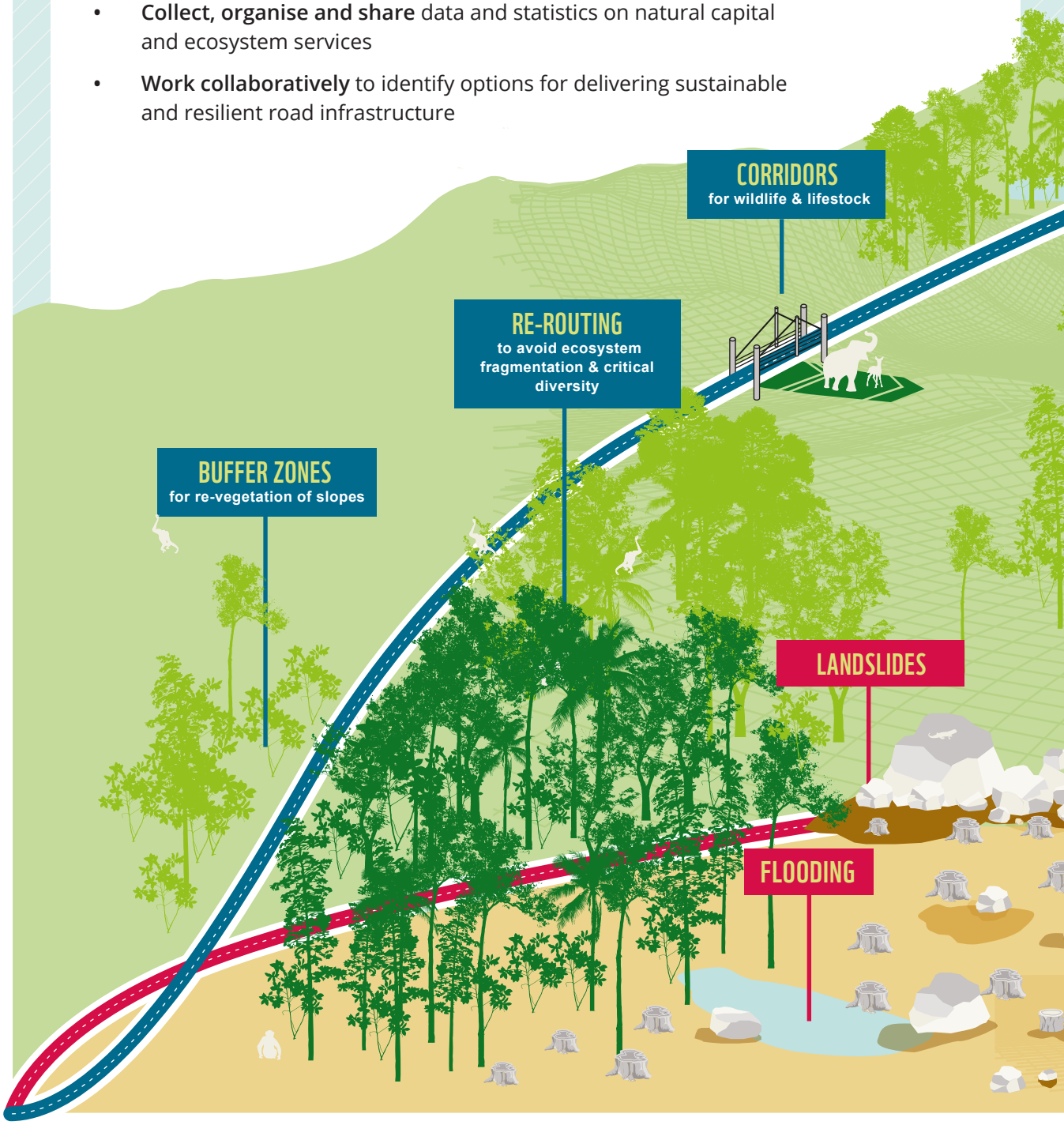
ENVIRONMENTAL IMPACT ASSESSMENT. Undertake high quality Environmental Impact Assessments and Environmental Management Plans for BRI road projects, with special consideration of the impacts (including cumulative) on natural capital, including biodiversity and ecosystem services.

DESIGN OPTIONS. Include design options that can enhance environmental, social and economic benefits, including buffer zones, re-vegetation of slopes and wildlife corridors.

CIVIL SOCIETY PARTICIPATION. Include and facilitate participation of Myanmar civil society at all levels and stages of project planning to avoid negative social and environmental impacts optimize benefit sharing of the BRI in Myanmar.

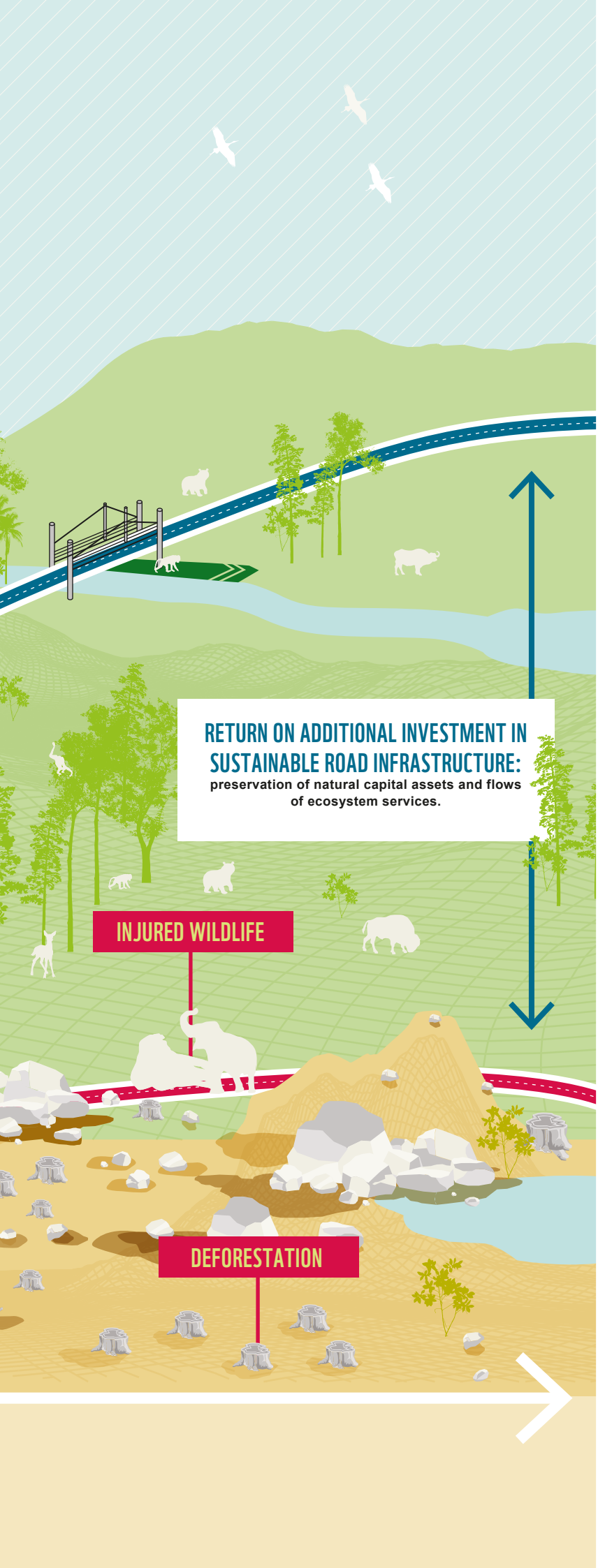
KEY ACTIONS FOR GOVERNMENT, BUSINESSES, INVESTORS, & DEVELOPMENT PARTNERS

- **Incorporate natural capital costs and impacts** into environmental impact assessments, and into development and project planning
- **Collect, organise and share** data and statistics on natural capital and ecosystem services
- **Work collaboratively** to identify options for delivering sustainable and resilient road infrastructure



NET BENEFITS TO MYANMAR'S DEVELOPMENT + social economic benefits - natural capital costs

TIME



MAXIMISING DEVELOPMENT BENEFITS OF BRI ROAD INFRASTRUCTURE

AN ILLUSTRATIVE NATURAL CAPITAL APPROACH FOR MYANMAR

SUSTAINABLE BRI ROAD INFRASTRUCTURE

- **Lower** risk of landslides, flooding & water pollution
- **Higher** upfront investment for road construction
- Preservation of ecosystems, and **critical services provided by ecosystems** to millions of people; e.g. clean drinking water, maintain dry-season water flows, disaster risk reduction

UNSUSTAINABLE BRI ROAD INFRASTRUCTURE

- **Lower** upfront investment for road construction
- **Higher** risks of landslides, flooding & water pollution
- Fragmentation of ecosystems, and **decline of critical services** they provide to millions of people

ABOUT THIS REPORT

The purpose of this report is to provide a rapid assessment of key opportunities and risks for Myanmar of China's Belt & Road Initiative, relating to natural capital impacts and dependencies.

THE ASSESSMENT FOCUSES ON IDENTIFYING:

- how construction of roads proposed by the Initiative could affect Myanmar's natural capital, and the benefits that these natural assets provide to people,
- how BRI road projects in Myanmar themselves depend on the ecosystem services provided by natural capital, and
- options for ensuring a sustainable BRI in Myanmar, through careful planning of the location and design of road infrastructure to minimize damage to natural capital and associated risks.

The assessment presented in this report is preliminary in nature and should be used for illustrative purposes only. It is not designed to support road planning decisions in specific locations, which would require more accurate follow up assessments.

