UN environment programme

CMS

CONVENTION ON MIGRATORY SPECIES

UNEP/CMS/COP14/Inf.30.3.1

4 January 2024

Original: English

14th MEETING OF THE CONFERENCE OF THE PARTIES
Samarkand, Uzbekistan, 12 – 17 February 2024
Agenda Item 30.3.1

FIRST ASIA-EUROPE TRANSPORTATION ECOLOGY FORUM: BOOK OF ABSTRACTS

1st Asia-Europe Transportation Ecology Forum

Book of abstracts

Organized online in November 24-25 2022

Organizers

Co-organizers

CONTENTS

1. PREFACE

Welcome to the 1st Asia-Europe Transportation Ecology Forum.

On behalf of CATS, Jiding Chen, Vice President of CATS

On behalf of the CATS, one of the organizers of this conference in Asia, I would like to express a warm welcome to all the experts and representatives to attend the 2022 first Asia-Europe Transportation Ecology Forum online!

CATS is a comprehensive scientific research institution directly under the Ministry of Transport of China, founded in 1960. CATS mainly carries out basic, forward-looking, public welfare research, technical consultation and service work for the relevant government departments and the transportation industry. CATS is the "national team" in the field of "transportation and environmental protection and ecological restoration" in China. CATS has presided over more than 100 scientific research projects at all levels, won two national Science and Technology Progress awards and more than 40 provincial and ministerial-level awards. CATS has carried out lots of research on ecological protection and restoration in ecological sensitive area in China, constructed the theoretical system of road ecology in China, and provided the highway ecological protection and restoration technology system, formed a relatively systematic solution of green road construction in China. CATS has filled in a number of gaps, including: wrote China's first textbook on road ecology "Road Ecology in China" to lead the development direction of the discipline. CATS complied China's first systematic monograph of green highway, "Green Highway Construction: Theory and Practice", to point out the development direction of ecological protection and restoration of China's transportation industry. In addition, CATS initiated the First Asian Transportation Ecology Forum in 2021.

In recent years, CATS's international academic exchange and cooperation has developed rapidly. For example, CATS was invited to join Infrastructure and Ecology Network Europe (IENE)in 2014, becoming the only institute in China to join this academic organization. CATS was also invited to join the Asian Elephant Transport Working Group (AsETWG), which is a collaboration of the Connectivity Conservation Specialist Group under IUCN's World Commission on Protected Areas and the Asian Elephant Specialist Group under the Species Survival Commission. Road ecologists in CATS were invited to serve as the editor of "Transport Ecology. Info", which is a globally-relevant open access resource to share information, knowledge and experience about ecologically-friendly transport planning and management. In addition, CATS was invited to join the compilation of several international books, including the "Global Strategy for Ecologically Sustainable Transport and other Linear Infrastructure" (published in 2021) and the "Handbook of Road Ecology" (published in 2005).

Recently, transportation ecology and environment protection have increasingly become the research focus among international stakeholders and scholars across the sectors of transportation, biodiversity conservation, and ecological safety. The Eurasian continent represents more than a third of the world's land, more than two-thirds of the world's population, and has a huge transportation infrastructure. At the same time, it is extremely rich in biodiversity. The economic and social development of the Eurasian continent urgently needs the construction and upgrading of transportation infrastructure, also facing the same time the responsibility and major challenges of protecting biodiversity.

In December 2021 CATS, partnering with several international organizations held the first Asian Transport Ecology Forum. Nearly 200 people from 13 countries attended the forum.

Participants expressed the need for more such transnational, regional and interdisciplinary academic sharing and collaborative exploration. IENE is the largest and most experienced network of transport experts. Based on the feedback from the participants of this inaugural Asian Transport Ecology Forum, CATS and IENE decided to hold the first Asia-Europe Transportation Ecology Forum from 24 to 25 November 2022 in order to continue to promote the exchanges and cooperation between the transportation industry and environmental professionals.

The co-organizers include: China Sustainable Transport Innovation Center, China highway &Transportation Society, Zoological Society of London (ZSL), Wildlife Conservation Society (WCS), Australasian Network of Ecology and Transportation (ANET), World Wide Fund for Nature - Beijing Office (WWF), IUCN/World Commission on Protected Areas (WCPA)/Connectivity Conservation Specialist Group's (CCSG)/Transport Working Group (TWG), Center for Large Landscape Conservation (CLLC), Nicholas Institute of Duke University, Road Ecology Research Society of Japan, Research Institute of Highway Ministry of Transport, World Transport Convention (WTC), China Communications and Transportation Association (CCTA), Centre for Research and Technology Hellas (CERTH)/Hellenic Institute of Transport (HIT), Permanent International Association of Road Congresses (PIARC)/Technical Committee (TC) 3.4 Environmental Sustainability in Road Infrastructure and Transport, and Center for Nature and Society of Peking University. I would like to take this opportunity to sincerely thank all the co-organizers and all the experts, scholars and colleagues who have participated in the organization and planning!

The forum lasted for two days with six sessions:

1) International experiences and implications for developing road ecology in Asia;
2) Transportation ecology in Asia: case studies (Part A);
3) Sustainability challenges for (road) mobility and wildlife in Eurasia, barriers, and opportunities;
4) Wildlife Roadkill in Asia;
5) Planning, habitat, and others;
6) Transportation ecology in Asia: case studies (Part B).

Thirty presenters from more than twenty countries and six continents (Europe, Asia, Africa, North America, South America and Oceania) gave oral or poster presentations and shared their research results and practical experience. I believe that through their wonderful speeches and exhibitions, we certainly broadened our vision, and thinking, expanded our contacts, and enriched our practice!

China is speeding up its efforts to build itself into a transportation power. We will continue to give top priority to ecology, strive to achieve a green and low-carbon development, and strive to avoid or minimize the impact on ecosystem integrity and ecological function. To this end, we hope this forum serves as an opportunity to jointly establish a regular academic exchange mechanism with colleagues from all countries, jointly promote the progress of transport ecology, and provide scientific solutions for the construction of global green transportation infrastructure. I sincerely invite all the experts and representatives to make more valuable opinions and suggestions for the preparations for the next forum!

On behalf of IENE Governance Board, Anders Sjolund, Chair of IENE Governance Board

IENE, a European key actor for the development and realisation of an ecologically sustainable linear infrastructure in connection with Asia

Infrastructure and Ecology Network Europe (IENE) was established 1996 in connection with an EU financed project, COST 341, which aimed to compile knowledge about the interaction between roads and ecology. The result was a *Handbook Wildlife and Traffic* that was launched 2003. Since then, IENE has developed to a full-bodied network and since 2019 is a non-profit, nongovernmental, non-political, formalised association of experts active in the fields of ecology, transportation, and infrastructure. The hub of the IENE consists of the General Assembly (GA) of the members, the Governance Board (GB) to execute tasks and missions according to decisions in the GA, and the Executive Secretariat contributing to their implementation and communicating with the members and all cooperative bodies. Lately also a Scientific and Expert Committee (SEC) has been established to advise and support the GB in its work.

The IENE vision is to be a key-actor in mainstreaming biodiversity in the sector of linear infrastructure, roads, railways, waterways, power lines, etc. Through the web-based IENE handbook, any person working in this field will be able to find the latest, well-established, actual, and quality secured knowledge. Appointed experts responsible for different chapters will constantly update the handbook.

IENE provides an independent, international, and interdisciplinary arena for the exchange and development of expert knowledge – and with the aim to promote a safe and ecologically sustainable Pan-European transport infrastructure. IENE arranges international conferences, workshops, training seminars, and symposia, initiates collaboration projects, and helps answering questions that require joint international expertise. Through IENE any financer of research can get support to set up calls, get help to carry out research projects, get support to adapt and implement results, and to disseminate the findings.

Global, national, and local conferences, forums, workshops, and seminars can be organised or supported by IENE on its own initiative or on request of other clients. IENE fosters cooperation between organisations, authorities, nations, and continents within the field of linear infrastructure and ecology. Such examples of creating of alliances is those with PIARC, Bern Convention, ICOET (International Conference on Ecology and Transportation) in North America, IUCN, WWF, ANET (Australian Network for Ecological and Transport), ACLIE (African Conference for Linear Infrastructure and Ecology), and others. Through these coalitions, IENE aims to be present in the society and to be an obvious and natural partner to everyone around the world involved in planning, designing, construction, and maintenance of linear infrastructure.

Establishing the Asia – Europe Transportation Ecology Forum, IENE very much looks forward to strengthening its alliances with CATS and other Asian organisations and authorities in order to support the transport ecology in Asia aiming to respond to the challenges of working against fragmentation of the landscapes and ecosystems in a common Eurasian approach as a biggest and united continental territory of the planet.

2. INTRODUCTION

In October 2021, the Kunming Declaration was adopted in the first part of the 15th meeting of the Conference of the Parties (COP15) to the United Nations Convention on Biological Diversity (UN-CBD). The declaration clearly states that a key objective of the post-2020 global biodiversity framework is to reverse the current trend of biodiversity loss and ensure that biodiversity is on a path to recovery by 2030 at the latest, leading to the full realization of the 2050 vision of "People and Nature in Harmony". In the same month, the second United Nations Global Conference on Sustainable Transport was held and called for "accelerating the development of green and low-carbon transport modes and strengthening green infrastructure". Transportation and biodiversity conservation, as two different disciplines, are constantly coming across each other to achieve a common goal for more sustainable development of the world.

Asia has the largest population and transport infrastructure in the world. At the same time, it is extremely rich in biodiversity. The economic development of developing countries and regions in Asia urgently requires the construction and upgrading of transport infrastructure, while facing the major challenges and responsibilities of biodiversity conservation.

In December 2021, the Chinese Academy of Transportation Science of the Ministry of Transport of China (CATS), together with several national and international organizations, organized the first Asian Transportation Ecology Forum, with nearly 200 participants from 13 countries. Participants expressed the need for more such transnational, cross-regional, and interdisciplinary exchanges of knowledge, research and collaboration. Such effort will promote the mainstreaming of biodiversity conservation in the practice of construction and operation of transport infrastructure and will encourage the transport industries and conservation communities to work together to support the process of global sustainable development.

IENE is the world's largest and most experienced network of transport ecology experts with more than 400 registered members in over 50 countries worldwide. IENE is dedicated to bringing the world's leading experts and to sharing knowledge and experience among countries and regions.

Based on the feedback from participants of the first Asian Transportation Ecology Forum, CATS and IENE decided to organize the first Asia-Europe Transportation Ecology Forum virtually from 24-25 November 2022 with the purpose of promoting exchanges and cooperation between people within the transport industry and the conservation community.

The aim of the **Asia-Europe Transportation Ecology Forum** is to bring together the experiences and knowledge of Asian and European countries in the field of transport ecology research and practice.

3. THE TOPICS OF THE FORUM

In pursuit of bringing together the experiences and knowledge of Asian and European countries in the field of transport ecology research, the Forum invited organizations and experts from Asia, Europe, and all over the world to prepare and submit abstracts on research or practices related to transport ecology focused on Asia and Europe.

The following are some of the research directions and themes in transport ecology that were proposed as the focus of the conference, though abstracts and sub-forum themes were also submitted outside of this list.

- Habitat loss, degradation, and fragmentation
- Road traffic injuries (roadkill, road fatalities, road injuries, wildlife-vehicle collision)
- Road impact domains
- Avoidance
- Barrier impacts
- Animal passage (wildlife crossing structure)
- Environmental impact assessment / strategic environmental impact assessment / planning environmental impact assessment/mitigation hierarchy approaches
- Vegetation protection and restoration
- Monitoring
- Transportation technology innovation to support environmental protection, ecological conservation, and biodiversity conservation
- Policy and management
- Standards and regulations
- Citizen science and public participation
- Stakeholder engagement

4. THE PROGRAM OF THE FORUM

Thursday 24th November, 2022		
CET	**China time**	**Presentations**
08:00-08:10	15:00-15:10	Opening remarks and presentation of CATS (Prof. Jiding Chen, Vice President, CATS, China)
08:10-08:20	15:10-15:20	Opening remarks and presentation of IENE (Anders Sjolund, Chair of Governance Board, IENE)
08:20-08:50	15:20-15:50	**Keynote speech** Plans, trains, and automobiles: a global picture of environmental risks and socio-economic benefits of planned road and rail infrastructure (Andy Arnell, UNEP-WCMC)
08:50-09:05	**15:50-16:05**	**Break**
Session I: International experiences and implications for developing road ecology in Asia (Moderator: Yaping Kong, Director, CATS, China)		
09:05-09:10	16:05-16:10	Introduction of this session (Yaping Kong, Director, CATS, China)
09:10-09:25	16:10-16:25	A global strategy for ecologically sustainable transport and other linear infrastructure (Lazaros Georgiadis, IENE and CERTH, Greece)
09:25-09:40	16:25-16:40	Utilizing states' international obligations to address linear infrastructure impacts on migratory species (Clara Nobbe and Marc Attallah, CMS, Germany)
09:40-09:55	16:40-16:55	Rebuilding bridges: engaging stakeholders and innovating approaches to improve habitat connectivity, social economics, and engagement in UK (Katherine Aburrow, Animex International, UK)
09:55-10:10	16:55-17:10	Austria's defragmentation programme: successes and challenges (Elke Hahn, Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology and IENE, Austria)
10:10-10:25	17:10-17.25	Linear infrastructures and biodiversity in South Africa (Wendy Jane Collinson, The Endangered Wildlife Trust, South Africa)
10:25-10:40	**17:25-17:40**	**Break**
Session II: Transportation ecology in Asia: case studies (Part A) (Moderator: Dr. Aili Kang, Strategic Engagement Director, Wildlife Conservation Society, China)		
10:40-10:45	17:40-17:45	Introduction of this session (Dr. Aili Kang, Wildlife Conservation Society, China)
10:45-11:00	17:45-18:00	**PII-1**: Global transport infrastructure development initiatives (Alice Hughes, School of Biological Sciences, University of Hong Kong, China)
11:00-11:15	18:00-18:15	**PII-2**: A holistic model for inclusive and resilient linear infrastructure in South-East Asia (Matthew Baird, Asian Research Institute for Environmental Law, ARIEL, Thailand)
11:15-11:30	18:15-18:30	**PII-3**: A global knowledge sharing platform in transport ecology: www.transportecology.info

Thursday 24th November, 2022		
		(Darryl Jones, Centre for Planetary Health & Food Security and School of Environment & Science, Griffith University, Brisbane, Australia)
11:30 -11:45	18:30-18:45	**PII-4**: A low-cost wild animal protection system through animal presence and movement detection using wireless sensor network (Subrat Kar, Electrical Engineering Department, Indian Institute of Technology Delhi, India)
11:45-11:50	**18:45-18:50**	**Short break**
SESSION III (PIARC's workshop): Sustainability challenges for (road) mobility and wildlife in Eurasia, barriers and opportunities (Moderator: Lazaros Georgiadis)		
11:50-12:00	18:50-19:00	Short introduction of PIARC and the TC 3.4 (Eric Dimnet, Mobility officer at the General Commission for Sustainable Development, France, PIARC TC 3.4 Chair)
12:00-13.20	19:00-20:20	Open discussion and interactive work session in the form of round table with invited guests aiming to identify the challenges towards achieving environmental sustainability on road networks development in Asia in connection with Europe defining the role of transport authorities
13:20-13:25	20:20-20:25	Conclusions of the Session (Lazaros Georgiadis)
13:25-13:30	20:25-20:30	Closing remarks of the day (Aili Kang, Strategic Engagement Director, Wildlife Conservation Society, China)

Friday 25th November, 2022		
CET	**China time**	**Presentations**
08:00-08:30	15:00-15:30	**Opening of the day and keynote speech** Ecological protection and restoration along roads in ecological sensitive areas, China (Yaping Kong, Director, CATS, China)
Session IV: Wildlife Roadkill in Asia (Moderator: Dr. Qilin Li, Hianan Tropical Ocean University, China)		
08:30-08:35	15:30-15:35	Introduction of this session (Dr. Qilin Li, Hianan Tropical Ocean University, China)
08:35-08:50	15:35-15:50	**PIV-1**: Factors influencing wildlife roadkill at Mt. Fuji, Japan, a UNESCO World Heritage Site (Yoichi Sonoda, International Industrial Technology College & Meiji University, Japan)
08:50-09:05	15:50-16:05	**PIV-2**: A large-scale analysis reveals unimodal and U-shaped effects of traffic volume on roadkill (Dror Denneboom, Technion – Israel Institute of Technology, Israel)

