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Infra Eco Network Europe

Towards developing sustainable Linear Transportation Infrastructure globally

Recommendations for priorities of international action

Final report of the IGELI project: Development of

International **G**uidelines for **E**cologically-adapted **L**inear **I**nfrastructure

Linköping, Sweden
November 2018

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Contact IENE: info@iene.info

Website: http://www.iene.info

Authors:

Lazaros Georgiadis[1-2], Tove Adelsköld[3-4], Yannick Autret[1-5], Marita Böttcher[1-6], Elke Hahn[1-7], Carme Rosell[1-8], Tony Sangwine[1-9], Paul Wagner[1-10], Andreas Seiler[1-11], Kate Newman[12], Rodney van der Ree[13], Anders Sjölund[1-14] , Hans Bekker[15].

[1]Members of the IENE Governance Board
[2]Biologist - Environmentalist, freelancer, Florina, Greece
[3]IENE Secretariat
[4]Calluna AB, Göteborg
[5]Ministry of Ecology, Sustainable development and Energy, Paris, France.
[6]Federal Agency for Nature Conservation (BfN), Leipzig, Germany
[7]Federal Ministry for Transport, Innovation and Technology, Vienna, Austria
[8]Minuartia, Barcelona, Spain
[9]Highways Agency, Bristol, UK
[10]Washington State Department of Transportation (USA)
[11]Swedish University of Agricultural Sciences, Grimsö Wildlife Research Station, Sweden
[12]WWF-USA
[13]ANET
[14]Trafikverket – The Swedish Transport Administration, Borlänge, Sweden
[15]Department Public Works; Duth Ministry of Transport and Water Management; The Netherlands

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Summary

Linear Transportation Infrastructure (LTI) is a major factor influences the continuity of natural habitats, the ecological connectivity and the gene flow of a lot of species globally which determine the status of the loss of biodiversity. The main problem that describes the environmental impacts of LTI is the fragmentation of natural ecosystems. In global level there are two "opposite" trends: the increased demand for LTI and the loss of biodiversity which create a special crossing point of conflicts between economic development and natural conservation. This conflict point is more sensitive on developing countries which have areas with high value biodiversity heritage as well as important social value of indigenous societies while the press and the demand for economic development are more intense.

Established in 1995 Infra Eco Network Europe (IENE) is a network of experts, working on transportation infrastructure and their environmental impacts as habitat fragmentation, loss of wildlife habitats and their ecological connectivity. Since 2014 IENE international conference in Malmo, Sweden IENE responded to a call of WWF for development of a project for consulting the environmental friendly designing of a Road which will connect Bangkok/Thailand with Dawei/Myanmar. This project lead after 2015 International Conference of ICOET in Raleigh, North Carolina USA, to an international cooperation between IENE, WWF and ANET (Australasian Network for Environment and Transportation) for Development of International Guidelines for Ecologically Friendly Linear Transportation Infrastructure (IGELI). In IGELI IENE, WWF, and ANET have been working together, in collaboration and consultation with colleagues in Europe, Africa, Latin America, Asia and the Pacific, to build a coalition of partners interested in developing a globally relevant best-practice guidance to ensure that the LTI we build today is as ecologically sensitive as possible.

The IGELI project focused on the Guidelines' needs of developing sustainable Linear Transportation Infrastructure globally including developing countries as more environmentally vulnerable countries and increased demands for development. The actions of the project included two parts:

A. A preparation of a review of the existing international policies on ecological connectivity, transportation, and development covered by five International Conventions:

   I. The Bonn Convention on Migratory Species (1979),

   II. The Convention on Biological Diversity (CBD) (1992) 2011-2020 Aichi targets,

   III. The UN Sustainable Development Goals (SDG) (2015),

   IV. The UN Framework Convention on Climate Change Paris Agreement (2015),

   V. The Convention on the Protection and Sustainable Development of the Carpathian (the Carpathian Convention) as local acting after having global thinking.

B. An international discussion on guidance has been underway through special sessions and workshops at international meetings, including:

   ✓ The IENE 2016 International Conference (Lyon, France),

   ✓ The IUCN World Conservation Congress (Hawaii, USA, September 2016),

   ✓ The ICOET 2017 International Conference (Salt Lake City, USA, May 2017),

   ✓ The International Forum on Sustainable Infrastructure (Ha Noi, Vietnam, May 2017),

   ✓ The International Workshop on Sustainable Harmonization of Green with Grey Infrastructure in South Eastern Europe (Faget, Romania, October 2017),

- ✓ The TransGreen Interreg Danube-Carpathian Project Conference (Bratislava, Slovakia, September 2018), and
- ✓ The IENE 2018 International Conference (Eindhoven, the Netherlands, September 2018) which was dedicated to the completion of 15th years of a national defragmentation project in the Netherlands.

During these events, special presentations and discussions took place on LTI guidance, defining the needs, concepts, tools, and strategies for an international policy that could be included in guiding the development of environmentally sustainable LTI projects globally. Participants at these events covered a wide range of topics, including specialists in ecology, engineering, policy making, international finance and economics and representing environment and transport sectors, government ministries, banks, universities, international institutions, and NGOs from all over the world.

At the IGELI workshop of IENE 2018 International Conference in cooperation with other international organisations, such as IUCN/Connectivity Conservation Specialist Group/Transport Working Group, the final project recommendations discussed to be focused for the parties to the Convention on Biological Diversity this year as they consider the priority theme of mainstreaming biodiversity in the infrastructure sector at the CBD Conference of the Parties in November of 2018.

In a parallel way IENE completed two special projects:

- ✓ Transforming in a web form the European Handbook on how to avoid Habitat Fragmentation due to Linear Transportation Infrastructure (WILDLIFE AND TRAFFIC. A European Handbook for Identifying Conflicts and Designing Solutions. COST 341 Habitat Fragmentation due to Transportation Infrastructure). During this project a survey for existed Handbooks and Guidelines on environmentally sustainable transportation took place with priority in European level and the results included in the overall framework of the project recommendations.
- ✓ Creating a European defragmentation map with all defragmentation projects implemented in Europe.

As a result of the overall implementation of the project, the adaptation of the title of the CBD Strategic Plan for Biodiversity 2011-2020 "*Living in harmony with nature*", and towards answering the question on "***How we are building Linear Transport Infrastructure in harmony with nature***?" the below Recommendations on achieving t*he Aichi Target 5 on "*significant reduce of degradation and fragmentation of natural habitats" are proposed:

1) Promotion and spread of a clear message internationally: "**Don't fragment the nature"**. The message from the Netherlands and the Declaration of IENE 2018 International Conference "*CONNECTING EUROPE, CONNECTING NATURE. Building bridges and crossing borders for the defragmentation of Europe"* has to be spread internationally: "***Be proactive and build sustainable Linear Transportation Infrastructure from the beginning***".

2) Development of a common international language in policy, ecology and engineering connected with the LTI development using as basic frame of fundamental terms:

   a) Genetic isolation as the **main problem.**

   b) Habitat fragmentation as the **main cause.**

   c) Ecological and Landscape connectivity as the **main aim.**

   d) Green and Grey Infrastructure as the **main crossing point and conflict areas.**

   e) Sustainability of LTI as the **main objective.**

   f) Mitigation as the main solution (without excluding avoidance and compensation).

3) Developing and implementing an **International Strategy** against fragmentation globally as a next emerging step including:

   a) The **general aim/goa**l.

   b) The concrete targets.

   c) The **objectives.**

   - Concept Tools on sustainable LTI.
   - The Audients –Stakeholders.
   - Principles to be followed.
   - Technical tools (Handbooks, Guidelines, Protocols, standards etc.).

   d) An **International Action Plan** with: Activities - Deliverables - Time table.

   e) The following up process.

   The aim of the Strategy and the Action Plan has to be adopted and implemented in National & regional Strategies for Biodiversity with their Action Plans evaluating how fragmentation as a concrete problem to be solved estimating LTI as "*certain human activity with concrete impacts on biodiversity loss*".

4) Defining the sustainability of LTI and based on the definition of "Environmentally friendly transport" described in the Carpathian Convention. The "Sustainable Linear Transport Infrastructure" can be defined as Linear Transportation Infrastructure which:

   a) *Limits negative impacts on land use, landscapes and ecosystems, and is constructed in such a way that ensure the ecological connectivity and minimize the fragmentation of natural environment ensuring ecological connectivity in a most possible way.*

   b) *Limits pollution, noise production, emissions and waste within the planet's ability to absorb them towards minimizing its impact to global climate change.*

   c) *Is save, adaptable and resilient into the climate change's status.*

   d) *Uses renewable resources at or below their rates of generation.*

   e) *Uses non-renewable resources at, or below the rates of development of renewable substitutes.*

   f) *Respects the local societies and cultures in the areas intersect by its alignment*.

5) Join common actions and supporting multidisciplinary, cross-sector and cross-boundary/international cooperation.

6) Increase and promote the Transport Ecology Knowledge and the development of research and technology on mitigation measures connected with Sustainable LTI (animal detection and monitoring systems, bat bridges, wildlife crossings' monitoring systems, reflectors, etc.) implemented in linear transportation toward producing effective applied solutions in practice. Filling this gap in developing countries is a priority.

7) Creating Guidelines for sustainable LTI in Developing Countries as a great challenge taking in to account the special particularities, social, environmental and economic status of each of the country or their geographical area adopting the principle of "any case, a unique case".

1. Introduction and basic background

The loss of biodiversity has been recognized by the United Nations officially at a global level since 1992 in Rio De Janeiro, Brazil through the Convention on Biological Diversity (CBD). In 2010 in Japan with the Aichi Biodiversity Targets a concrete framework of goals and targets have been established by the United Nations setting halting biodiversity loss as a major challenge for the 21st century. One major threat to biodiversity is the fragmentation and degradation of habitat caused by the construction and use of transport infrastructure (*Canters et al 1997*, *Forman et al, 2003; Sherwood et al, 2003; Trochme et al, 2002, Van der Ree et al*, *2015)*.

Photo 2: *Highways, four lane artificial barrier for ecosystems and landscapes, Greece (©L. Georgiadis)*

In the context of fragmentation, transport infrastructure has both primary and secondary effects on nature (*Iuell et al 2003, Van der Ree et al 2015*). It is possible to distinguish in five major categories of primary ecological effects that negatively affect biodiversity plus a group of secondary ecological effects.