01 INTRODUCTION: THE BELT AND ROAD INITIATIVE

The BRI has been described as 'probably the most ambitious Chinese international policy initiative in history'.[1] The Initiative's two key proposals—a "Silk Road Economic Belt" and "Maritime Silk Road"—include activities spanning at least 60 countries, which represent ~60% of the world's population and ~30% of global GDP.[2] On land, the Silk Road Economic Belt features several economic corridors that connect Central Asia, Russia, India, Pakistan and Europe. The Maritime Silk Road connects China's coastal ports with those in Asia, East Africa, and Europe (see Figure 2).[3]

The purpose of China's BRI is to promote regional economic development, underpinned by four principles: (1) *openness and cooperation*, (2) *harmony and inclusiveness*, (3) *market-based operation*, and (4) *mutual benefits and win-win outcomes for all countries*. The Initiative emphasizes investment in the development of regional infrastructure, but its official objectives are much broader—including policy dialogue, infrastructure connectivity, free trade, and people-to-people trade. These economic and geopolitical objectives are likely to shape China's foreign policy for decades to come. By 2015, participating financial institutions and companies may have raised funds exceeding US$800 billion to support the BRI.[4]

TOWARDS A GREEN BELT AND ROAD INITIATIVE

In 2016, China's president Xi Jinping highlighted the importance of working towards a 'green, healthy, intelligent and peaceful' Silk Road, suggesting that participating countries should 'deepen cooperation in environmental protection, intensify ecological preservation and build a green Silk Road'.[5] In 2017, the Ministry of Environmental Protection of China released *'Guidance on the Building of the Green Belt and Road'* that sets out detailed principles and objectives emphasizing cooperation, capacity building, policy dialogue, and adherence to regulatory standards.[6] These commitments are strongly influenced by China's ambitious national blueprint for an 'Ecological Civilization', and 'major objective' in its 13th Five-Year Plan for Economic and Social Development to 'Achieve an overall improvement in the quality of the environment and ecosystems'.[7]

1 Huang Y. 2016.
2 Ibid.
3 HKTDC. 2017.
4 Inclusive Development International. 2016.
5 State Council Information Office of the People's Republic of China. 2016.
6 Belt and Road Portal. 2017.
7 United Nations Environment. 2016., Central Committee of People's Republic of China. 2016.

WHAT IS NATURAL CAPITAL?

"NATURAL CAPITAL IS ANOTHER TERM FOR THE STOCK OF RENEWABLE AND NON-RENEWABLE RESOURCES (E.G. PLANTS, ANIMALS, AIR, WATER, SOILS AND MINERALS) THAT COMBINE TO YIELD A FLOW OF BENEFITS TO PEOPLE. THE BENEFITS (ECOSYSTEM SERVICES) PROVIDED BY NATURAL CAPITAL INCLUDE CLEAN AIR, FOOD, WATER, ENERGY, SHELTER, MEDICINE, AND THE RAW MATERIALS WE USE IN THE CREATION OF PRODUCTS. IT ALSO PROVIDES LESS OBVIOUS BENEFITS SUCH AS FLOOD DEFENCE, CLIMATE REGULATION, POLLINATION AND RECREATION." [8]

8 Natural Capital Coalition. 2016.

CHINA RECOGNIZES THE IMPORTANCE OF NATURAL CAPITAL

The Government of China has recognized the importance of natural capital for its own social and economic development objectives. It has established a domestic network of "Ecosystem Function Conservation Areas" to focus conservation in areas with high return-on-investment for public benefit.[9] Ecosystem Function Conservation Areas now span more than 35% of the country.[10] China has conducted an ambitious national assessment of biodiversity and ecosystem services, including food production, sandstorm prevention, soil retention, carbon sequestration, flood mitigation, water regulation and biodiversity conservation, recognizing the importance of this information for planning and policy, including infrastructure.[11]

BRI CORRIDORS CUT ACROSS IMPORTANT CONSERVATION AREAS

The BRI area spans many important conservation areas, such as Protected Areas, key landscapes, Global 200 Ecoregions, and biodiversity hotspots. These cover the distribution range of important species, and provide many important benefits (ecosystem services) to people that underpin social and economic development. Based on the concern of potential impacts on people and nature, WWF undertook a preliminary spatial analysis of the possible environmental impacts along 6 land-based economic corridors, initially proposed for the BRI as a whole. The analysis revealed that BRI corridors overlap with 1,739 Important Bird Areas or Key Biodiversity Areas and 46 biodiversity hotspots and that potentially all protected areas in BRI corridors could potentially be impacted. 32% of the total area of all protected areas in countries crossed by BRI corridors could potentially be affected. [12]

Based on the analysis, WWF provided a number of recommendations for how the BRI could be designed and implemented to maximize the potential sustainable development benefits and minimize the potential negative impacts. Recommendations include use of system level design, direct investments towards ecological infrastructure and renewable energy, use of Strategic Environmental Assessments to support policy and planning, assess natural capital risks and opportunities, secure integrity of ecosystems along BRI corridors by establishing transboundary protected areas, enhance collaboration on biodiversity conservation, follow highest environmental and social safeguards and standards when planning, designing and implementing BRI projects and encourage civil society participation and consultation at all levels and at all stages of the BRI development.[13]

9 Daily G. 2013.
10 National Development and Reform Commission. 2013.
11 Ouyang. 2013.
12 WWF. 2017.
13 Ibid.

02 THE BELT AND ROAD INITIATIVE IN MYANMAR

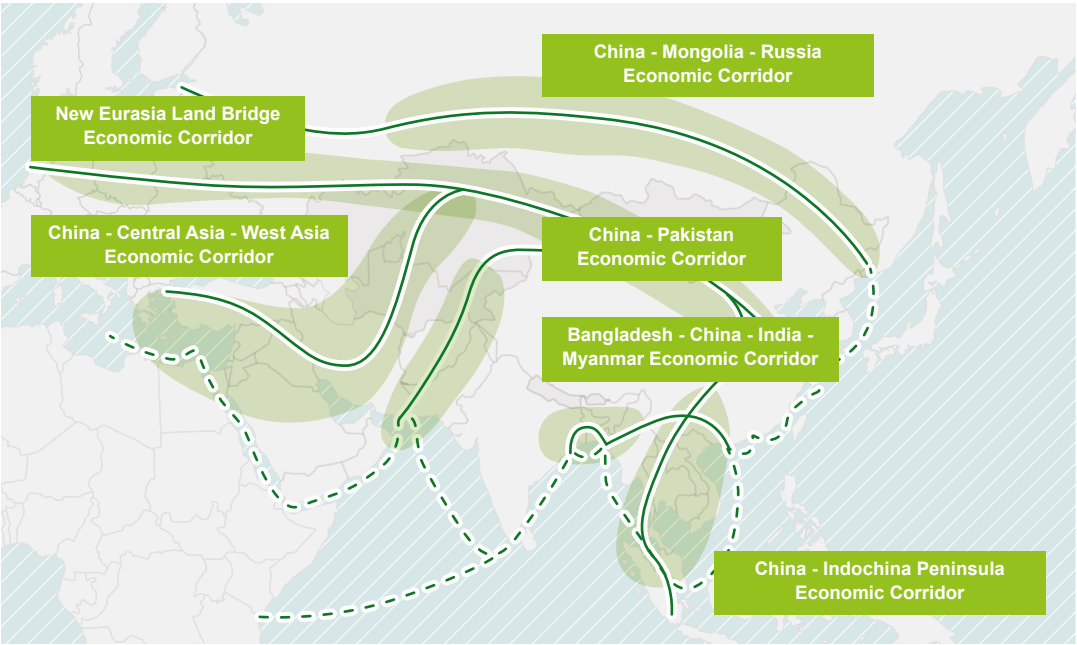
A key objective of the BRI's Bangladesh–China–India–Myanmar (BCIM) Economic Corridor is to deepen connections between China's Yunnan province and its neighbours, and between China as a whole and the Bay of Bengal. BRI objectives in Myanmar are also shaped by China's 'Two-Ocean' Strategy, which aims to secure strategic influence over sea lanes in the Indian Ocean to the west, and Pacific Ocean to the east (in particular the South China Sea and East China Sea).[14] Sea lanes in these locations are vital economic and energy supply lines for China—for example they carry more than 80% by volume of China's oil imports.[15]

According to press reports and accounts available online, two corridors for road infrastructure in the BCIM Economic Corridor have been proposed as part of the BRI in Myanmar:

1. An *East–West corridor* connecting China through Mandalay and central Myanmar with India and Bangladesh.
2. A *North–South corridor* connecting the East–West corridor with the Indian Ocean via Yangon.[16]

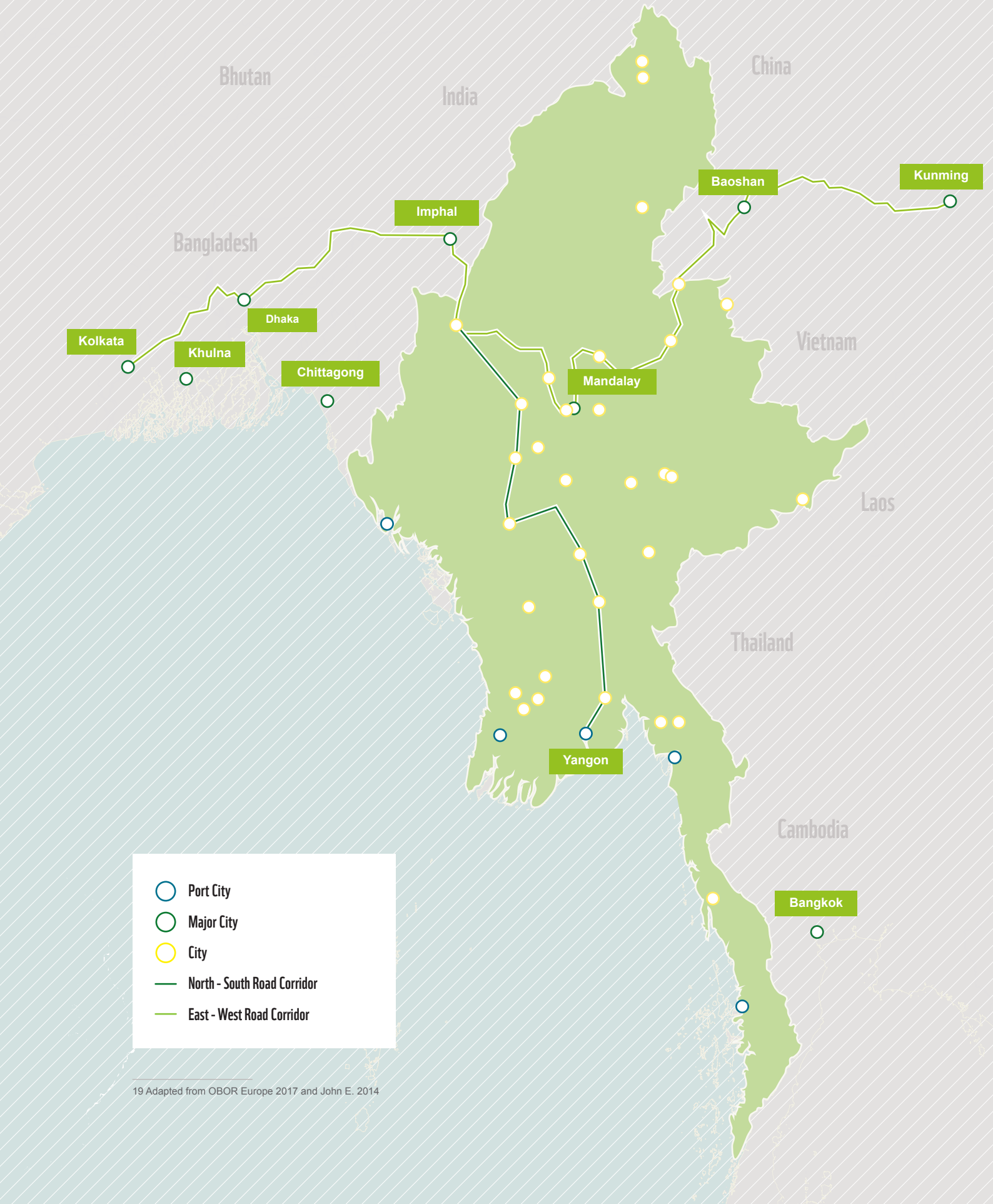
There are also plans in Myanmar to develop a US$7.3 billion deep water port in Kyaukpyu township, Rakhine State (western Myanmar), in which a consortium led by China's CITIC Group has reportedly proposed to take a 70–85% ownership stake.[17]

