

OCTOBER 2017

Is Asia Reconnecting?

Essays on Asia's Infrastructure Contest

EDITOR

Jonathan E. Hillman

CONTRIBUTING AUTHORS

Atif Ansar
Lawson W. Brigham
Mary R. Brooks
Heather A. Conley
Louisa Denier
Thomas Fingar
Bent Flyvbjerg

Georg Inderst
Genia Kostka
Melba Kurman
Johannes F. Linn
Matthew Melino
Christopher Miller
Arild Moe

Sebastien Peyrouse
Catherine L. Phipps
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Center for Strategic & International Studies
1616 Rhode Island Avenue, NW
Washington, DC 20036
202-887-0200 | www.csis.org

Rowman & Littlefield
4501 Forbes Boulevard
Lanham, MD 20706
301-459-3366 | www.rowman.com

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Preface

“Eurasia is thus the chessboard on which the struggle for global primacy continues to be played,” the late Dr. Zbigniew Brzezinski wrote two decades ago. His words ring true again as a massive infrastructure competition unfolds across the Eurasian supercontinent. If the roads, railways, and other connections that are emerging today shift flows of goods, people, and ideas, the long-term implications could be profound.

CSIS launched the Reconnecting Asia Project to make sense of these developments. Our website, ReconnectingAsia.CSIS.org, has a growing database of over 2,100 projects and an interactive map that tracks what is happening on the ground. In our Big Questions series, leading experts respond to wide-ranging questions. This report includes highlights from the first six questions posed in the series.

The Big Questions series begins with the biggest question of all: Is Asia reconnecting? Until the rise of Europe’s colonial powers in the sixteenth century, many of the world’s most important trading routes ran overland. Today, emerging overland routes aim to shift trade away from the sea, where 90 percent of international trade currently travels. As our experts point out in Chapter 1, many obstacles—economic, political, and strategic—stand in the way of this potentially epochal shift.

With a frenzy of investment and construction in recent years, Asia has in some respects become the world’s infrastructure laboratory. Reflecting this trend, China overtook the United States as the global leader in built assets in 2015, while three of the top four per-capita leaders were also in the region (Singapore, Hong Kong, and Japan). In Chapter 2, experts consider what the rest of the world could learn from Asia about how—and how not—to make infrastructure investments.

Just as the compass and the domesticated camel facilitated greater mobility in ancient times, emerging technologies could impact Asia’s economic landscape. In Chapter 3, experts examine how automation could impact existing modes of transportation, whether shipping terminals on the water or driverless cars on land. They also considered an entirely new form of transportation: the Hyperloop concept popularized by Elon Musk.

Greater connectivity can also create unintended consequences. The ancient Silk Road, for example, carried not just commerce, but also disease. In Chapter 4, experts consider how greater connectivity could impact the movement of illicit drugs, wildlife trafficking, and infections. New roads, railways, and ports are not the primary drivers of these challenges, but could exacerbate them if policy is not updated to reflect an increasingly integrated region.

New connections are emerging in the Arctic as well. During the past year, Arctic sea ice has dropped to record lows. In August, a Russian tanker became the first ship to complete the Northern Sea Route, traveling from Norway to South Korea and shaving days off the dominant route through the Suez Canal. In Chapter 5, experts consider how the Arctic's transformation might impact economic opportunities and what factors will drive or delay the region's future development.

Economics has been our primary lens, but we have begun to consider strategic implications as well. History is filled with infrastructure projects that have advanced national security and foreign policy objectives. The same road network that Darius the Great used to rule the Persian empire was used by Alexander the Great to conquer it. In Chapter 6, experts consider how ports and railways transformed Japan, India, and Russia, and what lessons those cases hold for today.

Eurasia's infrastructure game is still heating up, and it could take decades before these questions are fully answered. Eurasia remains the chessboard for global primacy, but the nature of that game has not remained static. Military power still matters, but economics has taken center stage. Infrastructure has become a more important tool for accumulating power as well as exercising it. As the world's economic center of gravity continues moving east, the stakes of this game are likely to rise even higher.

Acknowledgments

This report was a truly collaborative effort. Thanks are due first and foremost to the scholars who participated in our Big Questions series. They tackled complex questions while speaking to a broader audience and meeting our unreasonable word limits. Their hard work left us with a good problem: there were too many responses to include in this first volume. Thankfully, readers can find the rest of the series at the Reconnecting Asia website (<https://reconnectingasia.csis.org/>). Matthew Goodman provided the intellectual guidance behind the questions, Maesea McCalpin kept the series on track, and the Brzezinski Institute on Geostrategy provided generous support.

Overland Connections

A SILK ROAD FOR THE TWENTY-FIRST CENTURY?

Thomas Fingar

Xi Jinping's 2013 call for China and the states of Central Asia to build a modern-day Silk Road to facilitate the movement of goods and people between Europe and Asia is a good idea that has been blown out of proportion by a variety of Chinese and non-Chinese commentators. Viewed from any perspective, the existing regional infrastructure is woefully inadequate and an obstacle to greater prosperity, economic integration, and political change. Many of the proposed projects will be delayed or never built, but those that are built will transform the region.

Geopolitical Considerations

Geography and geopolitics explain, in part, the current pattern of roads, railroads, pipelines, and other regional infrastructure. They also help explain why countries seek to change the current situation. By the time railroads and internal combustion engines began to transform other inland regions, Central Asia had been incorporated into the Russian empire and its Soviet successor. For political and economic reasons, infrastructure projects were designed to strengthen dependence on Moscow and impede options for interaction with Asia and Europe. The now independent countries of Central Asia are eager to complement existing routes in order to reduce dependence on Russia, expand economic opportunities, and establish links to China, South Asia, and Europe that will counterbalance Russia's current advantages. China, in particular, wants to use infrastructure development to increase Beijing's influence and to constrain that of Russia and India, among others.

Economic Considerations

Infrastructure is a public good that is usually constructed by governments because only governments have the broad interests and access to funding required to undertake the construction of roads, bridges, power grids, and the like. The need is great, but given the distances involved, the

demographics of Central Asian states, and the alternatives available, governments in the region would find it difficult to obtain funding or amortize more than a limited number of projects on their own. Many proposed projects might never be economically viable, so if they are to be built, they must promise economic and/or geopolitical benefits to external actors. In the case of Central Asia, the key external actor is China, which seems willing to commit substantial funds in order to gain access to hydrocarbons, metals, minerals, and markets; to expand economic opportunities for people living in its frontier regions; and to increase its political profile and influence in a region Beijing considers important for security and stability reasons.

Beijing's reasons for promoting infrastructure development in 2013 through the Belt and Road Initiative include, in addition to those noted above, the desire to use external projects to sop up some of China's excess capacity to produce cement, steel, and construction equipment and maintain employment in these industries and the construction sector, and to make better use of foreign exchange reserves that it does not want to repatriate for fear of fueling inflation. When Xi made his initial proposal, it was widely assumed that China would "pay" for the projects through some combination of grants and concessionary loans in exchange for access and, possibly, recipient country endorsement of Beijing's position on certain international issues. Establishment of the Asian Infrastructure Investment Bank (AIIB), substantial drawdown of China's foreign exchange holdings, and the prospect of difficulty obtaining repayment from African countries that over-borrowed from China when commodity prices were high now make it appear that China will use the cover of multilateral lending to reduce the risk of default. That would constrain the number of projects undertaken.

Developmental Considerations

Infrastructure can be enormously beneficial, but only if projects are well chosen and well executed. Prestige and make-work projects may add little to long-term growth or deeper integration into production or supply chains, but well-conceived projects can jumpstart local economies, facilitate economies of scale, and enhance prosperity and quality of life. Economic viability is one consideration, but so too are environmental impact and opportunity costs. Given systemic problems such as corruption and capacity limitations, one cannot assume that all projects undertaken in the region will be optimized for long-term and spin-off benefits. "Good" projects will create synergies and generate benefits that enhance prosperity, regional integration, and overall capacity. "Bad" projects will have the opposite effects.

What to Expect

What actually happens over the next decade or more is likely to be considerably less extensive or consequential than predicted by over-enthusiastic boosters and those who forecast benefits to China at the expense of the United States and the West more broadly. Local impacts—within and among the countries of Central Asia—are likely to be more significant than the impact on countries at the eastern and western ends of the new Silk Road. Most commercial traffic and most people moving between Europe and Asia will continue to move by sea and air respectively, but regional and subregional integration and prosperity could increase substantially. Prosperity and other dimensions of modernization will change societies (e.g., they will become better educated, better

informed, more urbanized, and more demanding) and this will transform the political landscape. The future Eurasia will look more like an upgraded version of the present than a restoration of the past.

WHITHER EURASIAN INTEGRATION?

Johannes F. Linn

With the fall of the Bamboo Curtain in Asia and the Iron Curtain in Europe, the progressive economic integration of the Greater Eurasian supercontinent became possible and by now it has become seemingly inevitable, especially after China announced its Belt and Road Initiative in 2013.

Major infrastructure investments¹ are under implementation or on the drawing board, supported by China, India, Russia, the EU, and international financial organizations. They are designed to provide East-West and North-South connectivity across Greater Eurasia for energy, transportation, and telecommunications, thereby accelerating the integration of the huge Greater Eurasian geographic and economic space. In the past, infrastructure investments have spurred economic integration in Western Europe, North America, the Soviet Union, and most recently in China. Indeed, Greater Eurasian economic integration can be seen as the last frontier of the economic globalization process that has characterized the seven decades since the end of World War II.

However, in considering the prospects of Eurasian economic integration seven obstacles and risks need to be considered, which may impede the process, even though they will likely not derail it altogether.

First, investments in roads, pipelines, and other “hard” infrastructure projects are generally relatively easy to plan and carry out, as long as there are financial resources and the readiness of countries to cooperate across borders for cross-border networks. But two key challenges arise, beginning with the need for systematic planning and implementation of network-wide improvements. Long-distance communication is only as good as the weakest link along the way. This requires the integration of national and regional plans, which is generally extremely weak or altogether absent. Furthermore, operating and maintaining a vast network of new infrastructure creates huge challenges for national governments. The public finances needed to pay for the debts created by these investments and to sustain the infrastructure often cannot be mobilized in today’s constrained national budgets. The institutional capacity to efficiently run and maintain the physical investments is missing in many Eurasian countries, especially the poorer ones.

Second, even more problematic is the provision of the “soft” aspects of efficient connectivity. For transportation, this includes the development of intermodal connectivity, including efficient customs, health, and other procedures for border clearances, and an absence of corrupt traffic police and other transit impediments behind the border. For trade, this means low tariff and nontariff barriers, and effective logistical services. For interconnected power systems, it means

1. “Our Bulldozers, Our Rules: China’s Foreign Policy Could Reshape a Good Part of the World Economy,” *Economist*, July 2, 2016, <https://www.economist.com/news/china/21701505-chinas-foreign-policy-could-reshape-good-part-world-economy-our-bulldozers-our-rules>.

cooperation among power regulators and dispatchers. For all major infrastructure investments, it means that the economic, environmental, and social impacts on local communities are fully considered, with detrimental impacts minimized as far as possible and positive development impacts along the infrastructure corridors maximized. None of these soft aspects of infrastructure provision are currently well supplied in many parts of the Eurasian continental space.

Third, the allocation of scarce cross-border natural resources, especially water and in some cases energy, is a common irritant to neighborly relations in some parts of Eurasia. Some Eurasian neighbors have shown that long-standing conflicts over cross-border resources can be amicably settled, as in the case of European riparians of the Rhine and Danube Rivers, and as between India and Pakistan for the Indus River. However, other regions of Eurasia have a long way to go, especially Central Asia and Southeast Asia, including China. The scope for misallocation of natural resources and for conflict over them is therefore significant.

Fourth, in some regions of Eurasia conflicts and security are a major constraint to greater integration, especially in the belt of conflict that stretches from the Middle East through parts of the Caucasus and of Central Asia, to the Indian subcontinent, and now even to the East China Sea. Whether it is closed borders as between Armenia and Turkey and between India and Pakistan, or civil war disrupting transportation routes as in Afghanistan, or international terrorist attacks on major transportation hubs as recently at Ataturk Airport in Istanbul, conflicts and insecurity cause disruptions to and raise the costs of transportation, communications, trade, and investment. In the future, cyber-crime may also disrupt electronic communication links across Eurasia, as can also happen anywhere in the world.

Fifth, on a wider scale, geopolitical competition among major powers inside and outside the region may interfere with the progress of Eurasian integration. The sanctions against Iran, albeit now lifted, have been a significant impediment to Iran's integration into Eurasia. The Western sanctions against Russia have reversed the trend toward greater economic links between Russia and Europe. The big question for the future of Eurasian economic integration is whether the relations among major Eurasian powers in the twenty-first century will be more like the peaceful and cooperative relations European countries were able to forge in the post-World War II era, or whether Eurasia will face a future of major-power conflicts as was typical for Europe until the mid-twentieth century. The apparent breakdown of the post-World War II political order in Europe over Ukraine and the escalating tensions in the East and South China Seas are a reminder that Eurasian integration faces many geopolitical challenges.

Sixth, there are some additional risks that can cause significant, continent-wide disruptions in Eurasia, including epidemics such as the bird flu, illicit drug trade, cross-border criminality, and demographic pressures such as refugees and illegal migration. Climate change may reinforce some of these risks, due to increased pressures on water, land, and other limited natural resources.

Finally, successful supercontinental economic integration requires the development of some minimal institutional structures to help plan and finance investments, harmonize regulations, and mediate tensions and conflicts. Currently such institutional infrastructure in Eurasia is almost entirely absent. The Asia-Europe Meeting (ASEM) brings together the heads of 53 states of the region for biannual summits, but misses some important countries and it is more form than

substance. Subregional institutions are either limited in membership, weak, or—in the case of the EU—subject to significant centrifugal pressures. Ultimately, it is not clear that the governments of the Eurasian countries will have the will to surrender parts of their sovereignty to supranational regional institutions, or that their populations are willing to support greater integration, as scepticisms about the benefits of globalization are dramatically on the rise in many countries.

Three institutional innovations might help mitigate the obstacles and risks. The first is upgrading ASEM along the lines suggested by Michael Emerson.² Second, a Eurasian steering group of major Eurasian powers, similar to the Group of Twenty (G20) at the global level, could be established. One compromise for membership might be a combination of permanent membership for major powers and rotating or constituency-based membership for smaller countries. Third, a coalition of key multilateral development banks could provide a platform for the systematic planning, financing, implementation, and institution building of Eurasian regional infrastructure. Some of these organizations already cooperate under subregional umbrellas and on specific infrastructure projects.

Given all the potential obstacles and risks, is Eurasian economic integration a mirage? Definitely not so. Economic integration is happening and will continue, as the supercontinent catches up with globalization elsewhere in the world. But it will likely proceed fitfully and remain partial, wracked by tensions and even open conflicts. Above all, institutional support will be needed for effective cooperation across the many borders of Eurasia.

MARCO POLO AND THE MONGOL HORDES

Christopher Miller

The leaders seeking to rebuild connections across Eurasia's vast landmass might not like to be compared to the great Mongol warlord and empire builder Genghis Khan. The harder edges of Mongol rule—whole cities razed, bones and skulls scattered over vast territories—are the exact opposite of the hopeful images that China, in particular, hopes that its trade initiatives will inspire. But to understand today's efforts to reconnect Eurasia, the Great Khan provides useful lessons.

The Mongol empire, which lasted from the early thirteen century to the mid-fourteenth century, stretched from Khiva to Hangzhou, Krakow to Karakorum. The Mongols were not the first people to trade over the Silk Road, but no one did more to facilitate exchanges across the vast Eurasian landmass. Travel times decreased, and overlapping customs tariffs were eliminated. The Mongols established a postal system, and built the roads that Marco Polo traveled. If the Belt and Road Initiative works a fraction as well as did the Mongols' trading bloc, Beijing will consider it a great success.