The primary ecological effects are related with:

a) Loss of wildlife habitats as considerable surface areas are occupied by roads and railways, their parallel supportive infrastructure as operation facilities, logistics etc. creating a wider zone of occupation of natural areas.

b) Barrier effects for both local and migratory species populations influencing negatively natural movements of the animals and increasing their genetic isolation, which especially for endangered species is a basic factor in extinction.

c) Fauna casualties – collisions between transport and wildlife with multiple costs primarily on humans and wild

animals' lives as well as car damage and economic losses.

d) Disturbance and pollution which increase the Linear Transportation Infrastructure's (LTI) influence zone on a wider scale than the land they occupy.

e) Ecological function of verges (edges of LTI development). The value of infrastructure verges is a much debated topic. They can be important habitats for some species of wildlife, but they can also lead animals to places where mortality is increased or aid the spread of alien species.

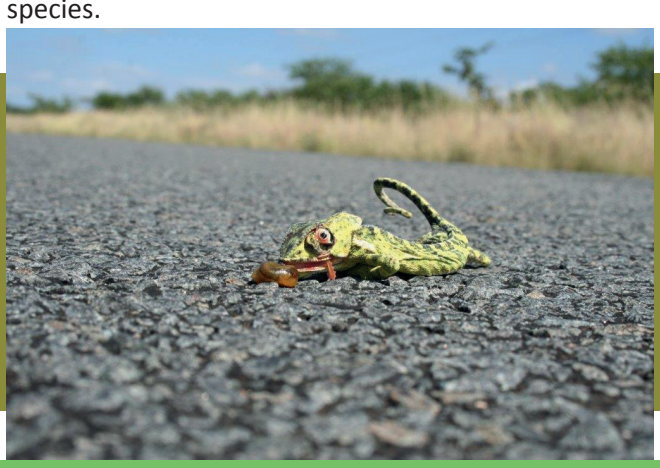


Photo 3: *Wolf road kill, Greece, (©L. Georgiadis)* ***Photo 4:*** *Chameleon road kill, South Africa, (©W. Collinson)*

Photo 5: *Road widening in Thailand close to the borders with Myanmar, (©L. Georgiadis)*

In practice, these effects usually interact and may significantly increase their negative impact through synergistic effects. The consequences of loss and deterioration of wildlife habitat, barrier effects, isolation and disturbance can be summarized by the term Fragmentation.

Basic secondary ecological effects are related with:

a) The later land occupation and clearing especially in forested areas by settlements and industries, further infrastructure and changed land use along the developed transportation infrastructures. New settlements and housing estates follow the construction of new regional roads and in turn induce the construction of local access roads.

b) The increased degree of human access and disturbance. Networks of small forest roads provide hunters, poachers and tourists access to otherwise undisturbed wildlife habitats.

c) Negative impacts on landscape ecology, caused by permanent linear intervention in important natural landscapes.

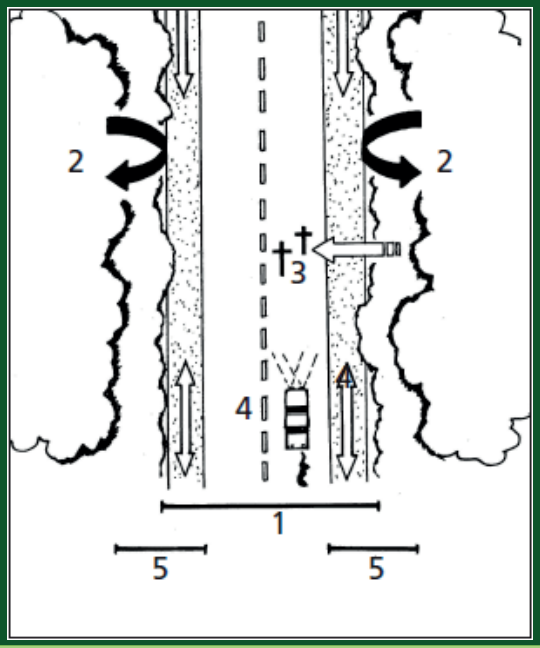


Figure 1.1: *Schematic representation of the primary ecological effects of transport infrastructure: 1) Loss of wildlife habitat, 2) Barrier effects, 3) Fauna casualties - collisions between transport and wildlife, 4) Disturbance and pollution, 5) Ecological function of verges (edges of infrastructure development) (Iuell et al 2003).*

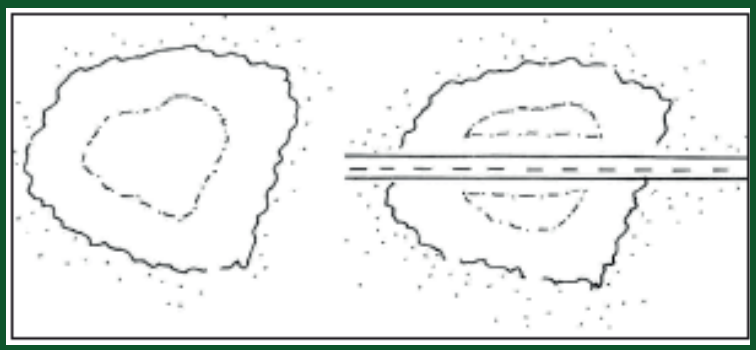


Figure 1.2: *Diagram showing the impact of infrastructure development on the interior core of habitat, important for its special flora and fauna. The area of core habitat lost is far greater than that taken by construction due to the increased edge effect along the rout of the road (Iuell et al 2003).*

Roads and other LTI, such as railways are essential for human civilizations, economic growth and communication but have often deleterious impacts on nature, wildlife and ecosystems. Impacts can extend for kilometers from the road itself and continue to develop for years, thereby affecting ecosystems and their services across the landscape especially when complementary infrastructures projects and natural resources exploitation activities are developed (*Laurance et al 2017*). On the other hand there is growing transport demand globally with its expanding infrastructure and increasing traffic flows (*Hahn et al., 2016, Van der Ree et al 2016, Quintero 2016*). There are 64 million km of roads on earth – enough for 83 round-trips to the moon. An additional 25 million km will be constructed by 2050; 90% of which will be in non-OECD countries (*Dulac 2013 in Van der Ree et al 2016*). While about 80% of Earth's terrestrial surface remains roadless, this area is fragmented into ~600,000 patches, more than half of which are surfaces that cover less than 1 km^2 and only 7% of which are larger than 100 km^2. Global protection of ecologically valuable roadless areas is inadequate (*Ibisch et al 2016*). Additionally roads have been singled out as generating intense natural selection pressures that have important consequences for population conservation as they change the landscape and the genetic communication status influencing at the same time the overall evolutionary processes of the species (*Brady et al 2017*).

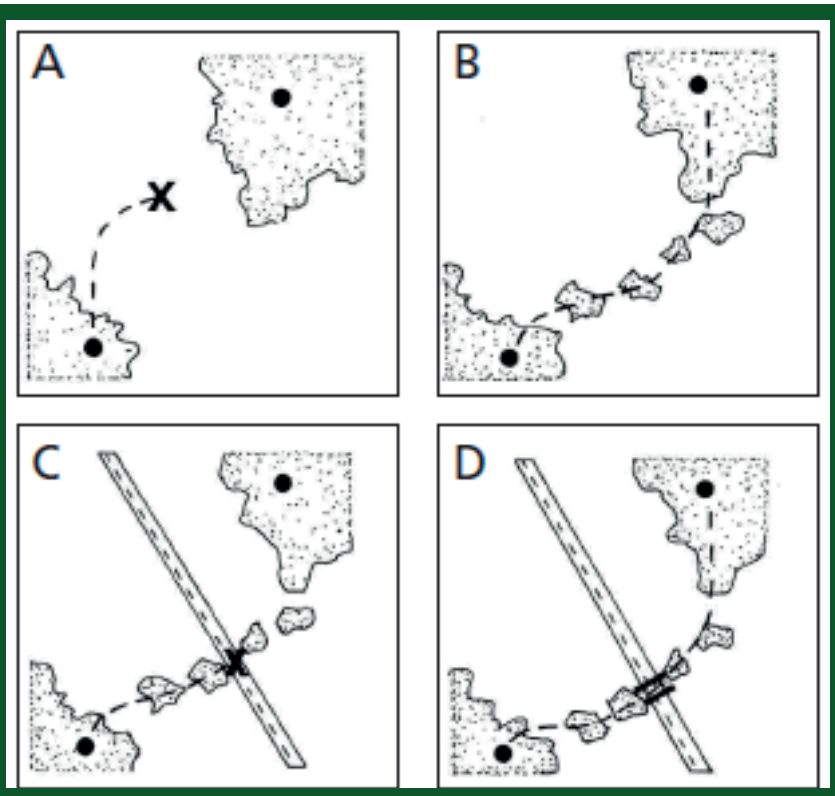


***Figure 1.3**. The effect of ecological corridors and road networks on the movement of species across landscapes: A) In open landscapes without ecological corridors, species may not be able to move between habitats, B) Small fragments of suitable habitat may serve as stepping stones connecting distant habitat patches, C) Ecological corridors in combination with roads may attract animals but direct them towards the road where they might be killed when attempting to cross, D) Mitigation measures such as fauna passages can help to re-link ecological corridors (Iuell et al 2003).*

While the growth of transportation infrastructure is inevitable as global demand for goods and services is necessary for economies to thrive and expand, markets and societal structures depend heavily on the transport of people and freight, there are two "opposite" trends globally: the increased demand for LTI and the loss of biodiversity. The opposite trends create a convergence of conflicts between economic development and natural conservation while extensive losses of wilderness have occurred in the last two decades. These negative results show that globally important wilderness areas are ignored in conservation policy and international policy must recognize the actions needed to maintain wilderness

areas (*Watson et al., 2016, Sloan et al 2016*). This conflict point is more sensitive in developing countries which have areas with high value biodiversity heritage as well as important cultural values of the indigenous local societies while the pressure and the demand for economic development are more intense.