Friday 25th November, 2022		
09:05-09:20	16:05-16:20	**PIV-3**: Wildlife-vehicle collisions in Asia: what we know so far about the impact on populations? (Clara Grilo, CESAM - Centre for Environmental and Marine Studies, Faculdade de Ciências da Universidade de Lisboa Portugal)
09:20-09:35	16:20-16:35	**PIV-4**: Concerns for herpetofauna: road associated mortalities in National Highway 715 in Assam, India (Somoyita Sur, Department of Zoology, Animal Ecology and Wildlife Biology Laboratory, Gauhati University, India)
09:35-09:50	16:35-16:50	**PIV-5**: Roadkill on Banling Highway in South China (Dr. Qilin Li, Hianan Tropical Ocean University, China)
09:50-10:05	16:50-17:05	Break
Session V: Planning, habitat, and others (Moderator: Dr. Xinjun Wang, Vice Director, CATS, China)		
10:05-10:10	17:05-17:10	Introduction of this session (Dr. Xinjun Wang, Vice Director, CATS, China)
10:10-10:25	17:10-17:25	**PV-1**: Impacts of planned linear infrastructure on the habitat of Asian elephants in Nepal's Terai Arc region (Prof. Ahimsa Campos-Arceiz and Dinesh Neupane, Southeast Asia Biodiversity Research Institute, Chinese Academy of Sciences & Center for Integrative Conservation, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences)
10:25-10:40	17:25-17:40	**PV-2**: Alignment optimization: a preliminary assessment of construction, economic, and environmental costs (in Myanmar) (Grant Connette, Smithsonian Institution, USA)
10:40-10:55	17:40-17:55	**PV-3**: Development regulations, perverse incentives, and strategic road planning (Jayden Engert, Centre for Tropical Environmental and Sustainability Science, James Cook University Australia)
10:55-11:10	17:55-18:10	**PV-4**: A monitoring and evaluation method on road impact and animal avoidance effects based on intelligence technology (Minghao Gong, Institute of Ecological Conservation and Restoration, Chinese Academy of Forestry, China)
11:10-11:25	18:10-18:25	**PV-5**: Current status and future of road ecology research for multidimensional health (Hui Li, Tongji University, China)
11:25-11:40	18:25-18:40	Break
Session VI: Transportation ecology in Asia: Case studies (Part B) (Moderator: Dr. Yun Wang, CATS, China)		
11:40-11:45	18:40-18:45	Introduction of this session (Dr. Yun Wang, CATS, China)
11:45-12:00	18:45-19:00	**PVI-1**: Impact of road on wildlife and mitigation measures in Sanjiangyuan National Park in China (Fei Zhou, Chief Program Officer of WWF China, China)
12:00-12:15	19:00-19:15	**PVI-2**: Effects of roads on leopards (*Panthera pardus*) movement: males vs. females

Friday 25th November, 2022		
		(Claudia Silva, Faculdade de Ciências da Universidade de Lisboa, Portugal)
12:15-12:30	19:15-19:30	**PVI-3**: Effect of roads on activities of North China leopard in the middle section of Taihang Mountains (Beibei Liu, China Felid Conservation Alliance, China)
12:30-12:45	19:30-19:45	**PVI-4**: The Effect of roads and railways on terrestrial species in Asia: A 20-year review. (Dr. Aditya Gangadharan, Program Lead-Lands, The Nature Conservancy-India)
12:45-13:00	19:45-20:00	**PVI-5**: Research-informed mitigation planning for Mahendra's Road expansion in the Terai Arc Landscape (Tony Clevenger, Western Transportation Institute, Montana State University, USA)
13:00-13:05	20:00-20:05	Closing remarks of the day and the 1st Asia-Europe Transport Ecology Forum (Lazaros Georgiadis and Yun Wang)

The following posters were available during the Forum:

P1. Road ecology for multidimensional health: current status and future development (Hui Li, Tongji University, China)

P2. Annual patterns of small vertebrates roadkilled in a city of China (Qiong Wu, Taozhu Sun and Zhongqiu Li, Nanjing University, China)

P3. Research status and challenges of road impact on wildlife in China (Abudusaimaiti Maierdiyali[1,2], Yun Wang[2]*, Shuangcheng Tao[2], Yaping Kong[2], Hao Wang[1], Zhi Lu, [1]Peking University, [2]Chinese Academy of Transportation Sciences, China)

P4. An analytical framework of factors affecting wildlife-vehicle collisions and barrier to movement (Haotong Su and Yun Wang, China Academy of Transportation Sciences, China)

P5. The impact and the countermeasures against the ecosystem barrier of temporary Projects of Railway (Wang Bijun, China Railway 11th Bureau Co., Ltd, Wu Zhen and Liu Lei, Center for Environmental Protection of Ministry of Transport,Cai zhizhou,2 Center for Environmental Protection of Ministry of Transport, China)

P6. Transportation technology empowers transportation governance reform: A three-dimensional perspective of technology, value, and goal (Guang Hui Zhao, Song Zhang, Guizhou University of Finance and Economics)

P7. Spatial and temporal characteristics of landscape pattern in the Three-River Headwaters Road Network from 2010 to 2020 (Zhaoming Wang, Shegang Shao, Xiaofei Liu, Yanan Qi and Sen Zhao, Research Institute of Highway, Ministry of transport, China)

P8. Land use, vegetation cover, and landscape pattern change of main linear infrastructure on the Qinghai-Tibet Plateau, China (Siqi Yang, Gaoru Zhu, Transport Planning and Research Institute, Ministry of Transport, China)

5. ABSTRACTS OF PRESENTATIONS (PER SESSION)

KEY NOTE SPEECH of the 1st day, 24th November 2022

Plans, trains, and automobiles: a global picture of environmental risks and socio-economic benefits of planned road and rail infrastructure

Andy Arnell[1], Fiona S. Danks[1], Javier Fajardo[1], Rowan Palmer[2]

[1]*UN Environment Programme World Conservation Monitoring Centre, Cambridge, UK.*

[2]*UN Environment Programme, Geneva, Switzerland.*

Contact author: Andy Arnell, **E-mail:** andy.arnell@unep-wcmc.org

Keywords: Sustainable infrastructure, impact assessment, biodiversity, ecosystem services, socio-economic, road, rail, risks, benefits.

Topics addressed:

- Habitat loss, degradation, and fragmentation
- Strategic environmental impact assessment
- Policy and management

Abstract

The prospective impacts of road and rail construction and use are routinely measured at local and subnational levels. However, until now, there has not been a standardised, comparable global assessment of the ecological risks and economic benefits of planned transport infrastructure projects.

To provide such an overview, we needed to first create a global database of planned large-scale road and rail projects. We then developed a methodology to map the risks of these projects to biodiversity and ecosystem services. To understand the associated socio-economic benefits for this planned infrastructure, we estimated potential boosts to jobs and countries' gross domestic product (GDP). Combining these various analyses, we highlighted the overall risks and benefits on a country level. In addition to national overall impact results, we calculated risks and benefits per km of road and rail infrastructure. All results are available for exploration in an online "web viewer" tool that we also created as part of this study.

We found that the planned or in progress transport projects will 1) impact habitats of nearly 2,500 amphibian, bird, and mammal species of conservation concern, with a high risk to persistence for 42 species; 2) intersect protected areas or Key Biodiversity Areas (KBAs) for 5% of the total summed length (i.e., for 1 km/20 km of infrastructure); 3) release 883 million tons of carbon from removed trees and vegetation – more than in Costa Rica's rainforests – and potentially 1.17 million tons of nitrogen with toxic downstream impacts; create 2.4 million global jobs, with varying increases in GDP, from 0.1% in higher income regions to 1.3% in lower income countries.

We found that Bolivia, Peru, and Hungary had planned road and rail infrastructure that, when analysed as a whole, fell in a "higher ecological risk - lower economic benefit" category. Countries with projects projected to be "higher ecological risk – higher economic benefit" are typically those with high quantities of planned infrastructure – including Russia, China, Brazil,

and Argentina. We suggest plans in both categories should have further scrutiny to better understand the risks and benefits.

As the project database is based on plans available to the researchers during the study, it could be expanded in future and made publicly available for widespread engagement. We hope the database and novel methods presented will provide a springboard for further analysis of the risks posed by global road and rail developments. Ideally this work might ultimately lead to focussed project risk assessments and policy reviews for planned transport infrastructure development.

Profile of corresponding author

Andy Arnell is a spatial analyst at UNEP-WCMC, where his research includes modelling the impacts on biodiversity of land use change and improving spatial conservation planning. He has nearly 15 years' experience in creating spatial analytical workflows, building on his academic background in zoology, primate conservation and species distribution modelling. Recent work has focused on impacts of linear transport infrastructure, including applying species-level metrics at the global scale.

SESSION I:

International experiences and implications for developing road ecology in Asia

(Moderator: Yaping Kong, Director, CATS, China)

Presentation I-1: A Global Strategy for Ecologically Sustainable Transport and other Linear Infrastructure

Lazaros Georgiadis[1,2], Anders Sjölund[2,3], Andreas Seiler[4,5], Antonio Mira[2,6], Carme Rosell[2,7], Cristian Remus (Cristi) Papp[8], Elke Hahn[2.9], Fiona Mathews[10], Fraser Shilling[11], Hans Bekker[12], Hildegard Meyer[13], Jose Rafael Garrido López[14], Juliana Moreno Pina[15], Kate Newman[16], Kishaylin Chetty[17], Lourens Leeuwner[18], Marita Böttcher[2,19], Radu Moț[20], Rob Ament[21,22], Rodney Van der Ree[23], Sandro Bertolino[24], Sarah Chiles[24], Tony Sangwine[2,25], Vaclav Hlavac[26], Yannick Autret[2,27], Wendy Collinson[5,28], Xiaochun Qin[29] and Yun Wang[30].

[1]*Biologist – Environmental Consultant, Florina, Greece*

[2]*IENE Governance Board member*

[3]*Swedish Transport Administration, Borlänge, Sweden*

[4] *Swedish University of Agricultural Sciences, Grimsö Wildlife Research Station, Sweden*

[5]*IENE Scientific and Expert Committee (SEC)*

[6]*University of Evora, Portugal*

[7]*Minuartia, Barcelona, Catalonia, Spain*

[8]*Wildlife and Landscape National Manager, WWF Danube Carpathian Programme Romania, Bucharest, Romania*

[9]*Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology, Vienna, Austria*

[10]*Mammal Society, University of Sussex, Falmer, UK*

[11]*Road Ecology Centre, University of California, (ICOET) Davis, USA*

[12]*Department Public Works; Dutch Ministry for Transport and Water Management, Retired, Netherlands*

[13]*WWF Central and Eastern Europe, Vienna, Austria*

[14]*Environmental and Water Agency, Regional Government of Andalucía, Spain*

[15]*Licensing Department at the São Paulo State Environmental Agency – CETESB, São Paulo, Brasil*

[16]*WWF-USA, Washington, USA*

[17]*Biodiversity Centre of Excellence, Environmental Management, Sustainability Division, Eskom, Johannesburg, South Africa*

[18]*Wildlife and Energy Programme, The Endangered Wildlife Trust, Johannesburg, South Africa*

[19]*Federal Agency for Nature Conservation (BfN), Leipzig, Germany*

[20]*Association Zarand, Brasov, Romania*

[21]*Center for Large Landscape Conservation, Montana, USA*

[22]*IUCN/CCSG/TWG*

[23]*Ecology and Infrastructure International Pty Ltd, ANET, Melbourne, Australia*

[24]*Department of Life Sciences and Systems Biology, University of Turin,*

Torino, Italy

[24]*Ewaso Lions and Grevy's Zebra Trust, Kenya*

[25]*Highways England, Bristol, UK.*

[26]*Nature Conservation Agency, Prague, Czech Republic*

[27]*Ministry for an Ecological Transition, Paris, France*

[28]*Wildlife and Transport Programme, The Endangered Wildlife Trust, Johannesburg, South Africa*

[29]*Professor, Department of Road and Railway Engineering, Faculty of Civil Engineering, Beijing Jiaotong University, Beijing, China*

[30]*Research Center for Environment Protection and Water and Soil Conservation, China Academy of Transportation Sciences, IENE SEC, Beijing, China*

Contact author: Lazaros Georgiadis, **Email**: lazgeo36@gmail.com

Keywords: Sustainable Linear infrastructure, ecological connectivity, biodiversity mainstreaming, mitigation hierarchy, strategic planning, stakeholders.

Topics addressed

- Policy and Management

- Environmental impact assessment, strategic environmental impact assessment, planning environmental impact assessment, mitigation hierarchy approaches
- Stakeholder engagement

Abstract

Roads and railways as main transport modes are major causes and drivers of fragmentation of natural ecosystems and biodiversity decline worldwide and other impacts for many years to come resulting from edge effects, barrier effects for migrating wildlife as well as consequences for human safety due to animal vehicle collisions (AVC). Other linear infrastructure, such as power lines, are also major causes of human-induced mortality for birds worldwide due to collision and electrocution, especially when towers and poles become attractive perches and roost sites. Both voltage distribution and transmission lines present a near-invisible flight barrier and collisions between birds and conductors and shield wires are well-documented.

The global demand for transport and other linear infrastructure (TLI) has progressed rapidly in the last decade providing access to remote areas as well as generating an improved understanding of both the positive and negative impacts on natural systems, both spatially and over time. Responding to this demand and in order to create a roadmap for improving humans and wildlife safety, ecological connectivity, biodiversity and resilient TLI under the climate change scenario, a global strategy has been developed by an international coalition of professionals and organisations from all over the world. This collaborative team is comprised of the four regional TLI conferences (ACLIE, ANET, ICOET, IENE) as well as IUCN and WWF. The Global Strategy for Ecologically Sustainable Transport and other Linear Infrastructure (Global Strategy) has focused on the need to mainstream biodiversity in TLI sectors, including through the Convention for Biological Diversity framework (CBD) and the Aichi Global targets in CBD 2018 COP 14 in Egypt in order to support the CBD 2020 COP 15.

The Global Strategy with its Action Plan addresses the overall framework of guiding directions on:

- launching proactive policies,
- establishing appropriate legal frameworks,
- supporting better planning, implementation, and maintenance,
- promoting multi-sectoral and interdisciplinary cooperation and networking,
- encouraging innovative science-based solutions, and
- supporting the culture of learning.

In order to establish a baseline on Asia-Europe cooperation on transport ecology, the Global Strategy will be presented as an international roadmap on mainstreaming biodiversity and ecological connectivity on LTI development which primarily establish:

- the objectives and the key concepts on transport ecology and ecological connectivity,
- the international principles for sustainable LTI to be adopted and implemented by governments, organizations, planners, constructors, and transport operators, and
- the overall spectrum of the key stakeholders which have to be engaged on transport development while concurrently respecting e needs to local societies, ecosystems, and economies.

Profile of corresponding author

Lazaros Georgiadis is biologist since 1992 and works as an environmental consultant while also attaining his master's degree on Environmental Policy and Biodiversity Conservation at the University of Aegean in Greece. His experience over the last for the first 20 years has focused on large carnivore and biodiversity conservation in Greece and the Balkans. The last 20 years' he has worked mainly on transport and ecological connectivity, participating in several projects on transport and ecological connectivity at the national, European, and international level. He is member of the Governance Board of IENE since 2010, the IUCN/ Connectivity Conservation Specialist Group/ Transport Working Group, and an external expert of Managing Authority of Region of Western Macedonia and the Hellenic Institute of Transport (HIT) of the Centre for Research and Technology Hellas (CERTH).

Presentation I-2: Utilizing states' international obligations to address linear infrastructure impacts on migratory species

Clara Nobbe[1], Marc Attallah[1]

[1] *Secretariat of the Convention on the Conservation of Migratory Species, Bonn, Germany*

The authors acknowledge the valuable comments received on the abstract from Aida Papikyan.

Contact authors: Secretariat of the Convention on the Conservation of Migratory Species, Platz der Vereinten Nationen 1, 53113 Bonn, Germany, Email: Clara.Nobbe@un.org

Keywords*:* International standards and regulations, policy, management, landscape planning, data accessibility, migratory species

Topics addressed

- Environmental Impact assessment / strategic environmental impact assessment /planning environmental impact assessment/mitigation hierarchy approaches
- Policy and management
- Standards and regulations
- Stakeholder engagement

Abstract

Infrastructure development creates barriers to the movements of species and fragments and destroys their habitats, thereby isolating populations and preventing access to essential resources such as food and water, causing die-offs and reduced fitness. The loss of ecological connectivity leads to genetic isolation of populations, leaving them more vulnerable and prone to local extinction. Infrastructure also causes direct injuries and mortality through

collisions and entanglement as well as disturbance and pollution. Infrastructure development may cause other indirect impacts, for example by providing access to formerly inaccessible areas, leading to poaching, land conversion, and human settlement.

Addressing the impacts of linear infrastructure development on migratory species reflects the core objective of the Convention on the Conservation of Migratory Species of Wild Animals (CMS). Under CMS Article III Range State Parties of Appendix I-listed species are under an obligation to *conserve and, where feasible […], restore those habitats […] which are of importance in removing the species from danger of extinction* and *prevent, remove, compensate for or minimize, as appropriate, the adverse effects of activities or obstacles that seriously impede or prevent the migration of the species.* Failure to address this obligation can be a basis for a case under the CMS Review Mechanism.

A resolution adopted by the CMS Conference of the Parties (COP) in 2002 urges CMS Parties *to include in Environmental Impact Assessments and Strategic Environmental Assessments as complete a consideration as possible of effects involving impediments to migration*. However, an analysis of National Reports by the Parties, which the CMS Secretariat commissioned in accordance with COP13 instructions has shown that this has not been the case.

Technical guidelines on best practices have been developed under CMS, including on the mitigation of renewable energy infrastructure, power grids, and linear infrastructure. Yet, an analysis prepared by the CMS Secretariat indicates that the impacts of linear infrastructure on migratory species are not sufficiently taken into consideration by investors, project developers, governments, and other key actors.

CMS COP13 recognized the importance of this issue by calling for the establishment of a working group under its Scientific Council to compile standards and guidelines and to assess the needs of Parties in better fulfilling their obligations. The working group consists of experts and representatives from environmental and infrastructure-related institutions of CMS Parties in Africa, Asia, Latin America, and Europe, international financial institutions, scientific and impact assessment communities, and NGOs.

The working group formulated a number of recommendations by identifying missing links between the environmental, finance, and planning sectors that should be overcome through improvements in international and national governance structures. It recommended addressing awareness and capacity gaps within the planning and finance sectors to better integrate the requirements of migratory species in planning processes; enhancing data availability on species distribution and mitigating measures for the finance and planning sectors; and making development plans more easily available to migratory species' experts.