FIGURE 2: MAJOR LAND AND SEA CORRIDORS OF THE BELT AND ROAD INITIATIVE[18]



14 Sun T. and Payette A. 2017., Owen N. and Schofield C. 2012.
15 Wang L. 2015.
16 OBOReurope. 2017. And John E. 2014.
17 Myanma Port Authority. 2017.
18 Adapted from HKTDC. 2017.

FIGURE 3: PROPOSED BRI ROAD CORRIDORS AND PORT PROJECTS IN MYANMAR[19]



19 Adapted from OBOR Europe 2017 and John E. 2014

03 OPPORTUNITIES AND RISKS FOR MYANMAR OF THE BELT & ROAD INITIATIVE

Myanmar is currently experiencing historic political, social and economic changes. The opening up of the country presents both opportunities to pursue rapid development, and risks that such development will not deliver sustainable or equitable benefits to Myanmar's people, and will deplete or damage the country's natural capital, including its rich biodiversity.

Evidence from other countries suggests that BRI road projects and associated investments offer considerable opportunities. A 2015 evidence review by the World Bank highlighted the potential of road infrastructure to deliver diverse socio-economic benefits including increased productivity, reduction of trade costs and barriers, agglomeration effects, and flow on effects for production, employment, and incomes.[20] According to the 2016 United Nations' State of the Least Developed Countries Report, development benefits of road infrastructure include transformation in the lives of rural communities through educational opportunities, increased access to health services, increased agricultural productivity, and higher school enrolment.[21] Given these benefits, BRI road projects and associated investment are likely to support delivery of key policy priorities in Myanmar—including the National Comprehensive Development Plan, Agricultural Development Strategy, Promoted Sectors for Investment, and Export Development Strategy. All of these documents emphasize the importance of connecting Myanmar with its neighbours and the world, in order to pursue trade and other development opportunities.

ENVIRONMENTAL AND SOCIO-ECONOMIC RISKS RELATED TO THE BRI

The significant potential benefits of the BRI in Myanmar are however coupled with substantial environmental and socio-economic risks, as well as the dependence of BRI infrastructure on natural capital. Socio-economic development can be undermined by adverse impacts of road projects on the natural environment, or by failures to accommodate the needs and priorities of affected local communities.

20 World Bank. 2015b. Adler S. 2017. Fardoust S., Kim Y. and Sepúlveda C. 2011.

21 United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States. 2016.

ROADS, IF NOT PROPERLY PLANNED OR CONSTRUCTED, CAN HAVE MANY NEGATIVE IMPACTS, INCLUDING:

- **INCREASED RISKS OF NATURAL DISASTERS:** in particular landslides and flooding[22] with impacts on the people of Myanmar, and on the integrity of roads and other infrastructure.
- **WATER POLLUTION**: in particular through increasing runoff of soil, sediment and other pollutants.[23]
- **WILDLIFE MORTALITY:** caused by collisions between vehicles and wildlife,[24] or by impairing the ability of wildlife to access essential food, water or habitat.[25]
- **ECOSYSTEM DEGRADATION:** caused by spatial fragmentation, or by roads enabling unsustainable intensification of natural resource use (e.g. timber harvesting or hunting).[26]

22 Renaud F. 2013.
23 Mandle L., Griffin R. and Goldstein J. 2016.
24 Glista D., DeVault T. L. and DeWoody J. A. 2009.
25 Fahrig L. 2003.
26 World Bank. 2016.

SUSTAINABLE MANAGEMENT OF MYANMAR'S NATURAL ENVIRONMENT

The United Nations Sustainable Development Goals—and Myanmar's National Comprehensive Development Plan—the government's economic policy and 2017 National Environmental Policy—all recognize that the country's development depends fundamentally on sustainable management of the natural environment. Recent studies have highlighted the extent to which Myanmar's natural environment functions as a capital asset, providing many goods and services to the country's people.[27]

Studies have also started to identify the economic implications of the goods and services provided by Myanmar's natural capital assets, and measure the (sometimes irreplaceable) contributions to human health, well-being and development. For example, a 2013 pilot study of forest ecosystems in Myanmar concluded that these assets contribute at least US$7.3 billion to Myanmar's economy, of which only 15% derives from extractive activities such as commercial forestry and non-wood product removals.[28]

27 WWF, 2016. And Emerton L. and Yan Min Aung. 2013.
28 Emerton L. and Yan Min Aung. 2013.

MYANMAR IS VULNERABLE TO EXTREME WEATHER EVENTS

According to the Global Climate Risk Index 2017, Myanmar is one of the most vulnerable countries to climate change and extreme weather events.[29] The country has suffered cyclones and floods in recent years, which have severely impacted people and the economy. For example, the monsoon flooding in 2015 caused economic losses amounting to 3.1% of GDP.[30] Myanmar's natural capital plays an important role in mediating these risks through benefits, such as flood regulation, and is a major component of the country's wealth, alongside its institutions, communities, built infrastructure and financial assets.

29 Kreft S., Eckstein D. and Melchior I. 2016.
30 World Bank. 2015a.

NATURAL CAPITAL RISKS AND THE BRI

There is a risk that BRI road projects in Myanmar could damage the stock of Myanmar's natural capital assets and thereby reduce benefits provided to the country's people, increasing costs to society, the economy and the infrastructure itself. The significance of these risks is underscored by the fact that the East–West and North–South road corridors cross through areas that are home to approximately 24 million people (see Figure 5 below). These people rely on natural capital assets located in those areas (in particular forest and riverine ecosystems) to filter drinking water; maintain water during the dry season for irrigation, livestock, and human consumption; reduce risks from natural disasters; and provide other critical ecosystem services.

Myanmar's natural capital is vital for mitigating the severe impacts of natural disasters on the country's built infrastructure, including roads.

In 2015, Myanmar's average annual loss (AAL) from natural disasters represented 30 percent of its annual capital investment–almost double the same figure for Philippines (14 percent), and triple that of Cambodia (10 percent). It was also ranked first globally for Flood AAL in relation to capital investment.[31]

31 UNISDR. 2015., ADPC/UNICEF. 2015.

04. MAPPING NATURAL CAPITAL RISKS ALONG THE BRI ROAD CORRIDORS IN MYANMAR

The proposed BRI corridors are likely to have substantial negative social, environmental, and economic impacts, if not carefully planned and designed. The viability and integrity of the BRI infrastructure would itself be at risk from degradation of natural capital. To better understand these risks, the assessment in this report focuses on human population density, selected ecosystem services, and areas of conservation importance in Myanmar, showing their overlap with or proximity to the proposed BRI corridors and watersheds (areas of land that separates waters flowing to different rivers, basins, or seas). Given data and resource constraints, the analysis was confined to three ecosystem services that were recently assessed in a national natural capital assessment.[32]

The assessment in this report identifies spatial overlaps between the East–West and North–South road corridors and:

- **POPULATION AND POPULATION DENSITY—**including identification of areas where upland ecosystems and services affect downstream population centres (see examples in bullets below)
- **ECOSYSTEMS THAT MITIGATE EROSION AND IMPROVE WATER QUALITY**—by capturing sediment run-off from surrounding land
- **ECOSYSTEMS THAT REDUCE FLOOD RISK—**by slowing or reducing water flows from surrounding land
- **IMPORTANT BIODIVERSITY AREAS—**including sites contributing significantly to the global persistence of biodiversity, also known as Key Biodiversity Areas (KBAs), intact forest landscapes, areas of higher mammal species richness, and Protected Areas.

This mapping exercise helps to identify locations in Myanmar where BRI road projects could damage natural capital, leading to *(1)* reduced flows of certain ecosystem services to surrounding populations, and *(2)* increased risks of damage to the roads themselves, for example from flooding or landslides. These impacts should be well understood in the planning, finance and design of BRI road infrastructure to maximize its development benefits and ensure the sustainability and cost-effectiveness of the infrastructure. A subset of data used to generate the maps depicting natural capital risks is summarized in Figure 3.[33] The scope of this assessment does not include intrinsic and cultural values, which are distinct from the quantifiable social and economic benefits that ecosystems provide to people. Other ecosystem services that are important in Myanmar were beyond the scope of this analysis, but should be included in future assessments.