Yet not all Eurasian exchanges were positive. Silk and spices traversed Eurasia, but so too did viruses and bacteria. The spread of the Black Death, which killed even more people than did Mongol armies, was likely facilitated by the Mongols' success in rejuvenating Silk Road exchanges.

2. Michael Emerson et al., *Upgrading the EU's Role as Global Actor: Institutions, Law, and the Restructuring of European Diplomacy* (Brussels: Centre for European Policy Studies, 2011), 111, <https://www.ceps.eu/system/files/book/2011/01/Upgrading%20the%20EU%20as%20Global%20Actor%20e-version.pdf>.

Other effects of Mongol rule were unexpected, such as the rise of the Grand Duchy of Moscow, which long collected taxes on cross-continental trade and remitted the proceeds to its Mongol overlords. When Mongol rule finally dissipated, the Grand Duchy began to build an empire in many of the lands Genghis Khan formerly controlled.

The success of the overland Silk Road trade routes, however, fueled their own demise. Great wealth flowed to the powers that dominated Eurasian trade—first the Mongols, later others—inspiring jealousy and resistance. Portuguese and Spanish adventurers took to the Atlantic in the fifteenth century, seeking a water route around Eurasia. When Columbus landed in the Caribbean in 1492, he hoped he had arrived at an Indian spice port, thus breaking the monopoly on Eurasian trade.

The greatest power shift of the last millennium—the rise of seaborne empires centered on Europe’s Atlantic coast—was driven, therefore, by competition for Eurasian trade. After the Spanish or Portuguese explorers, seaborne transit was cheaper and, for a long time, faster than travel by land. For several centuries, technological innovation in sailing outpaced that of land-based transport, pushing more Eurasian trade away from Silk Road caravans into the hulls of the growing fleets, soon steam-powered, that plied intercontinental trade routes.

The rise of railroads might have changed this. Russia’s czars, who in the centuries after casting off Mongol rule united the territory from St. Petersburg to Vladivostok, realized the strategic implications of a transcontinental railroad. In 1916, Russia finally finished a line through the Siberian tundra, the first railway to connect the Atlantic and Pacific via Eurasia. But the Russian empire fell the following year. The Soviet Union, which inherited the czarist railway infrastructure, was too insular and too inefficient to turn the Trans-Siberian Railway into a challenger for seaborne or, increasingly, airborne trade.

Now it is China’s turn. Like its predecessors, China’s efforts at unifying Eurasia are driven by several factors: a desire to boost trade, a need to find new markets for firms struggling with overcapacity at home, and a desire to set the rules of the new Silk Road. Will China be more successful than its predecessors?

The fate of Genghis Khan and the Russian czars provide some lessons. One is that uniting Eurasia’s economies is only in part a technological challenge. The Trans-Siberian Railway did less to boost Eurasian trade than might have been expected due to politics and poor management. Beijing is betting, at least for now, that soft power coupled with inexpensive loans can reduce trade barriers despite Eurasia’s thorny politics. The Mongols exercised soft power too, supporting literacy, trade, and some religious freedom. But the Khans also paraded their enemies’ severed heads on the highways that crisscrossed their empire, a reminder of the hard power that undergirded their rule.

Economics dictates that transcontinental commerce is likely to increase. Efforts to cut shipping time and transaction costs on Eurasian trade routes, whether proposed by China, Russia, or anyone else, are only to be encouraged. Yet history suggests that the struggle for control of the lucrative trade between Europe and Asia is unlikely to be left solely to businesses, nor will it be determined solely by commercial factors. Eurasian trade routes have always been a matter for high politics and for grand geopolitical designs. Marco Polo may have benefited from the Mongols’ efficient roads, but it was the cavalry of the Mongol hordes that cleared his route to China.

The World's Infrastructure Laboratory

CHINA'S INFRASTRUCTURE BOOM THREATENS ITS ECONOMIC PROSPERITY

Atif Ansar and Bent Flyvbjerg

A typical Chinese infrastructure investment suffers a double whammy of cost overruns and benefit shortfalls so large that it destroys economic value. There is an even more detrimental boomerang effect of infrastructure overinvestment. Unproductive projects carry unintended pernicious macroeconomic consequences: sovereign debt overhang, unprecedented monetary expansion, and economic fragility.

Low-quality infrastructure investments pose significant risk to the Chinese economy. Unless China shifts to fewer and higher-quality infrastructure investments, the country is headed for an infrastructure-led national financial and economic crisis, which is likely to spread to the international economy.

We reached these conclusions based on an analysis of 95 large Chinese road and rail transport projects and 806 transport projects built in rich democracies, the largest dataset of its kind. Our China study is part of a larger ongoing investigation¹ of large-scale projects around the world at the University of Oxford's Saïd Business School. We were thus able to report valid international comparisons between China and many of the rich democracies in the Americas, Europe, and Asia Pacific for the first time.

The salient findings are fivefold. First, China is now the world's biggest spender on fixed assets in absolute terms. The scale and speed of China's investment boom are staggering. China spent \$4.6 trillion in 2014, accounting for 24.8 percent of worldwide total investments and more than double the entire gross domestic product (GDP) of India. By way of comparison, China's total domestic

1. Atif Ansar et al., "Does Infrastructure Investment Lead to Economic Growth or Economic Fragility? Evidence from China," *Oxford Review of Economic Policy* 32, no. 3 (July 2016): 360–390.

investment was merely 2.1 percent of the world total in 1982. Undoubtedly, China has been in the grips of the biggest investment boom in history for over 15 years.

Second, in line with global trends, in China actual infrastructure construction costs are on average 30.6 percent higher than estimated costs, in real terms, measured from the final business case. The evidence is overwhelming that costs are systematically biased toward underestimation.

Third, in terms of absolute construction time schedule overrun, China performs better than rich democracies. In democracies, politicians seem to have an incentive to over-promise and then under-deliver. China has built infrastructure at impressive speed in the past but, it appears, by trading off due consideration for quality, safety, social equity, and the environment.

Fourth, with respect to traffic performance, demand in China represents two extremes. A majority of the routes witness paltry traffic volumes but a few routes are highly congested. Too little and too much traffic of this magnitude both indicate significant misallocation of resources.

Fifth, 55 percent of the projects were economically unviable at the outset of their operational lives. Another 17 percent of the projects generated a lower-than-forecasted benefit-to-cost ratio. Any future risks, such as greater-than-expected operation and maintenance costs, can impair the future economic viability of these projects. Only 28 percent could be considered genuinely economically productive.

The pattern of cost overruns and benefit shortfalls in China's infrastructure investments is linked with China's growing debt problem. Cost overruns have equaled approximately one-third of China's \$28.2 trillion debt pile. China's debt-to-GDP ratio stands at over 280 percent, exceeding that of many advanced economies, such as the United States, and all developing economies for which data are available. Because many corporations and financial institutions in China are state owned, our revised calculation of China's implicit government debt as a proportion of GDP suggests that China's is the second-most indebted government in the world after Japan's. Extraordinary monetary expansion has accompanied China's piling debts: China's money supply, broadly defined, grew by \$12.9 trillion in 2007–2013, greater than the rest of the world combined. The result is increased financial and economic fragility.

The infrastructure policy implications of our research are three-fold. First, China's high-octane investment program in infrastructure is not a viable strategy for other developing countries such as Pakistan, Nigeria, or Brazil. Instead, China's is a model to avoid. It is a myth that China grew thanks largely to heavy infrastructure investment. It grew due to bold economic liberalization and institutional reforms, and this growth is now threatened by overinvestment in low-grade infrastructure. The lesson for other markets is that policymakers should place their attention on software and orgware issues (deep institutional reforms) and exercise far greater caution in diverting scarce resources to large-scale physical infrastructure projects.

Second, less is more when it comes to infrastructure investments. Infrastructure supports economic development if the investments are productive. This big "if" is all too often ignored in policy debates, leading to the predicament in which China now finds itself. Our findings suggest that had China focused on about a third of its most productive investments it would have reaped lasting economic benefits without the debt overhang it is currently suffering.

Finally, incurring huge piles of debt to fund infrastructure is a destabilizing strategy. New-Keynesian arguments that see public debt in a benign light are misguided at the level of debt we see in China. Negative macroeconomic impacts include volatile movements in interest, exchange, and inflation rates; unpredictable movements in asset prices, such as house prices and listed public equities; adverse growth outcomes; rising unemployment from deleveraging; and lack of capital to finance productive investments. Several of these negative consequences were already materializing in China in 2016.

ASIA'S INFRASTRUCTURE CULTURES

Georg Inderst

Since the 1980s, infrastructure investment has been trending down in the Western developed world to a level of about 2.5 percent of GDP while rising to 5.5 percent in emerging markets. East Asia is often seen as leading in building infrastructure. But the picture is rather mixed across the continent. Japan and China have the highest capital expenditure in infrastructure at 5 percent and over 8 percent of GDP respectively,² while South Asia (4 percent)³ and Southeast Asia (2–3 percent)⁴ are well below the required levels of 6–7 percent of GDP.

Dominance of State Funding and Finance

Is there an “Asian model”? It is worth taking a closer look before jumping to conclusions. Asia is, of course, not a homogeneous continent, but there are some interesting features in relation to infrastructure investment and finance:

- Asia's infrastructure is mainly driven by the state. The ratio of public to private finance is 2:1 to 3:1 or higher,⁵ compared to a ratio of roughly 1:2 in Europe and North America.
- The private sector still plays a subdued role in Asian infrastructure, often supported by substantial government subsidies and guarantees. Both privatizations and public-private partnerships (PPPs) are below the global average.
- Private participation in infrastructure investment is still only 0.1–0.2 percent of GDP in most of Asia, and much lower than the global emerging markets average of 0.6–0.8 percent.⁶

2. Richard Dobbs et al., *Infrastructure Productivity: How to Save \$1 Trillion a Year* (n.p.: McKinsey Global Institute, 2013), 12, <http://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/infrastructure-productivity>.

3. Shahrokh Fardoust et al., ed., *Postcrisis Growth and Development: A Development Agenda for the G-20* (Washington, DC: World Bank, 2011), 366, <https://openknowledge.worldbank.org/bitstream/handle/10986/2533/582810PUB0ID231crisis09780821385180.pdf?sequence=1&isAllowed=y>.

4. Biswa Nath Bhattacharyay et al., ed., *Infrastructure for Asian Connectivity* (Cheltenham: Edward Elgar, 2012), 38, 51.

5. Georg Inderst, *Infrastructure Investment, Private Finance, and Institutional Investors: Asia from a Global Perspective*, ADBI Working Paper 555 (Tokyo: Asian Development Bank Institute, 2016), 9–10, <http://www20.iadb.org/intal/catalogo/PE/2016/16479.pdf>.

6. Henry Kaspar, “2014 Global PPI Update,” World Bank, 2014, http://ppi.worldbank.org/~/_/media/GIAWB/PPI/Documents/Global-Notes/Global2014-PPI-Update.pdf.

Asia's project finance is very dependent on bank loans, especially from state-owned banks and development institutions. Nontraditional and foreign lenders are frequently deterred by low credit standards and excessively inexpensive funds from public banks.

Scope for More Private Market Development

There is scope for more securitization in this field, even in countries with relatively advanced capital markets such as Korea, Taiwan, or Thailand that provide, for example, stocks and corporate bonds of utility companies. The use of project bonds⁷ or U.S.-style revenue bonds⁸ is still tiny overall, although interest is rising in some places.

Faced with budgetary and banking problems, many Asian governments are now trying to find new sources of infrastructure finance, especially from institutional investors. However, the local scene is rather concentrated, with a predominance of public or semipublic institutions.

The Asian private pension systems are very small. Very sizeable public pension reserve and social security plans in the region have total assets of about \$2.5 trillion. Asia also has a significant share (40 percent) of global sovereign wealth funds, and there is massive capital with other public institutions, including central banks.

Conservative Investment Policies and Regulation

Most Asian investors traditionally run very conservative investment policies with a high allocation to domestic government bonds and deposits. Investor regulation tends to keep insurers and pension funds away from riskier and less liquid assets such as infrastructure debt and equity. Some change is under way. For example, the world's largest pension scheme, Japan's Government Pension Investment Fund, started to move into infrastructure in 2015. But higher commitments to real assets do not necessarily mean more finance for Asian infrastructure. Singaporean and Chinese Sovereign Wealth Funds, for example, have been very active in European real estate and infrastructure markets in recent years, and so has the Korean National Pensions Service.

What about international investors? Asia's attractiveness has so far been subpar. There are widespread restrictions on foreign direct investment in infrastructure sectors, not only in China but also in most Association of Southeast Asian Nations (ASEAN) and South Asian countries.⁹ Other factors that make life difficult for potential foreign investors include cryptic regulations and land laws, bureaucracy, and judicial processes.

7. Alexandra Heath and Matthew Read, ed., *Financial Flow and Infrastructure Financing* (Sydney: Reserve Bank of Australia, 2014), 67–91, <https://www.rba.gov.au/publications/confs/2014/pdf/conf-vol-2014.pdf>.

8. Asian Development Bank (ADB), *Local Currency Bonds and Infrastructure Finance in ASEAN+3* (Manila: ADB, July 2015), <https://www.adb.org/publications/local-currency-bonds-and-infrastructure-finance-asean3>.

9. Shubhomoy Ray, *Infrastructure Finance and Financial Sector Development*, ADBI Working Paper 522 (Tokyo: Asian Development Bank Institute, March 2015), 5, 29–32, <https://www.adb.org/sites/default/files/publication/159842/adbi-wp522.pdf>.

An “East Asian Model”?

In a nutshell, there are certain commonalities across Asia but is there an “Asian model”? If any, it would apply to East Asia’s massive public expenditure programs from abundant state budgets on the back of strong export revenues. This also drives the construction, engineering, and related industries to the extent they can be exported worldwide. It is also remarkable that, at the same time, China has managed to become the largest producer of renewable energies with many highly competitive companies. But not many countries are in such a position.

Nor should other countries follow such models, at least not fully, despite the visible successes. Japan ended up with expensive overcapacities and a massive debt burden. Even China is changing its reliance on heavy state spending at all levels and on easy credit from domestic public banks and local government financing vehicles.

What other lessons can we glean from Asia? Most of them are not dissimilar to other regions.

Diversity of Infrastructure Cultures

Different approaches work in different places. Korea, Taiwan, and Hong Kong, for example, are following a more open model with capital markets that attract private and international investors. India has seen substantial domestic private activity in project finance and private equity funds. Malaysia has developed the world’s biggest market for *sukuk* (Arab financial certificates), including Islamic infrastructure bonds. Other countries are following these footsteps. More generally, people’s views on ownership and funding of infrastructure vary considerably across the globe. Many emerging countries find it easier to divest in telecommunications than in transportation. Water, sewage, and even electricity are often considered free goods. Western societies, too, disagree on issues such as road pricing, privatization of water or railways, nuclear energy projects, climate change policies, or strategic infrastructure assets.

Public-private partnerships (PPPs), in particular, take plenty of time and trust to develop. They also tend to be cyclical, even in developed markets such as the United Kingdom. PPPs were booming in Indian energy when bank loans were easily available, but volumes have fallen back.

Investor Governance and Regulation

Private finance of infrastructure requires weighty long-term savings institutions with good governance and adequate investment policies.¹⁰ They can help rebalance the wide maturity mismatch between short-term bank deposits and long-term project financing. A few things can be learned from the Pacific examples of Australia, New Zealand, and Canada about institutional investor involvement. Long-term investing requires continuity and predictability of the legal and institutional environment. Coinvestment of domestic and international institutions is often a good idea in order to combine local knowledge with external discipline.