At the Forum, the CMS Secretariat will present the policies and recommendations adopted and formulated by CMS bodies.

Profile of corresponding author

Clara Nobbe joined the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) in 2014. Before taking on the position of Head of Terrestrial Species Team, she served as CITES-CMS Programme Officer, supporting Parties to CITES with the development and implementation of the National Ivory Action Plans and the establishment of the Joint CITES-CMS African Carnivores Initiative. Prior to joining the CMS Secretariat Clara has held various positions with UNEP in Nairobi from 2007 – 2014, where she was part of the teams that conceptualized and led the upgrading of UNEP at the Rio+20 Conference and designed UNEP's input to the SDG process.

Presentation I-3: Rebuilding bridges: engaging stakeholders and innovating approaches to improve habitat connectivity, social economics, and engagement in the south of England.

Aburrow, K[1], & Bega, S. B[1]

[1]*Animex International, Lee-on-the-Solent, UK*

Contact author: Katherine Aburrow, **Email**: Katherine.aburrow@gmail.com

Keywords: collaboration, stakeholder engagement, wildlife connectivity, community

Topics addressed

- Stakeholder engagement
- Citizen science/public participation
- Animal passage

Abstract

Collaboration is key to the success of wildlife connectivity and infrastructure projects. The support of stakeholders is vital to this and establishing relationships early on is key for project development and long-term success.

In this presentation we explain the approach we have taken to engage partners and stakeholders in an ambitious infrastructure rewilding project in the UK that incorporates:

- community engagement and education,
- social enterprise,
- tourism,
- innovation,
- habitat creation,
- and more…

We also explore the outline plan for the project from its initiation through to completion and describe how we plan to utilise each partnership to deliver key aspects during this time.

This project focuses on a disused bridge that spans the M27 motorway in Hampshire on the south coast of England. The surrounding areas are incredibly fragmented, yet the bridge connects Swanwick Nature Reserve on the north side of the motorway to priority woodland on the south. The project is a dynamic process that will be adapted to suit stakeholder needs but ultimately focus on restoring connectivity and engaging local communities. Throughout this project we will be working with The Minstead Trust to provide upskilling and employment opportunities for people with learning disabilities.

The stakeholders include:

- The Minstead Trust - a social charity,
- The Bursledon Brickworks - a heritage charity and museum,
- Highways England - the national road authority,
- The Hampshire and Isle of Wight Wildlife Trust,
- Fareham Borough Council - the local government authority.

Key milestones include collaborative workshops, testing new technologies and innovative materials, installing temporary ecological enhancements leading to establishing a fully rewilded bridge. Throughout the entire process we will also be monitoring the impact our efforts have on wildlife connectivity and social economics.

This project is part of a larger scale rewilding project across the south coast of England, particularly along this stretch of motorway which has a number of disused bridges that could provide future connectivity opportunities. This particular project was initiated in July 2022 and is set to run over a five-year period. We aim for this project to set an example of how this can be replicated in other areas and have a similar social and environmental impact.

Profile of corresponding author

Katherine Aburrow is an ecologist specialising in transport ecology. She currently works in the research and development department of Animex International and has experience working with government agencies, NGOs, universities, and the private sector. Her current focus is developing and implementing connectivity projects across the south coast of England and working with stakeholders to improve wildlife connectivity. She is also the production manager for the online open access resource sharing platform, transportecology.info.

<u>Presentation I-4</u>: Austria's defragmentation programme: successes and challenges

Elke Hahn[1,2]

[1]*Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology, Vienna, Austria*

[2]*IENE Governance Board member*

Contact author: Elke Hahn, **Email**: Elke.Hahn@bmk.gv.at
Keywords: Fragmentation, defragmentation,

Topics addressed

- Habitat loss, degradation, and fragmentation
- Policy and management

Abstract

Austria has a total of about 2000 km of motorways. Since 1986 it is obligatory to fence them on both sides for traffic safety reasons. Since then, Austrian motorways build a barrier to most of the terrestrial fauna species. In the early 1990s the first wildlife overpass was built above the A4. 1997 the first version of the Guidelines for wildlife protection were released.

Several studies about fragmentation of wildlife corridors lead to a Directive of the former Ministry for Transport, Innovation and Technology (currently the Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology) regarding "Habitat connectivity", which obliged the Motorway company, ASFINAG, mainly to install 20 wildlife over-passes above existing motorways to connect internationally important corridors within 20 years.

The Directive "habitat connectivity" is being implemented in locations where the circumstances allow it. Four bridges have been built, five more will be constructed in the near future. But about half of the necessary locations face big difficulties either caused by the lack of legal protection of the corridors in spatial plans or by other linear transportation infrastructures very close to the motorways.

Habitat connectivity is a multi-stakeholder topic, which can only be implemented in a long-term, effective, and sustainable way if all parties cooperate and do their piece of work.

Profile of corresponding author

Elke Hahn, lives in Vienna, Austria, where she studied landscape planning and design and graduated in 2001 at the University of Natural Resources and Life Sciences. Since 2006 she has been working in Austria's Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology in the Department Road planning, operation and environment as an EIA Coordinator. She is working in several expert groups on the creation of guidelines and codes of best-practice in Austria. She represents the Ministry in international working groups in CEDR and PIARC. Since 2009 she is member of the Governance Board of IENE.

Presentation I-5: Linear infrastructures and biodiversity in South Africa

Wendy Jane Collinson[1,2] & Gabi Teren[1]

[1]*The Endangered Wildlife Trust, Austin Road, Midrand, Johannesburg, South Africa*

[2]*Research Fellow: South African Research Chair in Biodiversity Value and Change, Faculty of Science, Engineering and Agriculture, University of Venda, Private Bag X5050, Thohoyandou, 0950, South Africa*

Contact author: W. J. Collinson-Jonker, **Email**: wendyc@ewt.org.za

Keywords: Roadkill, transport ecology, linear infrastructure, biodiversity, protected areas, stakeholder engagement, lessons learning

Topics addressed

- Road traffic injuries (roadkill, road fatalities, road injuries, wildlife-vehicle collision)
- Road impact domains
- Animal passage (wildlife crossing structure)
- Monitoring
- Citizen science/public participation
- Stakeholder engagement

Abstract

Linear infrastructure is essential for connecting society: our systems of roads, railways, pipelines, canals, and power lines all serve to link our cities, developments and resources, and our energy and water supplies. Therefore, it is perhaps ironic that linear infrastructure does exactly the opposite for natural systems – by crisscrossing landscapes, linear infrastructure serves to fragment ecosystems, isolate populations, reduce natural flows, and constrain animal movements. Transportation infrastructure poses direct threats to species from collisions and indirect threats by increasing access by people to previously untapped resources.

In many ways, Africa represents the final frontier for infrastructure development. Her population has doubled in the last three decades and currently stands at 1.3 billion. As populations and economies grow, they require greater investments in infrastructure. Over the next few decades, we will need significant investments in railways, roads, energy, and other infrastructure to meet the growing demands of emerging African economies.

The Endangered Wildlife Trust's Wildlife and Transport Programme is working to reduce the negative impacts of transport infrastructure on biodiversity in South Africa. Here we present on some of our work over the past decade; since 2011, our focus has primarily been on the impacts of roads on biodiversity, with several research projects across South Africa, whose focus has been to gather baseline wildlife road mortality (roadkill) data. Most recently, we have trialled several measures to reduce roadkill, and here, we report on these interventions. Rail ecology is a less studied discipline, globally, and we are seeking to address this gap through baseline data surveys in one of the country's protected areas.

We discuss opportunities to build on lessons from elsewhere in the globe – to find the sweet spot between economic growth and ecological resilience before irreversible damage is done.

Profile of corresponding author

Wendy Collinson-Jonker works for a conservation NGO in South Africa, where she is the project coordinator for the Wildlife and Transport Programme. She has been involved with road ecology since 2011, and rail ecology since 2018. Most recently, she started a project at one of the international airports in South Africa, looking at bird and wildlife collision prevention. All of the above are primarily research and mitigation. She works closely with other NGOs, government departments, and conservation agencies throughout Africa.

Wendy sits on the Infra Eco Network Europe Scientific Expert Committee (IENE SEC) and the IENE 2022 Programme Committee, the International Conference for Ecology and Transportation Steering Committee (ICOET) and co-hosts the African Conference for Linear Infrastructure and Ecology (ACLIE) and the Global Congress for Linear Infrastructure and the Environment (GCLIE). She is also a member of the Transportation Research Board and the IUCN's Transport Working Group.

SESSION II:

Transportation ecology in Asia: case studies

(Moderator: Dr. Aili Kang, Strategic Engagement Director,

Wildlife Conservation Society, China)

Presentation II-1: Global transport infrastructure development initiatives

Alice Hughes[1], Fernando Ascensão[2]

[1]*School of Biological Sciences, University of Hong Kong, Pok Fu Lam Road, Hong Kong, China*

[2]*cE3c – Center for Ecology, Evolution and Environmental Changes & CHANGE – Global Change and Sustainability Institute, Faculdade de Ciências da Universidade de Lisboa, Portugal*

Contact authors: Alice Hughes, **Email:** ach_conservation3@hotmail.com

Keywords: Belt and Road Initiative, sustainable development, green finance, road development

Topics addressed

- Environmental impact assessment / strategic environmental impact assessment / planning
- Policy and management
- Standards and regulations

Abstract

Infrastructural growth and expansion continue to grow across much of the planet, with an estimated 3.0–4.7 million km of new road set to be built before 2050. Yet understanding the strategies behind this growth, the funders responsible, and how environmental mitigation strategies vary tremendously. In this presentation we provide an overview of some of the major infrastructural development initiatives, their funding, and the policies and partnerships between various funding agencies and conservation agencies. We highlight the risk of unsustainable development where few policies are in place to organize and enforce environmental impact assessments and recommendations, and conversely the opportunity of green finance and even environmental (green) bonds in facilitating sustainable development. Ultimately, infrastructure and global infrastructure investment gaps (especially in developing countries) cannot be ignored from an environmental standpoint, and proactive actions to mitigate against potential issues and even explore opportunities around offsetting are needed to reduce unsustainable impacts of infrastructure expansion.

Profile of corresponding author

Alice is a former Professor for the Chinese Academy of Sciences, before moving to the University of Hong Kong in late 2021. She has worked extensively across the tropics, and previously held positions in Thailand, Australia, Costa Rica, and the UK before moving to China. Alice is the author of one book and over 125 papers, including papers in Cell, Nature Communications, Current Biology and Science advances. She also serves as an editor for six journals. Alice also works with a number of NGOs, the Biodiversity committee of the Chinese Academy of Sciences, and the biodiversity special policy study of CCICED, as well as a member of the APBON work group, and Secretary general for INTECOL. Alice aims to ensure that biodiversity policy reflects the best of biodiversity science and works to actively communicate conservation standards and tools on a regional and global basis. Her work aims to span the gap between conservation science and conservation action, understanding the threats to diversity and analyzing effective targets to be developed which provide a practical path to stemming global and regional drivers of diversity loss, and maximizes synergies with climate goals and ecosystem service provision.

Presentation II-2: A holistic model for inclusive and resilient linear infrastructure in ASIAN

Matthew Baird[1], Martin Cosier[2]

[1]*Director, Asian Research Institute for Environmental Law (ARIEL), Thailand*

[2]*Consultant to ARIEL, Australia*

Contact author: Martin Cosier, **Email**: martincosier@gmail.com

Keywords*:* Linear infrastructure; landscape planning; impact assessment; integrated regulatory model

Topics addressed

- Standards and regulations
- Avoidance
- Policy and management – due diligence and risk assessment, stakeholder engagement, public participation, EIA.

Abstract

This study is focused on opportunities and benefits of investing in linear infrastructure that is informed by considerations of sustainability, resilience and inclusivity, with a particular focus on strengthening regulatory arrangements that can support such approaches in South East Asia.

Linear infrastructure is expected to grow significantly throughout Asia in the coming decades, representing significant risks (in addition to potential benefits) across South East Asia. Transportation and energy supply infrastructure are the major elements of this anticipated growth, given their importance to the region's economic and social development, as well as its increasing interconnectedness.

The study is premised on a recognition that the environmental and social impacts of linear infrastructure development are largely considered through the lens of safeguards mechanisms (i.e., environmental impact assessments), which are important but reactive tools that cannot adequately take the regional and holistic perspective of needs and risks required to maximize resilience and inclusivity.

The focus of this study on resilience is particularly concerned with how biodiversity and climate change are considered in an assessment of the vulnerability of linear infrastructure to natural hazards. At the same time, the study is concerned with ensuring linear infrastructure development is inclusive of the needs and interests of potentially affected communities.

The authors draw on their extensive experience with EIA systems and public participation frameworks in South East Asia, particularly the Lower Mekong countries, as well as a broad range of practitioner and academic material, to construct a conceptual model of the application of both regulatory and non-regulatory tools for promoting sustainable, inclusive, and resilient development to the linear infrastructure project cycle. This conceptual model is then used to identify gaps and opportunities for a more integrated, holistic approach to regulations that integrates upstream strategic planning with project-specific assessment and approval processes.

This study is being undertaken by ARIEL as part of the USAID Mekong for the Future program, implemented by WWF, which works to improve natural resource governance in the Lower Mekong region by strengthening civil society's participation in natural resource management.

Presentation II-4: A global knowledge sharing platform in transport ecology: www.transportecology.info

Rodney van der Ree[1,2], Darryl Jones[3], Katherine Aburrow[4], Steve Bega[4] and Darrelle Moffat[4]

[1,2] *WSP Australia Pty Ltd and The University of Melbourne, Melbourne, 3000, Australia*

[3] *Centre for Planetary Health & Food Security and School of Environment & Science, Griffith University, Brisbane, Australia*

[4] *Animex International, UK*

Contact author: Darryl Jones, **Email**: d.jones@griffith.edu.au

Keywords: Transport ecology, linear infrastructure, impact mitigation, impact assessment, global case studies, knowledge sharing

Topics addressed

- Global and open access knowledge sharing
- International collaborations
- Transport ecology – impacts and mitigation

Abstract

There is much concern globally about the current and proposed massive investment in linear infrastructure development. An additional 25 million-lane km of new roads will be built by 2050, and 90% of this will be in non-OECD countries, and railways, pipelines, and powerlines are similarly expanding. Many countries and regions lack the expertise, resources, and experience to implement ecologically-friendly infrastructure development.

www.TransportEcology.info is a freely accessible resource for planners, designers, ecologists, engineers, funders, approvers, and construction teams to incorporate best practise into their projects. Importantly, this site gives the same information to the general community, informing them of new initiatives and world's best practise, thereby allowing them to genuinely participate in the decision-making process.

TransportEcology.info has three main components: (1) research summaries on latest findings in road ecology; (2) best practice information on how, when and where to avoid, minimise, and mitigate impacts; and (3) mitigation case studies. Additional streams will be added as needed.

Research Summaries**:** Research summaries will summarise peer-reviewed journal articles and reports using a blog-style approach. Research summaries ensure that the key findings of important research are visible and accessible to practitioners, and not hidden behind paywalls and scientific jargon. Research summaries are written in a conversational scientific style and 'tell a story' that practitioners who are planning, designing, building, or managing linear infrastructure need to know. The summaries include links to the published research, allowing people to find and download the primary publications, if interested.

Best practices**:** Although there are many publications on the impacts of linear infrastructure and use and on the effectiveness of mitigation, there is comparatively little on how, when, and where to mitigate. Researchers and practitioners will be invited to provide accessible information about methods that can be used to quantify the impacts of linear infrastructure and inform where, when, and how to mitigate those impacts.

Mitigation Case Studies**:** Case studies are be written to "tell a story", using a blended "conversational" style and a "scientific" style. The conversational style will ensure chapters are readable and understandable by laypeople. The scientific style will ensure the "story" is reliable and evidence-based, and can include references to provide supporting information or evidence sources.

Profile of corresponding author

Professor Darryl Jones is an academic, researcher, and writer from Griffith University in Brisbane, Australia. He has been actively engaged in road ecology since 2005, when he assisted in the design and subsequent monitoring of the famous Compton Road Fauna Array, now one of the most intensively studied wildlife crossing structures in the world. With Associate Professor Rod van der Ree, he was a founder of the Australasian Network for Ecology and Transportation. He has published almost 200 scientific publications and seven books including *A Clouded Leopard in the Middle of the Road* (2022, Cornell), the first popular science exploration of global road ecology.