32 WWF. 2016.
33 See also detailed technical appendix, Dailey M. 2017.

TABLE 1: SUMMARY OF APPROACH USED TO MAP NATURAL CAPITAL RISKS

Services or circumstances mapped	Data inputs and methodology	Key limitations
5.1 POPULATION AND POPULATION DENSITY	FAO 2015 population estimates with UN -INWEH WaterBase fourth level watersheds and calculated the FAO 2015 estimated population within those watersheds that are intersected by the BRI proposed roads.	Not all populations are downstream of the potential road impacts.
5.2 SEDIMENT RETENTION BY LAND COVER	InVEST DelineateIt model to create service sheds of points along each road. InVEST sediment retention model used to calculate role of natural vegetation in retaining sediment under current climate conditions.[3]	Does not include the impact of roads on sedimentation but rather how vegetation upland of a road may impact sedimentation if all converted to agriculture. Does not incorporate future climate conditions. Not calibrated.
5.3 FLOOD RISK REDUCTION	InVEST DelineateIt model to create *service sheds* of points along each road. InVEST Seasonal Water Yield used to calculate flood risk reduction provided by natural vegetation under current climate conditions.[4]	Does not include the impact of roads on flood risk reduction but rather how vegetation upland of a road may impact flood risk if all converted to agriculture. Does not incorporate future climate conditions. Not calibrated.
5.4 BIODIVERSITY	World Database on Protected Areas (WDPA), Key Biodiversity Areas (KBAs), Intact Forest Landscapes, and IUCN Red List of Threatened Species (using mammal species ranges to create an indicator of biodiversity).	Does not include areas that may be highly diverse but lack any formal designation. Biased towards forested areas, birds, and mammals. Does not account for areas important for connectivity.
5.5 RIPARIAN AREAS	InVEST DelineateIt model to create a stream network; buffered by 500 meters to approximate the maximum riparian area required by terrestrial species.	A study of all species present and their riparian habitat needs would provide more precise buffer distances.

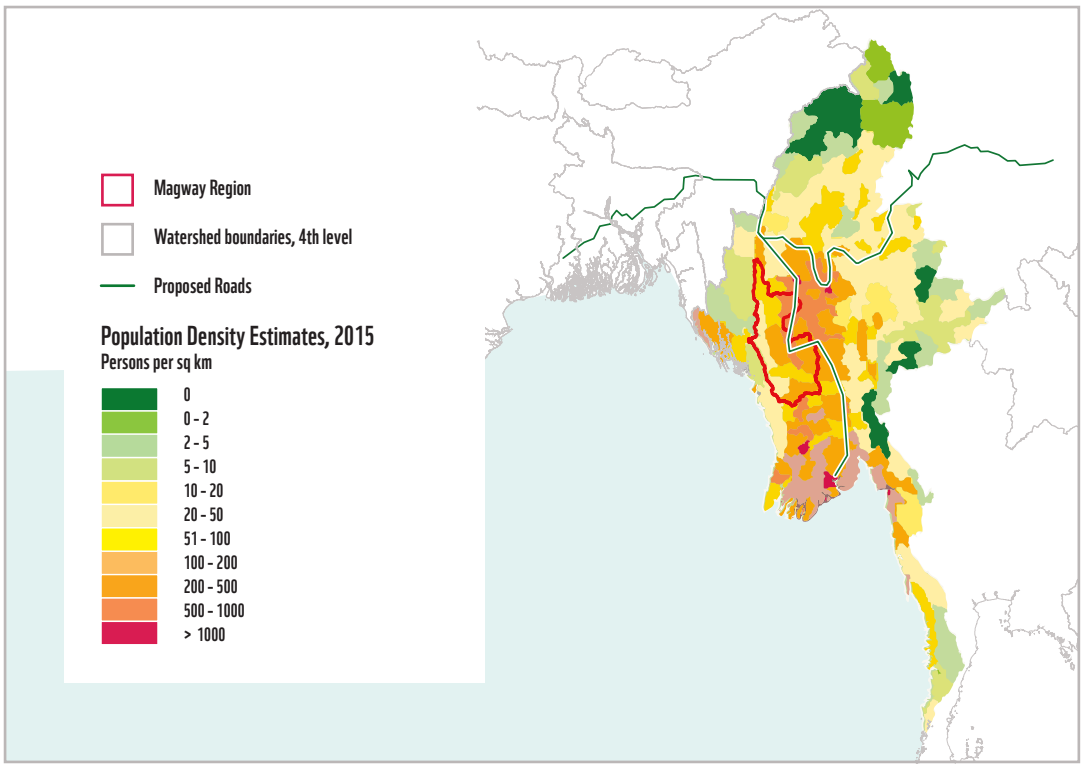
4.1 UP TO 24 MILLION PEOPLE LIVE IN WATERSHEDS INTERSECTED BY BRI ROAD INFRASTRUCTURE

Many people in Myanmar rely on surface water for drinking water. Figure 4 illustrates how some of the most densely populated areas in Myanmar are intersected by the East–West and North–South road corridors. The grey lines delineate the boundaries of modelled areas in which upland ecosystems and services affect downstream locations — for example by reducing sediment run-off or flooding.

Approximately 24 million people live in these areas and could be impacted by increased sedimentation due to upstream infrastructure development, deforestation, and other land use change.

This could affect the quantity and quality of drinking water, and flood risks. For example, in the Magway Region, which is intersected by the North–South road corridor and located downstream of the East–West road corridor, ~10% of the population of 4.2 million rely entirely on surface drinking water, making them more vulnerable to increased sedimentation.[34]

FIGURE 4: POPULATION DENSITY OF WATERSHEDS INTERSECTED BY BRI ROAD CORRIDORS.



34 World Health Organisation. 2015.

4.2 EROSION AND WATER QUALITY RISKS ALONG THE BRI CORRIDORS

Increased erosion and sediment in streams have direct impacts on infrastructure and can cause degradation of roads and bridge scouring, where sediment around a bridge structure is removed through erosion, which can cause bridge failure or collapse. Increased erosion also affects soils that underpin agricultural productivity and are often neglected in decision-making despite their critical importance for agriculture and food supply and security. Figures 5 and 6 illustrate where the upland landscapes and ecosystems regulate erosion and water quality by capturing sediment run-off from surrounding areas can impact BRI road corridors. Darker brown areas show where land cover (e.g. forests) has a larger role in retaining sediment. The assessment does not include the impact of roads on sedimentation but rather how vegetation upland of a road may impact sedimentation, if all land cover would be lost and converted into agriculture.

The North-South and East-West road corridors intersect with natural capital providing high levels of sediment retention in two key areas: north-west Myanmar and the Shan Plateau in central eastern Myanmar.

Figures 5 and 6 highlight the need for careful planning of road projects in these key areas—to *(1)* minimize impacts of erosion and sediment run-off on road infrastructure, and *(2)* ensure that landscapes and ecosystems retain their ability to provide erosion and water quality regulation across the downstream areas.

FIGURE 5: SEDIMENT RETENTION DUE TO PRESENCE OF NATURAL HABITAT ACROSS NORTH-SOUTH BRI ROAD CORRIDOR.

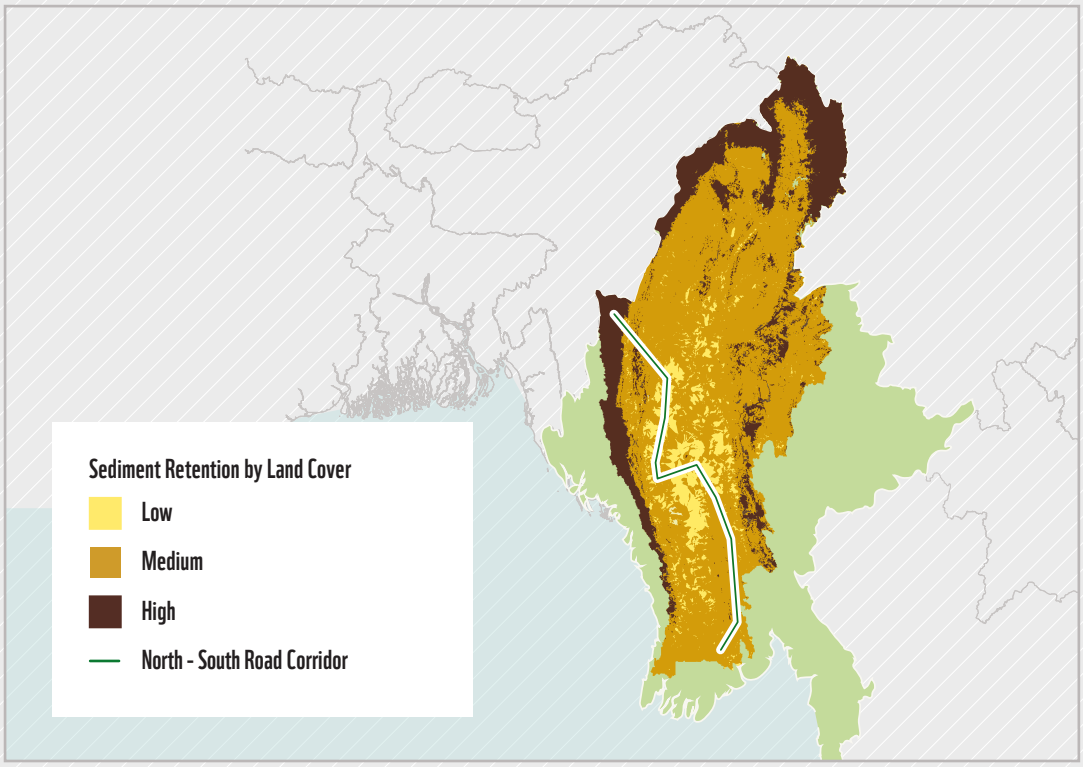
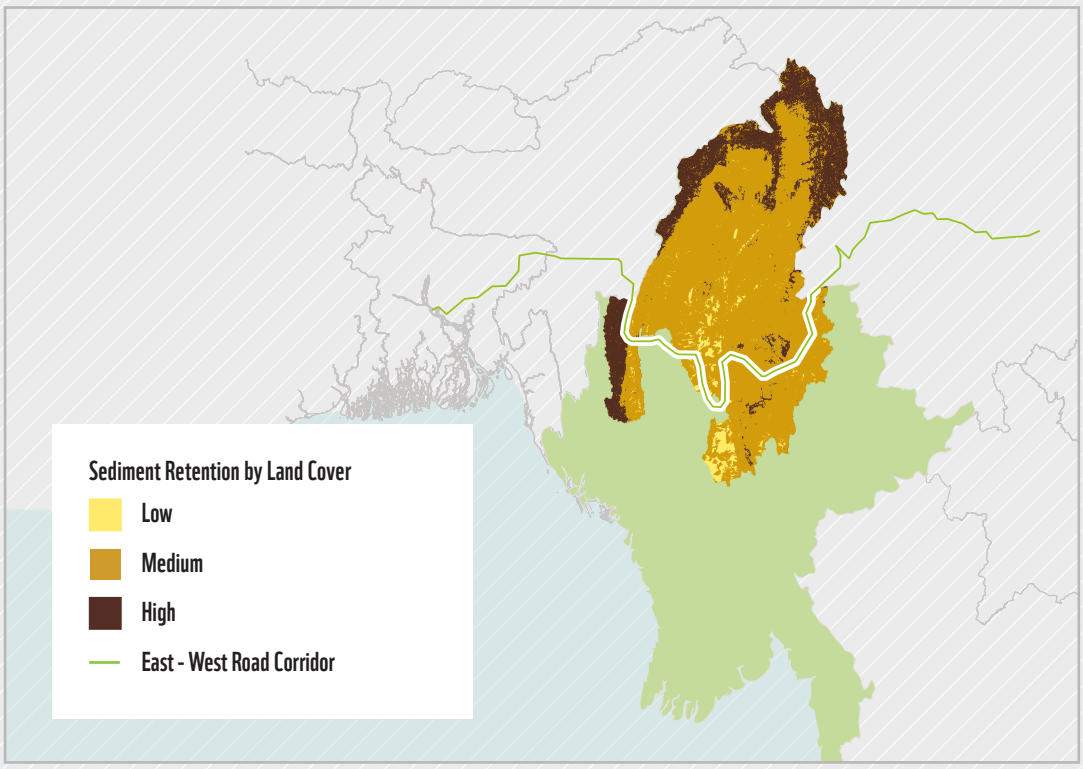