10. Georg Inderst and Fiona Stewart, *Institutional Investment in Infrastructure in Emerging Markets and Developing Economies* (Washington, DC: Public-Private Infrastructure Advisory Facility, 2014), 1–5, <http://documents.worldbank.org/curated/en/748551468337163636/pdf/913070BR0SecM20itutorial0investment.pdf>.

Policy Stability, Consistency, and Implementation

Infrastructure investment is inherently political. There is certainly merit in having dedicated infrastructure plans and institutions, as many Asian countries have set up. However, even with the best intentions at the top, they can be frustratingly slow, as Indonesia and the Philippines, for example, have experienced.

When the state is trying to facilitate private involvement, it is typically standing in its own way. Infrastructure investment is hindered by policy reversals, regulatory changes, poor implementation, and inconsistencies across government departments. The classic case in infrastructure finance is that fiscal incentives are counteracted by restrictive sectoral and financial regulations.

Politicians favor flashy new projects. More investment should go into maintenance, efficiency improvements, and renewal of existing infrastructure, especially in more developed places. Commonly, the long-term funding of mega-projects is opaque, and the social and ecological cost-benefit analysis is inadequate or ignored.

Conclusion

So, what can be learned from Asia? There is probably more to learn about political determination than about infrastructure finance or setting the framework for private investment. Political leadership and consensus building are most needed for cross-border projects such as intercontinental railways or large distribution networks for energy, water, and communications.

With the Belt and Road Initiative announced in 2013, the fast establishment of the Asian Infrastructure Investment Bank, the construction of ports and railways in Africa and elsewhere, and by pushing green energy, China is demonstrating what has been lost in the West in recent times.

LESSONS FROM CHINA'S INFRASTRUCTURE BOOM

Genia Kostka

Among Asian countries, China has invested the most in large infrastructure projects. There is much to praise about China's infrastructure investment path, such as a remarkable scale and speed of infrastructure delivery. These achievements can be partly attributed to devising effective incentives for local government officials to invest in infrastructure; local officials received binding economic growth targets in their annual performance evaluations, triggering impressive infrastructure investments. One takeaway from the Chinese experience is that compared to the central government, local governments can be more effective in planning and delivering local infrastructure. For instance, in my research of 136 large infrastructure projects in China constructed between 1983 and 2015, I found that projects' cost and time overruns were lower when provincial or municipal governments were in charge rather than the national government. One lesson for other countries might be to consider whether it is feasible to delegate infrastructure planning and delivery to subnational governments.

Yet, there are also numerous mistakes China has made over the past decades that should be avoided by other countries. First, many of the investments in China have not been put to productive use. “Image projects”¹¹ were often planned to further the career of government officials and resulted in unproductive investments, such as oversized government buildings, massive public squares, or large, empty “ghost towns.” Many of the approved infrastructure projects did not undergo transparent bidding contests. Even if a bidding process was conducted, the cheapest offers often won at the cost of quality. This is a problem faced by many countries and is known as the problem of the “survival of the unfittest.”¹² As a result, in China today one can find much poorly built infrastructure, commonly referred to as Tofu buildings or Tofu projects.

Second, almost all of China’s local infrastructure projects were debt-financed. Local governments across China set up local government financing vehicles (LGFVs) to get around a formal ban on municipal bond issues, leading to reckless lending from state-owned banks to finance local infrastructure projects. LGFVs opened the door for soft budget constraints for local governments as they helped local governments to raise extra-budgetary finance outside authorization of the central government. Many of these investment approvals did not follow strict scrutinization and local LGFVs repeatedly faced financial troubles and did not repay their loans. By 2015, China had seen an exponential rise of local debt and local governments accumulated an infrastructure debt of more than \$1 trillion.¹³ One lesson here is that the use of local government financing vehicles can result in substantial infrastructure investments, but such financial platforms and accumulating debt levels need to be carefully monitored.

Finally, like many other countries in the world, China was also not very effective in planning and delivering infrastructure within budget and time frame. Drawing again on the database of 136 large infrastructure cases, findings show that cost overruns in rail projects were on average 35 percent, in hydro 32 percent, and in road 29 percent. This suggests that China is doing slightly better than the world in hydro, but the same or worse in rail and road infrastructure investments. Many of these cost overruns resulted from deficiencies in the governance arrangements. Typical examples here include inappropriate or complex governance set-ups and rent-seeking behavior by individuals or firms. These cost overruns could have furthermore been partly avoided if comprehensive front-end planning was adopted. That could include using sector-based benchmarking such as Reference Class Forecasting, a method of predicting the future costs and time budgets of a project by comparing it to actual outcomes of similar projects in the past. Supervisory bodies also need to be in place, staffed with experts in infrastructure project management.

11. Melia Robinson, “Surreal Photos of China’s Failed ‘City of the Future,’” *Business Insider*, January 29, 2016, <http://www.businessinsider.com/ordos-china-ghost-town-2017-5>.

12. Bent Flyvbjerg, “Survival of the Unfittest: Why the Worst Infrastructure Gets Built—And What We Can Do About It,” *Oxford Review of Economic Policy* 25, no. 3 (October 2009): 344–367.

13. Syetarn Hansakul and Hannah Levinger, “Asia Infrastructure Financing: Getting It Right Would Lift Medium-Term Growth,” Deutsche Bank, January 8, 2016, 7, http://www.iberglobal.com/files/2016/asia_infrastructure_db.pdf.

In sum, the China example shows that it will be important for other countries to invest not only in high-quality infrastructure, but to also dedicate sufficient thought in how best to plan and deliver these projects to stay within cost and time budgets. Three factors seem to be of particular importance. First, countries should promote transparency throughout a project's life cycle, including providing comprehensive information during the planning phase or competitive bidding processes. Second, sufficient thought should go into creating appropriate financing tools that do not bring financial instabilities. And finally, tight supervision and regular monitoring through supervisory boards is associated with better outcome.

Emerging Technology

DISRUPTION ON THE DOCKS

Mary R. Brooks

In 1991, Geoffrey Moore¹ wrote, in his famous marketing bestseller *Crossing the Chasm*, that the key to successful technology adoption by the marketplace was the marketing plan that recognized the benefits sought by early adopters (techies or geeks) were significantly different than those required by early majority purchasers (who would seek proven technologies without glitches). The differences in target market and product benefits created not merely a gap but a chasm that could doom many technologies to failure. Products that crossed the chasm would reshape the competitive landscape and the technology would become profitable and widely distributed. In Moore's third edition (2014), the examples have changed but the concept of disruptive technology adoption has not.

The popular press speculates as to which technologies will be disruptive in changing the competitive landscape, and which will not. Is container terminal automation a disruptive enough technology to change the competitive landscape of global trade?

Automation in container terminals is not exactly new technology, but rather has evolved as capital equipment replacements have been made. Full automation tends to come only with completely new terminal developments.

The world's first automated container terminal was developed in Rotterdam in the early 1990s. With the opening of the Delta/Sea-Land Terminal in 1993, Europe Container Terminals created the first modern automated container terminal. Automated guided vehicles (AGVs) transport boxes between the berth and container stacks and automated stacking cranes add or remove the boxes from the stacks. This fascinating and bold vision saw AGVs move boxes in a slow dance. As automation improved, new technologies made the process much faster.

1. Geoffrey Moore, *Crossing the Chasm* (New York, NY: HarperCollins, 1991).

By 2016, the new container terminal in Middle Harbor, Long Beach, boasted “no more humans” on the working terminal and truck turns of five minutes. The benefits were those initially envisioned by the early adopters (greater efficiencies resulting in lower costs and greater unit productivity), and many more. For truckers moving boxes to and from the terminal, safety was improved. Upon arrival at the automated terminal, the driver positions the truck, gets out of the cab, and walks to the adjacent protected driver area; the automated equipment does not unload the truck until the driver is sensed: to be in the safe zone. Instead of longshoremen on the terminal, operators are housed in comfortable, ergonomic workspaces with joysticks, and surrounded by computer screens. The port industry now has a different kind of worker doing a different kind of work as a result of choosing the technologies of full automation.

In addition to a focus on safety, the Long Beach facility design also paid much more attention to the type of equipment in use. In particular, the goal of zero emissions was a key factor in selling the technology to local community interests. Battery-driven container-handling equipment is quieter, addresses noise pollution concerns, and is generally more acceptable to a local community, which is capable of preventing new terminal development. Given the current number of new terminals globally, it can be argued that automated container terminals have crossed the chasm.

However, existing terminal capacity is over-built in many parts of the world. In North America, trade growth is slow; consumer purchases of imported products have been dampened by a migration to a greater sharing economy, and a larger share for services in the economy. The fastest growing container trade in the world is intra-Asian trade. It is here that the business case for automated terminal investment is strongest. In North America, investments in automation will be focused more on environmental factors like air pollution, noise pollution, and worker safety in addition to the reduction in labor uncertainty.

The decision about which port or terminal to use is more often driven by issues like route risk and diversification, labor strife, and competing offerings by shipping lines. Shipping line network configuration, own terminal investments, existing alliance partner investments, and availability of the cranes to service ever-larger ships are also critical factors. Much of recent investment in automated equipment at older terminals was just taking advantage of innovations when crane investment was made to achieve the greater reach required by wider ships.

Therefore, the reality is that changes to the economic geography of trade are less about terminal investment and more about responding to opportunities arising from the relocation of global manufacturing and distribution centers. It would be a mistake to assume that reducing the cost of moving a bottle of wine from Australia to New York by one cent, equivalent to a 10 percent improvement in transportation cost, would make a difference in the number of bottles of wine consumed and whether that wine is Californian or Australian. Reducing costs through terminal automation might trigger a review by a user of the port or terminal, but it is unlikely to be the primary factor in the competitive landscape.

Wherever the location, international trade requires long-game infrastructure investments with local impacts requiring social license for continued development. Both ports and shipping are industries currently recovering from an unprofitable operating environment, and automated equipment is not a small capital investment to finance. Therefore, while the chasm may have been

crossed, the growth trajectory for adoption in the early majority phase will be a long one; investments must have both clear business and social cases for the investors. The secondary nature of shipping as a driver of economic investment means that the terminal industry will respond to the new economic geography rather than lead the charge.

DRIVERLESS IN EURASIA

Melba Kurman

In 2007, two British motorists in a specially equipped Aston Martin undertook a record-breaking, 10,000-mile-long journey from Tokyo to London (a distance roughly equal to driving from Anchorage, Alaska, to Mexico City and back). Over the course of several weeks, they passed through Japan, South Korea, China, Kazakhstan, Kyrgyzstan, Uzbekistan, Azerbaijan, Georgia, Turkey, Bulgaria, Hungary, Austria, Germany, and France, where they took the Channel Tunnel to the United Kingdom. Several years after this ambitious undertaking, it is intriguing to ponder whether an autonomous vehicle, if programmed and “trained” appropriately, could successfully complete this same journey. Thanks to dramatic advances in artificial intelligence, the vehicle’s software would likely be able to handle the driving. However, I suspect the vehicle would be brought to a standstill by a decades-old problem that thwarts even the best human drivers: negotiating the border checkpoints to cross from one Eurasian country to the next.

Autonomous vehicles have the potential to reshape the continent of Asia’s economic geography, but they face infrastructure challenges unique to the region. First, briefly consider their potential benefits. Autonomous vehicles could reduce the annual global death toll from car accidents, a tragically high figure of an estimated 1.25 million lives each year.² Cities would be safer and cleaner. Projects are already afoot in Korea,³ China,⁴ Singapore,⁵ and Japan⁶ to build driverless cars and taxis that can use data and algorithms to efficiently guide themselves through troublesome (and polluting) traffic bottlenecks.

Given how rapidly the technology is maturing, autonomous vehicles have the potential to transform long-distance road transportation. On rural stretches of roadway, autonomous freight trucks could drive in tightly spaced platoons, reducing their wind resistance and therefore their fuel consumption. Because no human driver will be needed, merchants could adapt the size and shape of their autonomous delivery vehicles to the loads they need to ship, thereby saving on fuel costs. For example, a company that sells long steel beams would ship its wares on a heavy-duty

2. World Health Organization (WHO), *Global Status Report on Road Safety* (Geneva: WHO, 2015), 2, http://www.who.int/violence_injury_prevention/road_safety_status/2015/en/.

3. “S. Korea Begins Development of Test Bed for Self-Driving Cars,” Yonhap News Agency, August 9, 2016.

4. Xinhua, “China’s First Test Zone for Self-Driving Cars Opens,” *China Daily*, December 18, 2016.

5. Andrew J. Hawkins, “A Self-Driving Taxi Was Involved in a ‘Minor’ Accident in Singapore,” *Verge*, October 18, 2016, <https://www.theverge.com/2016/10/18/13317634/self-driving-car-accident-singapore-nutonomy-grab>.

6. Dan Frommer, “Japan Is Building a ‘Robot Taxi’ Service, with Thousands Planned for the 2020 Olympics,” *Quartz*, November 2, 2015, <https://qz.com/538758/japan-is-building-a-robot-taxi-service-with-thousands-planned-for-the-2020-olympics/>.

autonomous truck, while an organic farmer would send fresh foodstuffs to nearby markets using a platoon of small, lightweight refrigerated vehicles.

Finally, while still exploring the bright side, compared to other forms of land transportation, autonomous vehicles require less upfront investment in infrastructure. Building a mile of highway costs significantly less than building a mile of rail; specialized rail systems such as high-speed rail are even more expensive. Autonomous vehicles are not impacted by variances in national standards, such as differences in the width of railroad tracks. Finally, autonomous vehicles are essentially mobile robots with machine vision so (if specially equipped) they can drive over rough terrain; on highways they require very little supporting infrastructure technology to find their way (except, perhaps, the presence of crisp, painted-on lane markers so they can “see” the edges of the road).

Although Eurasian cities and nations could reap tremendous benefits from autonomous vehicles, one critical barrier remains: road border checkpoints. Should an autonomous passenger bus or freight truck attempt to conduct business across national borders, it would be quickly brought to a halt by the invisible walls that encircle each individual Asian and Middle Eastern nation. Until the region’s international highway system is equipped with an infrastructure that provides rapid and secure border crossings, individual nations will not reap the full economic benefits of autonomous vehicles.

Many Eurasian countries boast modern economies that are built on global tourism and a foundation of vast, elaborate global supply chains that casually sprawl across the borders of several different nations. Yet their international roadways are parsed by strong national boundaries. An analysis of the wait times experienced by freight trucks at the borders of eight Eurasian countries showed that time spent waiting in queues for border control and inspections accounted for 30 percent of total trip time.⁷ For reasons both economic and political, the vast stretches of roads and highways that criss-cross the continent of Asia remain parochial, subject to the rules and cultural climates of the individual nations through which they run.

Roads were not always so difficult to traverse. In ancient times, Asian and Middle Eastern traders used overland routes—the famed Silk Road—to transport their wares to distant markets. However, in the twentieth century, as maritime navigation improved and the airline industry matured, the vast majority of Eurasian merchants began to utilize ships and airplanes to transport goods. At the time, not only were most of the continent’s highways in poor condition, these other modes of international transportation were already adequately set up to meet the demands of a global marketplace, enjoying robust international standards bodies, and the protection of trade agreements and well-defined intergovernmental organizations. As a result, today the vast majority of Asian-made goods and products destined for international markets are shipped by boat or plane; once the shipped containers reach the destination port, freight trucks are used to carry the cargo to its nearby destination.

Meanwhile, in North America and Europe after the end of World War II, governments made major investments in highway infrastructure and “soft infrastructure,” which includes the trade

7. International Road Transport Union, *ECO [Economic Cooperation Organization] Regular Monitoring of Trucks/New European Land Transport Initiative Phase III (NELTI-3)—Final Report* (May 16, 2014), 68, http://www.iru-nelti.org/index/en_nelti3_index.

agreements and legal frameworks to enable the rapid flow of people and goods across state and national borders. More critically, these legal frameworks were put into effect. In contrast, although the United Nations' Economic and Social Commission for Asia and the Pacific (ESCAP) database contains more than 400 bilateral interstate road transport agreements between nations on the Asian continent, for many reasons most of them have not been implemented. Efforts are under way to change this situation. In 2013, China proposed to lead a Belt and Road Initiative, a rapidly expanding multitrillion dollar economic and diplomatic program to finance and build up the road and sea transportation infrastructure in several different nations. However, standardizing the road transportation infrastructure across the economically and culturally diverse nations that comprise Eurasia will be a formidable undertaking that will take years to gain real traction.