Presentation II-5: A low-cost wild animal protection system through animal presence and movement detection using wireless sensor network

Subrat Kar[1,2], Bodhibrata Mukhopadhyay[1], Sahil Anchal[2]

[1]Electrical Engineering Department, Indian Institute of Technology Delhi, New Delhi, India

[2]Bharti School of Telecommunication Technology and Management, Indian Institute of Technology Delhi, New Delhi, India

Contact Author: Subrat Kar, **Email:** subrat@ee.iitd.ac.in

Keywords: Sensors network, tracking, detection, animal presence, camera, PIR, seismic, optical reflectometry, locomotive, classification

Topics Addressed:

- Animal passage (wildlife crossing structure)
- Transportation technology innovation to support environmental protection
- Ecological conservation
- Biodiversity conservation
- Monitoring
- Road traffic injuries (roadkill, road fatalities, road injuries, wildlife-vehicle collision)

Abstract

The death of elephants due to collisions with locomotives is a national problem in India. This project presents a technical solution preventing these deaths with two objectives. First, to

detect animal movement using different types of sensors mounted on radio-frequency (RF) sensor nodes and, second, to log such detections and establish an automated warning system at the nearest manned point through RF links to provide warning of animal movement to warn the locomotive driver to slow down or halt the train. We developed four types of sensor systems – passive infrared sensor (PIR), seismic, optical reflectometry, and camera sensor. The sensor's data get stored in the central database server through RF communication links. The server processes the data and initiates the alert signal to be sent to the locomotive pilot through an RF link. *PIR sensors* are heat sensors that get triggered when an object emitting IR radiation (an elephant) comes inside the field of view (FOV) of the PIR pole and transmit the signal to the base station. The PIR data gets stored in a server running on the base station. For *seismic sensor-based* object detection, a geophone sensor is used for picking up the footsteps of an elephant within range of the sensor. The nodes detect, classify, and transmit it to the base station. The *optical reflectometry sensor* detects the presence of an object/animal by calculating the time of flight of the infrared light pulse in a distance range of 0-25 m with an accuracy of 5 cm. It differentiates the position based on 16-segment acquisition data, over 45-degree detection angle. A *camera system* automatically detects elephant's presence by processing the image in the field. It detects at 12 fpm in various illumination conditions. Our image classification algorithm is trained using machine learning methods on a dataset of several classes of objects (across age groups of male and female elephants).

Profile of corresponding author

Subrat Kar graduated with Honours in Electrical & Electronics Engineering from the Birla Institute of Technology & Science, Pilani in 1987. He holds a Doctoral Degree in Electrical Communication Engineering from the Indian Institute of Science, Bangalore (1991). He has been with the International Center for Theoretical Physics, Trieste, as a Post-Doctoral Fellow (1991-1994). Presently he is a Professor at the Department of Electrical Engineering, Indian Institute of Technology Delhi, where he is also the Ram and Sita Sabnani Chair Professor.

His research areas are in optical communication, switching, access technologies, telecom protocols, embedded systems, and high-speed networks. As a member of the Optoelectronics and Optical Communication research group, he works in the area of non-linear optical CDMA networks, free-space optical communication (ground-satellite and inter-satellite), and in ultra-fast optical LSI and fault-tolerant integrated optical switching architectures. His interests also involve formalisms in embedded system design, hardware-software co-design, telecom protocol design, and verification tools for telecommunication protocols. He has designed and holds patents in the field of large-scale sensor networks, routing

algorithms, macro languages, large scale repository design for sensor data, and localization issues in sensor networks.

SESSION III (PIARC workshop):
Sustainability challenges for (road) mobility and wildlife in Eurasia, barriers and opportunities
(Moderator: Lazaros Georgiadis)

Sustainability challenges for (road) mobility and wildlife in Eurasia, barriers and opportunities

Eric Dimnet[1,2], Elke Hahn[2,3,4], Sone Shinri[2,5], Lazaros Georgiadis[4,6]

[1] *Ministry of Ecological Transition, General Commission for Sustainable Development, Paris, France*

[2]*PIARC, TC 3.4: Environmental Sustainability in Road Infrastructure and Transport, Paris, France*

[3]*Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology, Vienna, Austria*

[4]*IENE Governance Board member (IENE), Paris, France*

[5]*Toyo University, Tokyo, Japan*

[6]*CERTH (Center for Research & Technology Hellas)/HIT (Hellenic Institute of Transportation), Thessaloniki, Greece*

Contact author: Eric Dimnet, **Email**: eric.dimnet@developpement-durable.gouv.fr

Keywords: Sustainable Road Development, Transport Connectivity, Ecological Connectivity, Road Ecology, Biodiversity Mainstreaming, Strategic Planning,

Topics addressed

- Policy and management
- Environmental impact assessment / strategic environmental impact assessment / planning environmental impact assessment/mitigation hierarchy approaches
- Standards and regulations

Abstract

PIARC is the World Road Association as existed network since 1909. The Association will be the world leader in the exchange of knowledge on roads and road transport policy and practices within an integrated sustainable transport context. PIARC exists to serve all its members by:

- being a leading international forum for analysis and discussion of the full spectrum of transport issues, related to roads and road transport,
- identifying, developing, and disseminating best practice and giving better access to international information,
- fully considering within its activities the needs of developing countries and countries in transition,

- developing and promoting efficient tools for decision making on matters related to roads and road transport.

To achieve these aims, PIARC:

- creates and coordinates technical committees,
- organizes a quadrennial World Road Congress, a quadrennial Winter Road Congress, and various technical seminars and
- publishes a large number of documents including a quarterly magazine (*Routes/Roads*).

In the framework of Strategic Theme 3 of PIARC Policy on Safety and Sustainability there is the *Technical Committee 3.4. Environmental Sustainability in Road Infrastructure and Transport (TC 3.4)*. TC 3.4 identifies traffic operations to minimize the health impact of vehicle emissions, and improvement of pavement design, construction, and maintenance to reduce traffic noise. Also, understanding the road and road transport impact on wildlife habitats and their interconnections is essential for road construction to be implemented in the area affluent with natural environment. Technical Committee 3.4 carefully considers environmental sustainability, and diligently presents how road organizations commit to restraining air pollution and traffic noise, and the impact on wildlife habitats.

In order to develop the appropriate strategies and given that Eurasia is the biggest united continental megaregion globally, the aim of the workshop is to define the sustainability challenges for PIARC in the Eurasia for developing road networks in the best sustainable way. Challenges are addressed during the workshop in the framework of defining (a) existing barriers and (b) opportunities for giving a baseline of sustainability on road design, construction and operation.

Structure

Duration: 60 min

Schedule: The workshop includes three parts:

1. The first part (20 minutes) sets the stage for discussions:
   - Short introduction of PIARC and the TC 3.4
   - Setting up the basic challenging questions of the workshop.
2. The second part (30 minutes) includes an open discussion and interactive work session in the form of round table with invited guests aiming to identify the challenges towards achieving environmental sustainability on road networks development in *Asia in connection with Europe,* while defining the role of transport authorities.
3. The third part (5 minutes) includes a short wrap up the workshop conclusions.

Moderator: Lazaros Georgiadis

Implementation of expected outcome:

The results of the workshop will be used by PIARC in order to define the policies needed for next steps to be used under the framework of promoting sustainability of road networks development in the Eurasian megaregion in relation to wildlife conservation and securing connectivity of ecosystems and landscapes.

Profile of corresponding author

Eric Dimnet graduated as an engineer from the Ecole Nationale des Travaux Publics de l'Etat and then as a doctor from the Ecole Nationale des Ponts et Chaussées. He started his career as a researcher on numerical modelling, risk assessment, and adaptation to climate change, and as a professor in engineering schools and universities including Gustave Eiffel University (GEU). He then became the manager of the large-scale experimental facility Sense City for the study of the smart city of tomorrow. His research and expertise earned him the qualification of international expert in the field of energy and climate by the French Ministry of Ecological Transition. After having been advisor to the Secretary General of PIARC for resilience and climate change issues and senior advisor for energy and climate resilience at GEU, he is currently in charge of mobility at the General Commission for Sustainable Development. He is also the chairman of PIARC's technical committee 3.4.

KEY NOTE SPEECH of the 2nd day, 25th November 2022

Ecological protection and Restoration along roads in Ecological Sensitive Area, China

Yaping Kong, Xinjun Wang, Jiding Chen

Research Centre for Environmental Protection and Water and Soil Conservation, China Academy of Transportation Sciences, Beijing 100029, China

Contact author: Yaping Kong, **Email**: ypkong@163.com

Keywords: Environmental monitoring, environmental impact assessment, ecological protection, vegetation restoration, wildlife, wetland, wastewater treatment, ecological eensitive area.

Topics addressed

- Environmental impact assessment / strategic environmental impact assessment / planning environmental impact assessment/mitigation hierarchy approaches
- Monitoring
- Transportation technology innovation to support environmental protection, ecological conservation, biodiversity conservation

Abstract

The number and extent of roads will still expand dramatically in the future in China. At least 400,000 km of new roads are anticipated by 2030. Ten percent of all road construction is expected to occur in western China, including many regions called ecological sensitive areas that sustain exceptional biodiversity and vital ecosystem services. While new roads can promote social and economic development, they also can open Pandora's box of

environmental problems. This is especially the case in ecological sensitive areas, where new roads often dramatically increase land colonization, habitat disruption, and overexploitation of wildlife and natural resources. Therefore, it is broadly understood that environmental protection for these regions is extreme important during highway construction. Unfortunately, road ecology research and practice in ecological sensitive areas has a great gap, such as insufficient technical support for eco-environmental monitoring, environmental impacts and benefits quantification, lack of natural restoration, and reconstruction technology for damaged ecosystems of transportation corridors.

Aiming at the ecological and environmental characteristics of road construction in different ecological sensitive regions, optimizing and regulating the structure and functions of road ecosystem, developing resource, saving environmental-friendly road ecological products, and constructing road ecological engineering technology system are important technical supports for promoting the green development of road construction. According to the strategic development requirements of ecological civilization in China, this study summarized the structure and function of road ecological system and its related research progress as well as the state of knowledge, industrial development demand, and technical development trend of road ecological engineering technology.

We focus on the construction of highways in ecological sensitive areas such as the Qinghai Tibet Plateau and carry out research on impact mechanism of road construction on environmental variables, key technologies such as low environmental impact design and construction, ecological restoration, and environment reconstruction. This study introduces five preliminary results. First, it describes a monitoring index system for the whole road construction process and operation, as well as an integrate satellite, UAV, and field survey technology to conduct regular monitoring of ecological conditions in the road area; second, it quantifies the impact of Qinghai-Tibet highway on vegetation coverage within 500 m, as well as the absence pf significant effect of theQinghai-Tibet railway on vegetation coverage; third, an evaluation method of road vegetation recoverability is provided, as well as a corresponding vegetation restoration technology in Tibet plateau, Loess Plateau and Rocky desertification area; fourth, drawing from the monitoring sample lines/areas of wildlife in North-East China, South-West China, and Qinghai-Tibet Plateau, data data that focus on roadkill, wildlife crossing structures, road effect zone from 2000 are described.; fifth, a description is provided of the study's wetland water system connectivity guarantee and ecological compensation and ecological planting tank with comprehensive functions of runoff drainage, purification, water storage, and recharge.

Profile of corresponding author

Yaping Kong is a Research Professor and Director in Research Centre for Environmental Protection and Water and Soil Conservation, China Academy of Transportation Sciences. She is pursuing her research work on road ecology. Her field of interests includes water and soil conservation, vegetation restoration, and context sensitive design.

SESSION IV:
Wildlife roadkill in Eurasia
(Moderator: Dr. Qilin Li, Hianan Tropical Ocean University, China)

Presentation IV-1: Factors influencing wildlife roadkill at Mt. Fuji, Japan, a UNESCO World Heritage Site

Yoichi Sonoda[1], Tomohiko Endo[2], Hiroaki Funatsu[3], Yuka Suetsugu[4], Haruka Aiba[5], Shusaku Minato[5], Koichi Otake[6]

[1]*International Industrial Technology College, Gunma, Japan & Meiji University, Tokyo, Japan*

[2]*National Agriculture and Food Research Organization, Ibaraki, Japan*

[3]*Fujisan Outdoor Museum, Shizuoka, Japan*

[4]*Architects, Regional Planners & Associates, Kyoto, Japan*

[5]*Dormouse & Wildlife Institute, Yamanashi, Japan*

[6]*Animal-pathway & Wildlife Association, Tokyo, Japan*

Contac author: Yoichi Sonoda, **E-mail:** sonogonia0210@gmail.com

Keywords: Wild mammals, roadkill, World Heritage Site, Japan

Topics addressed

- Road traffic injuries (roadkill, road fatalities, road injuries, wildlife-vehicle collision (WVC))
- Monitoring
- Citizen science/public participation

Abstract

Various measures have been established to prevent roadkill in Japan, both to promote traffic safety and protect endangered wild animals that may encounter cars. Roadkill is an important issue in terms of biodiversity conservation. The Japan Highway Public Corporation has been reporting roadkill data for Japanese roads since the 1980s. In 1996, > 25,000 animals were reported as roadkill on highways, including wild mammals, birds, snakes, and turtles. In 2020, expressway companies processed 53,000 animal carcasses on expressways nationwide, and 74,000 on national highways. Roadkill occurrence increases with the distance between road services.

At United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Sites in Japan, several endangered species with small populations, including the Bengal wildcat (*Prionailurus bengalensis*), Amami rabbit (*Pentalagus furnessi*), Ryukyu rat (*Diplothrix legata*), and Okinawa rail (*Gallirallus okinawae*), have been reported as roadkill. The International Union for Conservation of Nature (IUCN) has flagged this as a conservation issue. The area around Mt. Fuji is a World Cultural Heritage site rich in nature; many tourists from Japan and abroad visit Mt. Fuji every year, which produced large amounts of traffic and promotes the occurrence of wildlife–vehicle collisions (WVCs).

The objective of this study was to examine the causes of WVC around Mt. Fuji and potential conservation measures for wild mammals. Around Mt. Fuji, WVC data for mammals, birds, amphibians, and reptiles were collected from 2014 to 2018 in collaboration with the Mt. Fuji Outdoor Museum and local citizens. We analyzed seven species: Japanese deer (*Cervus nippon*), raccoon dog (*Nyctereutes procyonoides*), Eurasian badger (*Meles meles*), Japanese hare (*Lepus brachyurus*), Japanese squirrel (*Sciurus lis*), masked palm civet (*Paguma larvata*), and Japanese marten (*Martes melampus*). Generalized linear models were used to analyze the relationships between roadkill occurrence and road structure, vegetation, and elevation; the best model was selected according to the Akaike information criterion.

Variables influencing WVCs included vehicle speed, road structure, altitude, and land use. Therefore, we conclude that conservation efforts should focus on the impacts of both human and ecological factors, including traffic volume and speed, road structure and ancillary facilities, and wild mammal habitat.

Profile of corresponding author

Yoichi Sonoda has a PhD in Agriculture and a PhD in Policy and Planning Science. Previously, he was engaged in research on road environmental impact assessment for five years at the National Institute. After that, he worked as an environmental consultant for 10 years. Now, Dr. Sonoda works at the International Industrial Technology College in Maebashi, Gunma Prefecture. He has been studying landscape ecology, road ecology, and mammalogy for about 20 years.

Presentation IV-2: A large-scale analysis reveals unimodal and U-shaped effects of traffic volume on roadkill probability

Dror Denneboom[1], Avi Bar-Massada[2], Assaf Shwartz[1]

[1] *Technion – Israel Institute of Technology, Haifa, Israel*

[2] *University of Haifa, Haifa, Israel*

Corresponding author: Dror Denneboom, **Email:** drordene@gmail.com

Key words: Roadkill, wildlife-vehicle collisions, traffic volume, unimodal effect, road mitigation

Topics addressed

• Road traffic injuries (roadkill, road fatalities, road injuries, wildlife-vehicle collision (WVC))

• Barrier impacts

Abstract

Wildlife-vehicle collisions are considered the predominant direct negative effect exerted by roads on many species, leading to increased mortality rates that play a major role in the biodiversity crisis. The probability of roadkill is affected by species traits, road attributes, landscape features, temporal factors, and traffic characteristics. Traffic volume is considered

one of the major factors that affect roadkill probability. It was theorized that the effect of traffic volume on roadkill probability should be unimodal, based on wildlife behavioral responses to traffic. However, empirical evidence of this theory is lacking, as only few studies have quantified quadratic effects of traffic volume on the probability of roadkill.

We tested for quadratic and linear effects of traffic volume on roadkill probability for twenty species with high road mortality rates in Israel. The analysis incorporated a nation-wide database of roadkill occurrences, encompassing ten years of data on 2,864 road km, with a total of 16,653 roadkill records. Roadkill data was recorded by rangers of the Israel Nature and Parks Authority, between the years 2010 and 2020. Traffic volume ranged from low traffic roads (300 vehicles per day) to very high traffic highways (148,000 vehicles per day). The effects of road attributes (e.g., lighting, median barrier, roadside vegetation), landscape features (land cover types and slope), temporal factors (year, season, and moon phase) and maximal speed limit were also quantified. We accounted for species abundance near roads by using habitat suitability as a proxy for abundance.

The unimodal effect was empirically supported for one species, the striped hyena, with maximal roadkill probability at a traffic volume of 23,600 vehicles per day. For the first time, a quadratic U-shaped effect was identified for five species: golden jackal, Indian crested porcupine, southern white-breasted hedgehog, stone marten, and Palestine viper. A negative linear effect was identified for three species: European badger, rock Hyrax and chukar partridge, and a positive linear effect was identified for the jungle cat. We also identified varying effects of road and landscape variables on roadkill probability. For example, road lighting decreased roadkill of six species, and a concrete median barrier decreased roadkill of four species while increasing roadkill of four other species. Woodland cover near the road increased roadkill of three species and increasing maximal speed limit increased roadkill of four species.

We found that the theorized unimodal effect was limited to the largest carnivore in our study but was otherwise not observed for other species. The novel U-shaped effect of traffic volume on roadkill probability was the most common effect among the studied species. We suggest that this U-shaped effect is caused by intra-species variability in road avoidance behavior, associated with species that are successful adapters to human dominated landscapes. For these species, increased tolerance of anthropogenic disturbances typical to human-adapted subpopulations may lead to reduced avoidance of high traffic roads. Furthermore, we found that low traffic roads can pose a major risk of wildlife mortality, and mitigation efforts should be directed accordingly. These insights, together with the gleaned effects of road and landscape attributes on roadkill probability, are valuable for improving ecologically sound road planning and implementing effective road mortality mitigation.