FIGURE 6: SEDIMENT RETENTION BY NATURAL CAPITAL ACROSS EAST-WEST BRI ROAD CORRIDOR



4.3 FLOOD RISKS ALONG THE BRI ROAD CORRIDORS

Monsoon flooding causes severe impacts in Myanmar—including loss of lives and livelihoods, environmental pollution, and damage to infrastructure including roads, buildings, and equipment for industry and agriculture. In 2015, Myanmar was ranked first globally for average annual capital losses (including road damage) caused by flooding.[35] Figures 7 and 8 illustrate where the upland landscapes and ecosystems reduce flood risk by slowing or reducing water flows from surrounding land and can impact BRI roads. Darker blue areas show where land cover (e.g. forests) provide higher levels of flood risk reduction. Figures 7 and 8 highlight areas of the BRI road corridors that are likely to be most at risk of floods, particularly in Chin state and Bago region (northern and southern ends of the North-South road). It also indicates potentially significant flood risks across much of the East-West Road, which cuts across Chin state and Shan state. There is a need for careful planning of road projects across these areas—to ensure that vital flood risk regulation services are maintained across the highlighted downstream areas.

If forests in these areas are lost, either to road construction or land use change, flood risks both to people and infrastructure investments could increase significantly.

Areas of high importance for flood risk reduction should be avoided as much as possible for road construction and in areas where the alignment cannot be changed, land use planning to avoid deforestation will be critical to protect people and the infrastructure investment from floods.

35 UNISDR. 2015., ADPC/UNICEF. 2015.

FIGURE 7: FLOOD RISK REDUCTION BY NATURAL CAPITAL ACROSS NORTH-SOUTH BRI ROAD CORRIDOR.

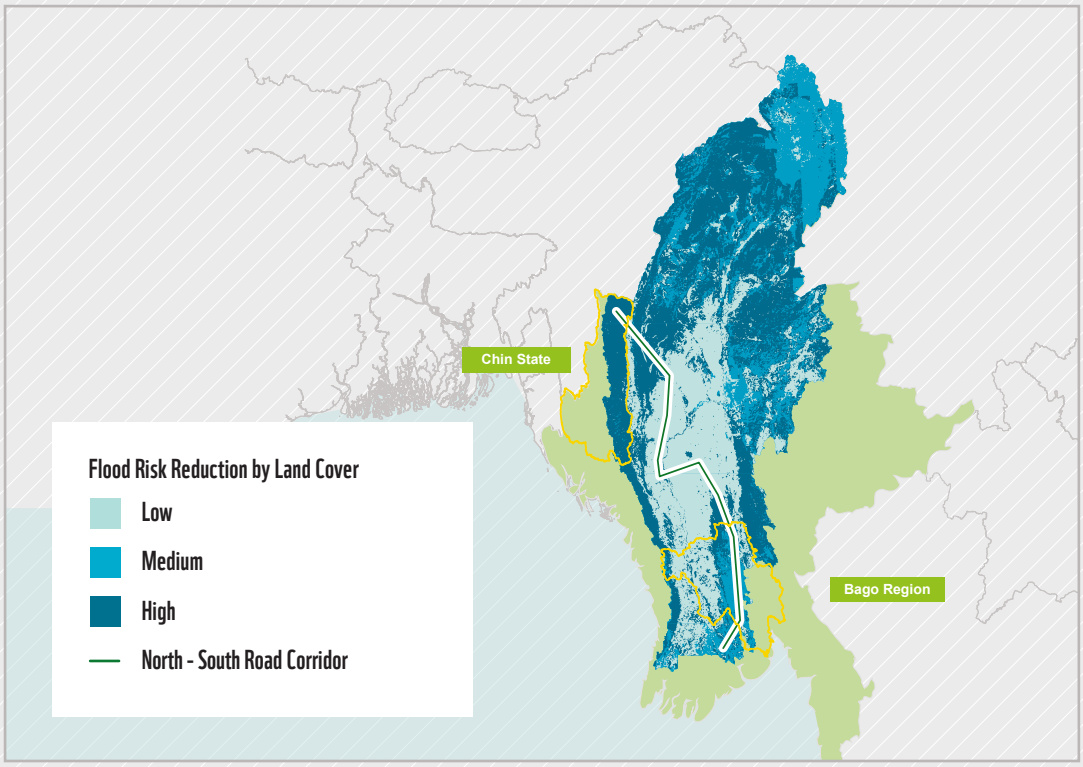
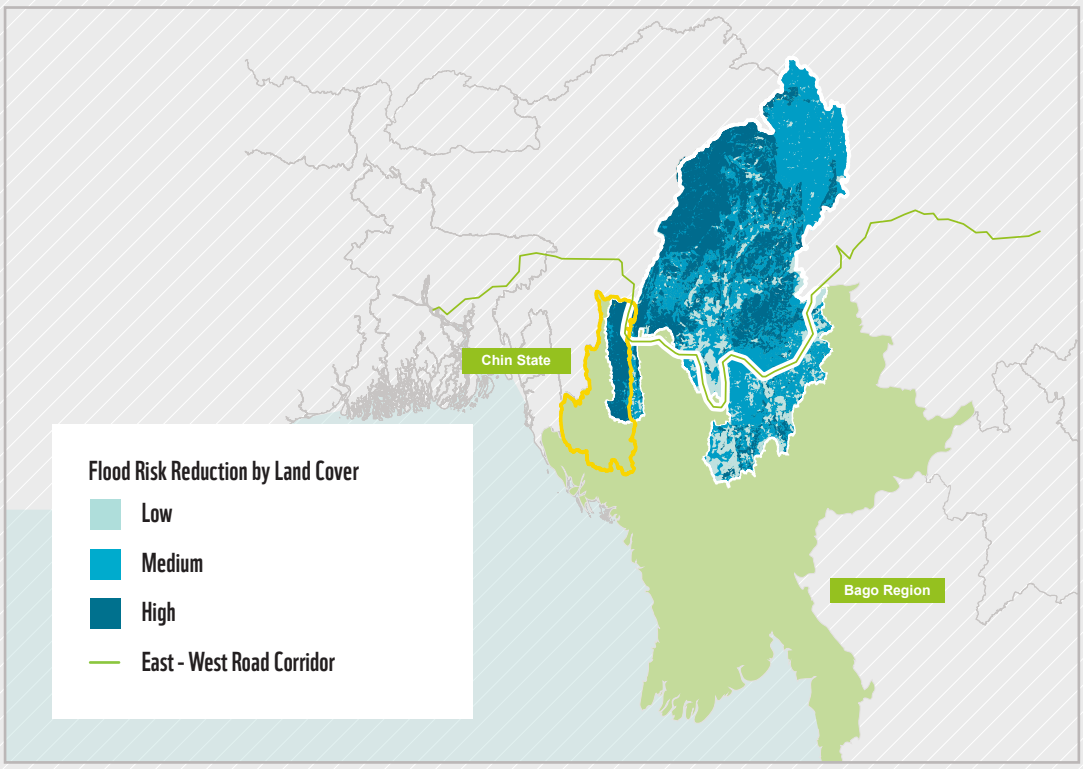


FIGURE 8: FLOOD RISK REDUCTION BY NATURAL CAPITAL ACROSS EAST-WEST BRI ROAD CORRIDOR.



4.4 BIODIVERSITY RISKS ALONG THE BRI ROAD CORRIDORS

Myanmar has a wealth of biodiversity, valuable in its own right, and as a foundation for the country's long-term prosperity. Biodiversity is a crucial contributor to ecosystem functionality, and consequently to the delivery of ecosystem services. In addition, Myanmar's ecosystems and wildlife can form the basis of a thriving ecotourism sector that should be accounted for when evaluating the costs and benefits of the BRI corridors. Infrastructure development can impact biodiversity in several direct and indirect ways, but loss of habitat due to deforestation and land use change, and increased access to important biodiversity areas facilitated by the new infrastructure present the greatest risks.