Autonomous vehicles will have an immediate and positive impact on the quality of life in Eurasian cities, and will help businesses create new business models. Yet to fully realize the benefits that the application of autonomous vehicles could lend to international commerce, Eurasian nations will need robust checkpoint customs departments and road-specific international trade agreements. Because terrorism plagues many of the nations in the region, another critical piece of soft infrastructure will be the development of a standardized automated infrastructure that can track potentially dangerous vehicles. Perhaps the emergence of autonomous vehicles will motivate the individual governments of Asian and Middle Eastern nations to invest in their region's border infrastructure so pan-Asian highways will someday be as easy and safe to traverse as the highways that stretch across Europe or North America.

HYPERLOOP ON THE SILK ROAD

Bruce Upbin

The northeastern Chinese city of Hunchun is like many of the country's smaller boomtowns, continually fed by an influx of rural jobseekers looking for factory work. China is building a new \$6 billion passenger high-speed rail line to connect Hunchun with the provincial capital of Jilin to the east.⁸ That said, Hunchun is a bit off the beaten path, tucked into a nook between the borders with Russia and North Korea. Geography has enabled Hunchun to become the largest logistics terminal in the region, preparing textiles, electronics, grain, and automobiles for export.

Hunchun could become an even more influential export hub if it had better access to the Pacific.⁹ Currently, it is cut off from the coast by rugged mountains and Russia's Primorsky Krai region to the west and south. In winter months, roads are often impassable.

8. Jeremy Page, "China Builds Up Its Links to North Korea," *Wall Street Journal*, June 6, 2013, <https://www.wsj.com/articles/SB10001424127887324069104578527080945326710>.

9. Anna Fifield, "A Remote Corner of China Wants Access to the Sea: The Obstacle Is North Korea," *Washington Post*, October 15, 2015, https://www.washingtonpost.com/world/asia_pacific/a-remote-corner-of-china-wants-access-to-the-sea-the-obstacle-is-north-korea/2015/10/15/45b7b5e4-3c40-11e5-a312-1a6452ac77d2_story.html?utm_term=.2e571c9ece57.

China would like to see Hunchun connect to the sea and Russian economic planners have long had their eyes on developing better, faster links between China's interior and Russia's deep-water, ice-free ports along the coast south of Vladivostok. Demand for the export of goods from Hunchun's logistics center is projected to surpass 40 million tons per year by 2030. There happen to be a couple of optimal places to build a port. One of them is the seaside town of Zarubino, which had long been a fishing village until the Russian government began taking steps to develop a cargo export operation there several years ago. With a little vision, investment, and long-term planning, Zarubino has the potential to become an important stop on the global cargo circuit. All it needs is a direct, high-capacity link back to Hunchun and its surrounding region.

That is where the Hyperloop enters the picture. Hyperloop is a new mode of passenger and freight transportation that uses a custom electric motor to accelerate and decelerate a levitated pod through a low-pressure tube. It is autonomous, energy-efficient, and safe. Because the vehicle is fully enclosed inside a steel tube, the system is immune to weather hazards and pilot error and runs continuously. Pods will glide silently at airline speeds for miles with no turbulence and very little energy use along the way. The idea of high-speed travel in vacuum tubes has been around for decades, but this particular concept was popularized by Elon Musk in a research paper in August 2013. Hyperloop One is the only company currently building a full-scale system and will be testing its prototype in 2017.

Hyperloop One began working with Russia's transport ministry in 2016 to explore the feasibility of a commuter link in the Moscow area as well as a cargo route in Russia's Far East. In December 2016, Hyperloop One and Russian investment firm Caspian Venture Capital (an investor in Hyperloop One) presented a preliminary feasibility study for the use of a Hyperloop One system to move cargo containers between Hunchun's logistics center and the planned Zarubino port. The study, carried out by Russian transport institute MosgortransNIIproekt (МосгортрансНИИпроект; MGTNIIP), confirmed that the system would generate a sizable operating profit at a throughput of six containers per minute, 20 hours a day, 365 days of the year.

The planned route calls for twin Hyperloop tubes on columns threading through 65 kilometers of terrain between Hunchun and Zarubino. The route is short enough to be an affordable first investment and long enough to take advantage of the energy efficiency of Hyperloop cruising speeds. The project, as proposed, would be built in two stages commencing in 2020 and 2023 with a total estimated capital cost of \$1.5–2.3 billion.¹⁰ By the time both stages are completed and operational, the Zarubino Hyperloop will be capable of carrying 1.3 million TEUs per year, just shy of the current volume at the ports of Houston, Genoa, or Fuzhou. (A TEU, or 20-foot equivalent unit, is a standard unit of measure in the container cargo business.) The system, when fully operational, would generate an estimated \$250 million in operating income per year with \$77 million in annual operating costs.

10. "The Construction of Hyperloop in Russia Was Estimated at \$ 1.5 Billion," Lenta.Ru, September 2, 2016, https://lenta.ru/news/2016/09/02/hyperloop_invest/; Bruce Upbin, "Hyperloop One Can Open Up Russia's Far East to China Trade," Hyperloop One, accessed September 21, 2017, <https://hyperloop-one.com/blog/hyperloop-one-can-open-russias-far-east-china-trade>.

Hyperloop is often touted for its potential to reach speeds of 1,000 kilometers per hour (km/h), but speed is not the primary benefit in cargo applications. Shippers want availability, or system uptime, which is one of Hyperloop's advantages over rail or roads. Being an autonomous system enclosed in a tube eliminates a lot of safety hazards such as grade crossings, but also takes weather and operator error out of the equation. The cargo will still be moving rapidly; average speeds attainable on the proposed line would be 540 km/h. Shippers also get flexibility. A Hyperloop can send a container when it is received instead of waiting for a mile-long train to be loaded with hundreds of other containers. Its magnetic noncontact traction allows it to climb grades three times steeper than the 5 percent for traditional freight rail, which will come in handy in the mountainous region between Zarubino and Hunchun.

If the project gets the green light from Russian and Chinese authorities, it will take two or three years to prepare the detailed feasibility study and to work with regulators to update the operating framework before construction begins in earnest. Project codeveloper Caspian Venture Capital is the venture arm of Summa Group, a diversified industrial firm based in Moscow with interests in logistics, oil pipelines, and port infrastructure. Its chairman, Ziyavudin Magomedov, has made it a goal to bring Hyperloop to Russia and envisions a day when cargo can zip overland at subsonic speeds from China to Europe across the vast Russian interior. It is a wildly ambitious idea with world-changing potential, reducing the time it takes cargo to get from the East to the West from weeks to hours.

A millennium ago, the rise of the Silk Road opened Central Asia and the Far East to global trade. One hundred years ago, Russia opened its own frontier by completing the epic Trans-Siberian Railway. A Hunchun-Zarubino Hyperloop would propel Russia to the forefront of transport innovation and could be the first step toward the twenty-first-century Silk Road.

Unintended Flows

DIAGNOSING CENTRAL ASIA'S DRUG PROBLEM

Sebastien Peyrouse

Central Asia is becoming an increasingly open trading area. China launched its Belt and Road Initiative in 2013, with plans for massive investment and substantial development of the transport infrastructure in the region. Moreover, Kazakhstan and Kyrgyzstan have been integrated, along with Russia, Armenia, and Belarus, into the Eurasian Economic Union (EEU), a free trade zone without border controls; Tajikistan also may soon join the EEU.

Greater connectivity and the development of free trade zones, despite their promise of economic benefit, have sometimes been criticized as opening the door to an increase in illicit trafficking, and particularly of drugs. This concern has been considered in the context of many economic zones (including the American continent and the European Union), and now is being looked at as a possible concern for Central Asia as well. The concern is heightened as this region neighbors Afghanistan, the world's largest opium and heroin producer, and is, therefore, an ideal transit route for illicit drugs to China, Russia, and Europe, now among the world's biggest illicit drug markets. The opening of internal borders in the Eurasian space, and the current and future development of transport infrastructure, certainly will open up new opportunities for traffickers. Once they cross the Kazakh or Kyrgyz border, they can carry their shipment to the gates of Europe without being subjected to any serious control.

However, studies carried out in several regions of the world, including the American continent, show that "greater openness to trade does not have a consistently significant effect on the prohibition capabilities of states in drug transit countries."¹ Central Asia will likely not be an exception. Illicit drug trafficking in Central Asia did not wait for the opening of a common economic space or for the development of road or railway infrastructure. Rather, since the breakup of the

1. Horace A. Bartilow and Kihong Eom, "Free Traders and Drug Smugglers: The Effects of Trade Openness on States' Ability to Combat Drug Trafficking," *Latin American Politics and Society* 51, no. 2 (Summer 2009): 117–145.

Soviet Union, there has been a tremendous increase in both trafficking and drug use throughout the region. The main causes of the development of drug trafficking are to be found elsewhere.

First, trafficking has been facilitated by the ineffectiveness of border controls. The length of the external borders of Central Asia (1,300 miles with Afghanistan, and more than 4,000 miles with Russia), the geographic difficulties of controlling them, including due to their mountainous nature (particularly between Afghanistan and Tajikistan), and the lack of training and equipping of border guards—despite international assistance²—have made the border porous. However, the EEU could serve to focus border management efforts on external borders, in particular with Afghanistan, through cooperation among its members, and thereby organize more effective border control efforts, which hitherto have been dispersed over too large a space.

Second, illicit drug trafficking in Central Asia has, to a large extent, been fueled by the corruption and complicity of security forces. Research in the region shows that some law enforcement officials actually oversee trafficking rings, turn over drugs seized during arrests to traffickers, and sometimes provide protection to dealers.³ This has become almost public knowledge in Tajikistan, where dealers operate in plain view of the authorities. Tajikistan's highest state structures, as well as the presidential family, are themselves suspected of being among the main beneficiaries of this trafficking. Consequently, efforts to secure or close borders have not had a significant impact, as some state structures have not shown the necessary political will to fight drug trafficking.

Finally, the current economic and social crisis in some Central Asian states appears to be stimulating drug trafficking. A growing number of individuals—men, women, and children—have been willing to transport drugs, either for themselves or for organized networks, in order to meet their basic needs. Poverty also contributes to corruption among underpaid civil servants in societies where corruption is socially criticized but “accepted” as a channel of redistribution and survival. This may be why the allegedly tight border controls of highly policed states, such as Turkmenistan, have never been able to significantly reduce drug trafficking.

Whatever the extent of border controls, and with or without the new development of transport infrastructure, it is likely that illicit drug trafficking will continue to grow in the region, spurred by poverty and bureaucratic corruption. It is to be hoped, however, that the development of more open trade policies with and among Central Asian states will contribute to economic development in a region long slowed down by the isolationist policies of some of its governments (in particular Turkmenistan and Uzbekistan), as well as to increased employment and reduced social problems.

The real challenge for fighting the illicit drug trade in Central Asia, therefore, stems less from the supposed risks associated with opening borders or developing transport infrastructure, than from dealing with poverty and corruption. What will be crucial is the political will of the governments in

2. George Gavriliš, *Central Asia's Border Woes and the Impact of International Assistance*, Central Eurasia Project Occasional Paper 6 (New York: Open Society Foundations, 2012), <https://www.opensocietyfoundations.org/sites/default/files/OPS-No-6-20120601.pdf>.

3. Alisher Latypov, *Drug Dealers, Drug Lords and Drug Warriors-Cum-Traffickers: Drug Crime and the Narcotics Market in Tajikistan* (Vilnius: Eurasian Harm Reduction Network, 2011), 12–13, <http://globalinitiative.net/wp-content/uploads/2011/07/cadpc-drug-dealers-drug-lords-and-drug-warriors-cum-traffickers-drug-crime-and-the-narcotics-market-in-tajikistan.pdf>.

Central Asia to tackle corruption and institute real reforms, as well as the capacity of international assistance—especially from China’s BRI program and the EEU—to deliver to Central Asia real socioeconomic benefits, and thereby reduce drug trafficking in the long term.

ASIA’S INFECTIOUS FLOWS

Mary E. Wilson

Asia’s infrastructure push will involve building roads, railways, and ports across a vast expanse of land that spans many different ecosystems, among them tropical and subtropical areas and biodiversity hot spots. The region includes sleek modern cities, huge urban slums, and relatively isolated and often unstudied rural areas. These will be joined in a network that will allow the physical movement of humans—and everything that accompanies them. Many benefits are likely to follow, but there are other possible consequences.

Consider first the building of roads, railways, and ports. Building roads can disrupt ecosystems, fragment landscapes, displace wildlife, and reduce biodiversity. Intruding on new environments and changing land use can be associated with exposure to previously unrecognized pathogens that can infect humans.⁴ Some are found in wildlife and can spill over into the human population, sometimes with dire consequences. Although HIV, for example, emerged from nonhuman primates in Africa, it spread throughout Asia (and the world), carried by travelers. Fragmentation and degradation of natural habitats are associated with increased infections acquired from animals.⁵

Asia’s remarkable biodiversity, a great asset, could also pose challenges. At lower latitudes, there is greater species richness, which includes pathogens that cause infections in humans.⁶ By spanning rivers, mountains, deserts, and other inhospitable barriers, roads and railroads can also eliminate natural barriers to the movement of pathogens or animals that carry them.

Recent history underscores the stakes. In recent decades, the Nipah virus, avian influenza viruses, and the severe acute respiratory syndrome (SARS) coronavirus have all originated in Asia. It is notable that all originated from animals, with bats playing a prominent role in two of the three. The dengue situation has worsened with all four dengue serotypes circulating in many areas. A new strain of vibrio (bacteria) that causes cholera emerged in Asia—and subsequently spread widely. A form of malaria, caused by *Plasmodium knowlesi*, a parasite found in nonhuman primates, has also increased in the region, especially in Malaysia.

Resistant bacteria could also arise. Growing populations of humans and food animals expand the interface between humans and animals—wild and domestic. Markets, where live chickens and other food animals are sold, are a rich source of new strains and combinations of influenza viruses.

4. Mark S. Smolinski et al., *Microbial Threats to Health: Emergence, Detection, and Response* (Washington, DC: National Academies Press, 2003), 53–148.

5. S. Morand et al., “Infectious Diseases and Their Outbreaks in Asia-Pacific: Biodiversity and Its Regulation Loss Matter,” *PLoS ONE* 9, no. 2 (February 2014), <https://doi.org/10.1371/journal.pone.0090032>.

6. Matthew H. Bonds, “Disease Ecology, Biodiversity, and the Latitudinal Gradient in Income,” *PLoS Biology* 10, no. 12 (December 2012), <https://doi.org/10.1371/journal.pbio.1001456>.

Antibiotic-resistant genes, many able to spread horizontally among bacteria, have been documented in abundance in estuaries along China's coastline,⁷ and bacteria that are resistant to most or all commonly used antibiotics are widely distributed throughout China and India. Intensive use of antibiotics for growth promotion in food animals in China has contributed to the selection of resistant bacteria. Humans can acquire, carry, and spread these antibiotic-resistant genes, which may be found in bacteria that live in the gut.