Another parallel level of "conflict crossing point" that can be recognized is between natural 'green' infrastructure and artificial 'grey' infrastructure such as linear transportation as European Environmental Policy has distinguished (*European Commission, 2013*). Green infrastructure is evaluating as fundamental natural capital providing a functionally linked network of high-quality ecosystems. Maintaining healthy ecosystems, particularly with respect to changing climate, can protect both 'green' and 'grey' infrastructure by reducing potential damage from hazards such as landslides, flooding and erosion. Green Infrastructure providing important ecosystem services, serves not only for the protection of biodiversity but also as a multifunctional resources delivering essential benefits and services that human society obtains from nature.

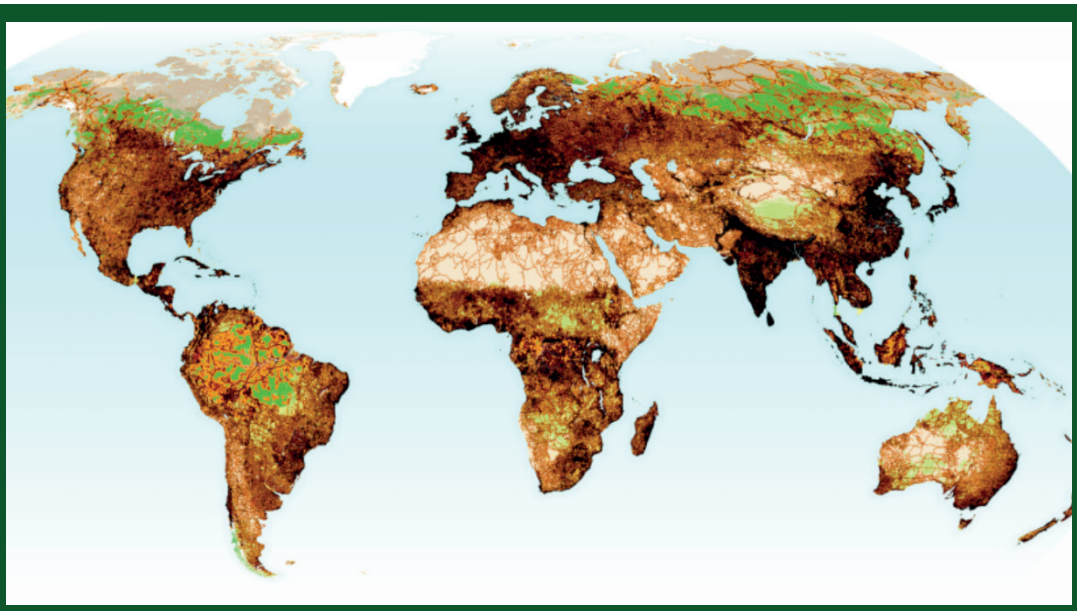


Figure 1.4: *Outlook to an infrastructured future. GLOBIO[1] – future outlook 2002 – 2032.*

The co-existence of linear - "grey" infrastructure and "green" – natural infrastructure in a developing world is of tremendous importance if we want to preserve the earth's living environment for future generations and implement United Nations' Sustainable Development Goals. Towards achieving this co-existence, there are means to mitigate the impact of transportation infrastructure on nature globally, reduce its pressure and decouple its adverse effects from the still growing demand for new infrastructure and IENE is working in this direction (*Spindler et al 2014, Georgiadis et al 2018a*). It's crucial to mention that at least in Europe several countries have recognized the fragmentation of natural environment by the LTI as a major issue and have developed special national defragmentation projects as in Switzerland, Austria, Netherlands, Germany, Poland, Czech Republic, Sweden, Spain, Bulgaria and France. Such measures can and should be implemented as a standard in infrastructure development and maintenance towards a safe, efficient and sustainable transportation system as a key to the modern way of life globally *(Seiler et al 2015, Iuell et al., 2003; Van Bohemen et al., 1996; Van der Sluijs et al., 1991*) and especially to developing countries. Obviously, there is a need for international collaboration in research and practice, for enhanced exchange of knowledge between disciplines, and for the development of harmonized standards and procedures that can be referred to by international actors (*Wagner and Seiler, 2015*).

1 http://www.globio.info/

Photo 6: *Egnatia Highway tunnels, Greece, (©L. Georgiadis)*

Established in 1995 Infra Eco Network Europe (IENE) is a network of experts, working on transportation infrastructure and its environmental impacts such as habitat fragmentation, loss of wildlife habitats and their ecological connectivity. IENE, today has circa 400 members from Europe and internationally, representing 51 countries (*Georgiadis et al, 2018a,* www.iene.info). One of the basic tools for IENE is its International Conferences as basic interdisciplinary arenas of exchange of scientific knowledge and practical experience encouraging and enabling cross-boundary and cross-sector cooperation on Ecology and Transportation. The Declarations of the IENE conferences are strong messages communicated in all continents of the world. In dealing with fragmentation at a global level, it's important to take in to account that the Declaration of the IENE 2018 conference in Eindhoven was connected with the celebration of the completion of 15 years of a National Defragmentation Project[2] of the Netherlands with the title: "*CONNECTING EUROPE, CONNECTING NATURE. Building bridges and crossing borders for the defragmentation of Europe*" (see ***ANNEX***).

Since IENE 2015 international conference in Malmo, Sweden, IENE responded to a call of the World Wildlife Fund (WWF) for cooperation and development as a special project for consulting and advising on the appropriate environmental friendly designing of the transnational Dawei Road which will connect Bangkok/Thailand with Dawei/Myanmar (*Georgiadis et all, 2015*). After the 2015 International Conference on Ecology and Transportation (ICOET) in Raleigh, North Carolina USA, this project led to an international cooperation between IENE, WWF and ANET (Australasian Network for Environment and Transportation) for Development of International Guidelines for Ecologically Friendly Linear Infrastructure (IGELI) while in 2017 ICOET and IENE 2018 Conferences important cooperation developed with other international organizations, such as IUCN (Connectivity Conservation Specialist Group/Transport Working Group). Actually IGELI was an initial step in working together towards building a coalition of partners interested in developing a globally relevant best-practice guidance to ensure that the LTI we build today is as ecologically sustainable as possible.

Since the Dawei Road project development, IENE developed its principles for environmentally friendly infrastructure presented in the ***Table I*** incorporating the 20 years of IENE's members experience in transportation ecology (*Georgiadis et al 2018a*).

2 https://www.iene2018.info/news/posts/2018/january/the-dutch-multi-annual-defragmentation-program/ and https://www.mjpo.nl/

Table I. *IENE Principles for Environmentally Friendly Transportation Infrastructure*

No	*Principles' description*
I	**"Strong legal framework":** Establishment and strengthening of a legal framework for sustainable linear infrastructure development.
II	**"Sustainable strategic planning"**: Sustainable strategic planning for development of any major transportation infrastructure project.
III	**"Ecosystem approach":** Adoption of ecosystem approach on crossing points of Grey and Green Infrastructure evaluate the values of Natural Capital and ecosystem services.
IV	**"Any case, a unique case":** Establishment of the "any case, a unique case" estimating any problem as unique problem and evaluating the use of existed solution without the absolute and blind "copy paste" implementation.
V	**"Multi-disciplinary cooperation"**: Establishment of multi-disciplinary cooperation among different professionals such as engineers and environmentalists.
VI	**"Civil society Involvement":** Involvement of civil society in the planning phase of linear infrastructure projects.
VII	**"Polluter pays principle":** Implementation of the "Polluter pays" principle, after clarifying the ethical and transparency concerns, by including concrete mitigation measures right from the beginning of the planning phase until the tendering and contracting of the building and operating phases.
VIII	**"Long life effective maintenance"**: Inclusion of maintenance of mitigation measures in the budget of the ordinary program for maintenance of the infrastructures under operation.
IX	**"Environmental supervision"**: Inclusion of environmental supervision of technical features of the infrastructure and monitoring of the habitat and wildlife populations' status in all phases of the projects from design to full operation.
X	**"Culture of learning":** Establishment of a culture of learning to build up and support continuous evaluation and exchange of knowledge and experience between the interested, relevant and authorized organizations and state services.

2. The aim and the project objectives

2.1 *The aim*

Towards evaluating the need for sustainable transportation infrastructure globally some basic questions are raised connecting the loss of biodiversity with the development of LTI:

1. Can we support species to survive without helping them to communicate?
2. Can we support species to communicate without securing the cohesion of the ecosystems and the landscape of where they live?
3. What do we mean by "sustainable" development concerning construction and operation of LTI?
4. What are the special needs in developing countries with large areas of high level importance for biodiversity?

Estimating the loss of natural ecological connectivity as a major negative environmental problem globally and fragmentation of natural ecosystems and landscapes due to LTI as the main cause of this problem, the aim of our project was double:

a) To evaluate the recognition of fragmentation of natural ecosystems as a cause of biodiversity loss through an evaluation of the reference and inclusion of ecological connectivity and fragmentation in international environmental policy texts in the framework of five International Conventions related with the biodiversity, nature conservation climate change and economic development.

b) To develop an international discussion with transport ecology experts recording their feedback on the requirements for designing and constructing environmentally sustainable transportation through special workshops organized in international conferences on ecology and transportation as IENE, ICOET and IUCN conferences.

2.2 *Evaluation of the international policy on ecological connectivity*

Shaping a framework of international policy on ecological connectivity to, (a) support the migration of the relevant species as a necessity for their survival and to improve and sustain nature conservation against biodiversity loss, (b) achieve sustainable development including transportation as a maior infrastructure demand, (c) the adoption of climate change goals, and (d) to act locally while thinking globally, the five (5) International Conventions that were evaluated are the following:

I. The Bonn Convention for Migratory Species (1979)
II. The Convention on Biological Diversity (1992) and the 2011-2020 Aichi targets (2010)
III. The UN Sustainable Development Goals (2015)
IV. The UN Paris Climate Change Agreement (2015)
V. The Convention on the Protection and Sustainable Development of the Carpathian (the Carpathian Convention).

The Carpathian Convention was included in the overall evaluation after 2017 after the completion of the evaluation of the first four conventions and the involvement of IENE in the TransGreen[3] project (Interreg, Danube Transnational Programme) and the creation of the "GreenWeb"[4] a platform of experts and organizations working on coexistence as an IENE working group in South Eastern Europe.

The evaluation on the ecological connectivity aspects of these Conventions was implemented taking into account three basic questions:

1. Is there recognition of "Fragmentation" as "Serious Threat" for biodiversity on a global level?
2. Is there any connection between the development of LTI and the loss of biodiversity?
3. Are there any references to LTI in those international conventions?

