Priority 3: GREENING INFRASTRUCTURE
Societal needs:

- Reduction of environmental impact
- Efficient use of natural resources
- Efficient use of energy
- Adaptation to climate change
Research objectives:

- **Reducing environmental impact**
  - standardize Environmental Impact Assessment
  - decrease negative environmental impact in all stages

- **Improve resource efficiency**
  - minimize resource consumption
  - minimize waste production

- **Improve energy efficiency**
  - optimize energy consumption / production
  - integrate renewable energy sources (RES)

- **Adaptation to climate change**
  - minimize loss of network capacity
Priority 3: GREENING INFRASTRUCTURE

Research items:

• Reducing environmental impact
  • develop assessment tools (based on LCA approach)
  • industrialize processes (e.g. installing, dismantling)
  • improve performance infrastructure elements (e.g. noise, pollution)

• Improve resource efficiency
  • (re)use (local/renewable materials), recycle (secondary materials)
  • optimize occupied space (e.g. underground transport corridors)

• Improve energy efficiency
  • low rolling resistance / infrastructure as energy nodes
  • RES integrated in construction / operation / maintenance

• Adaptation to climate change
  • classification of climate change impacts on infrastructure
  • develop adaptation / mitigation measures, strategies and policies
Impact research:

- **Europe 2020** (Innovation Union, Resource efficient Europe)
  - improve resource / energy efficiency (e.g. RES)
  - adaptation to climate change

- **White Paper 2011** (Roadmap to Single EU Transport Area)
  - 60% reduction of GHG emissions (2050)
  - List of EC initiatives: near-"zero emission urban logistics" 2030

- **Energy 2020** (SET-Plan, Energy Efficiency Plan)

- **Relevant EU Directives**:
  - Energy Efficiency
  - Environmental Noise
  - Environmental Impact Assessment
  - Air Pollution (light-duty, heavy-duty vehicles)
Thank you for your attention
“Enabling sustainable life in built environment threatened by water”

Innovative technological and policy solutions for tackling major challenges in densely populated deltaic areas / coastal zones:

- available space is scarce → urban infra, tunnels
- relatively high (ground) water levels → infra security (geohazards), harbors
- soft soil conditions → durable & sustainable infra

Examples of projects:
- North-South Metro Line Amsterdam
- Flood Protection New Orleans (USA)
- Land Reclamation Singapore
SOCIETAL NEEDS

Decreasing negative environmental impact (pollution, emissions, resources) of planning, design, construction, upgrading and maintenance of new and existing infrastructure.

Research sub-themes:
1a. Realistic assessment of environmental impact through LCA
1b. Optimizing use and reliability
1c. Decreasing negative environmental impact
   • noise and air pollution
   • GHG emissions
1d. Optimizing occupied (underground) space
SOCIETAL NEED

Have a realistic assessment of the Environmental Impact of Infrastructures taking into proper consideration all factors and stages involved in the process from the raw materials, design, construction, operation, conservation, etc. until the final disposal or recycling of the components so all alternatives can be properly assessed and compared.

OBJECTIVE

Set LCA as common standard for Infrastructure analysis, combining properly and in a standardized and structured manner, all environmental factors related to the process, its components and agents.
1b. Optimizing use and reliability

SOCIETAL NEED

Optimizing the use and reliability (capacity) of new / existing infrastructure network which leads to an increase in safety (less accidents), cost-effectiveness and sustainability of maintenance / upgrading of infrastructure

OBJECTIVES

• Interaction between infrastructure and user
• New tunneling techniques, less environmental impact, n-D modeling
• Cost-effectively design, build, operate, upgrade and maintain
1c. Decrease environmental impact – Noise and air pollution

**SOCIETAL NEED**

- Transport has become cleaner, but increased volumes mean it remains a major source of noise and local air pollution.
- Directive 2002/49/EC6 assessment and management of environmental noise (END) aims to define a common approach in order to avoid, prevent or reduce the harmful effects due to exposure to environmental noise.
- 10% of the population in the EU-15 is exposed to significant noise from rail transport.
- Cities suffer most from congestion, poor air quality and noise exposure.
- The use of electric, hydrogen and hybrid technologies would not only reduce air emissions, but also noise.
1c. Decrease environmental impact - Noise and air pollution