Roads and railroads provide mobility to hosts and mosquito vectors. Humans and animals can carry infections (with or without symptoms) that can be introduced into a new area. Infections that are spread from person to person, such as tuberculosis, influenza, and measles, can be carried anywhere and introduced into new populations. Mosquito vectors have been dispersed globally through travel and trade. After the Asian tiger mosquito, *Aedes albopictus*, was introduced into the United States from Asia in used tires, it initially spread along major roadways.⁸ HIV/AIDS moved along truck routes. Plant pathogens, including ones that threaten food crops and hence food security, will be able to move more easily in food, vehicles, and with other materials.⁹

Populations and places can be described by their receptivity or vulnerability either to the introduction of new pathogens or to the reintroduction of old ones. Tropical and subtropical areas that are infested with *Aedes aegypti* mosquitoes are vulnerable to the introduction of many viruses that they are competent to transmit, including dengue, chikungunya, yellow fever, and Zika viruses. The likelihood of introduction is higher when a high volume of travelers is arriving from an area with active transmission. The risk of local and sustained spread will depend in part on the housing (screens and air conditioning), the strength of mosquito control activities, and ecoclimatic conditions.

The new network will connect populations with widely different economic statuses. Diagnostic capacity and surveillance activities in many poor and rural areas may be limited, which means little may be known about locally endemic infections in many of the areas. Undetected pathogens could move out of isolated niches when transport is possible.

But there are also health advantages to increased connectedness. New infrastructure could allow better access to the remaining populations in Asia with malaria, especially in Myanmar. There is urgency in the effort to eliminate malaria before parasite resistance to drugs and mosquito resistance to the insecticides used to treat bednets disable the current key control tools. Of course, those with infection may also become more mobile, transporting infection to other areas. Even after malaria elimination, many areas will remain susceptible to reintroduction by infected persons visiting the area, assuming competent mosquito vectors continue to infest the area.

A number of steps can be taken to reduce these risks. Good diagnostics and surveillance will be essential to identify and promptly treat any new cases. In fact, increased connectedness should be

7. Yong-Guan Zhu et al., "Continental-Scale Population of Estuaries with Antibiotic Resistance Genes," *Nature Microbiology* 2 (January 2017), <https://www.nature.com/articles/nmicrobiol2016270>.

8. Institute of Medicine, *Infectious Disease Movement in a Borderless World: Workshop Summary* (Washington, DC: National Academies Press, 2010), 20.

9. "Late Blight, Potato—Bangladesh: (Rajshahi)," ProMED-mail post, International Society for Infectious Diseases, January 15, 2017, <http://www.promedmail.org/post/20170115.4767829>.

accompanied by better surveillance of mosquito vectors and infections in humans, animals, and plants.

Responses should be tailored to specific threats and locales. It is useful to consider the concept of the receptivity of a place and population to specific microbial threats. Receptivity will depend on the specific agent and its means of transmission. Infections that can spread directly from person to person, such as influenza and sexually transmitted infections, including HIV, can be carried by mobile populations and introduced anywhere.

Local conditions matter greatly. Local spread may be affected by the living conditions and density of the population, ecoclimatic conditions (temperature and humidity), demographics of the population, behavior, host factors such as nutrition, immunosuppression, and previous infections or immunizations. Measles and diphtheria, for example, cannot be introduced into a population that is completely immunized. Infections that require a specific vector, such as a mosquito, cannot be introduced into an area where the specific vector is absent.

One must consider the dynamics of known infectious diseases that are present in the area and acknowledge the likelihood that currently unknown or unrecognized infections are likely to emerge as new areas are explored and populations are linked by roads. New connections are just that—conduits for flows. To make the most of them, we must not only seize the positive opportunities they present but also reduce the health risks they could carry.

THE ROAD TO EXTINCTION

Peter Zahler and Louisa Denier

By 2050, Asia's urban population will reach more than three billion people, which will require a significant increase in transportation and infrastructure. The Asian Development Bank estimates that in order to meet infrastructure development needs, the region would have to spend \$8 trillion between 2012 and 2020,¹⁰ with a big part of it on roads, railways, and other linear infrastructure. Huge projects are already under way, from China's Belt and Road Initiative to the India–Myanmar–Thailand Trilateral Highway and the Trans-Asian Railway.¹¹

Long seen as a driver for improving economic conditions around the world, linear infrastructure also poses risks, particularly to the environment. This is especially true in Central Asia, where hot dry summers and cold snowy winters mean many animals must make extensive movements annually to find food and avoid inclement weather. Roads, railroads and other transportation

10. World Wildlife Fund (WWF), *The Road Ahead: Protecting Tigers from Asia's Infrastructure Development Boom* (Gland, Switzerland: WWF, 2016), 4, https://c402277.ssl.cf1.rackcdn.com/publications/974/files/original/the_road_ahead_final_for_web_.pdf?1479905675.

11. Roderic Broadhurst, "Asia Is in the Grip of a Transnational Crime Crisis—But Governments Look Away," *Conversation*, December 6, 2016, <https://theconversation.com/asia-is-in-the-grip-of-a-transnational-crime-crisis-but-governments-look-away-69780>.

corridors can act as significant barriers¹² to the movement and survival of these highly mobile animals. The same roads and railways that are opening up areas previously off the grid to commerce and economic growth are also facilitating access to pristine and wildlife-rich areas. Consequently, the development of new roads can provide more opportunities¹³ for wildlife poaching.¹⁴

The stunning growth in wildlife poaching and trade has happened so quickly that it is still not widely recognized. Illegal trade in wildlife is now the fourth most lucrative transnational crime after drugs, counterfeit goods, and human trafficking.¹⁵ Southeast Asia, one of the world's biodiversity hotspots, generates \$8–10 billion in illicit revenues per year, in part due to easy links to markets such as China, Indonesia, and India.

Wildlife traffickers rely heavily on logistics and modern infrastructure, taking advantage of new roads, ports, and airports to cross borders more quickly and easily.¹⁶ Similar to (and often linked with) other transnational organized crimes, the networks involved in wildlife crime span multiple countries over several continents, and criminals have developed elaborate ways of smuggling goods through major international airports, ports, and border crossings. High amounts of wildlife, dead or alive, are hidden in passengers' suitcases and clothing or mixed in with legal shipments.

Large seizures happen frequently. In March 2017, for example, 21 horns from South African white rhinos, worth an estimated \$5 million, were seized by authorities at Suvarnabhumi airport in Bangkok, Thailand. The horns had been smuggled from South Africa and transported to Thailand on a flight from Ethiopia.¹⁷ In a single month, there were seizures of 14 tons of pangolin scales across different locations in Africa and China, an amount equivalent to roughly 20,000 pangolins.¹⁸ If poaching continues, the world will lose many species including iconic wildlife such as tigers, elephants, and rhinos—many of which have seen population declines of 50 to 90 percent or more in the last century.

12. Convention on the Conservation of Migratory Species of Wild Animals (CMS), *Guidelines for Addressing the Impact of Linear Infrastructure on Large Migratory Mammals in Central Asia* (Bonn: CMS, 2015), 21–32, http://www.cms.int/sites/default/files/publication/cms-cami_pub_linear-infrastructure_wcs_e.pdf.

13. World Bank, *Going, Going, Gone: The Illegal Trade in Wildlife in East and Southeast Asia* (Washington, DC: World Bank, 2005), 18, <http://documents.worldbank.org/curated/en/690321468032401520/pdf/334670PAPER0Going1going1gone.pdf>.

14. UN Office on Drugs and Crime (UNODC), *World Wildlife Crime Report: Trafficking in Protected Species* (Vienna: UNODC, 2016), 19, https://www.unodc.org/documents/data-and-analysis/wildlife/World_Wildlife_Crime_Report_2016_final.pdf.

15. Jeremy Haken, *Transnational Crime in the Development World* (Washington, DC: Global Financial Integrity, 2011), 11–14, http://www.gfintegrity.org/wp-content/uploads/2014/05/gfi_transnational_crime_high-res.pdf.

16. UNODC, *Protecting Peace and Prosperity in Southeast Asia: Synchronizing Economic and Security Agendas* (Vienna: UNODC, 2016), 23–45, https://www.unodc.org/documents/southeastasiaandpacific/Publications/2016/Protecting_peace_and_prosperity_in_SEA.pdf.

17. "Rhino Horns Worth \$5m Seized in Thailand Off Flight from Ethiopia," BBC News, March 14, 2017, <http://www.bbc.com/news/world-asia-39268084>.

18. Matt Lowton, "New Year Sees Devastating Number of Pangolin Seizures," Environment Investigation Agency, January 20, 2017, <https://eia-international.org/new-year-sees-devastating-number-of-pangolin-seizures>.

This rising threat to the world's natural capital requires action. At the policy level, countries must be encouraged to improve legislation aimed at ensuring that transportation infrastructure projects are planned in ways that do not significantly negatively impact wildlife. A recent study by the Convention on Migratory Species (CMS) showed that few countries in the Central Asian region have any infrastructure laws or regulations that even mention wildlife. Even fewer have legislation that addresses the need to have infrastructure avoid significant negative impacts on wildlife or other aspects of the environment.¹⁹ International donor and lending institutions, all of whom have strong internal requirements related to biodiversity protection, should play an important role in pressing governments to improve their existing legislation and responsibly adhere to their existing requirements.

A number of steps can help address illegal cross-border movements. First, there needs to be improved collaboration and information exchange between agencies domestically. Second, similar steps are needed between law enforcement agencies such as customs in different countries. While mutual agreements between certain local customs agencies in countries such as Vietnam and China exist,²⁰ more efforts are needed to strengthen collaboration and intercept criminals. Third, capacity must be built for the better management of border, port, and airport infrastructure.²¹ Inspection capacity at ports is telling. The United Nations Office on Drugs and Crime (UNODC) has estimated that while maritime shipping contributes 90 percent of all trade globally, less than 2 percent of the 500-plus million containers are inspected.²²

The transport sector itself has an important role to play in helping to identify key routes and smuggling hotspots. In 2015, Prince William's United for Wildlife initiative set up a transport task force,²³ bringing together representatives from a range of airlines, shipping companies, and a few non-governmental organizations to identify the main routes exploited by traffickers and take measures to ensure wildlife is no longer part of their operations. The members of the task force signed the Buckingham Palace Declaration in March 2016. The declaration focuses, among other things, on securing information-sharing systems for the transport industry to receive credible information about high-risk routes and methods of transportation.²⁴ These efforts could be expanded to include additional participants from the private sector.

Ultimately, the stakes extend well beyond the environment. Wildlife trafficking is a huge business and is driving species to extinction and accelerating the loss of biodiversity.²⁵ It can also significantly impact local economies by reducing ecotourism opportunities and contributing to the

19. CMS, *Guidelines for Addressing the Impact of Linear Infrastructure on Large Migratory Mammals*, 38–40.

20. Lang Son Province Government, "Leaders of the Provincial People's Committee Attended the Signing Ceremony of the Second 'Four Quarters' Dialogue 2015," June 12, 2015, <http://www.langson.gov.vn/node/48555>.

21. UNODC, *Protecting Peace and Prosperity in Southeast Asia*, 46.

22. UNODC, "UNODC-WCO Global Container Control Programme," accessed September 21, 2017, <https://www.unodc.org/ropan/en/BorderControl/container-control/ccp.html>.

23. United for Wildlife, "What Is the Transport Taskforce?," March 15, 2016, <https://www.unitedforwildlife.org/#!/2016/03/what-is-the-transport-taskforce>.

24. United for Wildlife, "The Buckingham Palace Declaration," March 15, 2016, https://www.unitedforwildlife.org/#!/2016/03/the-buckingham-palace-declaration?_escaped_fragment_.

25. UNODC, *World Wildlife Crime Report*.

spread of viruses and diseases.²⁶ Wildlife trafficking also threatens security by providing funding to criminal and militant networks.²⁷ New transportation infrastructure developments need to be funded, designed, and established with the understanding that additional resources must be directed toward minimizing direct impacts on biodiversity and building stronger enforcement capacity to control the growing illegal traffic in wildlife. For all these reasons, we cannot afford to wait.

26. Timothy Bouley, "Trafficking Wildlife and Transmitting Disease: Bold Threats in an Era of Ebola," *Voices: Perspectives on Development* (blog), World Bank, October 2, 2014, <http://blogs.worldbank.org/voices/trafficking-wildlife-and-transmitting-disease-bold-threats-era-ebola>.

27. UNODC, *World Wildlife Crime Report*, 23–25.

Arctic Opportunities

ARCTIC MARITIME CONNECTIONS

Lawson W. Brigham

The twenty-first-century maritime Arctic is experiencing extraordinary change. Profound climate change and the connection of Arctic natural resources to world markets are shaping new opportunities for the global shipping enterprise in this once remote region. The Arctic Ocean's sea ice cover, responding to regional and global warming, has been dramatically changing in ice extent, thickness, and character during more than four decades. In turn, these physical changes in sea ice provide for greater marine access and potentially longer seasons of navigation throughout the Arctic Ocean.

Yet these changes should not be exaggerated. In fact, the Arctic Ocean will remain fully or partially ice-covered for up to seven to eight months each year in the decades ahead. The Arctic Ocean will never be ice-free year-round but may be entirely ice-free for periods of time in future summers. The presence of sea ice and the likelihood that Arctic marine routes will be open only seasonally limits the potential for year-round, trans-Arctic navigation. Icebreaker escorts of ice-class commercial ships can extend the Arctic navigation season in some areas, such as along Russia's Northern Sea Route (NSR), but full trans-Arctic routes will remain limited except perhaps during the summer months. These routes are not economically attractive to the largest, global container shippers with time-sensitive cargoes. There will likely be niche seasonal markets, but such ocean-to-ocean Arctic voyages will not become direct competitors to the main global marine trade routes through the Suez and Panama canals. Russian experts have suggested that the NSR could become a seasonal supplement to the southern Suez Canal marine route. But a majority of future traffic will surely be "destinational," meaning that ships will carry cargo out of the Arctic to global markets.

If not sea ice retreat, then what is the primary driver of future Arctic marine operations and shipping? The Arctic Marine Shipping Assessment (AMSA), an influential study released by the Arctic Council in April 2009, developed a set of scenarios, or plausible futures, to identify the key

uncertainties and factors influencing the future of Arctic navigation. The complexity and range of potentially important factors include global oil prices, climate change severity, new Arctic resource discoveries, legal and governance stability, conflicts with indigenous marine users, the seasonality of marine operations, new global actors in the Arctic (such as China, Korea, and Japan), new international agreements on Arctic marine safety and environmental protection, and others. The AMSA provides strong evidence that future Arctic marine operations and shipping are driven principally by Arctic natural resource developments that are, not surprisingly, highly coupled to global commodities prices and markets. The majority of future Arctic commercial ships will likely be bulk carriers, oil tankers, and liquefied natural gas (LNG) carriers. With cargoes of oil, gas, hard minerals, fish, and plausibly fresh water, most of these voyages will be destinational.

Russia's NSR is the most visible symbol of a marine transportation system driven by Arctic natural resource developments. Defined in Russian federal law from Kara Gate in the west to the Bering Strait, the NSR is a national waterway, a marine transportation corridor in the Russian Arctic along the top of Eurasia, and an integral component of Russia's northern economic strategy. Not only does the NSR facilitate the movement of natural resources out of the Arctic to global markets, but it also provides marine access to all regions of the Russian Arctic for effective sovereign presence, law enforcement, security, and supply to coastal communities.

The large and well-known Russian icebreaker fleet, made up of nuclear and nonnuclear icebreakers, maintains this coastal Arctic marine access and thus extends the navigation season along the route. The fleet also is available to escort convoys of commercial ships. Since 1979, year-round navigation on the western NSR has been maintained to Dudinka, a port on the Yenisey River that services the industrial complex at Norilsk, the world's largest producer of nickel and palladium. Today, independently operated ice-class container carriers, which do not use convoy icebreakers, move nickel plates westward to Russian and European markets on a year-round basis. During the summer navigation season, these container ships sail east to Asian ports in the Pacific.