Profile of corresponding author

Dror Denneboom is a PhD student at the Architecture and Town Planning faculty at the Technion – Israel Institute of Technology. He is studying and applying spatial analysis methods for systematic conservation planning of wildlife habitat connectivity, with an emphasis on mitigating the effects of transportation infrastructure. His research is focused on planning effective mitigation measures to reconnect fragmented habitats. Another aspect of his research is understanding the factors that affect wildlife-vehicle collisions, to promote effective roadkill mitigation. Dror has a B.Sc. in Environmental Sciences from Tel-Hai Academic College, and an M.Sc. in Environmental Quality Sciences from the Civil and Environmental Engineering faculty at the Technion.

Presentation IV-3: Wildlife-vehicle collisions in Asia: what do we know so far about the impact on populations?

Clara Grilo[1,2]

[1] *CESAM - Centre for Environmental and Marine Studies, Faculdade de Ciências da Universidade de Lisboa, Lisboa, Portugal*

[2] *Setor Ecologia/Departamento de Biologia Universidade Federal de Lavras, Minas Gerais, Brasil*

Contact author: Clara Grilo, **Email**: clarabentesgrilo@gmail.com

Key words: Extinction risk, mammals, roadkill, Asia

Topics addressed

- Road impact domains
- Road traffic injuries (roadkill, road fatalities, road injuries, wildlife-vehicle collision (WVC))
- Environmental Impact assessment /strategic environmental impact assessment/ planning environmental impact assessment/mitigation hierarchy approaches

Abstract

Several regions in Asia are known global hotspot of biodiversity and endemism, yet these regions are also highly threatened by human activities. One of the recent threats to wildlife is the road network and associated traffic. The main effects of roads include mortality from collision with vehicles (WVC), barrier to movement, and habitat degradation. Research on WVC is still in its infancy in Asia. However, several publications have highlighted that WVC can be a major threat mainly for endangered mammal species. For example, Komodo dragon (*Varanus komodoensis*), lion-tailed macaque (*Macaca silenus*), Nilgiri tahr (*Nilgiritragus hylocrius*), Indian pangolin (*Manis crassicaudata*) and tiger (*Panthera tigris*) are species that are regularly killed by vehicles and classified by IUCN as Endangered. A study published in 2022

led by Neil Carter predicted that existing roads near Chitwan National Park would kill 46 tigers over 20 years reducing the adult tiger population by 39%. Another study analyzed the impact of roadkill on mammals worldwide for all threatened species with observed roadkill and species with high roadkill rates. Results showed that high roadkill rates do not necessarily mean that a high fraction of the population will be lost. In contrast, low roadkill rates in species with low population densities may have high negative impact on their populations. Findings identified that at least one population of leopard has 83% risk of local extinction in the region of Rajaji National Park and the Haridwar conservation area (North India) if the roadkill rate of 0.052 ind/km/year is maintained in the coming years. The same study evaluated which species maybe particularly vulnerable to roadkill (if 20% of the population were killed by vehicles it would increase the probability of extinction by 10%) and found that tiger, lion-tailed macaque, and sloth bear (*Melursus ursinus*) -- already threatened by other factors -- are also particularly vulnerable to WVC. Even with scarce information, recent findings highlight that the expansion of the road network in Asia can have severe implications on biodiversity conservation if prevention of WVC is not secured.

Profile of corresponding author

Clara Grilo is an Assistant Researcher at CESAM – Centre of Environmental and Marine and Invited Assistant Professor at Faculty of Sciences in the University of Lisbon. She completed a PhD degree in Conservation Biology at University of Lisbon in 2009. Clara co-edited the "Handbook of Road Ecology" with more than 100 collaborators and the e-book "Integrating Transport Infrastructures with Living Landscapes". Over the last years, her research has largely focused on the effects of road network on birds and mammals, such as behavior, relative abundance, mortality, genetic structure, and extinction risk.

Presentation IV-4: Concerns for Herpetofauna: Road associated mortalities in National Highway 715 in Assam, India

Somoyita Sur [1], Prasanta Kumar Saikia [2], Malabika Kakati Saikia[3]

[1*] *Research Scholar, Department of Zoology, Animal Ecology and Wildlife Biology laboratory, Gauhati University, Guwahati- 781014, Assam, India*

[2] *Professor, Department of Zoology, Animal Ecology and Wildlife Biology laboratory, Gauhati University, Guwahati- 781014, Assam, India*

[3] *Assistant Professor, Department of Zoology, Animal Ecology and Wildlife Biology laboratory, Gauhati University, Guwahati- 781014, Assam, India*

Corresponding author: Somoyita Sur; **Email:** somoyita.sur@gmail.com

Keywords: Kaziranga National Park, roadkill, amphibia, reptiles, vehicular collision, national highway, herpetofauna, mortality.

Topics addressed

- Road traffic injuries (roadkill, road fatalities, road injuries, wildlife-vehicle collision (WVC)) Road impact domains
- Habitat loss, degradation, and fragmentation
- Avoidance
- Barrier impacts
- Animal passage (wildlife crossing structure)

Abstract

Bilateral casualties often occur when wild animals have to share a common space with humans. One of the most dreadful and generally ignored trouble spots is the high speeding automobiles, passing through the habitats, which leads to most of the road associated ecological problems. We sampled road-killed amphibians and reptiles along a section of NH 715, which cuts through Kaziranga National Park (KNP), Assam, India, forming its southern boundary for a continuous stretch of 64 km, to evaluate the direct effect of vehicular traffic on herpetofauna. A higher rate of mortality caused by vehicular movement was found among amphibians (72% of all incidents) than reptiles (27%). A total of 3,157 amphibians belonging to three genera and two families and 1,202 reptiles belonging to 21 genera and eight families were found killed by vehicles. This stretch of the road is very crucial for animal movement as both the sides of the road has protected areas, with KNP being on the north and North Karbi Anglong Wildlife Sanctuary on the south, thus making it a tricky passage for the animals. Herpetofaunal movement was evident regularly during the entire study period. Herpetofaunal mortality was found to be reduced considerably during the winters and showed a sharp increase with the onset of pre-monsoon and monsoon. On an overall scale, mortality of herpetofauna is lesser during the non-flooding season (36% of all incidents) as compared to their sharp increase during the flooding season (63%). We also report that the land use around the road and species trait contributed to vulnerability of a species to WVC. Possible explanations for differences in relative counts are discussed. This study can help in identifying scenarios where species are at high risk of WVC due to their required movement in search of feeding and breeding areas.

Profile of corresponding author

Somoyita Sur is a doctoral research fellow in the Department of Zoology, Gauhati University, Guwahati, Assam. She is pursuing her research work on road ecology and currently working on the animal vehicle interaction on National Highway 715 that passes through Kaziranga National Park, Assam, India. Her field of interests includes herpetofauna and birds. She is a keen birder and eBirder.

Presentation IV-5: Roadkill on Banling Highway in South China

Qilin Li[1], Limin Li[1], Tonghe Yuan[1], Jiding Chen[2], Yaping Kong[2], Yun Wang[2]

[1]*College of Ecology and Environment, Hainan Tropical Ocean University, Sanya, Hainan Province 572022, China*

[2]*China Academy of Transportation Sciences, Beijing 100029, China*

Contact author: Qilin Li and Yun Wang

Email: kylinlee49@163.com, wangyun80314@163.com

Keywords: Roadkill, Banling Highway, road ecology

Topics addressed

- Road traffic injuries (roadkill, road fatalities, road injuries, wildlife-vehicle collision (WVC))

Abstract

Roadkill are one of the largest potential causes of wildlife biodiversity loss. Although the scale of global roads is still expanding, there remains a lack of relevant research in many regions. In this study, a roadkill survey was conducted along a 16 km highway in Sanya, Hainan Province, China, from April 2018 to December 2021. In the 151 surveys carried out over 2416 km in a period of 4 years. Over the course of these surveys, researchers observed 786 roadkills, belonging to 4 classes, 5 orders, 15 families, 29 genera and 34 species. Amphibians and reptiles accounted for most of the survey results. Black-Spectacled toad (*Bufo melanostictus*) suffered the most. The annual roadkill density fluctuated. Because of the construction of a nursing home, roadkill decreased from 2018 to 2019. Roadkills occurred in all months of the year; however, seasonal patterns in the kill rates were evident. The average roadkill density is 37.18 ind/100 km, highest in June and lowest in September. Spring and summer had more victims, however, no statistical differences occurred in the six taxonomic groups among seasons. Roadkill density was in the middle among tropical areas, which was affected by the number and activity of nearby wildlife, traffic flow, vehicle speed, human interference, road width, weather or seasons, and other factors. Management recommendations have been provided to minimize loss.

Funding: This research was funded by Hainan Natural Sciences Fund (Grant No. 320MS057)

Profile of corresponding author

Dr. Qilin Li, associate professor in Hainan Tropical Ocean University. She obtained her PhD from Beijing Normal University in ecology, mainly focused on road ecology and butterfly research. She worked as a visiting scholar in ecology at UC Davis in USA, funded by the China Scholarship Council. She has been invited to participate in many international academic conferences on road ecology in the United States, India and Germany and received travel reimbursements. Each time she delivered speeches or displayed research boards.

Dr. Yun Wang, a research professor in the Chinese Academy of Transportation Sciences (CATS). He obtained his PhD from Chinese Academy of Sciences in road, landscape, and ecological protection in 2007. In 2005, he translated Road Ecology: Science and Solution by Richard Forman into Chinese and in 2009, he co-wrote Road Ecology in China. In 2021, as one of key members, he initiated 1st Asia Transportation Ecology Forum. Now his research focus on the interactions of roads and wildlife, landscape fragmentation, and transport ecology.

SESSION V:
Planning, habitat, and others
(Moderator: Dr. Xinjun Wang, Vice Director, CATS, China)

Presentation V-1: Impacts of planned linear infrastructure on the habitat of Asian elephants in Nepal's Terai Arc region

Dinesh Neupane[1,2], Suraj Baral[2], Ahimsa Campos-Arceiz[1]

[1] *Southeast Asia Biodiversity Research Institute, Chinese Academy of Sciences & Center for Integrative Conservation, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Mengla, Yunnan 666303, China*

[2] *Resources Himalaya Foundation, Nayabato, Sanepa, Lalitpur, Nepal*

Corresponding author: Ahimsa Campos-Arceiz, **Email:** ahimsa@xtbg.ac.cn

Keywords: Asian elephant, Elephas maximus, Nepal, Terai Arc, linear infrastructure, fragmentation, connectivity

Topics addressed

- Road impact domains
- Habitat loss, degradation, and fragmentation
- Policy and management

Abstract

Nepal hosts one of Asia's most complex large mammal assemblages, including a small (but growing) population of Asian elephants (*Elephas maximus*). These elephants occur in four widespread and geographically disjunct subpopulations, and some of them undergo seasonal transboundary movements. Elephants, like most large animals, have large home ranges and are sensitive to habitat loss and fragmentation. Nepal is also undergoing a rapid economic development that includes several linear infrastructure projects that could fragment and further threaten the habitats of elephants and other wildlife. Here, we analyzed the potential impacts of current and planned linear infrastructure development in Nepal's Terai Arc region on Asian elephant habitats. We overlaid forest cover maps and the itinerary of the planned

infrastructure projects to quantify the expected spatial changes in forest fragmentation in four different scenarios: (1) with the current east-west highway, (2) expanding the number of lanes in the existing east-west highway, (3) following the construction of a new postal road, and (4) adding a planned railway. Our results showed that, with the currently existing east-west highway, Nepal has a mean shape index of 1.4721, while the planned expansion of the highway, and additions of the postal road and the railway resulted in mean shape indexes of 1.4805, 1.4811, and 1.4812, respectively. Additionally, the number of habitat patches increased from 13,022 to 13,713, 13,845, and 14,202. Further, road network expansion projects would decrease large core areas (by 1.6%, 2.1% and 2.8% respectively) and mean patch sizes (5.4%, 6.3%, and 8.8% respectively), while increasing the number of small patches (small and medium-sized forest patches and edge). The planned infrastructure development in Nepal's Terai Arc will result in important fragmentation of Asian elephant habitat. Further work is necessary to understand the consequences in terms of landscape functional connectivity. We recommend the cautionary principle and the use of road passes and other mitigation measures to reduce negative impacts of these infrastructures on elephants and other threatened wildlife in the region.

Profile of corresponding author

Professor Ahimsa Campos-Arceiz is a conservation ecologist at the Xishuangbanna Tropical Botanical Garden. His research focuses mainly on the behavior, ecology, and conservation of Asian megafauna, particularly elephants, which he has studied for nearly 20 years. Professor Campos-Arceiz studies the ecological role of large animals in seed dispersal and works on evidence-based strategies to mitigate human-wildlife conflicts. His work also includes social aspects of wildlife conservation, such as the impact of people's behavior, governance, economics, and policy. He is currently based in Xishuangbanna, southwest China, and has spent nearly 20 years in Asia. He has conducted research in Malaysia, Sri Lanka, Myanmar, Japan, Mongolia, and other counties. Professor Campos-Arceiz holds a PhD in Biodiversity Science from the University of Tokyo (2009) and has published over 80 articles in international scientific journals, that have been cited over 3300 times. Professor Campos-Arceiz is a former President of the Association for Tropical Biology and Conservation (ATBC) and former President of the Society for Conservation Biology (SCB) Asia Section.

Presentation V-2: Alignment optimization: A preliminary assessment of construction, economic, and environmental costs

Grant Connette[1], Hanna Helsingen[2], Nirmal Bhagabati[2], Carl Reeder[2], Urvana Menon[2], Sai Than Lwin[2], Gustavo Nicolas Paez[2], Ramiro Crego[1], Katie La Jeunesse Connette[1]

[1]*The Smithsonian Institution*

[2]*World Wide Fund for Nature*

Contact authors: Grant Connette and Sai Than Lwin, **Email**: ConnetteG@si.edu, sai.thanlwin@wwf.org.mm

Key words: Environmental impact, alternative routes, Google Earth Engine

Topics addressed

- Habitat loss, degradation, and fragmentation
- Assessment/planning environmental impact assessment/mitigation hierarchy approaches
- Avoidance

Abstract

The Alaungdaw Kathapa National Park (AKNP) is Myanmar's oldest and one of its largest national parks. Located in the northwest part of the country, the 1,426.45 km^2 park is near Myanmar's border with India and falls within one of the largest intact expanses of forest in the country. The park was also designated as an Association of South East Asian Nations (ASEAN) Heritage Park and an Important Bird Area due to its unique biodiversity value. Myanmar has recently been planning to upgrade an unimproved dirt road through the AKNP to increase the flow of people, goods, and services as part of the India-Myanmar-Thailand Trilateral Highway Investment. Myanmar law and numerous international investment standards dictate that the environmental impacts of linear infrastructure development projects should be properly assessed and alternative routing options considered during the planning process to avoid unnecessary impacts on environmentally sensitive areas.

The upgraded road through the AKNP is expected to result in increased traffic volume, wildlife collision risk, and habitat fragmentation that would negatively affect the park's biodiversity. To explore options for avoiding or mitigating these impacts, we engaged with authorities and several conservation organizations to explore alternative road alignments for a proposed 25.6 km stretch of road that is currently proposed to bisect the northeast corner of the national park. Given that this proposed highway project is being planned as an upgrade of an existing road, we focused on this relatively small stretch of road as we assumed a large realignment would likely be cost-prohibitive. We implemented a genetic algorithm in Google Earth Engine, a web-based spatial analysis platform, to find optimal alignment alternatives under each of four scenarios that differed in their environmental and economic objectives:

- Scenario 1 ("Go Anywhere"): Route selected based only on road construction costs and technical design criteria (e.g., slope).
- Scenario 2 ("Avoid Park"): Route must avoid the park while minimizing cost and meeting design criteria.

- Scenario 3 ("Connect People"): Route seeks to connect areas of higher predicted economic activity while minimizing cost and meeting design criteria.
- Scenario 4 ("Connect People/Avoid Park"): Route must avoid the park and prioritize economic activity while minimizing cost and meeting design criteria.

Alternative routes identified for this road section ranged from 26.8 km (Scenario 1) to 59.6 km in length (Scenario 2) while construction costs (paving + earth moving + land acquisition/clearing) were projected to vary from being roughly equal to the original route (+1% for Scenario 1) to being double or more in Scenarios 2, 3, and 4 (+163%, +100%, +142% respectively). However, the lengths of these potential realignments are relatively small compared to the entire ~350-km section of road planned for upgrading between the cities of Kale and Monywa and would therefore entail a modest "green premium" for avoiding the AKNP. For example, avoiding the park would add only 8.5% - 9.5% to the overall paving cost of this larger section of road.

Highlights**:** We implemented a genetic algorithm in Google Earth Engine to identify and evaluate alternative route alignments for a planned highway project through Myanmar's Alaungdaw Kathapa National Park.

Profile of corresponding author

Grant Connette is an ecologist at the Smithsonian Conservation Biology Institute with a research focus in landscape ecology, population dynamics, Geographic Information Systems (GIS), and data analysis. He is part of the Smithsonian's Working Land and Seascapes initiative and currently focuses on providing tools and information to support large-scale conservation planning.

He started with the Smithsonian in 2015 as a postdoctoral fellow under the umbrella of Smithsonian's Myanmar Biodiversity initiative and spent four years living and working in Myanmar with a focus on collaborative biodiversity data analysis efforts with local partner organizations. He transitioned to a research ecologist position in 2019, and has since supported large-scale conservation planning efforts, such as Myanmar's National Tiger Action Plan, the IUCN Amphibian Specialist Group's Amphibian Conservation Action Plan, and the National Red List of Birds for Myanmar.