Additionally, except of the use of the terminology of ecological connectivity and fragmentation we evaluated:

- ✓ The reference and the use of Transport as a crucial human activity and especially the development of LTI influencing directly the fragmentation and ecological connectivity,
- ✓ The connection with the need of LTI in the framework of sustainable development especially in developing countries which host high value biodiversity areas with global interest,
- ✓ The connection with climate change as a great parallel global problem with the loss of biodiversity under a general framework of environmental sustainability.

Also the evaluation includes the terms of "Fragmentation" and "Linear Transportation Infrastructure" as key words at three levels: direct reference, indirect reference (in connections with biodiversity, ecosystems, natural habitats, alien species and sustainable development) and possible correlation with climate change and sustainable development in developing countries evaluated them as "emerging countries".

2.3 *Developing an international debate on ecological connectivity*

The implementation of the international discussion with transport ecology experts on the needs and guidance on environmentally sustainable transportation took place through organizing special workshops and events in the following international conferences on ecology and transportation:

- ✓ The IENE 2016 International Conference, Lyon, France, September 2016 (*Van der Ree et al*, *2016*),
- ✓ The IUCN 2016 World Conservation Congress, Hawaii, USA, September 2016 (*Hahn et al, 2016)*.
- ✓ The ICOET 2017 International Conference, Salt Lake City, USA, May 2017 (*Georgiadis et al, 2017a*),
- ✓ The International Forum on Sustainable Infrastructure, Hanoi, Vietnam, May 2017[5],
- ✓ The International Workshop on Sustainable Harmonization of Green with Grey Infrastructure in South Eastern Europe, Faget, Romania, October 2017 (*Georgiadis et al, 2017b*),

3 http://www.interreg-danube.eu/approved-projects/transgreen
4 http://green-web.eu/
5 Ha Noi Principles of International Forum on Sustainable Infrastructure: Integrating Climate Resilience and Natural Capital into Transport Infrastructure Planning and Design. Ha Noi, Viet Nam 17-18 May 2017, http://www.gms-eoc.org/uploads/resources/1192/attachment/27.Next-Steps.pdf

- ✓ The TransGreen Interreg Danube-Carpathian Project Conference, Bratislava, Slovakia, September 2018 *(Georgiadis et al, 2018b*) and
- ✓ The IENE 2018 International Conference, Eindhoven, the Netherlands, September 2018 *(Georgiadis et al, 2018c*).

Participants at these events covered a wide range of topics based on their professional experience and technical and scientific background, including specialists in ecology, engineering, policy making, international finance and economics and representing environment and transport sectors, government ministries, banks, universities, international institutions, and NGOs from all over the world. During these events, special presentations and discussions took place, defining the needs, concepts, tools and strategies for an international policy that could be included in guiding the development of environmentally sustainable LTI projects globally. The agenda of the discussions included 3 directions:

1. The need to define the basic concepts as:
   - ✓ the main problem,
   - ✓ the cause of the problem,
   - ✓ our aim,
   - ✓ the main objectives,
   - ✓ the main solutions.
2. The direction of the next Strategic Steps as:
   - ✓ on policy making level,
   - ✓ on technical level (just Guidelines development?), or
   - ✓ both of them policy making and technical level.
3. The stakeholders that need to be involved.

At the IGELI workshop of IENE 2018 International Conference in cooperation with other international organisations, such as IUCN/Connectivity Conservation Specialist Group/Transport Working Group, the final project recommendations discussed were focused on informing the parties to the Convention on Biological Diversity this year as they consider the priority theme of mainstreaming biodiversity in the infrastructure sector at the CBD Conference of the Parties in November of 2018 (*Georgiadis et al 2018c*).

2.4 *Parallel actions: Web-forming of the COST 341 Wildlife and Traffic Handbook and creation of the Defragmentation map of Europe*

In a parallel way IENE completed two special projects:

- ✓ Transforming in a web form the European Handbook on how to avoid Habitat Fragmentation due to Linear Transportation Infrastructure (WILDLIFE AND TRAFFIC. A European Handbook for Identifying Conflicts and Designing Solutions. COST 341 Habitat Fragmentation due to Transportation Infrastructure, *Iuell et al 2003*). During this project a survey of existing Handbooks and Guidelines on environmentally sustainable transportation took place with a priority on European level documents and the results were included in the overall framework of the project recommendations.
- ✓ Creating a European defragmentation map showing all defragmentation projects implemented in Europe.

Photo 7: *Ecoduct constructed in the framework of 15 years Dutch Defragmentation programme, The Netherlands, IENE 2018 international conference on ecology and transportation (©L. Georgiadis)*

Photo 8: *Badger underpass constructed in the framework of 15 years Dutch Defragmentation programme, The Netherlands, IENE 2018 international conference on ecology and transportation (©L. Georgiadis)*

3. Results from the evaluation of the five conventions

3.1 *Bonn Convention for Migratory Species, 1979*

Bonn Convention is specialized on free movement of species and animals, is a "Species" oriented convention based on the "Conservation Status of a migratory species" with three categories of Conservation Status: "Favourable", "Unfavourable" and "Endangered" (article I) and focus on Range States of the target species (article IV).

Bonn Convention is the first international convention referring in an indirect way to the problem of "fragmentation" in Article III (Endangered Migratory Species: Appendix I). In this article, in paragraph (§) 4.b, parties that are Range States of a migratory species listed in Appendix I, shall endeavour to 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.

Referring to taking special measures, one of the guidelines on proposed Agreements for protection of the migrations foreseen is related with (article V, §h): Elimination of, to the maximum extent possible, or compensation for activities and obstacles which hinder or impede migration. Also, a general comment is that there is need of international or trans-boundary cooperation referring actions "outside of national jurisdictional limits".

3.2 *Convention on Biological Diversity, 1992 and 2011-2020 Aichi targets, 2010*

3.2.1 Convention on Biological Diversity (CBD)

In the Biological Diversity Convention there is no recognition of any special kind of threat or problem for biodiversity like or similar to "fragmentation" but in a preamble are referring the following that can be connected with ecological connectivity, habitat fragmentation and LTI:

- ✓ "*Concerned that biological diversity is being significantly reduced by certain human activities*".
- ✓ "*Noting further that the fundamental requirement for the conservation of biological diversity is the in-situ conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings*".
- ✓ "*Stressing the importance of, and the need to promote, international, regional and global cooperation among States and intergovernmental organizations and the non-governmental sector for the conservation of biological diversity and the sustainable use of its components*".
- ✓ "*Recognizing that economic and social development and poverty eradication are the first and overriding priorities of developing countries*".

Also, there is a basic use of the terms "Developing", "Developed" and "Least Developed" countries, the "environmentally vulnerable" countries, the "sustainable use" of biological diversity. According to the Convention international cooperation has to be developed with the main duty to transfer financial advice, knowledge, and technological support from Developed to Developing and Least Developed Countries on planning, decision making, strategies and implementation processes in special sectors or at cross-sectoral level.

Taking into account the above we can adopt the commitment that "*fragmentation*" is a threat or a negative environmental impact for biodiversity by the LTI as a "*certain*" human activity, while any action such as the rovision of mitigation measures where needed, must be applied to transportation infrastructure and their zones of influence as "*in-situ conservation and species protection in their natural surroundings*". Also considering "Developing" or "Emerging" countries such "*in-situ influence zones*" is essential to recognize the demand for more infrastructure globally and especially for TLI as basic tool for economic and social development in developing countries.

3.2.2 CBD 2011-2020 Aichi targets, 2010

In CBD 2011-2020 Aichi targets there is a first reference in an International convention about fragmentation of nature, while at the Strategic Goals text there are three targets in two Strategic Goals immediately connected with LTI and fragmentation, as well as other ecological effects such as alien species invasion outside of their native territories range:

Strategic goal B: *Reduce the direct pressures on biodiversity and promote sustainable use:*

- ✓ ***Target 5****: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero,* ***and degradation and fragmentation is significantly reduced.***

- ✓ ***Target 9****: By 2020,* ***invasive alien species and pathways*** *are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.*

Strategic goal C: *Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity:*

- ✓ ***Target 11:*** *By 2020, at least 17 per cent of terrestrial and inland water areas, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative* ***and well-connected systems of protected areas and other effective area-based conservation measures****, and integrated into the wider landscapes and seascapes.*

An important reference which emerges is the value of LTI related with their environmental impact in developing countries described as "*the most environmentally vulnerable countries*" and among "*developing*" and "*least developing countries*". This reference gives a basic factor for special environmental needs that have to be considered in the parallel way of satisfying economic and development demands in these countries.

3.2.3 International "Fragmentation" status in Global Biodiversity Outlook 4

According to the evaluation of Target 5 on Habitat loss, in the Global Biodiversity Outlook 4[6] and the summary of the progress towards achieving the target, the habitats' degradation and fragmentation reduction is still in negative trends (3rd diagram in *Picture. 1*) which is the most important message which has to be spread.