The most significant development in the Russian North today is the construction of an LNG plant and port (named Sabetta) on the western shore of the Ob Bay on the Yamal Peninsula. This new complex will be supplied with gas from fields on the Yamal Peninsula and liquefied gas will be carried by ship out of the Russian Arctic to world markets. An initial fleet of fifteen icebreaking LNG carriers (both Russian and foreign-flag), all being built in Korea's Daewoo Shipbuilding & Marine Engineering yard, will operate out of Sabetta. Capable of carrying 170,000 cubic meters of liquefied gas, these large ships will sail westbound and year-round on voyages to northwest Russian and European ports. During the summer months, these ships will sail into the Pacific and to Asian markets. The length of the navigation season for eastbound voyages has yet to be determined and will depend on the availability of Russian icebreakers. The first ship of this class, the *Christophe de Margerie*, has been undergoing ice trials in the Russian Arctic.

The geoeconomic context for Arctic shipping and the NSR is quite clear for the next few decades. The NSR is a national Arctic waterway that facilitates the movement of Russian Arctic natural resources to trade partners and markets throughout Eurasia. However, the NSR is not likely to compete with rail across the continent, or with more southern routes developed by China linking Indian Ocean and Mediterranean ports, as a future maritime corridor to Europe for exports. Future

increases in global commodities prices will plausibly lead to greater exploration of the Arctic's, and specifically Russia's, natural resources. Many of these future resources will surely be carried by sea out of the Arctic to distant markets. Profound changes are happening in the Arctic Ocean, especially the increases in marine access from sea ice retreat, but these changes do not foretell a retooling of global maritime trade routes as many speculate.

ECONOMICALLY CONNECTING THE ARCTIC

Heather A. Conley and Matthew Melino

Welcome to the world's newest blue-water ocean: the Arctic Ocean. You are forgiven if you think the Arctic is a mostly frozen and forbidding place covered in darkness for most of the year. It still is. But this ocean is rapidly changing: since 1979 Arctic sea ice maximum extent has dropped by an average of 2.8 percent per decade; in the summertime, the ice cap declined at 13.5 percent per decade;¹ and the Greenland Ice Sheet lost an estimated 9,103 gigatons or over 9 trillion tons of ice since 1900 and between 25 to 35 gigatons annually.² On land, the near-surface permafrost in the Northern Hemisphere is projected to decline by 20 percent relative to today's area by 2040, and it could be reduced by as much as two-thirds by 2080 under a scenario of high greenhouse-gas emissions.³ We may be at the dawn of a new Arctic Age.

If so, this dawn has been characterized by hype, hysteria, and hyperbole. Newspaper headlines have declared the Arctic to be the next energy frontier. At \$100 per one barrel of oil, companies were interested and enthusiastic about Arctic energy exploration; with energy prices below \$50 per barrel, interest cooled. The predicted international race for resources is currently a saunter. Sluggish commodity prices and global economic demand have chilled the most ambitious Arctic economic development plans. For example, the Chinese mining firm, General Nice, had announced plans to develop a \$2 billion iron ore mine in Greenland, but low commodity prices have placed this investment on hold. And Russian president Vladimir Putin's 2011 declaration that the Northern Sea Route (NSR) will become a rival shipping route to the Suez Canal is another example of hype distorting the reality of Arctic development. In 2016, approximately 18,000 vessels traversed the Suez Canal;⁴ only 19 vessels⁵ navigated the NSR.

1. Maria-José Viñas, "Sea Ice Extent Sinks to Record Lows at Both Poles," NASA, March 22, 2017, <https://www.nasa.gov/feature/goddard/2017/sea-ice-extent-sinks-to-record-lows-at-both-poles>.

2. Chris Mooney, "Greenland Has Lost a Staggering Amount of Ice—And It's Only Getting Worse," *Washington Post*, December 16, 2015, https://www.washingtonpost.com/news/energy-environment/wp/2015/12/16/greenland-has-lost-a-staggering-amount-of-ice-and-its-only-getting-worse/?utm_term=.e499de38d957.

3. Arctic Monitoring and Assessment Program (AMAP), *Snow, Water, Ice and Permafrost: Summary for Policy-makers* (Oslo: AMAP, 2017), 12, <https://www.amap.no/documents/doc/Snow-Water-Ice-and-Permafrost.-Summary-for-Policy-makers/1532>.

4. "Cargo Ships Test New Suez Canal," *World Maritime News*, July 27, 2015, <http://worldmaritimenews.com/archives/167537/cargo-ships-test-new-suez-canal/>.

5. Center for High North Logistics (CHNL) Information Office, "Vessels Transited NSR in Y2016," http://www.arctic-liaison.com/docs/nsr/transits/Transits_2016.pdf.

This Arctic Age is also distinctive in that it is no longer exclusively driven by Arctic nations such as the five coastal states—Russia, Norway, Canada, Denmark (Greenland), and the United States—but by nations that consider themselves to be near-Arctic states, such as China. In 1996, the five coastal states plus Iceland, Sweden, and Finland, which have territory above the Arctic Circle, founded the Arctic Council as the premier intergovernmental body to oversee environmental protection and sustainable development activity in the Arctic. In 2008, the five coastal states reaffirmed, through the Ilulissat Declaration, that the international law of the sea and their sovereign rights as coastal states were sufficient to govern the Arctic. Yet by 2013, addressing Arctic issues was no longer restricted to this exclusive regional club, as the Arctic Council welcomed a number of new permanent observing nations and organizations, dominated by countries from the Indo-Pacific region, including China, Japan, South Korea, Singapore, and India.

For the past 20 years, the Arctic has been the purview of scientific research and environmental stewardship, but as reduced ice presence and rising ocean temperatures become the norm, this Arctic Age may be increasingly characterized by slow but advancing commercial opportunities. No longer exclusively national in character and with increased realism of its developmental prospects, there is growing evidence of the early formations of an Arctic Belt and Road economic construct that mirrors the southern Eurasia land and maritime route counterpart (Belt and Road Initiative launched in 2013) but with a unique addition of a circle.

An Arctic Belt

The contours of an Arctic infrastructure belt take some imagination, but there is a network of ports and rail projects that extend primarily across the Russian Arctic. There are at least 17 ports⁶ along the Northern Sea Route that serve as major shipping hubs during the summer months and export outlets for Russian oil to various global markets. President Putin has expressed his desire to better connect these ports not just as hubs for shipment operations of liquified natural gas (LNG) but also as universal ports where different types of goods can be rerouted from the Trans-Siberian Railway or Baikal-Amur Mainline.⁷ The focal point of an Arctic Belt is the Port of Sabetta on the Yamal Peninsula. Traffic through the port has increased as the nearby Yamal LNG plant continues to be constructed. A total of 120 ships with goods docked in 2016, more than twice the number in 2015. They delivered a total of 505,000 tons of goods valued at \$5.2 billion.⁸ Designs to increase connectivity between the port and major transport routes are under way. In 2016, the governor of the Russian Yamal-Nenets region signed a deal with Russian Railways to construct the 707-kilometer-long Northern Latitudinal Passage that will connect Russia's Ural and West Siberian region with the Northern Sea Route.⁹ The project is expected to start in 2018. Although this

6. CHNL Information Office, "Arctic Ports," accessed September 21, 2017, <http://www.arctic-liaison.com/arcticports>.

7. Atle Staalesen, "Railway for Sabetta," *Independent Barents Observer*, December 22, 2015, <https://thebarentsobserver.com/en/industry/2015/12/railway-sabetta>.

8. Atle Staalesen, "Multi Billion Dollar Shipments to Russia's New Arctic Port," *Independent Barents Observer*, January 10, 2017, <https://thebarentsobserver.com/en/industry-and-energy/2017/01/multi-billion-dollar-shipments-russias-new-arctic-port>.

9. Atle Staalesen, "Grand Railway Deal for Yamal," *Independent Barents Observer*, October 20, 2016, <https://thebarentsobserver.com/en/2016/10/grand-railway-deal-yamal>.

infrastructure stopped at the Cold War Soviet borders, there are new efforts to develop a rail link between Finland and Norway that would connect Roveniemi, Finland, to Kirkenes, Norway. Former Finnish prime minister Paavo Lipponen described this project in 2015 as the last “missing link” in the EU South-North traffic network.¹⁰

An Arctic Maritime Road

The Arctic Maritime Road is a bit easier to imagine. Increasingly ice-free waters also offer opportunities to increase destinational and transshipping across the Arctic region, primarily the shipment of energy (liquified natural gas and oil) and mineral resources (uranium, gold, iron ore, zinc, and rare earth metals). Once considered dangerous and noncommercial, there are three possible Arctic maritime “roads”: the Northern Sea Route (NSR), the Northwest Passage (NWP), and the transpolar route (TPR). These routes could be potential economical alternatives to some of the world’s most popular maritime passages in the future, but with important caveats that shipping will likely remain limited to summer months and is largely for resupply of Arctic communities. Harsh weather conditions, a lack of infrastructure, and limited satellite coverage will continue to restrict future Arctic shipping.

The Arctic Circle

The Arctic Circle is both a latitudinal designation and its own distinctive regional feature, specifically focusing on the Central Arctic Ocean, which consists of the international waters beyond the five coastal states’ exclusive economic zones around the North Pole, the so-called Donut Hole. The circle contains a road component (the transpolar route) and a governance component (under the auspices of the UN Convention on the Law of the Sea), which focuses on fisheries and extending sovereign claims. Governance in the Central Arctic has focused on the potential for marine species to expand northward as key elements of the food chain migrate to warming waters, which is likely to result in countries seeking to exploit these new fisheries to satisfy a rise in demand for protein. Wary of these developments, the five Arctic coastal states negotiated and signed a moratorium on fishing in the Central Arctic Ocean in 2016 until better scientific knowledge is available and a regulatory system is in place to ensure sustainability. Four other nations (Iceland, Japan, Korea, and China) as well as the European Union are taking part in negotiations to expand this agreement.

For the past several years, Chinese authorities have been the most vocal regarding the rights of all countries to explore the region. However, as Arctic coastal states Russia and Denmark, and potentially also Canada, submit scientific claims to extend their outer continental shelves to the North Pole, there could be restrictions placed on international access to certain areas of the Donut Hole. It is unclear whether this circle will remain open or will increasingly become closed.

Russia has historically viewed the economic development of the Arctic as a national imperative. This imperative has been revitalized and resourced under President Vladimir Putin’s ambitious leadership despite national economic challenges. And, although a relative newcomer to the Arctic

10. Atle Staalesen, “Norway Positive to Finland’s Arctic Railway Plan,” *Independent Barents Observer*, April 12, 2017, <https://thebarentsobserver.com/en/arctic/2017/04/norway-positive-finlands-arctic-railway-plan>.

region, China has also emerged as a very active and engaged economic, diplomatic, and scientific actor in the Arctic. It is possible that Russia and China—as demonstrated by their joint investment in the Yamal Peninsula—could drive development to connect Asia and Europe through a northern Arctic Belt, Road, and Circle. If their efforts are successful, we will know that the Arctic Age is upon us.

CHINA'S EXAGGERATED ARCTIC INTERESTS

Arild Moe

The world's awareness of petroleum resources in the Arctic soared in 2008 after an assessment from the United States Geological Survey¹¹ indicated that 12.3 percent of global undiscovered oil resources and 32 percent of gas resources could be found there. The analysis was widely misinterpreted to reflect offshore reserves and created the perception of a huge untapped potential that was becoming more accessible because of the ice melt. It resonated strongly in China, which worried about soaring energy needs and overdependence on the Middle East.

A common misperception in China was that much of the Arctic's resources were up for grabs. Literature and media coverage supported the myth that untapped energy resources were in maritime areas outside national jurisdiction. In fact, those resources overwhelmingly are located within national jurisdictions. This means that engagement in Arctic energy development essentially becomes a bilateral issue. It cannot be separated from the overall bilateral relationship with the resource owners, notably Russia, which has the largest Arctic continental shelf, by far.

Not long after China set its sights on the Arctic's energy resources, major developments in the oil and gas markets created a new supply situation. The "unconventional revolution," mostly associated with shale oil and shale gas, mainly took place in the United States but had repercussions for world markets. It made the world's largest oil importer almost self-sufficient and opened the possibility of the United States exporting liquified natural gas (LNG). Moreover, supplies previously destined for the United States became available for other buyers. In sum, the supply situation for China did not look as constrained as it had only a few years earlier.

For China, a breakthrough in gas supplies came through the construction of a pipeline from Turkmenistan with a capacity of 30 billion cubic meters (BCM) per year in 2012, involving supplies also from Kazakhstan and Uzbekistan.¹² It was followed by a pipeline from Myanmar, completed in 2013, with a capacity of 12 BCM and a deal with Russia in 2014 for supplies of 38 BCM via a new pipeline from Eastern Siberia. With three major pipeline gas supply routes in addition to a more diversified group of LNG suppliers, the need for Arctic gas seemed less pressing.

11. USGS, "90 Billion Barrels of Oil and 1,670 Trillion Cubic Feet of Natural Gas Assessed in the Arctic," accessed September 21, 2017, <https://www.usgs.gov/media/audio/90-billion-barrels-oil-and-1670-trillion-cubic-feet-natural-gas-assessed-arctic>.

12. China National Petroleum Corporation, "CNPC in Turkmenistan," accessed September 21, 2017, http://www.cnpc.com.cn/en/Turkmenistan/country_index.shtml.

Oil is a different story. After China became a net oil importer in 1993, Chinese state oil companies were encouraged to acquire production assets abroad. In addition, China embarked explicitly and implicitly on a hedging strategy to enhance its energy security. Whereas the Chinese policy was successful in establishing new energy links, it did not manage to reduce the dependence on oil supplies from the Middle East. In fact, the share of China's oil imports from that region increased from 39 percent in 2006 to 51 percent in 2015.¹³ These supply dynamics suggest greater Chinese interest in Arctic oil resources than in gas resources.

But actual Arctic offshore oil-related investments and projects have been quite modest.¹⁴ In 2013, Rosneft, Russia's largest oil company, agreed to cooperate with the Chinese National Petroleum Corporation (CNPC) to study three structures in the Barents Sea. Since then, nothing has happened. China National Offshore Oil Corporation has a big stake in a still commercially uncertain project on Iceland's continental shelf,¹⁵ but there has been no serious Chinese interest in licensing rounds on Norway's Arctic continental shelf. An important reason is that Chinese companies have become more familiar with technological, cost, and operational challenges in the Arctic. They are in no position to replace Western majors as partners for Russian companies. Another reason is that companies are reevaluating their Arctic prospects after the fall in oil prices.

The major exception is Chinese involvement in the Yamal LNG project. The project, which involves the development of gas fields on the eastern side of the Yamal peninsula in West Siberia and construction of an LNG factory and port, was initiated by the Russian gas company Novatek and the French company Total. In 2014, CNPC bought a 20 percent stake in the \$27 billion project, and the Chinese Silk Road Fund obtained a 9.9 percent stake in 2015. A contract of \$12 billion for project financing was signed with two Chinese state banks in 2016. Chinese shipping companies are involved in international joint ventures set up to own and operate the large icebreaking LNG carriers custom built for the project. Lastly, CNPC has contracted annual deliveries of 3 million tons of LNG, out of a total production of 16.5 million tons.¹⁶ Through the Yamal LNG project, therefore, China is deeply involved in Arctic energy.

Why has China jumped into this project, while limiting its energy engagement elsewhere in the Arctic? To explain this apparent contradiction, it is necessary to understand the particularities of Yamal LNG. When CNPC entered the project, it was already far advanced: the resource base was extensively explored and infrastructure construction was under way. Solid partners with technical competence, particularly Total, brought credibility to the project. Russia also played an important role, providing subsidized infrastructure and preferential tax conditions to make the project

13. BP, *Statistical Review of World Energy: June 2016* (London: BP, 2016), <http://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review-2016/bp-statistical-review-of-world-energy-2016-full-report.pdf>.