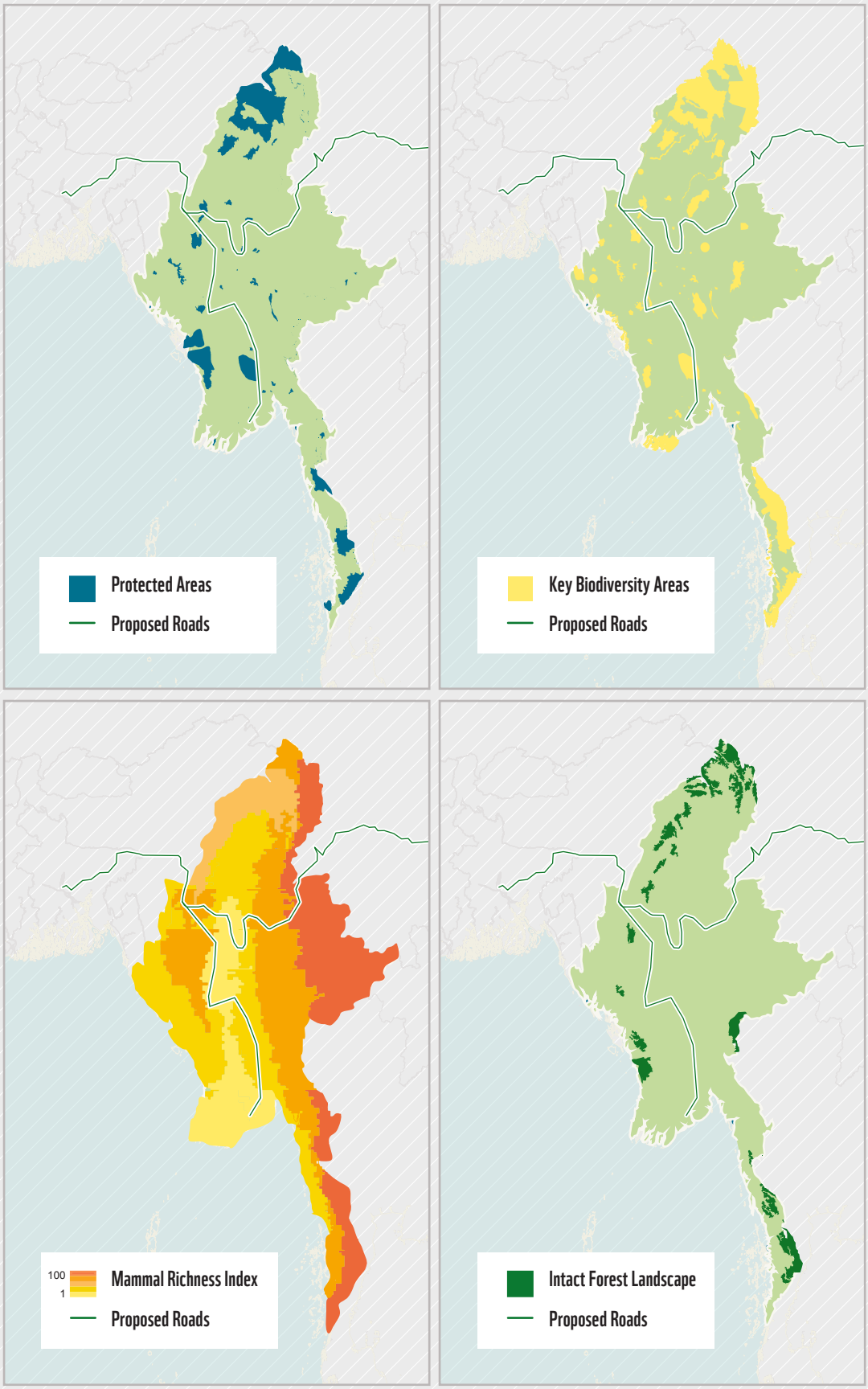
Figure 9 indicates that there are not extensive spatial overlaps between the proposed BRI road corridors, and important sites of biodiversity determined by four different designation methods: Key Biodiversity Areas,[36] Relative Mammal Richness,[37] Protected Areas designated by the Government of Myanmar, and Intact Forest Landscapes.[38] However, in Shan state (eastern part of the East–West road corridor), the road will cut through areas of high Relative Mammal Richness. This suggests a need for planning and design of roads to maintain wildlife corridors, and minimize risks of wildlife–vehicle collisions. In addition, the BRI road corridors also intersect with several Key Biodiversity Areas and Protected Areas that are important sites for nature-based tourism in Myanmar. Re-alignment of roads around these areas would minimize the impacts of the BRI on Myanmar's biodiversity and associated eco-tourism potential. However, more biodiversity assessments are needed to better understand potential risks and impacts related to biodiversity.

Finally, even if the BRI road corridors themselves do not directly intersect with many biodiversity priority sites, the opening up of new roads often trigger land use change in an expanding frontier around new infrastructure and as such requires careful and proactive land use planning to avoid impacts on areas important for biodiversity.

Avoiding areas important for biodiversity is the best way to reduce risks but if avoidance is not possible, measures must be taken to fully mitigate impacts.

36 IUCN. 2016.
37 Rovero F. Martin E., Rosa M., Ahumada J. A., and Spitale D. 2014.
38 Intact forests. 2017.

FIGURE 9: BIODIVERSITY ACROSS BRI ROAD CORRIDORS



05. ENSURING A SUSTAINABLE BELT & ROAD INITIATIVE IN MYANMAR

The findings in this report illustrate the extent to which BRI road infrastructure could impact on natural capital and the important benefits it provide to people and infrastructure itself. In some areas, these impacts on natural capital could be significant, if plans do not incorporate the risks and appropriate mitigation measures. The long-term costs and resilience of BRI road infrastructure in Myanmar also depend on ecosystems services, in particular the flood risk reduction services provided by forests. Although only a few aspects of natural capital are included in this analysis, the report highlights ways in which the BRI road corridors would impact and depend on natural capital. More comprehensive assessments would almost certainly reveal significant additional trade-offs, making it essential to conduct such assessments so that BRI investments can bring about the hoped-for benefits without incurring major economic, environmental, and social costs.[39]

The negative impacts of BRI road projects on natural capital and Myanmar's development are likely, but need not be inevitable.

Options are available to maintain benefits flowing from both BRI infrastructure, and natural capital in the corridor areas.

These options will be highly specific to the social, geophysical, and environmental context of an area, and must be identified through careful assessments of relevant costs, benefits, synergies, and trade-offs between natural capital and infrastructure.

USING STANDARDS & TOOLS TO ENSURE A GREEN BELT & ROAD INITIATIVE IN MYANMAR

Voluntary frameworks such as the SuRe® (The Standard for Sustainable and Resilient Infrastructure) and Natural Capital Protocol can now be used by investors and project developers to support cost-effective assessments of natural capital risks and opportunities associated with BRI road infrastructure. SuRe® sets out criteria covering social, governance and environmental factors to establish an understanding of sustainable and resilient infrastructure projects and provide guidance on how to manage those aspects from both a risk management and a benefit creation perspective.[40] The Natural Capital Protocol (and related Finance Sector Supplement) provides a flexible framework for integrating natural capital risks and opportunities into private sector decision-making.[41] Project developers can also take advantage of a growing range of natural capital analysis tools, for example Roads Filter, ESRforIA, InVEST, OPAL, Co$ting Nature, and Waterworld (see Natural Capital Protocol Toolkit).[42]

In practice, the value of natural capital and the benefits it provides need to be recognized in decision-making in order to make careful site-specific choices about the: (1) location of roads, taking into account other categories of land use and conservation priorities and (2) the design and type of road infrastructure.

39 See Dailey, M., 2017 for preliminary social and economic benefit analysis including proximity to population centres, mines and highly productive agriculture, and connectivity between towns.
40 Global Infrastructure Basel. 2017.
41 Natural Capital Coalition. 2017.
42 Ibid.

5.1 LOCATION OF ROAD INFRASTRUCTURE

Evidence from other countries suggests that careful planning of the location of roads minimizes adverse impacts on natural capital assets. For example, alternative alignments were evaluated for a proposed superhighway that would cut through critical forested areas in southeast Nigeria. The conclusion was that alternative alignments would reduce environmental impacts, cost less to construct, and better serve local communities and agricultural areas. [43] Similar analyses have been conducted for the Mekong region[44] and globally.[45] However, trade-offs between increased distance, emissions and raw material requirements also need to be evaluated to identify optimal road alignments (and these considerations were not included in this report). In practice, re-alignment decisions can vary depending on specific factors considered, including economic cost of construction, socio-economic benefits and environmental aspects. Figure 10 illustrates how less direct road alignment can, in general, maintain the integrity of ecosystem assets and services, compared to more direct alignments that fragment and damage these assets and thereby reduce associated ecosystem services but also could also increase related emissions. This highlights the importance of better understanding trade-offs for road alignment.

FIGURE 10: ILLUSTRATIVE RE-ALIGNMENT OF ROAD INFRASTRUCTURE TO PROTECT NATURAL CAPITAL ASSETS AND SERVICES.

Ecosystem asset and services degraded through habitat conversion and fragmentation

Ecosystem asset and services maintained through re-alignment

43 Mahmoud M. I., Sloan S. Campbell M. J., Alamgir M., Imong I., Odigha O., Chapman H. M., Dunn A. and Laurance W. F. 2017.
44 Balmford A., Chen H., Phalan B.,Wang M., O'Connell C., Tayleur C. and Xu J. 2016.
45 Laurance W. F., Clements G. R., Sloan S., O'Connell C. S., Mueller N.D., Goosem M., Venter O., Edwards D. P., Phalan B., Balmford A., Van Der Ree R. and Burgues Arreaet I. 2014.