He received his B.S. from Davidson College and his Ph.D. from the University of Missouri, where he studied the impacts of timber management on salamander populations in the Southern Appalachian Mountains of North Carolina. After receiving his Ph.D., he was a postdoctoral fellow with the University of Missouri and the Northeast Climate Science Center.

Presentation V-3: Development regulations, perverse incentives, and strategic road planning in Indonesia

Jayden Engert[1], F. Yoko Ishida[1], William F. Laurance[1]

[1]*Centre for Tropical Environmental and Sustainability Science, College of Science and Engineering, James Cook University, Cairns, Queensland 4878, Australia*

Contact author: Jayden Engert, **Email:** Jayden.engert@my.jcu.edu.au

Keywords: Deforestation, development policy, environmental planning, infrastructure, nature conservation, roads, spatial planning.

Topics addressed

- Habitat loss, degradation, and fragmentation
- Policy and management
- Standards and regulations

Abstract

Strategic land-use planning has been proposed as a method to mitigate the adverse impacts of development and maximize the benefits. For example, improving existing roads rather than constructing new roads can result in development with lower financial costs and lower environmental impacts. However, environmentally destructive activities, such as clearing forest for road construction, can generate revenue that offsets development costs. Additionally, there are currently few incentives for corporations to share costs and benefits of development projects, leading to redundant infrastructure to support multiple separate objectives. These issues are especially poignant in Indonesia, where in 2019 forestry regulations were re-written in order to allow road construction within an important ecosystem-restoration concession, while ignoring less environmentally destructive routes through oil palm concessions. We aimed to assess the potential benefits of two changes to road development regulation, (1) preventing companies from raising revenue from forest products gained through land-clearing; and (2) intentionally directing development projects where it is possible to achieve benefits for multiple stakeholders. To do this we created models of current road construction cost, land acquisition cost, and forest product revenue for Indonesia. We then ran over 3,000 least-cost path models following six different road-development cost scenarios, using a recently approved major coal-transport road within the Harapan Forest (Hutan Harapan) as a case study. Our results suggest that even relatively minor changes to infrastructure-development regulations can have significant influence on road-route design, and the eventual environmental impacts of road development projects.

Profile of corresponding author

Jayden Engert is a PhD candidate under Prof. William Laurance at James Cook University in Australia. His PhD focuses on developing models to predict land-cover change and habitat loss that is driven by large-scale infrastructure development projects and methods to minimise adverse impacts. Jayden has five years of experience as a geospatial technician.

Presentation V-4: A Monitoring and evaluation method on road impact and animal avoidance effects based on intelligence technology

Minghao Gong, Yuhang Wang, Wanyu Wen

Institute of Ecological Conservation and Restoration, Chinese Academy of Forestry, Beijing, China

Contact author: Minghao Gong, **Email**: Gongmh2005@hotmail.com

Keywords: Road ecology, road safety, animal monitoring, monitoring application

Topics addressed

- Habitat loss, degradation, and fragmentation
- Road impact domains
- Avoidance
- Transportation technology innovation to support environmental protection, ecological conservation, biodiversity conservation

Abstract

Road construction causes animals to avoid the area around road. Human activity around roads also changes of wildlife population fitness and occurrence patterns due to human utilization of wild animals. Monitoring the spatial utilization of wild animals by humans around roads, and comparing the distance between animals and roads, occurrence patterns, and their changes can quantitatively evaluate road impacts and avoidance effects of roads on wild animals. Monitoring is a traditional means of biodiversity conservation and research. In traditional monitoring methods, the monitoring personnel walk along roads and obtain information such as animal locations with global position system (GPS), and record names, and quantities of discovered animals. However, due to technological limitations, this traditional monitoring technology can not accurately obtain the position data of animals around the road because the latitude and longitude of the of the road location was used by GPS as a surrogate for the real position of the discovered animals; the distance from the road to animal is also estimated by the monitoring personnel, but this always has some errors to the real value and affect the accuracy of the monitoring data and the next results of study and assessment.

In order to improve the accuracy of survey and monitoring data fundamentally, the research team of wildlife in the Institute of Ecological Protection and Restoration, Chinese Academy of Forestry, combined the technology of WebGIS with GPS navigation and positioning functions based on online maps or customized map, to produce an application(App) software named “Monitoring expert” and used in mobile terminal such as cell phone or PAD which it can freely identified the position of an animal stay in online map image or setting map image, and captured the latitude and longitude value form the position of discovered animal in map image correctly not using GPS, regardless of whether the animal occurs in mountain peak, marsh, or coastal beach. Furthermore, based on the measure function in App Monitoring expert, the length of animal to road or resident area can be calculated based on the position in map image using the distance measure module. Because all above data are from the real position of

animal and environment spot in map image, it can ensure the accuracy of value and calculation result by GIS and intelligence technology. Therefore, the software can help accurately obtain the longitude and latitude data of animals at different positions on both sides of the road and measure the distance between animals and the road. Thus, it can provide accurate and rich data for evaluating the road impact and the avoidance effect of animals on the road, scientifically ensuring the research results. At present, it has been applied in Tangjiahe protected areas (PA), Sichuan province, and Foping protected area, Shanxi province， China, and achieved good results. Through monitoring the distance of giant panda to the road in hiking road and self-driving road with our App from 2000 to 2011, we found the effects of both roads on giant panda has a great increasing, but there are no significant differences between hiking road and self-driving road with scientific management of Tangjiahe PA.

Profile of corresponding author

Dr. Minghao Gong is a professor at the Chinese Academy of Forestry (CAF). He obtained PhD from Chinese Academy of Sciences in zoology institute major in animal ecology and animal protection. He has been keeping research on endangered mechanism and conservation biology of rare animals, such as giant pandas, red crowned cranes, and black necked cranes mainly in population ecology, conservation genetics, habitat assessment, global climate change, and conservation strategies. His research-on-research wildlife monitoring methods, technology, and devices aims to improve the accuracy of study data and results. He holds several invention patents and software copyrights of monitoring technique. In 2019, he was awarded the title of "Advanced Individual for Protecting Forest and Wildlife Resources" by the State Forestry and Grassland Administration.

Presentation V-5: Urban road ecology: Environment impacts from road pavement and control technologies

Hui Li, Ning Xie, Jiawen Liu, Xue Zhang

Tongji University, China

Contact author: Hui Li, **Email**: hli@tongji.edu.cn

Keywords: Transportation ecology, road ecology, multimedia environment, multidimensional health

Topics addressed

- Road impact domains
- Environmental Impact assessment
- Transportation technology innovation to support environmental protection, ecological conservation, biodiversity conservation

Abstract

Urban roads, highways, airports and port pavements, squares, parking lots and other types of roads are paved in a large amount and a wide area, accounting for more than 20% of the urban area. Although the traditional roads meet the traffic demand and support the social and economic development, they have significantly changed the material cyclic process of the ecosystem, which has an important impact on the multimedia ecological environment such as water, soil, air, sound, light, and thermal environment in the road area. It is easy to induce urban waterlogging, runoff pollution, heat island effect, light pollution, noise pollution, habitat barrier and other ecological problems, so the impact on environmental health, human health and biological health cannot be ignored. However, current research in the field of roads mostly focuses on the improvement of structural safety and durability but lacks investigation on road ecological benefits and health risks. Therefore, it is urgent to build a research system of road ecology to promote its development. This presentation characterizes three aspects of road ecology: the research background and connotation of road ecology, water-soil-air-sound-light-heat multimedia environmental impact and control technology, and environmental impact and multi-dimensional health risk assessment. The then explores the research status of road ecology for multi-dimensional health, including research theories and technologies involving road engineering, environmental science, materials science and health science, as well as trends of road ecology development. The proposed research is conducive to improving the comprehensive ecological benefits of road pavement and promoting the development of transportation ecology.

Profile of corresponding author

Professor Hui Li, China national overseas high-level young talent, mainly works on the sustainability, resilience and intelligence of transportation infrastructure as well as road ecology. Prof. Li has completed more than 10 scientific research projects, including projects of the National Key Research and Development Program of China and the General Program of National Natural Science Foundation of China. Three Chinese and English academic monographs and 63 SCI indexed papers (44 papers are listed in JCR Q1) were published, the highest impact factor is 11.1, and the total number of citations is 2464. 10 invention patent (including a U.S. patent) and 4 software copyrights have been authorized, and 4 local and group technical standards have been published. He has won the First Prize of Science and Technology Award of China Highway and Transportation Society (provincial and ministerial level), Invention Pioneer Award of China Invention Association, the Special Prize of 1st Science and Technology Award of Shanghai Transportation Engineering Society, the Wang Binggang Young Scholar Award and so on.

SESSION VI:

Transportation ecology in Asia: Case studies (part B)

(Moderator: Dr. Yun Wang, CATS, China)

Presentation VI-1: Impact of road on wildlife and mitigation measures in Sanjiangyuan National Park in China

Lixia Du[1], Yun Wang[2], Fei Zhou[1], Yangang Yang[2], Shuangcheng Tao[2], Yaping Kong[2]

1 World Wide Fund for Nature Beijing Office, Beijing 100037, China

2 China Academy of Transportation Sciences, Beijing 100029, China

Contact author: Lixia Du and Yun Wang

Email: lxdu@wwfchina.org, wangyun80314@163.com

Keywords: Tibetan antelope, Kiang, ungulate, mammals, Tibetan plateau, habitat connectivity, barrier effect, wildlife crossing structure

Topics addressed

- Road impact domains
- Avoidance
- Barrier impacts
- Animal passage (wildlife crossing structure)

Abstract

Sanjiangyuan National Park is the largest national park in China until now. It is located in the hinterland of the Qinghai-Tibet Plateau. Many rare and endangered wildlife are endemic to the Qinghai-Tibet Plateau. With the development of local economy, the construction of transportation infrastructure would boost the local economy. The inherent conflicts between transportation and wildlife protection must be appropriately addressed to achieve the goal of sustainable transportation development. The purpose of this study are two fold. The first is to evaluate the scope and extent of transportation infrastructure on wildlife, to serve for line selection and subgrade design; second, to propose technical measures for wildlife protection in transportation construction.

GIS and Maxent models were used to identify the setting location of wildlife crossing structures (WCS); field observation and historical data were used to analyze the impact of highway and railway on wildlife movement, and infrared cameras was used to monitor the existing WCS to analyze the key factors affecting the utilization WCS of target species.

There are 15 Tibetan antelope migration corridors in Sanjiangyuan National Park, and 13 wildlife crossing structures are planned to be set up at the conflict points between roads and migration corridors. Among this conflict points those along Qinghai-Tibet Highway and railway is the most important. The influence domain of Qinghai-Tibet Highway and railway on the four typical ungulates generally changes from 200-1000m. The continuous observation for 13 years shows that the adaptation time to traffic interference varies among species: Tibetan gazelle

and Kiang can take 2 years, and Tibetan antelope needs about 4 years. The Qinghai-Tibet Highway and the Qinghai-Tibet Railway have the greatest impact on the Tibetan antelope serving as a substantial barrier, by contrast, they have no significant impact on the other three animals. Finally, we propose WCS design size parameters adapted to different animals for inclusion in the standard specification of Ministry of Transport of China.

This study is a representative of the collaborative results of the WWF and CATS in recent years and will provide important guidance for the Qinghai-Tibet Plateau green transportation project.

Profile of corresponding author

Lixia Du, the senior Programme Officer of National Park in WWF (China) Beijing Office. She obtained a master's degree in Beijing Forestry University, where she majored in Protected Areas and Conservation Biology.

March 2018, she joined in National Park Programme of WWF, and assisted the coordinator in developing and designing the strategy of national park project, including strategies / proposals / work-plans /monitoring plans. During the period of the project implementation, she was involved in Forest Landscape Restoration (FLR), the mitigation of Human-Wildlife Conflict (HWC) mechanism, habitat loss and fragmentation.

Dr. Yun Wang, a research professor in the Chinese Academy of Transportation Sciences (CATS). He obtained his PhD from Chinese Academy of Sciences in road, landscape, and ecological protection in 2007. In 2005, he translated Road Ecology: Science and Solution by Richard Forman into Chinese and in 2009, he co-wrote Road Ecology in China. In 2021, as one of key members, he initiated 1st Asia Transportation Ecology Forum. Now his research focus on the interactions of roads and wildlife, landscape fragmentation and transport ecology.

Presentation VI- 2: Effects of roads on leopards' (*Panthera pardus*) movement: Males *vs*. Females

Cláudia Silva[1*], Chris Wilmers[2], Katy Williams[3], Lynne Isbell[4,5], Mohammad Farhadinia[6], Russell Hill[7], Sanjay Gubbi[8], Vidya Athreya[9], Tiago Marques[10,11], Clara Grilo[12,13]

[1] *Faculdade de Ciências da Universidade de Lisboa, Lisboa, Portugal.*

[2] *Environmental Studies Department, University of California Santa Cruz, Santa Cruz, USA.*

[3] *The Cape Leopard Trust, Cape Town, South Africa.*

[4] *Department of Anthropology and Animal Behavior Graduate Group, University of California, Davis, USA.*

[5] *Mpala Research Centre, Nanyuki, Kenya.*

[6] *Department of Zoology, University of Oxford, Oxford, UK.*

[7] *Department of Anthropology, Durham University, Durham, UK.*

[8] *Holématthi Nature Foundation, Banashankari, Bengaluru, Karnataka, India.*

[9] *Wildlife Conservation Society - India, Kodigehalli, Bengaluru, Karnataka, India.*

[10] *Centre for Research into Ecological and Environmental Modelling, The Observatory, University of St Andrews, St Andrews, Scotland.*

[11] *Centro de Estatística e Aplicações, Departamento de Biologia Animal, Faculdade de Ciências da Universidade de Lisboa, Lisboa, Portugal.*

[12] *CESAM - Centro de Estudos do Ambiente e do Mar, Departamento de Biologia Animal, Faculdade de Ciências da Universidade de Lisboa, Lisboa, Portugal.*

[13] *Setor Ecologia, Departamento de Biologia Universidade Federal de Lavras, Lavras/MG, Brasil.*

Contact author: Cláudia Silva, **Email**: claudiapmsilva@gmail.com

Key words: SEM (Structural Equation Models), paved, unpaved, land uses, period of the day, female, male, GLMM (Generalized Linear Mixed Models), transportation infrastructure, road ecology

Topics addressed

- Road impact domains
- Avoidance
- Habitat loss, degradation, and fragmentation

Abstract

Transportation infrastructure has several impacts on felids. A few studies highlight the effects of roads on felids' spatial behavior but, to our knowledge, none has aimed to find a unified pattern across a species' range, neither to analyze whether the effects affect differently males and females. In this context, the main goal of this study was to analyze the direct relationship between leopard occurrence and distance to roads and the indirect relationship between leopard occurrence and habitat loss associated to the road development, in different regions of its distribution by sex. We also intended to analyze these effects on four scenarios: type of road (paved/unpaved) and period of the day (day/night). We had four hypotheses: paved roads have a negative direct effect during day for both sexes; unpaved roads have a negative indirect effect via humanized land uses during day only for females; paved roads have a negative indirect effect via all land uses at night for both sexes; unpaved roads have a positive direct effect at night for males.

We compiled GPS locations from 36 leopards from South Africa (years in which data was obtained: 2012-2015), Kenya (2014-2015), Iran-Turkmenistan (2014-2017), and India (2009-2010, and 2014). Two locations were selected per day, getting a total of 11862, and absence locations were randomly generated. Roads were classified into paved and unpaved, and land uses into six land uses categories (shrublands, herbaceous vegetation, forest, cropland, and urbanization). We then calculated the distance of each individual location (presence or

absence) to the nearest unpaved or paved road and assigned the respectively land use category.

The direct and indirect effects were calculated using Structural Equation Models (SEM). We ran eight (4 to males and 4 to females) SEM to test our hypothesis, each of them composed by three Generalized Linear Mixed Models (GLMM): M1 – leopard locations ("presence/absence") ~ distance to roads; M2 – distance to roads ~ each land use; M3 – leopard locations ~ each land use. The coefficient estimated at M1 was the direct effect quantification whereas the indirect effect was obtained by multiplying coefficients from M2 and M3. Individuals were accounted as random effects.

In general, paved roads had a stronger negative effect on leopards than unpaved on both sexes. Females tended to be directly affected by roads, while males were more affected by their indirect effects via land uses. For both sexes, paved roads had a negative direct effect during day and unpaved roads a positive direct effect at night. Paved roads had a negative effect via forest and unpaved roads a positive direct effect on males. At night, unpaved roads had a negative indirect effect via farming only for males. Differences by sex may have implications on the structure of leopard populations and highlight the importance of genetic analysis to understand the real impact of roads on these species.

Profile of corresponding author

Cláudia Silva is a master's student at FCUL – Faculty of Sciences in the University of Lisbon. She has completed a degree in Biology in 2020 at the same university. She has now been studying the direct and indirect effects of roads on leopards' movement and spatial use.