14. Christopher Weidacher Hsiung, "China and Arctic Energy: Drivers and Limitations," *Polar Journal* 6, no. 2 (October 2017): 243–258, <http://www.tandfonline.com/doi/pdf/10.1080/2154896X.2016.1241486?needAccess=true>.

15. "CNOOC-led Consortium Meets to Discuss Exploration Offshore Iceland," *Offshore*, July 10, 2016, <http://www.offshore-mag.com/articles/2016/10/cnooc-led-consortium-meets-to-discuss-oil-and-gas-exploration-offshore-iceland.html>.

16. Zheng Xin, "To Russia with Energetic Love," *China Daily*, January 23, 2017, http://www.chinadaily.com.cn/business/2017-01/23/content_28029344.htm.

commercially attractive. Taking these factors into account, the risk level must have been perceived as very low, especially compared to Arctic offshore oil projects.

There is no doubt that China wants to be a player in the Arctic and gain competence for such a role. Chinese technology and service companies can be expected to play an increasing role, even if Chinese oil companies will not be in the driver's seat. The Chinese stepwise approach is to learn from others, without taking undue risks or incurring unnecessary costs. China may initially have approached the region with unrealistic energy expectations, but its currently cautious approach could give way to greater confidence over the long term.

Strategic Infrastructure

JAPAN'S PORTS AND POWER

Catherine L. Phipps

At the turn of the nineteenth century, Japan's ports had long been key to the country's transportation infrastructure, serving domestic coastal shipping networks and limited East Asian and Dutch trade. In the East Asian state system, trade and diplomacy were combined rather than separate functions of foreign interactions, and designated ports, like Nagasaki, were equipped to handle both. By the 1850s, however, Japan's port system changed dramatically with the forced opening of select seaports to international trade.¹ Paradoxically, both the earlier maritime restrictions and their gradual undoing through the opening of international trade ports aimed to ensure Japan's national security and state sovereignty.

The tipping point in foreign policy came in 1853–1854 when, after half a century of minor attempts by the British, Russians, and others, an American expedition, led by Commodore Matthew Perry, used gunboat diplomacy to force Japan's Tokugawa shogunate to accept limited trade and diplomatic relations with the threat of military confrontation.² In this famous incident, the Americans compelled the Japanese to change two centuries of austere policies that were largely designed to restrict foreign, especially Western, contact. Initiated in the 1630s, the so-called closed country edicts³ cut off what proved to be an emerging global trade to protect the fledgling Tokugawa regime from unwanted influences, especially Western Christians—and their Japanese trading partners and converts—who were seen as subversive to the new order.

1. Nagasaki Prefecture Civil Engineering Division, "History of Nagasaki Port," accessed September 21, 2017, http://www.doboku.pref.nagasaki.jp/~kouwan/2010_03/nagasakiport_english/no03.pdf.

2. Asia for Educators, "Commodore Perry and Japan (1853–1854)," accessed September 21, 2017, http://afe.easia.columbia.edu/special/japan_1750_perry.htm.

3. University of Pittsburg, "Text of the Sakoku (Closed Country) Edict of June 1636," accessed September 21, 2017, <http://www.pitt.edu/~annj/courses/sakoku.html>.

The short-term objective of Perry's expedition was to secure maritime access to Japan, including fair treatment of distressed sailors and the provision of necessities like water and coal. These demands came at a time when an increasing number of foreign vessels were plying East Asian waters as shipping and navigation technologies improved worldwide. The longer-term goal was to establish diplomatic relations and direct trade. Japan signed "unequal" commercial treaties, also known as the Ansei Treaties, in 1858 with the United States, the United Kingdom, Russia, the Netherlands, and France.⁴ These opened five treaty ports to foreign commerce, giving the Western powers privileges such as fixed tariffs, extraterritoriality, and most favored nation status, none of which were reciprocated.⁵

Some domestic factions, especially those located at the country's margins, saw the promise of opening to trade and the risks of not doing so. Engaging the foreigners and purchasing vessels and firearms gave them an edge over the central government, strengthening them to overthrow the Tokugawa with the rallying cry of *sonnō jōi*, "Revere the Emperor, expel the barbarians." Under the modernizing Meiji government,⁶ the new domestic agenda supported foreign policy and national security imperatives in conceding to Western demands, beginning what would be an economically fraught process of engaging in global trade, and funding and establishing the infrastructure and services (such as jetties, lighthouses, customs offices, and connecting railroads) that provided shippers and merchants with the technologies they needed to conduct trade.

Moreover, Japanese business and political leaders strategically targeted particular industries and products, including silk, cotton, tea, wheat, and rice, for export. Coal was one of these key commodities and the development of Japan's coal industry met more than one need.⁷ Beyond its sale for domestic use in fueling the country's modern industries, coal immediately began fulfilling foreign demand in the treaty ports. In addition to generating revenues for the growing network of foreign steamships operating in the region, entrepreneurs established coaling stations and created a vigorous export trade, supplying key Asian hubs in the British empire, especially Shanghai, Hong Kong, and Singapore.

In some cases, ports like Moji, at the tip of northern Kyushu, became so-called Special Trading Ports, which opened in the 1880s and 1890s to handle limited trade under full Japanese jurisdiction.⁸ The designation of these ports allowed foreign vessels to enter a greater number of harbors to load and unload cargo, including coal for export or ships' use. Moji was also retooled to serve military needs during the Sino-Japanese War of 1894–1895, handling the nation's strategic interests in addition to commercial ones. Other Special Trading Ports, like Naha in the Ryukyus and

4. Michael Hoffman, "The 'Barbarians' Were Coming—Like It or Not," *Japan Times*, June 23, 2013, <https://www.japantimes.co.jp/news/2013/06/23/national/history/the-barbarians-were-coming-like-it-or-not/#.WbK7rdiQwb4>.

5. Catherine L. Phipps, *Empires on the Waterfront: Japan's Ports and Power, 1858–1899* (Cambridge, MA: Harvard University Press, 2015).

6. Asia for Educators, "The Meiji Restoration and Modernization," accessed September 21, 2017, http://afe.easia.columbia.edu/special/japan_1750_meiji.htm.

7. UNESCO, "Sites of Japan's Meiji Industrial Revolution: Iron and Steel, Shipbuilding and Coal Mining," accessed September 21, 2017, <http://whc.unesco.org/en/list/1484>.

8. Phipps, *Empires on the Waterfront*.

Muroran in Hokkaido, were opened to curb illegal trade and expand state oversight in these remote sites.

In the closing decades of the century, as government officials worked to revise the unequal treaties through a combination of legal, institutional, and social change at home and diplomacy abroad (revisions were enacted in 1899⁹), the Japanese enhanced and expanded their own system of ports, linking them directly to a broad web of shipping lines and international seaports throughout East Asia and around the world. Doing so helped the country emerge from semi-colonial status to become an economically and militarily strong state that reordered traditional East Asian relations and launched its own empire. Ports were essential to this island country's efforts to regain national sovereignty, develop economically, and compete in an imperialistic world order.

During the latter half of the nineteenth century, Japan's seaports were transformed from sites that primarily handled domestic coastal shipping to deep-water harbors with the equipment necessary to accommodate commercial steamships and state-of-the-art warships. If anything, the transition in Japan's port system tells us something about the degree to which a country's transportation infrastructure is plugged into other national and supranational networks in such a way as to impact not just domestic economic interests but also advance national security and foreign policy objectives.

HOW BRITAIN'S COLONIAL RAILWAYS TRANSFORMED INDIA

Christian Wolmar

Nowhere other than India is the railway so indelibly connected with the image of the nation. Just as there is no single country on earth that has such a broad cultural, ethnic, and racial mix as India, there is also no railway system that has played and, crucially, continues to play such a fundamental role.

There are endless paradoxes about the Indian railways. They were the greatest gift left by the colonial power, and yet they were not built to serve the needs of local people. The fact that they did so, and continue to do so, was almost incidental. The British companies that laid down the tracks had not envisaged that people would pour en masse onto the iron road to take advantage of the immeasurably improved experience of traveling across the vast subcontinent offered by train services. Even though for the best part of the first 100 years of the railway age, they were owned and controlled by companies based 5,000 miles away in the United Kingdom, they immediately assumed an Indian identity, which only became stronger over time. A neat illustration of that is the fact that Indian Railways adopted a rather bowdlerized version of the famous London Underground roundel on its station signs.

9. Hugh Cortazzi et al., *The Revision of Japan's Early Commercial Treaties*, Discussion Paper No. IS/99/377 (London: Suntory and Toyota International Centres for Economics and Related Disciplines, London School of Economics and Political Science, 1999), 21–22, http://eprints.lse.ac.uk/6899/1/The_Revision_of_Japan%27s_Early_Commercial_Treaties.pdf.

The Indians took to the railways, not just physically, but emotionally. Railways and India are a good fit, an enduring one because not only are the Indians still building new lines, but virtually none have ever been closed. The railways delivered much for India. Just as with the United States of America, they bound the country together. They allowed fast travel between one end of the country and the other and cemented relationships between the various provinces. They enabled goods to be carried around the country far more cheaply than ever before. They allowed the development of markets in foodstuffs and other agricultural produce that increased their availability and, eventually, did make famines less likely. They created an infrastructure that in India was unprecedented in its sophistication and extent. They gave the opportunity of secure jobs to millions of Indians and enabled many of them to acquire new skills. They helped the development of the trade union movement. They laid the foundations of the large Indian middle class. They brought sophisticated technology to the subcontinent.

And so much more. They were transformative in so many ways, creating the India we know today. As Theroux summarizes,

The railway was the bloodstream of the Raj, and it affected nearly everyone. It linked the centers of population; and the cities, which until then had been identified with their temples and forts, became identified with their railway stations, Howrah with Calcutta, Victoria with Bombay, Egmore and Madras Central with Madras.¹⁰

He goes on to suggest, with some justification, that India only functions thanks to its railways.

That is not to say that the railways were always welcomed by Indians. Indeed, they were the subject of huge controversy because they were seen as the principal instrument of colonization. The British, with their small army, could not have kept hold of a turbulent country for so long without the ability of the railways to move troops around quickly. After a slow start in 1853, the construction of the railway network envisaged by Lord Dalhousie was sped up rapidly after the 1857 Rebellion. The railways were an instrument of control. The stations became fortresses, the white and, later, the Eurasian, staff became an auxiliary army, and the tracks became lines of communication in the event of conflict. The 1857 Rebellion, coming as it did at a crucial stage in railway development, had an enormous impact on the railways' eventual shape and the attitude of the British colonial rulers to their Indian subordinates. This was a nakedly military project, but not solely one. There were immeasurable economic benefits, too, and though the very design of the railways was as conduits to and from the ports to help British imports and exports, inevitably the Indian economy received a stimulus through their construction.

There was another source of mounting antagonism: the treatment of third-class passengers who were virtually all Indian. While the Europeans traveled in world-class luxury in first class, the masses were crammed into world-class squalor. There was even a long battle for them to have toilets on trains and conditions remained squalid well into the twentieth century. This proved to be a great source of dissent and encouraged nationalistic sentiment. The invention that did most to keep the Indians in check proved to be double-edged, stimulating the nationalistic forces that

10. Michael Satow and Ray Desmond, *Railways of the Raj* (London: Scolar Press, London, 1982).

eventually triumphed. Gandhi made great use of the railways but also criticized the conditions that third-class travelers—of which he deliberately was one, despite his relative wealth—endured.

At times it seemed that the authorities set out willfully to ensure that the railways antagonized the local population. In the mid-1880s, various lines were built supposedly to relieve famine, though they were a remarkably inefficient way of doing so. The Bengal-Nagpur line, for example, was built with funds from the Rothschild family but the British government decided that their guaranteed profits should be paid by an extra tax on the local peasantry. Consequently, the profits accrued by the richest family on earth were being provided from a group that was certainly among the poorest. You could not make it up.

Quite apart from the antagonism created by their construction and operation, the railways could have done so much more for India had they not been first and foremost a colonial project. There was a fantastic missed opportunity with ramifications that stretched far beyond transport considerations. If the British had nurtured the skills of their Indian workers and used the economic clout of the railways to stimulate the Indian economy, and if the companies had treated their third-class passengers as customers rather than as chattels, much of the anger toward the colonial power might have been allayed. That is not to say independence would not have happened, as clearly decolonization was an irresistible historic force, but the horrors of Britain's rapid departure might have been avoided.

The failure was, above all, economic. In an analysis of the impact of railways, John Hurd,¹¹ an economist who has written extensively on India, concludes that India only enjoyed limited economic development under the Raj precisely because the railways were not allowed to be the catalyst for growth that they proved to be in so many other countries. While the railways undoubtedly enabled the cheaper flow of goods, stimulated increased agricultural output, and created many jobs in modern industry and mining, "these changes did not affect the basic structure of the economy. Not until Independence when economic development became a conscious and pursued policy did the railways begin to realize their potential for assisting in the transformation of the Indian economy."

The failure was cultural, too. Imagine if the British had allowed far greater mingling of the races on the railways; if they had consciously helped to develop a managerial class of Indians able to share the burden of running the railways with them; if they had, essentially, seen Indians as partners rather than subordinates. Who knows, there might still be a group of Europeans working on India's railways today.

THE STRUGGLE BEHIND THE TRANS-SIBERIAN RAILWAY

Tom Zoellner

Other than the Apollo 11 mission to the moon, it would be hard to envision a national transportation project that was less about daily efficiencies and more about psychological conquest than the Kremlin's effort to build a railroad across Siberia.

11. John Hurd and Ian J. Kerr, *India's Railway History* (Boston, MA: Brill, 2012).

The guiding principle of the Trans-Siberian Railway was not about the routine moving of people from place to place, but sticking a pair of iron rods into bleak territory that had strategic importance in defining Russia's role in the Far East. The road was more geopolitical than economic, and it took a wildly profligate financing scheme to pull it off.

At the beginning of the 1890s, Czar Alexander III worried about pressure from Germany in the west as well as the possible expansion of Chinese influence into Siberia, which was then a barely populated gulag region mastered only by tigers and bandits. He decided the best way to reaffirm Russia's dominance in the East and even into Manchuria, as well as strengthen its internal economy through natural resources, would not be through posting isolated army divisions in the frozen wilderness but by creating a mechanical link between St. Petersburg and the far provinces, which were rich in iron, fur, and lumber.

The Russian minister of finance, Sergei Witte,¹² was not worried about long-term currency inflation. He told the czar that the best way to build up the national treasury was to spend "lavishly" on public works and let the corresponding revenue make up the difference—a strange reverse-echo of the famous Laffer Curve of U.S. Republican faith which says that tax cuts pay for themselves through increased payments.

"European know-how and capital will find for itself an extensive new field of employment for the exploration and development of the natural riches of the Eastern nations," Witte wrote. It was an audacious gamble whose only real major-scale comparative—the building of the Union Pacific and Central Pacific railways across the American West—had too many of its own idiosyncrasies to serve as a useful model.

Construction began in 1891 with an increase in taxes and the money supply to pay for wages and equipment, and Witte put the ruble on the gold standard six years later. He also opened the economy to unprecedented levels of foreign investment particularly from France, Britain, and the United States.

With the help of forced prison labor and the diversion of a third of Russian iron reserves, the railroad pushed steadily east into terra incognita, even as crews started westward from Vladivostok in hopes of meeting on the taiga within a decade. The construction camps were beset with malaria, cholera, and starvation. The ties and some bridges were made of immature green wood that buckled and created maintenance headaches all along the 5,772-mile route—about a fourth of the circumference of the earth—that would not be tied together until 1901.

The railway's strategic value, or at least its potential, would be made apparent by the Russo-Japanese War of 1904–1905, in which troops were sent closer to the combat zone more rapidly than by ship or by crossing the tundra on foot and sled. But the single track that had been completed suffered traffic jams and cut off the flow of Siberian wheat back to European Russia.