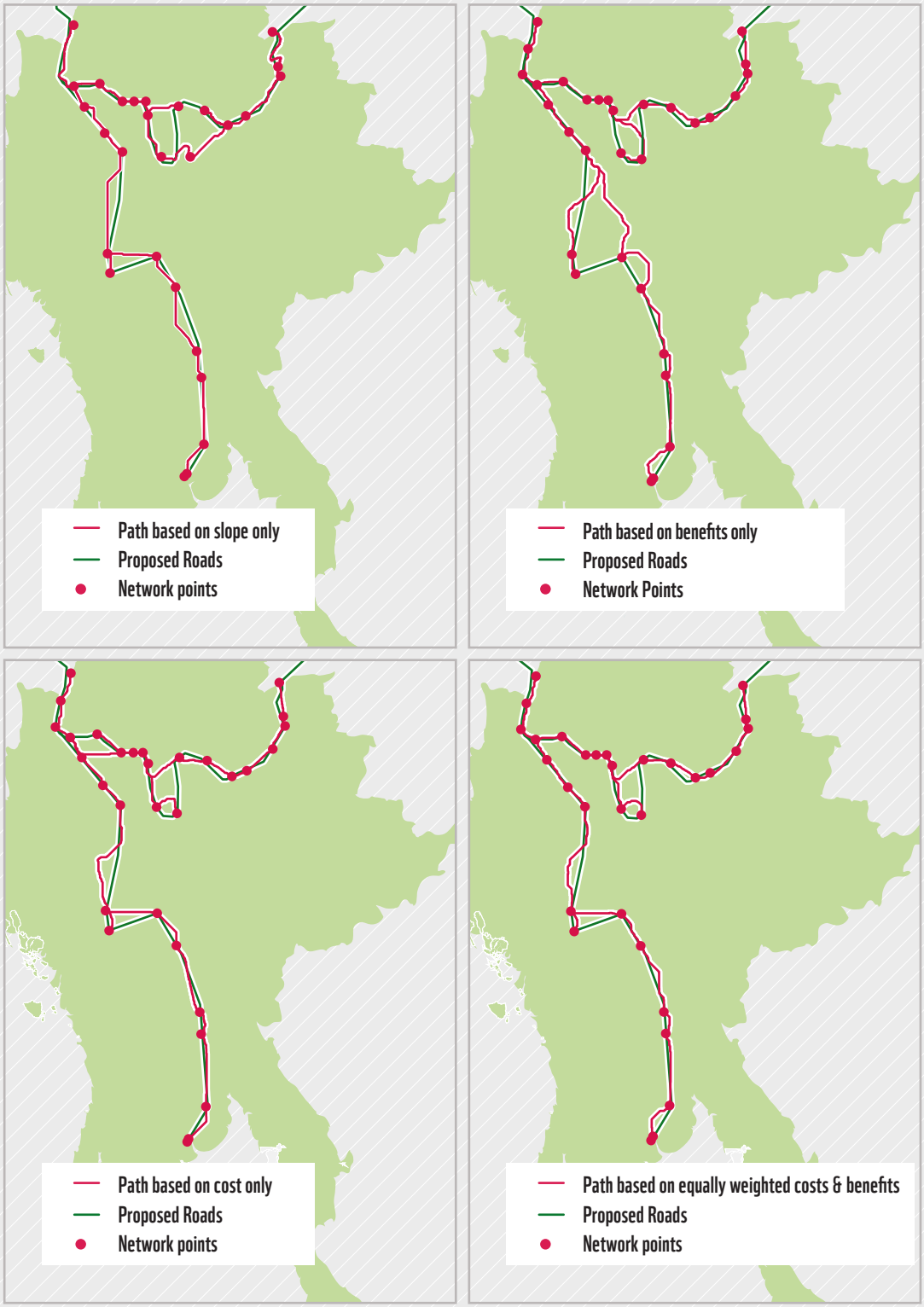
ASSESSING RE-ALIGNMENT OPTIONS TO MAXIMIZE BENEFITS

Figure 11 compares four different re-alignments of the North–South and East–West road corridors in Myanmar, which are based on different indexes and weightings of costs and benefits.[46] The first re-alignment attempts to minimize road costs per kilometre considering only the slope of surrounding terrain, as costs of road construction are significantly affected by slope. The second optimizes the alignment of the road taking into account potential socio-economic benefits, as measured by proximity of road corridors to mines, highly productive agricultural areas, and population centres. The third re-alignment attempts to avoid overlaps with important biodiversity areas, and natural capital benefits assessed in Section 5 (flood risk reduction, regulation of erosion and water quality). The fourth re-alignment combines all costs and benefits described previously and weights them equally. It is important to note that this is a coarse analysis, designed to demonstrate how considering costs and benefits together can help inform infrastructure planning. The results presented in Figure 11 are illustrative only, and are not suitable for road alignment decision-making in specific locations, which would require both a finer scale of analysis, and weighting of a greater number of costs and benefits. The results do however demonstrate clearly that the optimal alignment of a road can vary considerably, depending on which factors are considered in planning decisions.

46 Dailey, M., 2017.

FIGURE 11: ILLUSTRATIVE RE-ALIGNMENT OF NORTH-SOUTH & EAST-WEST ROAD CORRIDORS

Based on slope of terrain as a proxy of construction cost; socio-economic benefits represented by proximity of road corridors to mines, highly productive agricultural areas, and population centres; cost connectivity for avoiding areas important for biodiversity and ecosystem services; and combined and equally weighted socio-economic benefits and biodiversity and ecosystem services impact costs.



5.2 DESIGN OF ROAD INFRASTRUCTURE

Many approaches and options are available for designing road infrastructure that minimizes impacts on natural capital. The options and approaches are becoming increasingly standardized.

Commonly used options include:

- **BUFFER ZONES—**areas of natural vegetation around a road, designed to minimize water and sediment run-off, and landslide risks, where a road is passing through high-slope areas
- **RE-VEGETATION OF SLOPES—**designed to restore sediment and water flow regulation services on slopes where these services have been degraded during or following road construction
- **WILDLIFE AND HABITAT CORRIDORS—**designed to minimize fragmentation of ecosystems by enabling wildlife to cross roads safely, and habitats to extend across road-crossed areas.

Figure 12 illustrates a real-world analysis of road design choices in the Peruvian Amazon, coupled with an analysis of impacts of those design choices in the form of loss of ecosystem services. In this case, targeted mitigation measures (buffer zones, vegetated road shoulders, slope stabilisation, etc.) applied to the Pucallpa-Cruzeiro do Sul road to Brazil enabled full retention of analysed ecosystem services across much of the road route.[47]

It is important to note that the upfront cost of sustainable road infrastructure is sometimes higher, but represents an investment in greater relative returns from natural capital assets, as well as non-monetary social and environmental gains. Where it is not possible to avoid or mitigate damage to natural capital, offsetting should be considered.

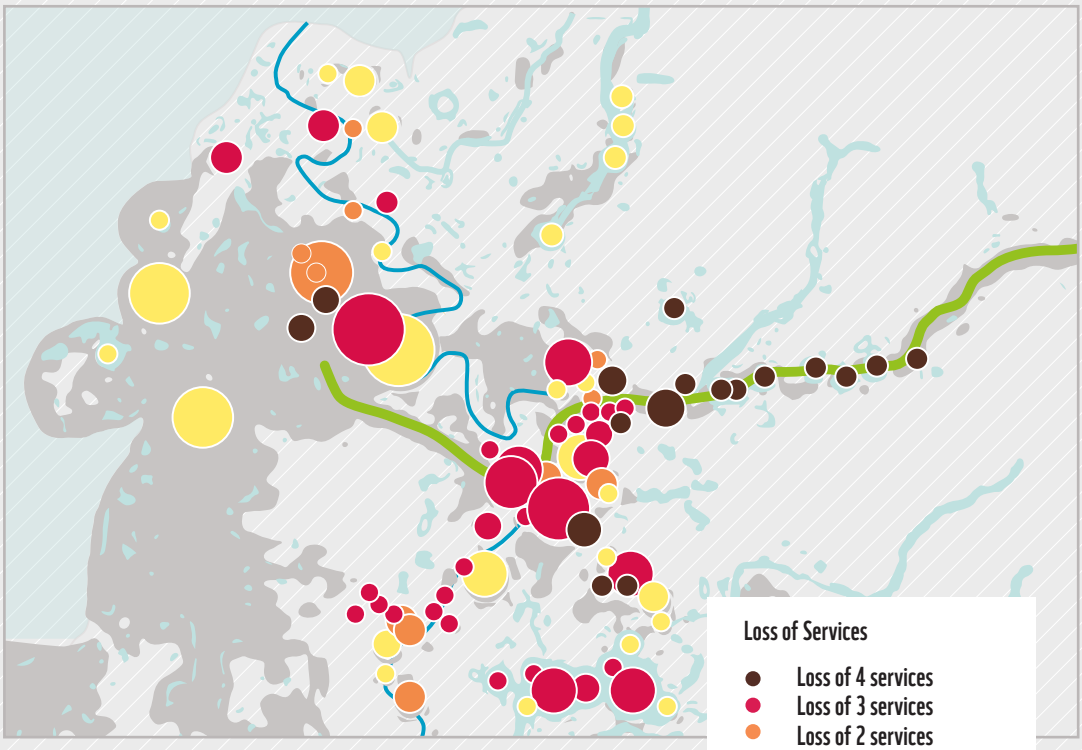
An offsetting regime requires any unavoidable environmental damage to be offset through compensation payments that are invested in the environment elsewhere.

It can also be a way to promote a net positive environmental outcome, as illustrated in Figure 14. Offsetting approaches are generally recommended only as a last resort, and can be difficult to implement in practice given the considerable challenges associated with restoration of complex ecosystems.

47 Mandle L., Tallis H., Vogl A., Wolny S., Touval J., Sotomayor L., Vargas S. and Rosenthal A. 2013.

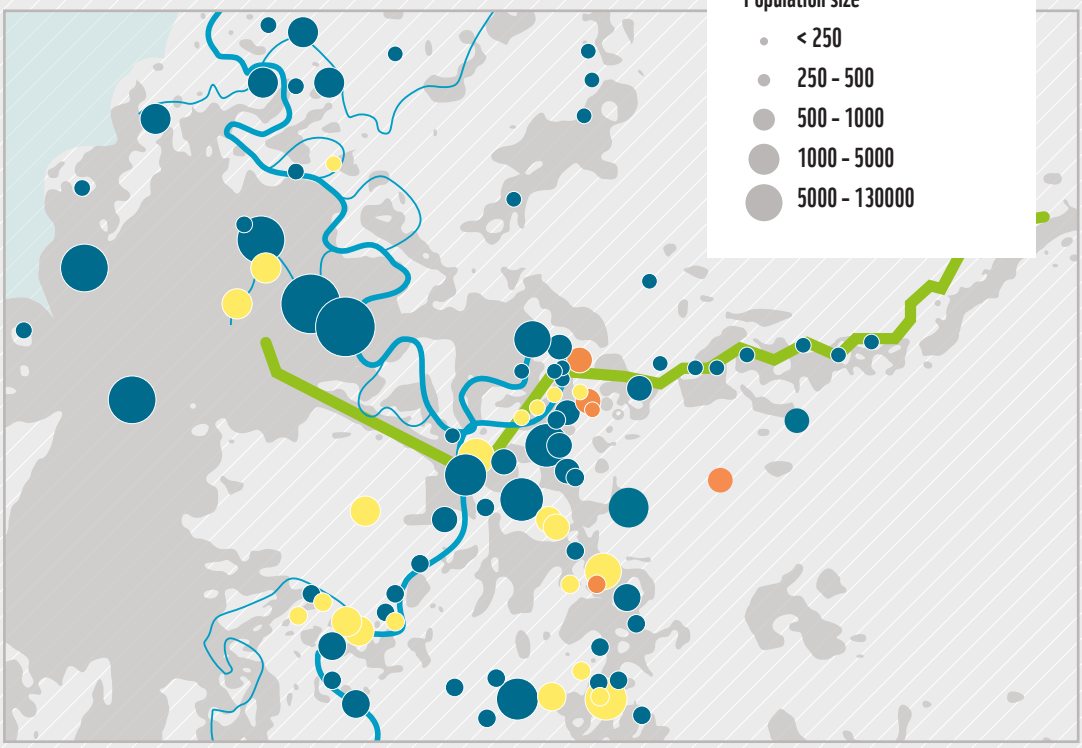
FIGURE 12: ANALYSIS OF ROAD DESIGN CHOICES IN PERU WITH HIGH (ABOVE) AND LOW (BELOW) IMPACTS ON NATURAL CAPITAL[48]