Presentation VI-3: Effect of roads on activities of North China leopard in the middle section of Taihang Mountains

LIU Bei-bei[1], WANG Yun[2], MA Zi-yu[1], SONG Da-zhao[1]

[1]*China Felid Conservation Alliance, Chongqing 400020, China;*

[2]*China Academy of Transportation Sciences, Beijing 100000, China*

Contact author: Da-zhao Song and Yun Wang,

Email: songdazhao@felidchina.org, wangyun80314@163.com

Keywords: *Panthera pardus japonensis*, population space utilization, road effect, barrier effect, habitat fragmentation, ecological corridors

Topics addressed

- Road impact domains
- Avoidance

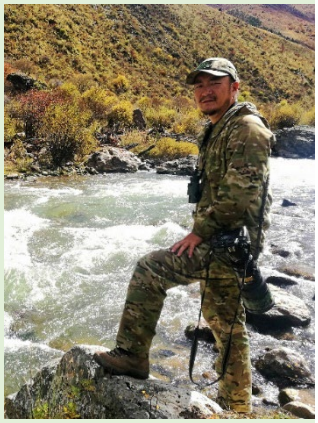
Abstract

North China leopard (*Panthera pardus japonensis*) is the only endemic leopard subspecies distributed in China among the nine subspecies of the world, and its range had seriously contracted, with only 2%-4% relative to the historical range area remaining at present. Habitat fragmentation was one of the most impactful consequences of habitat degradation for the North China leopard, and roads were one of the main factors leading to fragmentation, but studies on the impact of roads on the activities of the North China leopard are still rare. Based on the monitoring data of the North China leopard from 2019 to 2021 in the western region of Heshun County in Shanxi Province, this study discussed the influence and barrier effect of different roads on the activities of the North China leopard in the area where it occurred. Mann-Whitney U test was used to analyze the effect zone of different roads on the North China leopard. In addition, t-test was used to compare the activity intensity of North China leopard in the effect zone before and after the increase of construction traffic flow on X337 (county road). The results showed that the Relative Abundance Index (RAI) of the North China leopard increased with increasing distance from S318 (provincial road) and X337(county road) and decreased with increasing distance from Y029 (rural road). The effect zones of S318 and X337 on North China leopard were 6000 m and 3000 m, respectively, while Y029 has no effect zones. The frequency of the North China leopard road-crossing was highest on Y029 and lowest on S318, suggesting that provincial roads could consist main barriers for the North China leopards. RAI of the North China Leopard in the effect zones of X337 was significantly lower than that before the increase of traffic flow (p = 0.041). This study demonstrated that the North China leopards were vulnerable to existing and under-construction high-grade roads, and it is recommended to strengthen the supervision of road construction in and around the habitat of North China leopard, to provide a good ecological corridor network for the dispersal and migration of the North China leopards.

Funding: This research was funded by Zhilan Foundation.

Profile of corresponding author

Song Dazhao is the founder of China Felid Conservation Alliance (CFCA) and a member of the IUCN Cat Specialist Group. He began surveying and protecting leopards in North China in 2008. The CFCA, which he founded, has developed a systematic conservation program for the entire North China region. In 2019, he co-wrote My Amazing Encounter with Nature, which won the gold award for "My Favorite Children's Book". In 2022, he co-wrote the book Wild Cats of China. In 2019, he organized the translation of Wild Cats of the World. His research now focuses on habitat restoration and conservation of the North China leopard.



Dr. Yun Wang, a research professor in the Chinese Academy of Transportation Sciences (CATS). He obtained his PhD from Chinese Academy of Sciences in road, landscape, and ecological protection in 2007. In 2005, he translated Road Ecology: Science and Solution by Richard Forman into Chinese and in 2009, he co-wrote Road Ecology in China. In 2021, as one of key members, he initiated 1st Asia Transportation Ecology Forum. Now his research focus on the interactions of roads and wildlife, landscape fragmentation, and transport ecology.

Presentation VI-4: The Effect of Roads and Railways on Terrestrial Species in Asia: A 20-year Review.

Aditya Gangadharan[1,2], Y. Chaitanya Krishna[1], Grace Stonecipher[2], Melissa Butynski[2], Anthony Clevenger[3], Rob Ament[2].

[1]*Linear Infrastructure Safeguards in Asia project*

[2]*Centre for Large Landscape Conservation*

[3]*The Western Transportation Institute*

Contact author: Aditya Gangadharan, **Email**: aditya.gangadharan@gmail.com

Keywords: Linear infrastructure, roadkill, train strike, wildlife-vehicle collision, wildlife crossing structure, safeguards

Topics addressed

- Direct and indirect impacts to wildlife from linear infrastructure

Abstract

Linear infrastructure, such as roads, railways, and power lines, is increasing across Asia at a rapid pace and impacts wildlife in several ways. Yet, there are few comprehensive reviews of the literature on the impacts and mitigation of such infrastructure in Asia, which makes is difficult to customize conservation for conditions across the continent. To address this gap, we collected 492 studies and documents from the peer-reviewed scientific literature as well as other sources from 2000 to 2020 and extracted information on the effects and mitigation of roads, railways, and power lines. Studies of roads outnumbered studies of railways by a factor of three. Studies from India and China comprised >50% of the literature, and mammals were represented in 69% and 80% of the peer-reviewed road and railway literature, respectively. Direct impacts (mortalities) were documented for 611 and 20 species for roads and railways, respectively; indirect impacts at small scales were studied for 34 and eight species, respectively; and impacts at the population level or large scale were studied for 41 and nine species, respectively. Studies on the mitigation of road and railway impacts were six and four times less prevalent than studies on the impacts themselves, and, of these, measures that involved structural separation of wildlife from roads or railways were predominant. We found the following key gaps in the literature that require further research: greater

understanding of the number of species directly impacted by railways; a shift away from documentation of roadkill to explanatory analysis; a greater focus on contextualizing raw mortality counts to local population size to understand conservation implications; and quantitative analysis of the efficacy of mitigation measures. We also provide a database of studies that will support meta-analyses on the impacts and mitigation of roads and railways in Asia.

Profile of corresponding author

Aditya Gangadharan has worked in the conservation sector for the last 16 years in private organizations, non-profits, research institutions, and international agencies. His work has ranged from supporting CITES implementation in South Asia for IUCN, to developing machine learning algorithms that predict mental resilience and evaluating the biodiversity impacts of linear infrastructure across Asia for USAID (under which this work was undertaken). His current affiliation is with The Nature Conservancy – India, where he is the Programme Lead (Lands).

Presentation VI-5: Research-informed mitigation planning for Mahendra road expansion in the Terai Arc Landscape in Nepal

Anthony P Clevenger (presenter) [1], Bhuvan Sharma[2], Clara Grilo[3], Babu Ram Lamachhine[4], Patricia Cueva del Bueno[5], Gordon Keller[6]

[1]*Western Transportation Institute, Montana State University, Bozeman, Montana USA.*

[2]*Conservation Development Foundation, Kathmandu, Nepal.*

[3]*CESAM = Centro de Estudios do Ambiente e do Mar, Depto de Biologia Animal, Universidade de Lisboa, Portugal.*

[4]*National Trust for Nature Conservation, Khumaltar, Lalitpur, Nepal.*

[5]*ESSA Technologies Ltd. Vancouver, British Columbia, Canada*

[6]*Genessee Geotechnical, Taylorsville, California USA*

Contact author: Anthony P Clevenger, **Email**: apclevenger@gmail.com

Keywords: Chitwan National Park, connectivity, mitigation, Nepal, Parsa National Park, road mortality

Topics addressed

- Biodiversity conservation in Terai Arc Landscape
- Mitigation measure planning and prioritization
- Taxonomically- and ecologically-scaled mitigation research

Abstract

The natural habitats of the Terai Arc Landscape (TAL) historically supported contiguous, high-density populations of tigers and their prey species, but much of the landscape has been converted to human land uses. Species of high conservation concern reside here, including Royal Bengal tigers (*Panthera tigris tigris*), greater one-horned rhinoceros (*Rhinoceros unicornis*), and Asian elephants (*Elephas maximus*), among others. To ensure the long-term population persistence and metapopulation integrity of wildlife populations it is critical that vital connections are maintained or restored across transportation infrastructure through the use of biodiversity safeguards and road mitigation measures. The Mahendra Highway links the cities of Narayanghat-Hetauda-Pathlaiya (NHP) in the TAL of Nepal and globally important conservation areas, notably Chitwan (CNP) and Parsa National Parks. To address biodiversity baseline objectives of the highway expansion project, a variety of ecological data were collected during a 1-year period (wet and dry seasons) along the NHP corridor including field-based methos (roadkill, camera trapping, sign, surveys, existing underpasses) and connectivity modeling. These data were synthesized and criteria developed to identify areas of high conservation importance along the NHP road. Biodiversity conservation objectives were focused on three main taxonomic groups that broadly represented the range of wildlife in the study area from wide-ranging to arboreal to small, localized species. The three groups were: large mammals, Tarai gray langur, small- and medium-sized mammals. These taxonomic groups covered three important conservation criteria of the project: 1) regional-scale connectivity, 2) local scale connectivity, and 3) biodiversity conservation. Data synthesis allowed for the identification of candidate mitigation sites through a valuation process of criteria developed, which recommendations were made in the form of wildlife crossing structure placement and their function. Key bridges and locations along the NHP corridor that did not score high in the synthesis but merit conservation attention were also identified in recommendations. Our study identified two main blocks of corridor habitat that are vital to ensuring the conservation of biodiversity in the TAL, including IUCN and GoN-listed wildlife and fragmentation-sensitive species at regional and local scales. Our approach has synthesized the most current science and field data from the region to inform the most important locations for biodiversity safeguards. The approach we used was novel as our focus was taxonomically broad, meeting varied ecological connectivity objectives from local to large landscape scales. The most important blocks of habitat that have a critical corridor function were identified and their mitigation potential prioritized based on biodiversity conservation objectives.

Profile of corresponding author

Dr. Anthony Clevenger is wildlife research scientist affiliated with the Western Transportation Institute, Montana State University (Bozeman, Montana). His research the last 26 years has focused on developing science-based solutions to the increasing problem of expanding road systems and the conservation of landscapes and animal populations. He has published his results in leading international scientific journals (over 90 articles) and co-authored three books including the seminal work Road Ecology: Science and Solutions (Island Press, 2003). Dr. Clevenger has expertise in directing road ecology research, having served as Principal Investigator on projects planning, designing and evaluating the use of wildlife fencing and crossing structures in Canada, the U.S., Latin America, and Asia. In working on these projects, he has gained insight into the needs of land managers and transportation practitioners responsible for environmentally sustainable transportation systems.

6. ABSTRACTS OF POSTERS

Posters are available on the IENE website[1]

Poster 1: Road Ecology for Multidimensional Health: Current Status and Future Development

Hui Li

Tongji University, China

Contact author: Hui Li, **Email**: hli@tongji.edu.cn

Keywords: Transportation ecology, road ecology, multimedia environment, multidimensional health

Topics addressed

- Road impact domains
- Environmental lmpact assessment
- Transportation technology innovation to support environmental protection, ecological conservation, biodiversity conservation

Abstract

Urban roads, highways, airports and port pavements, squares, parking lots and other types of roads are paved in a large amount and a wide area, accounting for more than 20% of the urban area. Although the traditional roads meet the traffic demand and support the social and

[1] https://www.iene.info/news/1st-asia-europe-transportation-ecology-forum/

economic development, they have significantly changed the material cyclic process of the ecosystem, which has an important impact on the multimedia ecological environment such as water, soil, air, sound, light, and thermal environment in the road area. It is easy to induce urban waterlogging, runoff pollution, heat island effect, light pollution, noise pollution, habitat barrier and other ecological problems, so the impact on environmental health, human health and biological health cannot be ignored. However, current research in the field of roads mostly focuses on the improvement of structural safety and durability but lacks investigation on road ecological benefits and health risks. Therefore, it is urgent to build a research system of road ecology to promote its development. This presentation characterizes three aspects of road ecology: the research background and connotation of road ecology, water-soil-air-sound-light-heat multimedia environmental impact and control technology, and environmental impact and multi-dimensional health risk assessment. The then explores the research status of road ecology for multi-dimensional health, including research theories and technologies involving road engineering, environmental science, materials science and health science, as well as trends of road ecology development. The proposed research is conducive to improving the comprehensive ecological benefits of road pavement and promoting the development of transportation ecology.

Profile of corresponding author

Professor Hui Li, China national overseas high-level young talent, mainly works on the sustainability, resilience and intelligence of transportation infrastructure as well as road ecology. Prof. Li has completed more than 10 scientific research projects, including projects of the National Key Research and Development Program of China and the General Program of National Natural Science Foundation of China. Three Chinese and English academic monographs and 63 SCI indexed papers (44 papers are listed in JCR Q1) were published, the highest impact factor is 11.1, and the total number of citations is 2464. 10 invention patent (including a U.S. patent) and 4 software copyrights have been authorized, and 4 local and group technical standards have been published. He has won the First Prize of Science and Technology Award of China Highway and Transportation Society (provincial and ministerial level), Invention Pioneer Award of China Invention Association, the Special Prize of 1st Science and Technology Award of Shanghai Transportation Engineering Society, the Wang Binggang Young Scholar Award and so on.

<u>Poster 2</u>: Annual patterns of small vertebrates roadkilled in a city of China

Qiong Wu[1], Taozhu Sun[1], Zhongqiu Li[1]

[1] *Lab of Animal Behavior and Conservation, School of Life Sciences, Nanjing University, Nanjing 210023, China*

Contact author: Zhongqiu Li, **Email**: lizq@nju.edu.cn

Keywords: Roadkills, seasonal variation, small vertebrates, spatial and temporal pattern

Topics addressed

- Road traffic injuries (roadkill, road fatalities, road injuries, wildlife-vehicle collision (WVC))

Abstract

This paper is the first to report data on wildlife-vehicle collisions in Nanjing, southwestern of Jiangsu Province. The study was carried out in a 224.27 km stretch of nine roads in Nanjing. We obtained carcasses of roadkills using 26 monitoring campaigns, between November 2020 to October 2021 to determine the temporal and spatial distribution patterns of roadkills. We recorded 259 carcasses of 22 species, of which 46.42% were mammals and 48.81% were birds. Cats and dogs are the mammals killed most frequently, and blackbirds and sparrows are the most killed birds. The temporal analysis demonstrated that overall roadkill distribution was seasonal， with peak vertebrate roadkills occurring between May to July. Spatial analysis showed that the distribution patterns of vertebrate roadkills on different roads were different, generally non-random distribution and aggregation. Mapping of accidents via Kernel density analysis permitted us to highlight areas with high risk of WVC. The problem of car accidents due to wildlife is an increasing concern. Our study suggests that the results of analysis of temporal and spatial patterns Should contribute to the establishment of mitigation measures.

Profile of corresponding author

Zhongqiu Li is a professor of Zoology at School of Life Sciences, Nanjing University. He serves as a wildlife specialist of IUCN/SSC since 2013, fellow member of China Ornithological Society, China Mammalogical Society, and editors of several scientific journals, including Animal Conservation, Avian Research, Journal of Biology, Zoological Research: Diversity & Conservation. He has focused primarily on exploring how prey behaviorally or cognitively respond to predator risk or human dimension. He has published about 100 scientific papers, and mainly focus on behavioral ecology, animal cognition, and conservation biology of Chinese endemic species.

Poster 3: Research status and challenges of road impact on wildlife in China

Abudusaimaiti Maierdiyali[1,2], Yun Wang[2], Shuangcheng Tao[2], Yaping Kong[2], Hao Wang[1], Zhi Lu[1]

[1]*College of Life Sciences, Peking University, Beijing 100871*

[2]*Chinese Academy of Transportation Sciences, Beijing 100029*

Contact author: Yun Wang, **Email**: wangyun80314@163.com

Keywords: Biodiversity safeguards, linear infrastructure, road ecology, capacity building, wildlife

Topics addressed

- Environmental impact assessment
- Policy and management.
- Citizen science/public participation

Abstract

Habitat loss and fragmentation, which is led by the constant expansion of global transport infrastructure networks, has become one of the significant factors contributing to the decline of biodiversity. A large number of studies on the impact of roads on wildlife have been carried out across the globe, yet the research in this field has just started in China.

This review summarizes 144 case studies conducted in China by the year 2021 and 210 pieces of information relating to roadkill from Sina Microblog. The impacts of roads on wildlife in China were divided into seven aspects: habitat loss, habitat fragmentation, avoid or gather at the roadside, hinder or promote migration, population differentiation, wildlife crossing structures (WCSs), and roadkill. This paper also reaches a comprehensive conclusion from the perspectives of research methods, sites, species and results were analyzed. Relevant studies in China have been developing continuously, the research sites of which are mainly concentrated in Hoh Xil, Changbai Mountain and Qinling Mountain. The main species studied are ungulates on Tibetan Plateau, giant pandas, and Asian elephants.

It is necessary to carry out the development of a road wildlife basic data collection platform, research on cross-regional road-wildlife in China, promoting interdisciplinary and departmental cooperation as well as international exchanges and cooperation. The relevant information released by the public on social media shows that the public has started to pay more attention to roadkill in recent years, and it is urgent and feasible to collect roadkill data based on citizen science in the future.

Profile of corresponding author

Dr. Yun Wang is a research professor at the Chinese Academy of Transportation Sciences (CATS). He obtained his PhD from Chinese Academy of Sciences in road, landscape, and ecological protection in 2007. In 2005, he translated Road Ecology: Science and Solution by Richard Forman into Chinese and in 2009, he co-wrote Road Ecology in China. In 2021, as one of key members, he initiated 1st Asia Transportation Ecology Forum. Now his research focus on the interactions of roads and wildlife, landscape fragmentation, and transport ecology.