According the Global Biodiversity Outlook 4 the actions to enhance progress towards Target 5 (+ other targets), if more widely applied are connected with:

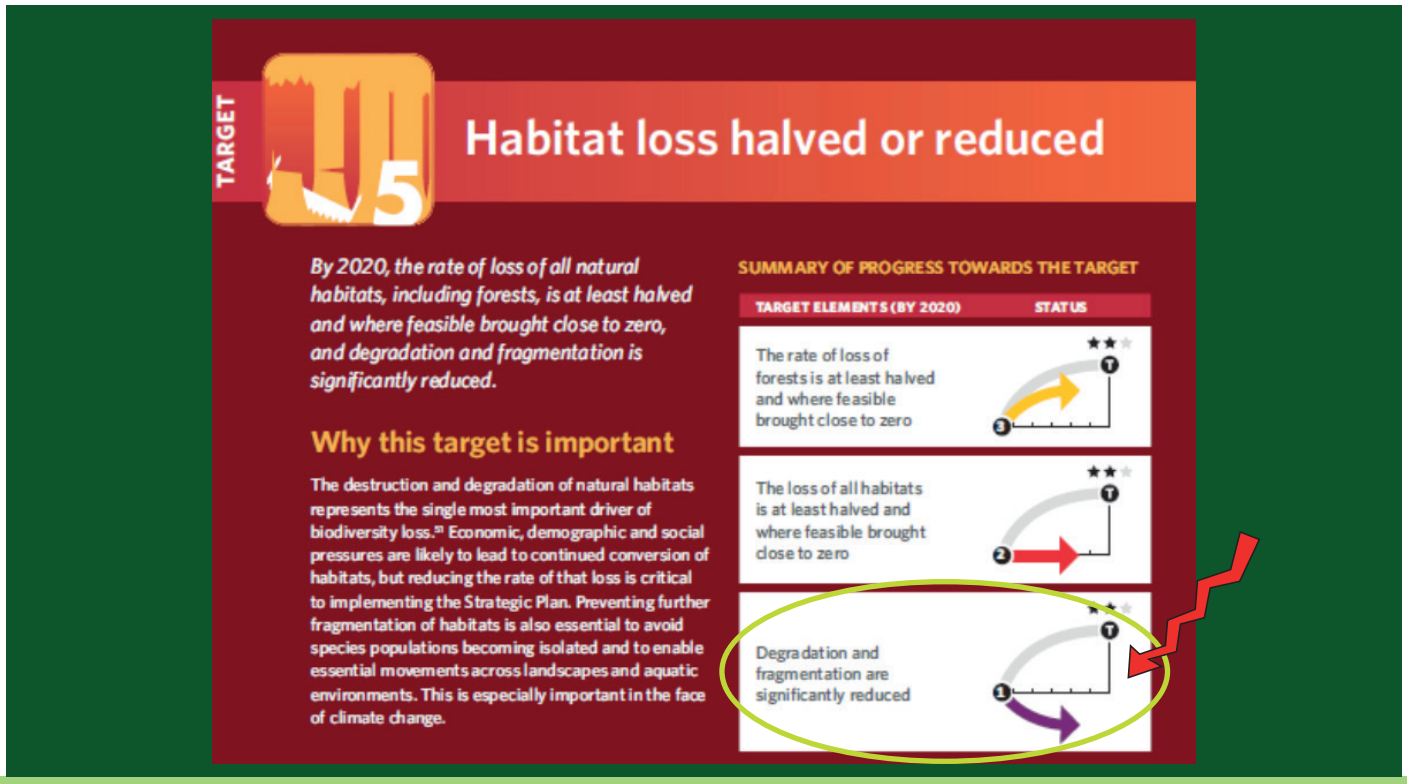
1. Identifying at the national level the direct and indirect causes of habitat loss with the greatest impact on biodiversity, to inform policies and measures to reduce loss.

2. Developing a clear legal or policy framework for land use or spatial planning that reflects national biodiversity objectives (Target 2).

3. Aligning existing incentives to national objectives for land use and spatial planning, and, the use of further incentives to reduce habitat loss, degradation and fragmentation, including as appropriate, payments for ecosystem services and REDD[7] mechanisms (Target 3).

Despite the clear reference to "Fragmentation" as a problem with a negative trend towards finding effective solutions, there is still no connection with concrete development activity as LTI with a general reference on infrastructure.

6 https://www.cbd.int/gbo4/
7 *Reducing emissions from deforestation and forest degradation



***Picture 1**. Summary of the progress towards achieving the target 5 of CBD Aichi Targets (source: Global Biodiversity Outlook 4, 2014).*

3.2.4 Towards develop recommendations for the parties to the Convention on Biological Diversity, Egypt, Nov. 2018

In the 21st meeting of Subsidiary Body on Scientific Technical and Technology Advice of CBD, Montreal, Canada, 11-14 Dec 2017, in the Recommendation XXI/4: **Mainstreaming of biodiversity in the sectors of energy and mining, infrastructure, manufacturing and processing, and health"** is proposed**:**

- ✓ *"To prepare, a proposal for a long-term strategic approach to mainstreaming with identification of key tasks and priorities, that includes best practices, guidelines, methodologies, experiences and tools, as well as challenges and gaps, avoiding duplication with other initiatives, based on the information contained in the additional note to be prepared by the Executive Secretary, and other relevant information sources, to ensure implementation of the Convention in a manner coherent with the 2030 Agenda for Sustainable Development as well as the 2050 Vision for Biodiversity".*

Additionally in the Information Document INF/11[8] while fragmentation is included in the negative environmental impacts, in the catalytic points on Mainstreaming biodiversity into infrastructure planning it is referred to in general: "If infrastructure development is to make a real contribution to conserving biodiversity, conservation and infrastructure development plans have to intertwine throughout the infrastructure development cycle through:

- ✓ Assessment of infrastructure needs
- ✓ Integrated master planning at the appropriate scale
- ✓ Environmental and social safeguards
- ✓ Procuring and contracting
- ✓ Financing
- ✓ Construction
- ✓ Operation
- ✓ Decommissioning

3.3 *UN Sustainable Development Goals, 2015*

In the framework of UN Sustainable Development Goals there is a common agreement, as a reference for international cooperation, with the phrase "*we the peoples…we seek to build…* (between others) …*sustainable transport systems; and quality and resilient infrastructure*".

From the overall framework of Sustainable Development Goals there are three Goals connected directly with infrastructure, transportation and habitat degradation and biodiversity loss:

Goal 9: *Build **resilient infrastructure,** promote inclusive and sustainable industrialization and foster innovation**.***

- ✓ ***Target 9.a**: Facilitate **sustainable and resilient infrastructure development in developing countries** through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States.*

Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable.

- ✓ ***Target11.2:** By 2030 provide access to safe, affordable, accessible and **sustainable transport systems for all**, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situation, women, children, persons with disabilities and older persons.*

Goal 15: *Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and **halt and reverse land degradation and halt biodiversity loss**.*

8 Biodiversity and infrastructure: a better nexus? Policy paper on mainstreaming biodiversity conservation into the infrastructure sector – CBD 21st meeting of SBSTTA (Subsidiary Body on Scientific, Technical and Technological Advice. WWF, IISD-International Institute for Sustainable Development, 2017)

In §60 which is related with the implementation and Global Partnership, it is mentioned that: *The revitalized Global Partnership will facilitate an intensive global engagement in support of implementation of all the Goals and targets, bringing together Governments, civil society, the private sector, the United Nations system and* ***other actors*** *and mobilizing all available resources.* LTI is an actor that has to be sustainable because it is evaluated as a strong demand for supporting developing economies. An additional factor that can be connected with Sustainable LTI is specialized technology and this can be a special section of development of technology on mitigation measures (animal detection and monitoring systems, bat bridges, wildlife crossings' monitoring systems, reflectors, etc.) implemented in linear transportation.

Also, in the Sustainable Development Goals there is a reference in two conventions that can be connected with the transportation infrastructure and its sustainable development:

a) The Convention on Landlocked Developing Countries in which it is referred on *"developing transportation infrastructure in trans-national level and this gives a special interest",* and

b) The Disaster Risk Reduction which is connected with the climate change global status.

3.4 *UN Paris Climate Change Agreement, 2015*

In UN Paris Climate Change Agreement there is not any reference to "fragmentation" or "Linear Transportation Infrastructure" specifically, but there is a basic and common use of the terms of "Sustainability", "Developing" and "Developed" countries in two directions:

a) Developing countries have to be adapted to climate change and their needs have to be taken into account, and

b) Developed countries should continue to take the lead for international action.

There is a framework of "Emphasizing the intrinsic relationship that climate change actions, responses and impacts have with equitable access to sustainable development and eradication of poverty".

LTI can be suggested as a "target" of "human activities" or a "Specific Sector for Development" that can be connected with Climate Change Policy with two ways:

1. Direct connection on CO_2 emission:
   - ✓ Railways preferable than roads on CO_2 emission,
   - ✓ Shorten roads/railways less emission of $CO_{2,}$
   - ✓ Shorten roads/railways have to secure ecological connectivity and minimum/zero fragmentation of ecosystems.
2. Evaluate transportation infrastructure as most vulnerable infrastructure to climate changes especially in:
   - ✓ Cases of infrastructure close to Natural Water Systems such as rivers, lakes and shores and being usually vulnerable to floods.
   - ✓ In case of crossing mountain habitats and increasing problems of erosion.
   - ✓ Relation with the natural capital and the ecosystem services in the approach of integration with Green Infrastructure.

The LTI – Climate Change framework can be connected also with the "Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts" (http://unfccc.int/adaptation/workstreams/loss_and_damage/items/8134.php).

3.5 *The Carpathian Convention, 2003*

The Carpathian Convention included in the overall evaluation of the international conventions in the framework of IENE participation in Faget Workshop (Romania, October 2017) is used as an example of "think globally, act locally". Therefore, as a local bio-region convention it is a useful case study for comparison with both the other conventions, but also with the results of the international discussion of the project on development of ecologically friendly LTI.

In the Carpathian Convention there are several clear references to "fragmentation", "connectivity" and "sustainable transport and infrastructure":

1. In the article 4 there is clear reference that "*the Parties shall take appropriate measures to ensure a high level of protection and sustainable use of natural and semi-natural habitats, their continuity and connectivity*… (§ 1).

2. The article 8 is fully dedicated to the "Sustainable transport and infrastructure" including three paragraphs:

   - ✓ The Parties shall pursue policies of sustainable transport and infrastructure planning and development, which take into account the specificities of the mountain environment, by taking into consideration the protection of sensitive areas, in particular biodiversity-rich areas, migration routes or areas of international importance, the protection of biodiversity and landscapes, and areas of particular importance for tourism.

   - ✓ The Parties shall cooperate towards developing sustainable transport policies which provide the benefits of mobility and access in the Carpathians, while minimizing harmful effects on human health, landscapes, plants, animals and their habitats, and incorporating sustainable transport demand management in all stages of transport planning in the Carpathians.

   - ✓ In environmentally sensitive areas the Parties shall co-operate towards developing models of environmentally friendly transportation.

3. The article 18 foreseen the development of Protocols on specific issues, a Special Protocol on "Sustainable Transport Development in Carpathians" has been set up. For the implementation of the Protocol in practice a Strategic Action Plan is on developing process under the coordination of the UN-Environmental office in Vienna as the secretariat host organization of the Carpathian Convention.