Even in peacetime, goods sat on the docks at Vladivostok for months at a time, awaiting a break in the snarled logistics window. The railway would function smoothly in the twentieth century only after an infusion of American cash and construction expertise, as well as the peace that came after

12. Francis W. Wcislo, *Tales of Imperial Russia: The Life and Times of Sergei Witte, 1849–1915* (Oxford, U.K.: Oxford University Press, 2011).

the Russian civil war. Up to five million settlers were eventually persuaded to give up the meager comforts of the west and make the journey out to the frontier to become farmers of the permafrost on free land given by the government, and outpost cities like Novosibirsk, Tomsk, and Irkutsk developed into manufacturing hubs in the era of the USSR.

As for the aggressive and visionary Witte, he got sidelined by the court of Nicholas II and left government fearing—correctly—the imminent collapse of the monarchy in the face of growing revolutionary sentiment. The Trans-Siberian Railway proved that heavy borrowing and crash building can pay dividends. They just might not be enjoyed by the current regime.

About the Authors

Atif Ansar is a fellow of Keble College and program director of the MSc in Major Programme Management (MMPM) at the Saïd Business School at Oxford University. The MMPM is a two-year part-time course that attracts senior executives from around the world who lead major programs across various arenas: large-scale infrastructure, major Information and Communications Technology, business change, urban development, defense equipment, big science, and major events. Atif Ansar has been a fixture at the University of Oxford since 2006. From 2006 to 2010, he undertook his DPhil (PhD), at Brasenose College, with the prestigious Clarendon Scholarship from Oxford University Press. He was a postdoctoral research fellow from 2010 to 2013 with Professor Bent Flyvbjerg at the BT Centre for Major Programme Management at Saïd Business School. From 2013 to 2015, he served as a lecturer at the Blavatnik School of Government and cohort manager of the Major Projects Leadership Academy (MPLA).

Lawson W. Brigham is a distinguished fellow at the University of Alaska at Fairbanks and a fellow at the U.S. Coast Guard Academy's Center for Arctic Study & Policy. A career Coast Guard officer, Captain Brigham commanded four ships, including the icebreaker *Polar Sea* on Arctic and Antarctic expeditions. During 2004 to 2009, he was chair of the Arctic Council's Arctic Marine Shipping Assessment and Alaska director of the U.S. Arctic Research Commission. He is a graduate of the U.S. Coast Guard Academy and earned his PhD at Cambridge University. His research interests have focused on the Russian maritime Arctic, environmental change, polar marine transportation, and polar geopolitics. Dr. Brigham is a Council on Foreign Relations member, was elected to the Norwegian Scientific Academy for Polar Research (2013), and was awarded the American Polar Society's Polar Medal (2015).

Mary R. Brooks is professor emerita at Dalhousie University's Rowe School of Business. In 2016, she was appointed chair of the Marine Board of the U.S. National Academy of Sciences. She has been active in the work of the Transportation Research Board in Washington, DC, since 1993 and is currently on its executive committee. She has chaired two International Transport Forum Roundtables for the Organization for Economic Cooperation and Development and most recently

chaired the Council of Canadian Academies Assessment on Social and Economic Value of Commercial Marine Shipping in Canada. Dr. Brooks is well known for her work on competition policy in liner shipping, port strategic management, and short sea shipping in Canada, the United States, South America, and Australia. She has authored more than 25 books and technical reports, more than 25 book chapters, and more than 85 articles in peer-reviewed scholarly journals.

Heather A. Conley is senior vice president for Europe, Eurasia, and the Arctic and director of the Europe Program at CSIS. Prior to joining CSIS in 2009, she served as executive director of the Office of the Chairman of the Board at the American National Red Cross. From 2001 to 2005, she served as deputy assistant secretary of state in the Bureau for European and Eurasian Affairs with responsibilities for U.S. bilateral relations with the countries of northern and central Europe. From 1994 to 2001, she was a senior associate with an international consulting firm led by former U.S. deputy secretary of state Richard L. Armitage. Ms. Conley began her career in the Bureau of Political-Military Affairs at the U.S. Department of State. She was selected to serve as special assistant to the coordinator of U.S. assistance to the newly independent states of the former Soviet Union. She is a member of the World Economic Forum's Global Agenda Council on the Arctic and is frequently featured as a foreign policy analyst on CNN, MSNBC, BBC, NPR, and PBS. She received her BA in international studies from West Virginia Wesleyan College and her MA in international relations from the Johns Hopkins University School of Advanced International Studies.

Louisa Denier is the regional law and policy adviser on wildlife trafficking for the Wildlife Conservation Society (WCS) Asia Program. Her work involves providing technical inputs and coordination to WCS counter-wildlife trafficking projects and activities relating to law and policy in the Asia region. Before joining WCS, she was a senior project manager for the Global Canopy Programme in the United Kingdom, where she managed multiple projects relating to forests, climate change, and sustainable landscape management. Prior to that, she worked for the International Union for Conservation of Nature (IUCN) Environmental Law Center in Germany as a consultant on human rights and the environment. Ms. Denier holds an LLM in environmental law from the School of Oriental and African Studies in London and a master's degree in French, English, and American business law from Nanterre Paris X University. She has been a member of IUCN's World Commission on Environmental Law since 2015.

Thomas Fingar is a Shorenstein Distinguished Fellow in the Freeman Spogli Institute for International Studies at Stanford University. From 2005 through 2008, he served as the first deputy director of national intelligence for analysis and, concurrently, as chairman of the National Intelligence Council. He also served as assistant secretary of the State Department's Bureau of Intelligence and Research (2000–2001 and 2004–2005), principal deputy assistant secretary (2001–2003), deputy assistant secretary for analysis (1994–2000), director of the Office of Analysis for East Asia and the Pacific (1989–1994), and chief of the China Division (1986–1989). Between 1975 and 1986, he held a number of positions at Stanford University, including senior research associate in the Center for International Security and Arms Control. His most recent books are *Reducing Uncertainty: Intelligence Analysis and National Security* (2011), *The New Great Game: China and South and Central Asia in the Era of Reform*, editor (2016); and *Uneasy Partnerships: China and Japan, the Koreans, and Russia in the Era of Reform*, editor (2017).

Bent Flyvbjerg is the first BT Professor and inaugural chair of Major Programme Management at Oxford University's Saïd Business School and professorial fellow of St. Anne's College. He works for better management of megaprojects and cities. He also writes about the philosophy and methodology of social science. Dr. Flyvbjerg is the most cited scholar in the world in megaproject management and among the most cited in social science methodology. He is the author or editor of 10 books and more than 200 papers in professional journals and edited volumes. His publications have been translated into 20 languages. Dr. Flyvbjerg serves as adviser and consultant to government and business, including the U.S. and UK governments and several Fortune 500 companies.

Jonathan E. Hillman is a fellow with the CSIS Simon Chair in Political Economy and director of the CSIS Reconnecting Asia Project, where he leads an effort to map and analyze new roads, railways, ports, and other infrastructure emerging across the supercontinent of Eurasia. His research focuses on the intersection of economics and foreign policy, including trade, globalization, economic statecraft, and China's Belt and Road Initiative. Prior to joining CSIS, he served as a policy adviser at the Office of the U.S. Trade Representative, where he directed the research and writing process for essays, speeches, and other materials explaining U.S. trade and investment policy. He is a graduate of the Harvard Kennedy School, where he was a Presidential Scholar, and Brown University, where he was elected to Phi Beta Kappa and received the Garrison Prize for best thesis in international relations.

Georg Inderst is an independent adviser to pension funds, institutional investors, and international organizations. His work is based on extensive experience in investment management, research, and pensions governance. Previously, he was director of the Law Debenture Pension Trust Corporation in London, head of the Global Asset Allocation and Fixed Interest teams at Foreign & Colonial in London, and an economist at HYPO Capital Management in Munich. Dr. Inderst authored several key studies on infrastructure investment and green finance, working, among others, with the Organization for Economic Cooperation and Development, the European Investment Bank, the Asian Development Bank, and the World Bank. He is also a member of various international committees in these fields.

Genia Kostka is a professor of Chinese politics at the Free University of Berlin. Her research and teaching interests are in China's energy governance, environmental politics, and political economy. Previously, she was a professor of governance of energy and infrastructure at the Hertie School of Governance (where she remains a fellow), an assistant professor at the Frankfurt School of Finance and Management, and a strategic management consultant for McKinsey & Company. She has a PhD in development studies from the University of Oxford, an MA with specializations in international economics and international development from Johns Hopkins University's School for Advanced International Studies, and a BSc in international relations from the London School of Economics and Political Science. Alongside her academic work, she regularly consults for international organizations, including the World Bank, Organization for Economic Cooperation and Development, Austrian Agency for International Development, German Corporation for International Cooperation, and Oxfam.

Melba Kurman writes about technology and its impact on how we live, work, socialize, and play. She has authored several books and articles about emerging technologies such as driverless cars, artificial intelligence, and three-dimensional (3D) printing. Her most recent book, *Driverless: Intelligent Cars and the Road Ahead* (coauthored with Hod Lipson), was translated into seven languages. Ms. Kurman has worked at Microsoft and Cornell University. She is a graduate of Cornell University and the University of Illinois, and a returned volunteer of the U.S. Peace Corps.

Johannes F. Linn is a distinguished resident scholar at the Emerging Markets Forum, a nonresident senior fellow at the Brookings Institution, and a senior fellow at the Results for Development Institute. From 2005 to 2010, he served as director of the Wolfensohn Center for Development at Brookings. Prior to joining Brookings in 2003, he worked for three decades at the World Bank. From 1996 to 2003, Dr. Linn was the bank's vice president for Europe and Central Asia. He has published extensively on development and global governance issues. His current research is in the areas of scaling up successful development interventions, global governance reform, and regional cooperation and integration (with a special focus on Central Asia and greater Eurasia). Dr. Linn holds a bachelor's degree from Oxford University (1968) and a doctorate in economics from Cornell University (1973).

Matthew Melino is a research associate with the CSIS Europe Program, where he provides research and program support on a range of issues, including developments in the Arctic, security and defense trends in northern Europe, and the evolution of NATO and transatlantic relations. Previously, he served as a research assistant with the Europe Program, analyzing political, economic, and security developments across the Eurozone. Mr. Melino has also worked with the U.S. Department of State on issues of conflict prevention and crisis response. He received his BA in government from Franklin & Marshall College and his MA in international relations and international economics from the Johns Hopkins University School of Advanced International Studies.

Christopher Miller is assistant professor of international history at the Fletcher School of Law and Diplomacy at Tufts University. He is also Eurasia research director at the Foreign Policy Research Institute. He is the author of *The Struggle to Save the Soviet Economy: Mikhail Gorbachev and the Collapse of the USSR* (2016). His next book, on economic policy in Vladimir Putin's Russia, will be published in spring 2018.

Arild Moe is a senior research fellow at the Fridtjof Nansen Institute, an independent social science research institute specializing in international energy and environmental and resource management politics. His degree is from the University of Oslo, where he studied political science, Russian language, and public law. Most of his research has been devoted to Russia, especially the energy sector and energy politics. In recent years, he has been engaged in studies of Arctic shipping as well as broader Arctic policy issues. He recently directed a project studying the interests of Asian countries in the Arctic.

Sebastien Peyrouse is a research professor at the Central Asia Program in the Institute for European, Russian and Eurasian Studies at George Washington University and a senior fellow at the East West Institute. His main areas of expertise are political systems in Central Asia, economic and social issues, Islam and religious minorities, and Central Asia's geopolitical positioning toward China, India, and South Asia. Dr. Peyrouse has edited *China and India in Central Asia: A New "Great Game"?*

(2010), authored *Turkmenistan: Strategies of Power, Dilemmas of Development* (2011), and coauthored, with Marlène Laruelle, *The “Chinese Question” in Central Asia: Domestic Order, Social Changes, and the Chinese Factor* (2011) and *Globalizing Central Asia: Geopolitics and the Challenges of Economic Development* (2012).

Catherine L. Phipps is associate professor of East Asian history at the University of Memphis. She received her PhD from Duke University in 2006 and specializes in the history of modern Japan, maritime empires, and historical geography. She is the author of *Empires on the Waterfront: Japan’s Ports and Power, 1858–1899* (2015), which analyzes Japan’s foreign trade ports (especially the little-known Special Trading Ports) and their networks. Her current research projects examine Japan’s coastal security and sovereignty in the nineteenth century and the physical, material, and cultural impact of Japan’s empire on the port and metropolis of Osaka.

Bruce Upbin is vice president for strategic communications at Hyperloop One, where he connects audiences globally to the promise and reality of the first new mode of transportation in 100 years. Prior to joining Hyperloop One, he worked as a business journalist for 25 years and ran Forbes Media’s worldwide technology coverage from 2008 to 2016, overseeing a network of more than 120 contributors. Mr. Upbin has written and edited dozens of cover stories, breaking news items, scoops, and award-winning features. He appeared frequently as a television and radio commentator on CNBC, Fox, NPR, ABC News, and the BBC. He oversaw Forbes’ iconic Billionaires and Forbes 400 wealth lists, the Midas List of top technology investors, and the Global 2000 list of the world’s biggest companies. He has covered diverse industries including retail, manufacturing, pharma, software, transportation, telecom, and information technology.

Mary E. Wilson, MD, is adjunct professor of global health and population at the Harvard T. H. Chan School of Public Health and a clinical professor of epidemiology and biostatistics at the University of California, San Francisco. Her academic interests include the role of travel and trade in emerging infections and antibiotic resistance. She is a member of the Forum on Microbial Threats (National Academies of Science, Engineering, and Medicine). She is the author of *A World Guide to Infections: Diseases, Distribution, Diagnosis* (1991); senior editor, with Richard Levins and Andrew Spielman, of *Disease in Evolution: Global Changes and Emergence of Infectious Diseases* (1994); and editor for *New and Emerging Infectious Diseases*. She also serves as an adviser to the Geo-Sentinel Surveillance Network and is associate editor for *Watch Infectious Diseases*.

Christian Wolmar is an author and broadcaster specializing in transport and social policy. He has worked for several national newspapers, including *The Observer* and *The Independent*, and frequently broadcasts as a commentator on radio and television. He is the author of a series of books on railway history, including *Fire & Steam* (2008), the story of Britain’s railways; *The Subterranean Railway* (2012); and *To the Edge of the World* (2013), which covers the construction and use of the Trans-Siberian railway. His book *Railways and the Raj*, covering the impact of railways in India, will be published in November 2017.

Peter Zahler works for the Wildlife Conservation Society (WCS) as the senior adviser for the Asia Program and director of the Training and Capacity Building Program. He has over 35 years of experience in wildlife conservation with over 60 conservation publications. He has performed research and consulted or managed programs in such locations as Afghanistan, Alaska, Iran,

Mongolia, Peru, Tajikistan, and Venezuela. He started and ran the WCS Pakistan Program from 1997 until 2001. In 2002, he coordinated and led the UN Environment Program's Post-Conflict Environmental Assessment of Afghanistan. In 2003, he helped design and became the first country director of the WCS Mongolia Country Program and then went on to design and start the WCS Afghanistan Program beginning in 2006. He continues to supervise projects and programs across Temperate Asia while also serving as the coordinator for the WCS Snow Leopard Program.

Tom Zoellner is the author of five nonfiction books, including *The Heartless Stone* (2007), *Uranium* (2009), *A Safeway in Arizona* (2011), and *Train* (2014), and serves as the politics editor of the *Los Angeles Review of Books*. His writing has also appeared in the *Atlantic*, *Foreign Policy*, *Harp-er's*, *Time*, *American Scholar*, *Men's Health*, *Slate*, *Los Angeles Times*, *New York Times*, and *Wall Street Journal*. He has served as a visiting professor at Dartmouth College and works full-time as an associate professor of English at Chapman University.

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