Road and Associated deforestation – Impacts without mitigation



Road and Associated deforestation – Impacts with targeted mitigation

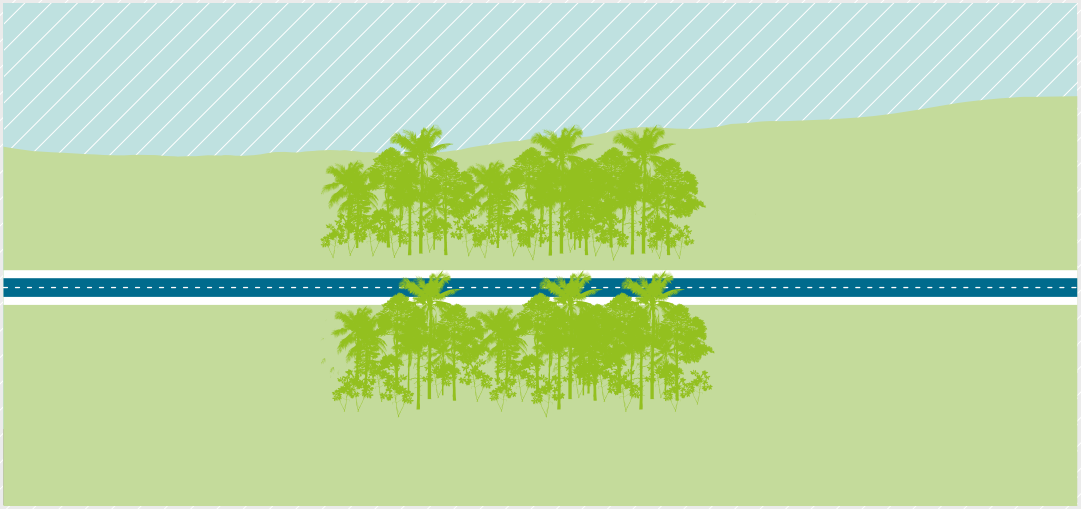
Anthopogenic areas (pastures, urban roads, mines) are shown in grey. Waterways are blue



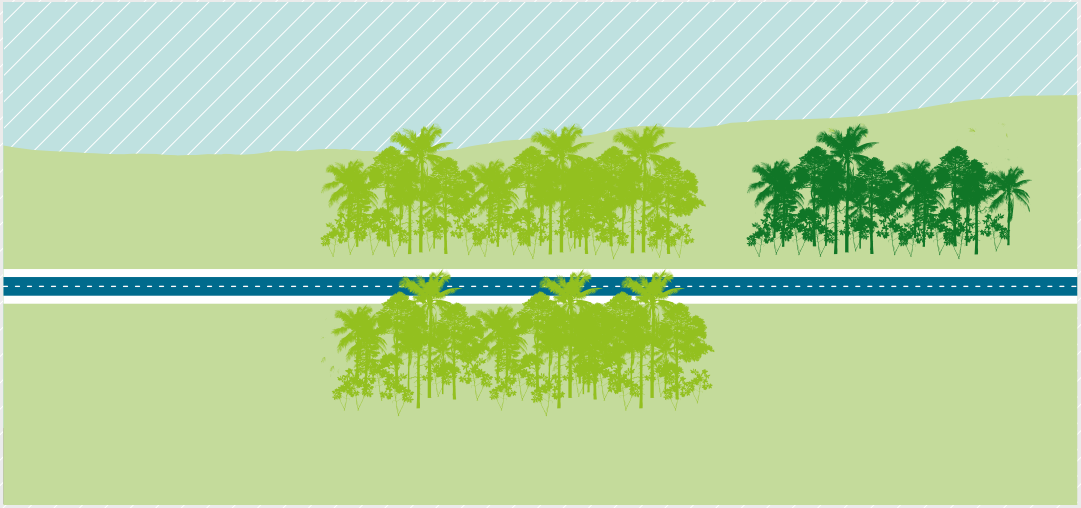
48 Adapted from Mandle L., Tallis H., Vogl A., Wolny S., Touval J., Sotomayor L., Vargas S. and Rosenthal A. 2013

FIGURE 13: ILLUSTRATIVE APPLICATION OF IMPACT OFFSETTING FOR NATURAL CAPITAL IMPACTS OF ROAD CONSTRUCTION

Original natural capital asset (forest ecosystem)



Road construction without natural capital offsetting



Natural capital losses offset with ecologically equivalent gains

06. CONCLUSIONS & RECOMMENDATIONS FOR KEY STAKEHOLDERS

Roads in the BRI's East–West and North–South corridors could make significant contributions to Myanmar's social, economic, and infrastructure development. This report highlighted the extent to which BRI road infrastructure can impact on natural capital including the important benefits it provides to millions of people and infrastructure itself. It also showed how the resilience of BRI road corridors depends on ecosystem services—in particular the water and sediment flow regulation services provided by forests, which reduce risks of landslides, erosion and flooding. The analysis in this report highlighted some areas and specific locations, where potential unexpected costs could arise from the environmental impact of the proposed BRI infrastructure development. This points to the need for further more in-depth analysis and consideration of mitigation measures in these areas.

The following initial recommendations to decision-makers in the Government of Myanmar, and to investors and companies in BRI road project should be considered:

RECOMMENDATIONS

FOR THE GOVERNMENT OF MYANMAR

NATIONAL SUSTAINABLE INFRASTRUCTURE PLAN. Undertake infrastructure planning at the national scale to identify 'no-go areas' and evaluate alternative BRI corridors. Avoid critical areas, including areas important for biodiversity and ecosystem services.

SUSTAINABLE INFRASTRUCTURE DEVELOPMENT GUIDELINES. Consider developing guidelines or criteria or apply global sustainability standards, such as The SuRe® – The Standard for Sustainable and Resilient Infrastructure, to guide sustainable infrastructure planning, finance and design. Such an approach would provide benefits to the environment, economy, and society, and to the road infrastructure itself.

COST BENEFIT ASSESSMENTS. Develop more detailed versions of the cost benefit assessments in potential risk areas highlighted in this report and gradually incorporate into Government approval and planning processes for road development. Impacts on natural capital and ecosystem services should be incorporated into the earliest possible stages of planning. Support for these efforts should be sought from development partners and BRI project proponents and investors.

STRATEGIC ENVIRONMENTAL ASSESSMENT. Undertake a Strategic Environmental Assessment for the entire BRI to better assess economic, social and environmental risks and required policies and plans to avoid and minimize these risks.

ENVIRONMENTAL DATA COLLECTION. Expand collection of environmental data and information for highlighted risk areas in this report (especially related to biodiversity and ecosystem services) within existing institutional structures established to implement the National Strategy for Development of Statistics. Such activities will support decision-makers to make more comprehensive assessments of the costs and benefits of BRI road infrastructure.

POLICY DEVELOPMENT. Identify policy measures (beyond simply subsidies) that could open up greater commercial space for sustainable road construction to a high standard. Communicate these with investors and develop a dialogue on collaborative action / public/private partnerships to deliver the BRI.

CIVIL SOCIETY AND COMMUNITY PARTICIPATION. Include and facilitate participation of communities and civil society at all stages of planning, design and implementation of BRI. Collaborate with communities and civil society organisations located along East-West and North-South road corridors to conduct local needs assessments to inform decision making about alignment and design of road construction in both corridors. Such assessments are important because they can help to identify non-quantifiable cultural and social preferences regarding natural capital and road infrastructure.

INTERGOVERNMENTAL POLICY DIALOGUE. Engage in intergovernmental dialogue with environmental regulators in China to ensure that China's ambitious sustainability objectives for the BRI are complied with by Chinese companies and investors.

FOR INVESTORS AND COMPANIES

BEST STANDARDS. Adopt and comply with standards in accordance with the *"Guidance on the Building of the Green Belt and Road"* (Ministry of Environmental Protection of China) and consider using The SuRe® – The Standard for Sustainable and Resilient Infrastructure and other relevant sustainability standards and safeguards.

NATURAL CAPITAL ASSESSMENT. Undertake a more comprehensive assessment of natural capital (beyond the 3 services and 4 conservation datasets included in this report but based on identified risk areas) to enable robust decision-making to ensure that natural capital impacts and risks are properly considered. Accounting for natural capital impacts can increase the resilience of BRI road infrastructure in Myanmar and mitigate the significant associated risks to credit, reputation, regulatory compliance, and timely project delivery.

BIODIVERISTY EXPERTS. Include biodiversity experts in the project planning and design, which can help reduce risks and impacts from BRI on biodiversity in Myanmar.

AVOIDANCE OF IMPACTS. Avoid critical areas, including areas important for biodiversity and providing ecosystem services, when deciding location for road corridors.

TOOLS. Identify and use tools that can support cost-effective integration of natural capital into decision-making about BRI road projects and related infrastructure. A range of tools and approaches (e.g. The Natural Capital Protocol, Roads Filter, ESRforIA - see the Natural Capital Protocol Toolkit for more examples) can be used by investors and project developers to better assess risks and improve decision-making.

ECONOMIC VALUATION OF NATURAL CAPITAL. Quantify, where appropriate and feasible, the economic value of natural capital and integrate into BRI corridor planning and design.

COST ASSESSMENT OF FLOODS AND LANDSLIDES. Assess costs of road delay as a result of floods or landslides. If roads are toll roads, this could be one cost to include as a result of road closures.

SUSTAINABLE DESIGN. Include design options that can enhance environmental, social and economic benefits, including buffer zones, re-vegetation of slopes and biodiversity and habitat corridors.

ENVIRONMENTAL IMPACT ASSSESSMENT. Undertake high-quality Environmental Impact Assessments and Environmental Management Plans of BRI road projects with special consideration of impacts (including cumulative) on natural capital, including biodiversity and ecosystem services. Assessment of impacts on flood risk reduction by natural capital could build on existing work by WWF and others.

CIVIL SOCIETY PARTICIPATION. Work with Myanmar civil society at all levels and all stages of project planning to avoid negative social and environmental impacts optimize benefit sharing of the BRI in Myanmar.

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