Also, the Carpathian Convention in Article 2 a frame of Principles is shaped including:

a) The precaution and prevention principles,

b) The "polluter pays" principle,

c) The public participation and stakeholder involvement,

d) The transboundary cooperation,

e) The integrated planning and management of land and water resources,

f) The programmatic approach, and

g) The ecosystem approach.

4. Results from the development of the international debate on sustainable LTI needs

4.1 Defining the basic framework of Concept Tools.

Developing the international discussion with transport ecology experts on the global needs of environmentally sustainable transportation, two groups of concept tools defined towards shaping a basic frame of suggestions:

A. The group of ecological connectivity's concept tools (described in ***Table 2***) towards supporting the "recognition of the problem" including:

1. **Genetic isolation** as the **main problem.**
2. **Habitat fragmentation** as the **main cause.**
3. **Ecological and Landscape connectivity** as the **main aim.**
4. **Green and Grey Infrastructure** as the **main crossing point and conflict areas.**
5. **Sustainability** as the main **objective.**
6. **Mitigation** as the **main solution.**

B. The second include concepts of strategic logical framework suggesting the determining:

1. The **general aim/goa**l
2. **The concrete targets**
3. The **objectives**
   - Concept Tools on sustainable LTI
   - The Audients -Stakeholders
   - Principles to be followed
   - Technical tools (Handbooks, Guidelines, standards etc.)
4. An **Action Plan** with: **Activities - Deliverables - Time table**
5. The **following up process**

Table 2. *Basic ecological connectivity's concepts*

	Logical framework concepts	Ecological connectivity concepts	Descriptions
1	The main problem	***Genetic Isolation***	Under the framework of the Biodiversity loss and species extinction and taking into account that genetic communication is essential for the species survival and their evolution, the main environmental problem related with the development of LTI, is the genetic isolation and the lack of the ecological connectivity.
2	The main cause of the problem	***Habitat Fragmentation***	The lack of genetic communication is caused by the habitat fragmentation (terrestrial or aquatic) while additional and crucial problem is the direct animals' mortality on LTI.
3	The main aim	***Securing the Ecological Connectivity***	The main aim is to secure the ecological connectivity in important natural areas, as species' basic habitats or ecological corridors when they are intersected by LTI.
4	The main objective	***Sustainability***	Sustainability has to be achieved in three different perspectives: Social, Environmental and Economic.
5	The main crossing point and conflict areas	***Green and Grey Infrastructure***	Adopting the concepts of Green Infrastructures, the Natural Capital and the Ecosystem Services the main "crossing points" are conflict points that Grey (technical/transportation) infrastructures cross through Green Infrastructures/natural areas.
6	The main solution	***The hierarchy of the priorities of Avoidance - Mitigation – Compensation***	The achievement of sustainable coexistence of Green and Grey Infrastructure needs to focus of resolving problems with specific measures following the hierarchy of priorities of Avoidance - Mitigation – Compensation.

From the above concepts more analysis is needed about the term of sustainability. Sustainability is a basic objective in several policy texts and international conventions and as it can have different meanings to people with different backgrounds it can be approached in three different perspectives: Social, Environmental and Economic. Sustainability on environmental aspects in the framework of development of transportation infrastructure needs to be focused and defined on achieving the aim of Ecological Connectivity included in the overall environmental impact (CO2 emission and climate change factors, soil erosion, etc.) in balance with economic growth and the social perspectives including population growth and viability as well as the culture and way of life of indigenous local people.

Especially in developing countries, keeping this balance is essential because they characterized both as:

- ✓ "Emerging countries" for economic and social development as they have special social value as they host significantly unique local indigenous human societies and
- ✓ "Environmentally vulnerable countries" as they have increased and high level of environmental and biodiversity values.

4.2 Defining the strategic steps' priorities

The discussion about priorities on the next strategic steps between the policy making level and the technical level (normally just Guidelines development), the priorities are set out in***Table 3*** which adopts a multiple level ranking of a range of actions and tools to use from the high policy level to the implementation of sustainable transports projects in practice.

Table 3. *Rand range of actions and tools needed for sustainable LTI from the policy to practical level*

Rank Range	Rank levels	Definition of Actions and tools needed from the policy and to practical level
↑ Policy level - ↓ Technical level	**Policy**	A statement of recognizing a problem, expressing the political will and decision to solve it and defining concrete goals to achieve.
	Strategy	A plan towards to achieve the goals, with analysis of the situation and defining the appropriate objectives to work on and the better solutions to be implement in practice.
	Principles	As a framework of general basic rules to be followed by the strategy.
	Action Plan	As a concrete framework of actions that follows the objectives towards to achieve the goals in a concrete time table.
	Handbook	As a special book or edition focusing and analysing of special topics and providing general directions for actions and possible special case studies*.
	Guidelines	As a special book or edition focusing on special topics and providing concrete directions for actions.
	Manual	As a special tool for guiding special actions, procedure or constructions.
	Standards	As a special tool providing precise details of characteristics of actions, procedures or constructions. Such a case is the establishment of Green ISO for Linear Transportation Infrastructures**.
	Protocol	As a special tool providing precise details of procedures of actions.
*	***Case studies***	*Case studies have been proposed and evaluated as very important for "lessons to be learned" to use or to avoid examples. Special editions of case studies evaluated as very important.*
**	***LTI Green ISO***	*Green ISO for Linear Transportation Infrastructures can be used as basic requirements on procurement procedures on Banks or Investor funding.*

4.3 The audients and the stakeholders that can be involved on development of the Sustainable LTI.

According the International Conferences workshops' feedback the potential audiences which will apply in practice the development of the Sustainable LTI can include the stakeholders involved in all the levels of the range of Actions in ***Table 3*** in **three** target groups:

A. A policy making stakeholders group, with two subgroups:

- ✓ *International players:* UN, EU, International Conventions (CBD, Bonn Convention etc.), World Bank, International Monitory Fund, Development Banks and other financiers, International Ecology Organizations working on sustainable transportation (IUCN, WWF, IENE, ICOET, ANET, ACLIE), International Transport

Organizations (CEDR, PIARC etc.)

- ✓ *National governmental bodies and mainly* Governments and Ministries adopting the international policies as national policies and creating strong strategies with a concrete legal framework and Action Plans.

B. An under - governmental and technical implementation level group:

- ✓ Adoption of the National Policy by the local regional services of the Ministries until the adoption of strong legal framework with special regulations and guidelines.
- ✓ Local Governments, Regions, Provinces and Municipalities with their transportation services according the national administrative structure and in cooperation with the environmental and the other involved sectors.
- ✓ The constructors and transportation operation companies and organizations.
- ✓ Local people and societies' involvement including NGOs, local cultural clubs and social organizations promoting the bottom up approach and the civil society involvement.

C. The education and the support of the "culture of learning" group:

- ✓ Universities and research centres providing scientific and educational support and promoting the production and exchange of knowledge.
- ✓ The above group B as producers of practical experience which has to be supported by universities and research centres towards producing scientific based effective and applied solutions.

4.4 Comparison of the results of the international debate with the Carpathian Convention framework

Towards concluding on "what we have to do" a special comparison of what the transport ecology experts suggest and what Carpathian Convention is doing in practice at local transnational and trans-border level. Inevitably the comparison is focusing on two concrete "deliverables" of the current report, the Principles of sustainable LTI and the Rank of actions and tools needed.

The Principles

The first comparison includes the three frames of Principles of Carpathian Convention, IENE principles including also Ha Noi Principles and is presented in ***Table 4***. The result of this comparison shows:

1. The most of the principles are the same or very similar and differences are on the details referring directions for actions and the mainly the involvement of climate change as factor included in the case of Ha Noi Principle which is absolutely necessary. Therefore a next step to make a uniform frame of principles can be easily achieved.

2. The principles of Carpathian Convention are included in a high level political text and therefore they are recognized officially by the signed countries. Adopting such a framework of the International Principles for Sustainable LTI in an officially recognized document can be a next step.

The rank of actions and tools

The second comparison gives ***Table 5*** including the needs for actions and tools in the spectrum from the policy making level to practical implementation of sustainable LTI at local and regional level. It's obvious in the table that:

1. The problem of habitat fragmentation is recognized and targeted to be solved at a high international level mainly in the framework of target 5 of CDB Aichi Targets.

2. The Carpathian Convention is a very good case study of making steps forward after the official recognition of the problem.

3. Towards the process of mainstreaming biodiversity in sustainable LTI globally in the last column there is a gap in the level of Strategy and its translation to a concrete Action Plan.

4. There are guidelines covering the technical support and actual experience of how to build sustainable LTI, mainly in Europe and USA/Canada, but transferring this experience to developing countries is a global necessity.

4.5 Towards building Guidelines

Building Guidelines was the first issue of development of IGELI and having already produced the COST 314 European Handbook on Wildlife and Traffic, translated in more than 30 countries and as an international demand to increase its availability, IENE decided to build it in a web form and make it widely available and more easy to be updated and interactive. In this process the IENE survey, that took place with priority at European level, identified about 90 existing Handbooks, Guidelines and Manuals on environmentally sustainable transportation which are presented in the web handbook in the special portal on Transport Ecology Guidelines[9]. This means that a lot of people working in ecology and transportation have ensured that their knowledge is available in documents on "transportation ecology" but with the emphasis on European ecosystems, landscapes and wildlife. Bringing this issue into the international debate, during discussions the main concern was that there is need to create "transportation ecology" quidance in developing countries based on their local ecology and the local sustainable green-grey infrastructure coexistence. The question of "what do you do for bears in Europe" asked during IENE-WWF Dawei project will not give an absolute answer on "what we have to do with elephants, tigers, and primates". This means that the experience of developing countries can be used as a baseline, but the principle of "any case, other case" avoiding the "blind copy paste" has to be applied to meet the demands of their local ecology and biodiversity.