Poster 4: An analytical framework of factors affecting wildlife-vehicle collisions and barrier to movement

Haotong Su[1], Yun Wang[1]

[1]*Chinese Academy of Transportation Sciences, Beijing 100029*

Contact author: Yun Wang, **Email**: wangyun80314@163.com

Keywords: Wildlife-vehicle collisions, factor, explanation, barrier, avoidance

Topics addressed

- Road traffic injuries
- Barrier impacts.
- Environmental impact assessment

Abstract

Wildlife-vehicle collisions (WVCs) are the most obvious negative effect of roads on wildlife. Identifying influencing factors and summarizing spatial-temporal patterns of WVCs are major research trends in recent decades, which is of great importance in mitigation measures. Various factors have been extensively discussed. However, most studies only consider a subset of possible factors. There is still lack of a relative complete framework showing large-scale factors of WVCs as well as the underlying transmission mechanism. By virtue of extensive literature research, we aim to build an analytical framework incorporating a wide range of factors that have been discussed. Factors associated with WVCs are divided into four categories: species characteristics, road and traffic characteristics, environmental characteristics, drivers related. We not only show the possible influence direction of each factor on WVCs, but also try to reveal the interaction between some factors and summarize the potential explanations behind under some circumstances. We start with two sub-frameworks: factors promoting road crossing and factors affecting barrier to movement. From another perspective, factors affecting WVCs comprise those related to the access to roads and those related to successful road crossing. Therefore, discussing the first sub-framework briefly helps to present the large framework of WVCs more clearly. Barrier to movement mainly represents road crossing avoidance that is an important factor related to WVCs. Moreover, barrier to movement is another significant negative effect of roads on wildlife, thus it is valuable to further analyze its influencing factors and integrate the second sub-framework into this paper.

Profile of corresponding author

Dr. Yun Wang is a research professor at the Chinese Academy of Transportation Sciences (CATS). He obtained his PhD from Chinese Academy of Sciences in road, landscape, and ecological protection in 2007. In 2005, he translated Road Ecology: Science and Solution by Richard Forman into Chinese and in 2009, he co-wrote Road Ecology in China. In 2021, as one of key members, he initiated 1st Asia Transportation Ecology Forum. Now his research focus on the interactions of roads and wildlife, landscape fragmentation, and transport ecology.

***Poster 5*: The impact of and countermeasures against the ecosystem barrier of temporary projects of railway**

Bijun Wang[1], Zhen Wu[2], Lei Liu[2], Zhizhou Cai[2]

[1]*China Railway 11th Bureau Co., Ltd, Wuhan, China*

[2]*Center for Environmental Protection of Ministry of Transport, Beijing, China*

Contact author: Zhizhou Cai, **Email**: 250788464@qq.com

Keywords: Environment impact, countermeasures, ecosystem barrier, temporary project

Topics addressed

- Avoidance
- Barrier impacts
- Transportation technology innovation to support environmental protection, ecological conservation, biodiversity conservation

Abstract

The spoil grounds, stock grounds, precast beam grounds, camps, and roads that are built during the highway construction period are usually classified as “big temporary projects” and “small temporary projects” according to their different scales. As highway projects are found all over the country’s different ecosystems, such temporary projects are varied accordingly and have their own impact on the environment.

This research takes the highway projects in Southwest mountains, Northwest Loess Plateau, Central China Dabieshan Mountains, and Northeast Daxinganling Mountains as the subject. Through whole-process environmental supervision, it is discovered that temporary projects like spoil grounds destroy vegetation, change permanently the local landforms, affect animal activities, and change or block water systems. Such projects remain permanently like scars, and develop barrier impacts on the surrounding ecosystems to different degrees.

The relieving countermeasures against the temporary projects’ impact on the ecosystem should follow the integral principle of “connecting, restoring, and optimizing”. UAVs (unmanned aerial vehicles) can be used to do digital analysis of the ecosystem connection and catchment areas, to make better decisions, from the very beginning, on the site selection of temporary projects like spoil grounds, and to avoid the blocking of the ecosystem of valleys. Landforms should be designed properly, with natural transition into the surrounding original environment. Ecological drainage canals should be designed with gabions and ecological pool bases to avoid all-cement pavement, where animal and plants should be restored and the aquatic ecosystems of upstream and downstream should be connected. Local plants should be properly chosen to restore and connect to the surrounding plant species. In the mountainous areas, safe and concentrated flat ground should be built after the spoil ground ecosystem is restored for the convenience of further development. Highly efficient agriculture and forestry can be developed taking into consideration of the local macro-environment.

Profile of corresponding author

Mr. Zhizhou Cai is a researcher born in 1964 and works at Environment Protection Centre of MOT (Ministry of Transport). He is a national expert engaged in ecological environment protection, highway landscape and UAV (Unmanned Aerial Vehicle) remote sensing research.

Poster 6: Transportation technology empowers transportation governance reform: A three-dimensional perspective of technology, value, and goal

Guanghui Zhao[1], Song Zhang[1]

[1]*School of public management, Guizhou University of Finance and economics, Guiyang 550025, Guizhou, China*

Corresponding author: Song Zhang; E-mail: 2952138860@qq.com

Keywords: Traffic management ecology, transportation technology, traffic management; technology empowerment

Topics addressed

- Transportation technology innovation to support environmental protection
- Ecological conservation
- Biodiversity conservation

Abstract

At present, new technologies based on new information technologies such as big data, artificial intelligence and block chain are constantly developing and maturing, bringing new opportunities and challenges to the field of public governance. For the field of traffic management, there is no exception. Traffic science and technology has become the main driving force to promote the reform of traffic governance. Through the empowerment of traffic science and technology, an exploration path of traffic governance reform has been formed with science and technology as the support, public value as the orientation, and governance innovation as the goal, thus contributing to the formation of a good and orderly traffic governance ecology. From the perspective of technical logic, the transformation of transportation governance enabled by transportation science and technology follows the triple technical logic of "data driven, algorithm operation as the core, and intelligent integration as the guidance"[2]. With the deepening of science and technology embedded in the field of traffic management, the technology system and the original value structure are

gradually moving towards a state of mutual adaptation, integration and shaping. The challenges such as technology dominance, fuzzy attribution of social responsibility, and upgrading of data security governance risk caused by technology in the process of enabling are beginning to penetrate the inherent public value system of traffic governance. Based on this, in addition to the pursuit of general values such as safety, convenience and green, traffic governance should also pay attention to the value risk issues such as technology dominance, social responsibility and data security management that may derive from the application of science and technology, to promote the transformation and upgrading of traffic governance in the scientific and technological era to intelligent, refined and ecological forms.

For example, the “new stop” of intelligent bus, which was first tested and successfully implemented in Shenzhen, China, is an electric travel mode of public transport based on big data, artificial intelligence, and cloud computing. Among them, big data and cloud computing technology accurately capture the travel route, distribution of surrounding obstacles, traffic flow and other data of intelligent buses through the “intelligent transportation” monitoring platform, and then form a set of accurate and scientific instructions through algorithm analysis to ensure smooth travel of pure electric public transport. Although pure electric bus has the advantages of green and environmental protection, it also has problems such as short battery mileage, long charging time, limited charging station resources, etc. In order to solve the above problems, the “Night Charging Queue” algorithm developed by Huawei’s traffic algorithm expert team can help mobile operators formulate night charging queue plans, greatly improving efficiency. However, during the operation of the pure electric bus, it is inevitable that the data will be inaccurate due to system failures, which may lead to some public value problems such as technical dependence, safety risks, and fuzzy attribution of social responsibilities.

Profile of corresponding author

Song Zhang is a postgraduate student in Guizhou University of Finance and economics. His major is administration, and his research direction is public policy and traffic administration. During the research period, he participated in the international cooperation project of the Ministry of education, “Guizhou transportation infrastructure training class for the” the Belt and Road “, chaired by his mentor Professor Guanghui Zhao, to analyze the current situation of Guizhou transportation infrastructure construction. The problems faced and the future development direction were comprehensively understood. In addition, he also participated in the business evaluation of Guizhou Province in 2021.Therefore, it has accumulated some research experience and laid a solid research foundation for later related research by taking part in above research activities. Now, he mainly studies public policy and traffic management.

Poster 7: Spatial and temporal characteristics of landscape pattern in the Three-River Headwaters Road Network from 2010 to 2020

Zhaoming Wang, Shegang Shao, Xiaofei Liu, Yanan Qi, Sen Zhao

Research Institute of Highway, MOT, Beijing, China.

Corresponding author: Zhaoming Wang, **Email**: zm.wang@rioh.cn

Keywords: Road network, landscape pattern, remote sensing

Topics addressed

- Habitat loss, degradation, and fragmentation
- Environmental impact assessment

Abstract

Road networks destroy habitat integrity and landscape structure, leading to physical destruction and adaptive changes of natural habitats of many organisms. Studying the impact of road networking on landscape pattern can provide reference for ecology, road construction, and regional sustainable development planning in rapidly urbanized areas. Based on Landsat TM images from 2010 to 2020, this paper took the road network in the headwaters of three rivers as the research object to analyze the spatial structure of the road network and the resulting landscape pattern changes. The results show that: 1) With the continuous progress of road construction, the road network landscape gradually appears to be complicated and fragmented. The scale of construction land expands and the degree of landscape aggregation increases. 2) In 10 years, low-grade roads gradually open up, and the landscape fragmentation effect is obvious, which is higher than that of high-grade roads and national and provincial trunk lines. 3) Different degrees of road network development have different effects on different land types: in the area with simple road structure, woodland and grassland are clustered into pieces with a high degree of aggregation, while arable land, water, and beach are fragmented and irregular in the influence domain of each grade of road network spatial index. Its precision can reach 88%. This index has a positive effect on the ecological planning of highway network. With reliable road network status predictions in floods, the index can reduce ecology destruction.

Profile of corresponding author

Dr. Zhaoming Wang is associate researcher at the Research Institute of Highway, Ministry of transport, China (RIOH). He obtained his PhD from Chinese Academy of Sciences in landscape and ecological protection in 2014. Now his research focuses on road network ecological environment effect, low carbon road network.	

Poster 8: Land use, vegetation cover and landscape pattern change of main linear infrastructure on the Qinghai-Tibet Plateau, China

Siqi Yang, Gaoru Zhu[1]

[1]Transport planning and research institute, Ministry of transport, Beijing 100028, China

Corresponding author: Gaoru Zhu (Principal researcher), **Email**: zhugaoru@foxmail.com

Keywords: Qinghai-Tibet traffic corridor, national highway, railway, expressway, land use change, vegetation dynamic, landscape pattern

Topics addressed

- Habitat loss, degradation, and fragmentation
- Road impact domains
- Barrier impacts

Abstract

The Qinghai-Tibet corridor includes railway, national highway, and planned expressway in the highland area, characterized as the highest altitude, longest route and various sensitive ecosystems. Quantitative analysis of ecological effects along the Qinghai-Tibet corridor is critical to understand the impacts of different traffic infrastructures on global hotpot of biodiversity maintenance. This study selected the Golmud-Lhasa traffic corridor as the typical area, analyzed the land use change, vegetation dynamic and landscape pattern change within 10 km buffer, thereby clarified the integrated ecological effects. The results showed that the dominant land types of grassland decreased and unused land increased over time in the national highway buffer; whereas the dominant grassland and unused land decreased, by contrast construction land increased over time in the railway station buffer. In the national highway buffer, there were contrary trends in cropland across periods, which decreased in 2000 and 2020 but increased in 2010; in different periods, the proportion of forest, water body, and unused land increased, the proportion of shrubland and construction land decreased, and water body and grassland were increased significantly within 0-3000 m. In the railway station buffer, there were threshold effects in each land use types alongside the distance gradients, in details, the threshold of grassland, shrubland and unused land was about 8000m. The vegetation dynamics in the national highway and railway buffer were improved over time, especially in 2010 and 2020 within the railway station buffer. The results of landscape pattern showed that although the highway construction caused the increased landscape fragmentation, it also improved the diversity and evenness of landscape. Therefore, the future expressway construction should be aimed at improving connectivity and maintaining stability.

Profile of corresponding author

Dr. Gaoru Zhu is a principal researcher at Transport Planning and Research Institute (TPRI). He obtained his PhD from Peking University in 2012. He has presided over more than 20 projects including National Natural Science Foundation and published more than 50 papers. He co-chaired the project of Research on Technology and Policy of Integrated Development of Highway Construction and Ecological Protection on the Qinghai-Tibet Plateau, which	

.

won the first prize of National Excellent Engineering Consulting Achievement Award and contributed to the compilation of Technical Guidelines for Green Highway Construction and other industry standards. Currently, his research focus on ecological effects and spatial optimization of road.	

7. RESULTS AND CONCLUSIONS ON NEXT STEPS

After the completion of the 1st Asia-Europe Transportation Ecology Forum and the fruitful discussions took place during the PIARC's workshop on shaping a framework of results and conclusions for next steps, the following points emerged:

1) 30 presenters from more than 20 countries and 6 continents (Europe, Asia, Africa, North America, South America, and Oceania) gave oral presentation or poster display, sharing their research results and practical experience.
2) 286 participants attended the Forum from 29 countries as presented in the graph of fig.1 below and 2 organizers and 17 co-organizers pointing out the high interest of people and on Transport Ecology in Eurasia.
3) The Asia-Europe Transportation Ecology Forum should be established on a permanent basis as an important platform for exchanging policies and strategies, scientific knowledge, and practical experiences on transport ecology.
4) Special challenges should be addressed given the huge demand for transport infrastructure development in combination with the framework of the post CBD COP 15 Global Biodiversity Framework, the UN Restoration Decade, the Paris Climate Change Agreement, and the Sustainable Development Goals.
5) CATS will translate the Global Strategy for Ecologically Sustainable Transport and other Linear Infrastructure in Chinese as a high priority policy document.
6) An International Working Group will be set up with the coordination of IENE and CATS in order to formulate a framework of concrete actions needed to respond to the challenges for development of transport networks in Eurasia in a sustainable way while securing the the cohesion of nature networks and the functionality of the ecological corridors and landscape connectivity.
7) CATS and IENE plan to apply for international cooperative research projects from both China and Europe or other potential funders to promote the advancement of Asia-Europe transportation ecology.

Additionally, in order to summarize the crucial points addressed in the Forum, the following key words and their combination have to be highlighted:

- "Aiming high" is important and therefore the "high-level decisions" are crucial.
- "Strategic planning" and "do the right thing from the beginning" is essential in order to avoid "wrong roads to wrong places".
- Trust the "precautionary principle" and "ecosystem approach" in order to build "resilient transport infrastructure" against the acceleration of "biodiversity loss" and "climate change".
- Follow the "mitigation hierarchy" which prioritizes "avoidance, mitigation, and then compensation" to avoid "landscapes and habitat fragmentation".

- Strive for “defragmentation” of existing “fragmented landscapes and habitats” and “decommission” abandoned transport infrastructure.
- “Learn from practices and their mistakes” in order to support the “culture of learning”.
- As “every case is a unique case”, develop the “Asian Transport Ecology” with its unique natural heritage using the local and global “lessons learned” adapted to the “local needs”.

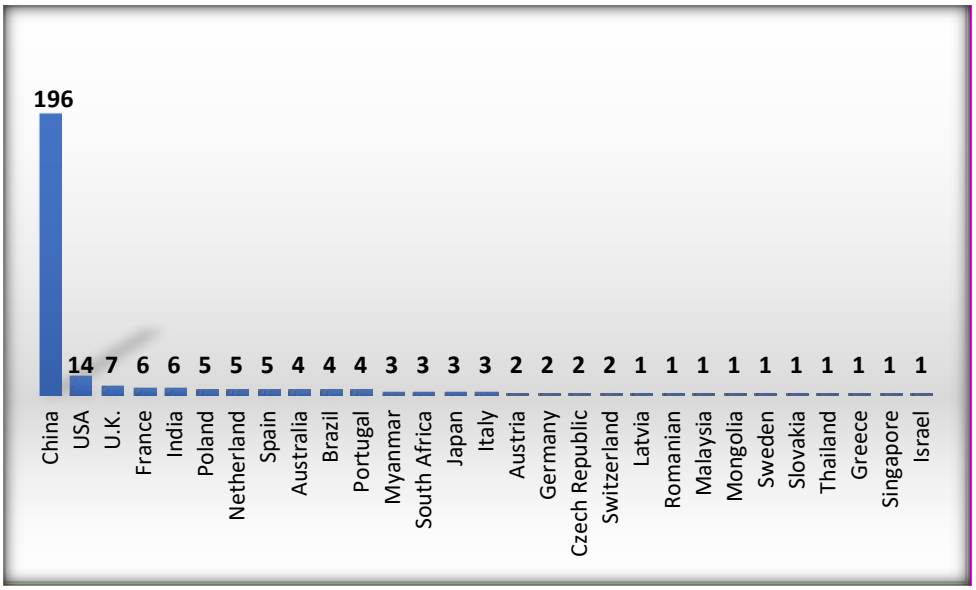


Fig 1. *Graph of 286 participants from 29 countries*

8. ACKNOWLEDGMENTS

We would like to acknowledge the joining of forces by the co-organizers of 1st Asia-Europe Transport Ecology Forum, the presenters of keynote speeches, Andy Arnell, and the rest members of the team of UNEP for their participation, Mr Yaping Kong, Director of CATS, as well as Elizabeth Losos from Duke University and Rowan Palmer from UNEP for offering the English review of the book abstracts.

Special acknowledges we must give to all participants for their interest to join the Forum, both for those were who were able to adjust to the change of date and time and those who wanted to join but could not do to the schedule change.

This book of abstracts was funded by the Second Tibetan Plateau Scientific Expedition and Research Program (STEP) (Grant no. 2021QZKK0203) and WWF-China Project (Grant no. A000500) and basic research program of centric level, scientific research institutes (Grant No. 20230602) and Supported by the Third Xinjiang Scientific Expedition Program (Grant No.2022xjkk0800).