Photo 9: *Ecoduct Groene Woud, the Netherlands (© https://beeldbank.rws.nl, Rijkswaterstaat/Joop van Houdt)*

9 https://handbookwildlifetraffic.info/transport-ecology-guidelines-portal/

Table 4. *Comparison between Carpathian Convention, IENE and Hanoi Principles*

	Carpathian Convention	IENE	Ha Noi
1	The precaution and prevention principle	Strong legal framework	**Theme 1: Designing Ecologically Sensitive Transport Infrastructure** 1. National policies must be in place for impact assessments, SEA, and strict safe guards, incentives, for all stages of the project cycle. Transparency must be part of this policy process. 2. Mitigating measures should be species and site specific and draw on regional/global expertise and lessons learned. 3. Mechanisms for cross--ministerial integration is key throughout and particularly during design / planning stages. Emphasis on bringing non--traditional partners together – wildlife and transport/construction departments together.
2	The "polluter pays" principle	Sustainable strategic planning	
3	Public participation and stakeholders' involvement	Ecosystem approach with the "Precautionary" principle	
4	Transboundary cooperation	Any case, a unique case (no blind copy paste)	**Theme 2: Building Resilient Infrastructure Working with Nature and Bioengineering** 1. Involve local communities throughout: ensure benefits to them, involve them in planning, implementation and monitoring, and use local technologies, materials and knowledge. 2. Integrated policy--setting and up--front planning that includes bioengineering design standards, natural capital assessments, risk assessment (including disaster risk), economic analysis, etc, going beyond typical EIA process. 3. Use a combination of bio--engineering and conventional engineering approaches based on a consideration of relative costs and benefits of these approaches.
5	Integrated planning and management of land and water resources	Multi-disciplinary cooperation	
6	A programmatic approach	Involvement of civil society	
7	Ecosystem approach	Polluter pays principle	**Theme 3: Facilitating Finance for Sustainable Infrastructure** 1. Develop financing systems and national policy to channel government funding and also attract international and private funding to ensure sustainability and resilience aspects of infrastructure projects. 2. Consider the full scope of impacts of infrastructure projects including comprehensive risk analysis (climate, disaster, and other finance related risks) using the widest range of tools and method (EIA, SEA etc.) 3. Mechanism to monetize environmental risks and bring out the full environmental cost of new infrastructure projects and «build metal bridges» between green and finance worlds.
8		Long life effective maintenance	
9		Environmental supervision and monitoring in all phases	

10		Culture of learning	**Theme 4: Improving Options with Better Planning** 1. Link SDGs to government infrastructure commitments and highlight outcomes, and integrate sustainability principles into all levels of education. 2. Map planning structures against issues relevant to natural capital and include prioritization criteria 3. Develop common and simple terminology for technically sound communication related to planning that assesses natural capital returns and is customized to a local context
11			
12			
13			**Theme 5: Strengthening the Enabling Environment** 1. Empower coordination across sectors and political parties in planning, policy and decision making. Processes can be strengthened through evidence--based decisions and scientific bodies. 2. Require transparency and accountability in project development and approval and project cycle, include multiple stakeholder consultation processes throughout. Must include financing sectors 3. Have clear local (existing and new) standards for sustainable infrastructure to fit each stage of development and conditions applicable for each country to gain acceptance.
14			
15			

Table 5. *Comparison on the needs for actions and tools defined by the international discussion of IGELI, Carpathian Convention as Case Studay and mainstreaming biodiversity in sustainable LTI globally.*

Rank Range	Rank levels	Definition of Actions and tools needed from the policy and to practical level	Carpathian Convention	Mainstreaming biodiversity in sustainable LTI globally.
↑ Policy level - Technical level ↓	**Policy**	A statement of recognizing a problem, expressing the political will and decision to solve it and defining concrete goals to achieve.	The Carpathian Convention it self	The target 5 of Aichi Target on reducing fragmentation significantly
	Strategy	A plan towards to achieve the goals, with analysis of the situation and defining the appropriate objectives to work on and the better solutions to be implement in practice.	The protocol of Sustainable Transport of Carpathians	**?**
	Principles	As a framework of general basic rules to be followed by the strategy. IENE has set up basic principles for development of Environmentally Friendly LTI.	Included in the Convention	There are, need to uniform them and include them in a Strategy
	Action Plan	As a concrete framework of actions that follows the objectives towards to achieve the goals in a concrete time table.	It's on development	**?**
	Handbook	As a special book or edition focusing and analyzing of special topics and providing general directions for actions and possible special case studies*.	It's on development	There are mainly in Europe, North America and Australia
	Guidelines	As a special book or edition focusing on special topics and providing concrete directions for actions.	It's on development	There are mainly in Europe, North America and Australia
	Manual	As a special tool for guiding special actions, procedure or constructions.	Manual on training of EIA is on development	There are mainly in Europe, North America and Australia
	Standards	As a special tool providing precise details of characteristics of actions, procedures or constructions. Such a case is the establishment of Green ISO for Linear Transportation Infrastructures**.		There are mainly in Europe, North America and Australia
	Protocol	As a special tool providing precise details of procedures of actions.	The protocol of Sustainable Transport of Carpathians	An international protocol of Sustainable LTI in connection with a Strategy**?**
*	***Case studies***	*Case studies have been proposed and evaluated as very important for "lessons to be learned" to use or to avoid examples. Special editions of case studies evaluated as very important.*	It's on development	There are globally
**	***LTI Green ISO***	*Green ISO for Linear Transportation Infrastructures can be used as basic requirements on procurement procedures on Banks or Investor funding.*		

5. Conclusions and recommendations

5.1 *Conclusions*

Taking in to account all the above results, the general conclusions on "recognition" of fragmentation of natural environment globally and promoting the development of sustainable LTI securing ecological connectivity are the following:

1) The evaluation of the five conventions about direct or indirect use of the terms of "fragmentation" and "Linear Transportation Infrastructure" shows that:

a) *There is a reference of "fragmentation" only in one text of Aichi Targets in Target 5/ Strategic goal B.*

b) *There are several indirect references of "fragmentation" in all conventions with more close case in Bonn Convention for migratory species.*

c) *There is no reference of "Linear Transportation Infrastructure", or "Transportation Infrastructure" but there are references on "Transport Systems" and "Infrastructure" which are the most common as more wide scale terms.*

d) *Possible correlation of "fragmentation" and LTI can be done in an indirect way in the most of the conventions and in several topics, themes and sectors.*

e) *There is a great global priority of actions in "Emerging Countries" with important indigenous humans' societies and high value biodiversity areas which include several kind of "Developing Countries" as "Least Developed Countries", and "Environmentally Vulnerable", while "Developed" countries have to give support on knowledge,* practice and funding.

It is important to mention that there are several other international policy texts as conventions or agreements that can be connected with the fragmentation of natural environment due to TLI as: a) The Vienna Landlocked Countries Programme 2014-24, b) The UN Sendai Disaster Risk Reduction Framework 2015-2030, c) The European Landscape Convention, d) The EU policy announcement on Green Infrastructure - Natural Capital, e) The Legal Aspects of Connectivity Conservation of IUCN.

2) Towards extracting a concrete framework of targets per Convention through the angle of fragmentation of the natural environment, according to the evaluated Conventions we have the following framework of targets to achieve through the perspective of sustainable LTI supporting ecological connectivity globally:

a) **To secure the free migration** of migratory species (*Bonn Convention*).

b) **To halt the loss of biodiversity** (*CBD*).

c) **To reduce significantly the degradation and fragmentation** of the natural habitats (*Aichi targets*).

d) To create the "framework" for **building "sustainable" LTI** which need to secure a combination and the **balance of the support of developing and environmental vulnerable countries** (*UN Sustainable Development Goals*).

e) To find the best way **to build sustainable and resilient infrastructure** in a **constantly changing climate** and world (*Climate Change Agreement*).

All the above targets are included in Carpathian Convention in the framework of implementation of the Protocol of Sustainable Transport in the local bio-region Carpathian level and therefore is a good case to be studied for

lessons' learnt and adapted to other bio-regions internationally.

3) From the development of the international debate on sustainable LTI, there is a need of the development of a common international language in policy, ecology and transport engineering.

4) **The global problem is recognized** actually in the framework of CDB Aichi Target 5, **but the negative trends of the fragmentation status** in Global Biodiversity Outlook 4 is emerging the **need for urgent action**.

5) **Following this urgent need, on defining** a strategic logical framework both from the international discussion of the project but also from the 2017: Recommendation XXI/4 for CBD on Mainstreaming of biodiversity in the developing sectors including infrastructure, **it's clear that a Strategy to identify of key tasks and priorities is needed**. A much more clear demand is to translate the international concern into concrete actions at national and regional level.

6) **Supporting the production of knowledge and experience** there are a lot of best practices, guidelines, methodologies, experiences and tools especially in developed countries with a lot of gaps and lack of knowledge **in developing countries**. A great challenge is to fill these gaps through developing of multidisciplinary and trans-national and cross-boundary cooperation of all the involved stakeholders.

5.2 *Recommendations on how we are building Linear Transport Infrastructure in harmony with nature*

Adopting the title of the Strategic plan for biodiversity 2011-2020 "*Living in harmony with nature*", and towards answering the question which has emerged after our conclusion on "***How we are building Linear Transport Infrastructure in harmony with nature***?" the Recommendations below on achieving t*he Aichi Target 5 on "*significant reduction of degradation and fragmentation of natural habitats" are proposed:

1) Promotion and spread of a clear message internationally: "**Don't fragment nature"**. The message from the Netherlands and the Declaration of IENE 2018 International Conference "*CONNECTING EUROPE, CONNECTING NATURE. Building bridges and crossing borders for the defragmentation of Europe"* has to be spread internationally: "***Be proactive and build sustainable Linear Transportation Infrastructure from the beginning***".

2) Development of a common international language in policy, ecology and engineering connected with the LTI development using as basic frame of fundamental terms:

   g) **Genetic isolation** as the **main problem.**

   h) **Habitat fragmentation** as the **main cause.**

   i) **Ecological and Landscape connectivity** as the **main aim.**

   j) **Green and Grey Infrastructure** as the **main crossing point and conflict areas.**

   k) **Sustainability of L**TI as the **main objective.**

   l) **Mitigation** as the main solution (without excluding avoidance and compensation).

3) Developing and implementing an **International Strategy** against fragmentation globally as a next emerging step including:

   f) The **general aim/goa**l.

   g) The concrete targets.

   h) The **objectives.**

   - Concept Tools on sustainable LTI.
   - The Audience –Stakeholders.
   - Principles to be followed.
   - Technical tools (Handbooks, Guidelines, Protocols, standards etc.).

   i) An **International Action Plan** with: Activities - Deliverables - Time table.

   j) The following up process.

   The aim of the Strategy and the Action Plan has to be adopted and implemented in National & regional Strategies for Biodiversity with their Action Plans evaluating how fragmentation as a concrete problem is to be solved estimating LTI as "*certain human activity with concrete impacts on biodiversity loss*".

4) Defining the sustainability of LTI and based on the definition of "Environmentally friendly transport" described in the Carpathian Convention. The "Sustainable Linear Transport Infrastructure" can be defined as Linear Transportation Infrastructure which:

   g) *Limits negative impacts on land use, landscapes and ecosystems, and is constructed in such a way that ensure the ecological connectivity and minimize the fragmentation of natural environment ensuring ecological connectivity in the most practical way possible.*

   h) *Limits pollution, noise production, emissions and waste within the planet's ability to absorb them towards minimizing its impact to global climate change.*

   i) *Is safe, adaptable and resilient to the climate change's status.*

   j) *Uses renewable resources at or below their rates of generation.*

   k) *Uses non-renewable resources at, or below the rates of development of renewable substitutes.*

   l) *Respects the local societies and their cultures in the areas intersected by its alignment*.

5) Join common actions and supporting multidisciplinary, cross-sector and cross-boundary/international cooperation.

6) Increase and promote the Transport Ecology Knowledge and the development of research and technology on mitigation measures connected with Sustainable LTI (animal detection and monitoring systems, bat bridges, wildlife crossings' monitoring systems, reflectors, etc.) implemented in linear transportation toward producing effective applied solutions in practice. Filling this gap in developing countries is a priority.

7) Creating Guidelines for sustainable LTI in Developing Countries as a great challenge taking in to account the special particularities, social, environmental and economic status of each of the country or their geographical area adopting the principle of "any case, a unique case".

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[TITLE]
CONNECTING EUROPE, CONNECTING NATURE

[SUBTITLE]
Building bridges and crossing borders for the defragmentation of Europe

IENE 2018
Crossing borders for a greener and sustainable transport infrastructure

[ACKNOWLEDGEMENT]
We, the participants of the IENE 2018 International Conference, acknowledge that:

- As of January 2014, the European Union adopted a new transport infrastructure policy that connects the continent: the **Trans European Transport Network** (TEN-T). The aim of the TEN-T is to strengthen the social, economic and territorial cohesion of the EU and to contribute to the establishment of a single European transport area.
  https://ec.europa.eu/transport/themes/infrastructure/about-ten-t_en
- Almost concurrently, since 2013, the European Commission adopted an EU-wide strategy - "The EU strategy on Green Infrastructure" - to promote the deployment of green infrastructure across Europe and to **develop a Trans-European Network for Green Infrastructure** (TEN-G).
  https://ec.europa.eu/environment/nature/ecosystems/strategy/index_en.htm
- The TEN-G aims to enhance nature's ability to deliver **multiple valuable ecosystem goods and services**, providing a wide range of environmental, social, climate change adaptation and mitigation, and biodiversity benefits.
  http://ec.europa.eu/environment/nature/ecosystems/index_en.htm
- Habitat fragmentation is a **top threat** to biodiversity, its impact enhanced by growing infrastructure networks (transportation, energy and ICT). Land fragmentation results in undermining ecological connectivity and making it harder or impossible for wildlife to migrate and find new and/or better suitable habitats. By preserving the intra- and inter-population connectivity and thus diversity, biodiversity loss and extinction of species can be prevented.
  https://www.eea.europa.eu/soer-2015/europe/biodiversity
- While also affected by other key threats - loss and degradation of wildlife habitats and while likely to be aggravated by increasing effects of **climate change** - the rate of biodiversity loss accelerates not only throughout Europe but equally worldwide. This is directly connected with the Aichi Biodiversity Targets (Target 5/Strategic goal B: "by 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced". (https://www.cbd.int/sp/targets/).
- As of 14 September 2012, the European Commission adopted a new strategy for **international cooperation in research and innovation**: "Enhancing and focusing EU international cooperation in research and innovation: a strategic approach."
  https://ec.europa.eu/research/iscp/index.cfm?pg=strategy

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[STATEMENT]
In this framework, we, the participants of the IENE2018 conference hereby state:

- The need to **acknowledge a sense of urgency** concerning habitat fragmentation throughout Europe. The IENE Conference 2018 is therefore dedicated in part to presenting the results of the Dutch Defragmentation Program (MJPO) as a success story in reconnecting fragmented habitats. Furthermore Austria, Germany, France Czechia or Switzerland have equally developed national defragmentation concepts for their existing linear (road) network, adding to the importance of developing a synergetic approach towards transportation and nature conservancy.
- At the same time, new **infrastructure developments**, on all levels, from local to transnational, are expected to be implemented in yet **unaffected landscapes** in other regions as Eastern and Southern Europe, whether or not in the framework of the TEN-T.
- These developments extend **beyond Europe**, as by 2050 an additional 25 million kilometres of transport infrastructure will be constructed globally.
- The integration of a solid and comprehensive **ecological connectivity strategy within transportation and infrastructural developments** would acknowledge the negative impacts on ecosystems and wildlife habitats, which result from land fragmentation, and provide the means to address thereof.
- We - the IENE community – therefore call the European Commission to support the development of a **European Defragmentation Program**, as a synergy between the TEN-T and TEN-G strategies.
- **Enhanced cooperation** is necessary for such a Program, and it cannot be limited to national governments only, but should equally **transcend sectorial collaboration**. Experts and practitioners in the transportation and nature conservancy fields should work together and conduct **joint research** to identify innovative and cost-efficient solutions for defragmentation.
- The development and implementation of the European Defragmentation Program will support the defragmentation of wildlife habitats throughout Europe and equally **use the resulting expertise** to implement similar actions **anywhere else in the world** were habitat fragmentation is emerging as a key threat to biodiversity.

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[CALL/URGE]
Therefore, we, the participants of the IENE2018 conference call for:

- The allocation of **research resources** to develop a synergetic approach between the TEN-T and TEN-G as well as **to identify and perform a detailed** analysis of the bottlenecks between the two strategies. An important first step could be an annotated analysis with one or more maps.
- **Improved impact assessment** of new or upgraded transport infrastructure (TEN-T) by integrating a budget for defragmentation measures. This would imply, for example, integrating the costs for defragmentation measures of the Green Infrastructure Network within the European transport strategy.
- The development of an **action plan** that would include financial resources for the environmental improvement of the existing European transport network.
- The creation of a comprehensive, publicly available **database** and including specific information per country on the European defragmentation program with the aim of **sharing data and knowledge** among transportation and nature conservation experts and practitioners working in the field of transport infrastructure and ecology.
- **The design and development of National and Cross-border Strategies for Defragmentation** with the support of the IENE and collegial networks in other parts of the world (ICOET, ANET, ACLIE, etc.) to exchange expert knowledge on defragmentation.
- **Strengthened interdisciplinary collaboration** and **cooperation with partner infrastructure related networks** like CEDR, TRA, ITF, and/or DACH in the transport sector but also with relevant actors in the environmental sector.

[DATE]
Declared by the participants of the IENE2018 International Conference on 14 September 2018.

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[DEFINITIONS]

1 **Trans-European Transport Network (TEN-T)**
The Trans-European Transport Network (TEN-T) is a European Commission policy directed towards the implementation and development of a Europe-wide network of roads, railway lines, inland waterways, maritime shipping routes, ports, airports and rail-road terminals. It consists of two planning layers:
•The Comprehensive Network: Covering all European regions
•The Core Network: Most important connections within the Comprehensive Network linking the most important nodes.
The ultimate objective of TEN-T is to close gaps, remove bottlenecks and eliminate technical barriers that exist between the transport networks of EU Member States, strengthening the social, economic and territorial cohesion of the Union and contributing to the creation of a single European transport area. The policy seeks to achieve this aim through the construction of new physical infrastructures; the adoption of innovative digital technologies, alternative fuels and universal standards; and the modernisation and upgrade of existing infrastructures and platforms.

2 **Green Infrastructure (GI)**: 'A strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings' (European Commission, 2003). Benedict & McMahon (2006) also defined as 'an interconnected network of protected land and water that support native species, maintains natural ecological processes, sustains air and water resources and contribute to the health and quality of life for communities and people'.

3 **Fragmentation**

The term fragmentation covers
1 the fragmentation/division/transection of
dispersal or migration corridors and habitats
by linear barriers or edge effects due to traffic infrastructure and other linear technical elements or urban corridors
and
2. the Isolation/islandization of habitats
which is a thinning out and downsizing of habitats and the loss of connectivity by distance
due to the expansion or intensification of agriculture, forestry or settlement.

References:
_ Communication from the Commission to the European parliament, the Council, the European economic and social committee and the committee of the regions. Green infrastructure (GI) — Enhancing Europe's Natural Capital (COM/2013/0249 final; http://ec.europa.eu/environment/nature/ecosystems/index_en.htm). _ Benedict, M.A. and McMahon, E.T. 2006. Green Infrastructure: Smart Conservation for the 21st Century. Sprawl Watch Clearinghouse Monographs Series. 32 pp. Washington.

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[DECLARATIONS]
What are IENE Declarations?
Since 1996, IENE operates as an international and interdisciplinary forum to encourage and enable cross-boundary cooperation in research and mitigation and planning in the field of ecology and transport infrastructures. The IENE biannual international conference provides interdisciplinary discussion panels for these activities with the aim to present cutting-edge research, identify urgent questions and problems, discus effective solutions, and outline the paths for upcoming activities in transport and infrastructure ecology.
Since 2012, a Declaration is produced during each conference and focused on a topic that requires particular attention from transportation and nature conservancy stakeholders. This message represents a common statement by the participants and addresses decision makers, planners, technicians and researchers as well as the general public, by calling for actions that contribute to finding solutions to old and emerging conflicts, filling the research gap and overall minimising the impact that transport infrastructure exerts on nature.

See also previous IENE Declarations:
· **IENE Declaration 2012: Overcome Barriers: Europe-wide and now**
http://iene2012.iene.info/?page_id=320
· **IENE Declaration 2014: Roadless Areas**
http://iene2014.iene.info/iene-2014-declaration/
IENE Declaration 2016: Habitats related to Transport Infrastructures
http://www.iene.info/iene-2016-declaration/

http://www.iene.info/

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«Harmonizing Transportation and Nature»