OBJECTIVES

- Noise and air pollution:
  - Sustainable self-cleaning materials that capture pollution
  - Reduce air and noise pollution from construction equipment
  - New road and tunnel surface materials that contribute to noise reduction
  - New road design service concepts
  - Prepare implementation of electric, hydrogen and hybrid technologies
  - European rail corridors
1c. Decrease environmental impact – GHG emissions

SOCIetal NEED

- Reduction of at least 60% of GHGs by 2050 with respect to 1990 required from the transport sector
  - Use of electric, hydrogen and hybrid technologies
    - Halve the use of conventionally fuelled cars in urban transport by 2020 and phase them out in cities by 2050
    - Optimizations of modal splitting for minimizing GHG emissions

EU27 greenhouse gas emissions by sector and mode of transport, 2007
OBJECTIVES

- Reduce CO2 and NO\textsubscript{x} emissions from roads in operation
- Reduced emissions from construction equipment and activities
- Reduce congestion by avoiding frictions between passenger and freight transport: adaption of existing and new infrastructure platforms in order to integrate different traffics and minimize emissions
- Optimize logistic chains
1d. Optimizing occupied space

**SOCIETAL NEED**

Minimization of land occupation and use of natural resources for infrastructure construction

**OBJECTIVES**

- Capacity of infrastructure to adapt to users’ needs
- New tunneling techniques, less environmental impact, n-D modeling
- Cost-effectively design, build, operate, upgrade and maintain through
  - multiple functions
  - reduction of uncertainties in ageing structures
- With regard to unstable slopes:
  - Minimize landslide hazards by identification, prevention and taking corrective measures on existing and new infrastructures
  - To develop a soil monitoring system that helps to prevent slope movement disasters and to initiate response actions immediately
1. Reducing the environmental impact

IMPACTS

• **Short term:**
  - Safe transport of hazardous materials in urban areas
  - EC stakeholders cooperate with regard to noise abatement by new technologies in vehicles

• **Medium term:**
  - Sustainable multipurpose materials are commonly used
  - Development of European safety standards
  - Quality of life of communities with regard to noise and air pollution is improved
  - Integration of CO2 absorbing materials in infrastructure works
  - Reduce congestion by avoiding frictions between passenger and freight transport
  - Identification of areas at risk of erosion, organic matter decline, compaction and landslides, and establishment of EU programs for measuring. Landslide risk zoning
  - In the risk areas identified, take measures to prevent landslides
  - Use of vegetation, either alone or in conjunction with civil engineering structures, to reduce instability and erosion on slopes
1. Reducing the environmental impact

IMPACTS

• Long term
  • Building underground in more challenging ground conditions ‘without’ impact
  • Infrastructure is seen as an integrated, pre-arranged product
  • Stakeholders accustomed to a simplified, industrialized and cost-effective building / maintenance / upgrading process, enabled by ICT tools (BIM)
  • Uncertainties that influence ageing civil infrastructure are significantly reduced
  • LCA is the normalized process for analysis of alternatives in Infrastructures
  • Reduction of at least 60% of GHGs by 2050 compared to 1990 levels
  • Infrastructure adapted to the requirements of freight and passengers transport
1. Reducing the environmental impact

**RESEARCH ITEMS**

**Short term:**
- Standards for assessing levels of road safety, the design of ‘self-explaining’ and ‘forgiving’ road concepts and the road-side component of driver support systems
- Locating and monitoring applications for hazardous goods and exceptional loads
- Rail-wheel interaction
- Rationalization of transport corridors (rail-road) in urban areas
- New technologies in noise barriers and sound absorbing materials
- New technologies for noise abatement of construction equipment and activities

**Medium term (1):**
- New concepts for interactive infrastructure and components, using embedded sensors / ICT
- New concepts for underground structures offering more efficient (logistical) operation conditions
- Digital decision support system (Underground Information Model)
- Easy to use and install building materials for friendly and safe construction
- Systemic analysis of alternative materials and sources integrating life-cycle environmental costs integrating durability and energy efficiency in the process
- Develop infrastructural solutions for reducing congestion and bottlenecks
- Risk based analysis methods for slope stability taking into consideration interaction with water (rainfall, runoff, water courses, ground water, etc.)
- Provide scientific improvements for geotechnical observational methods
1. Reducing the environmental impact

**RESEARCH ITEMS**

- **Medium term (2):**
  - Develop new retaining systems that can provide steep slopes with environmental benefits
  - Develop design and construction tools for erosion prevention
  - Tele-detection of potential problems related to slope stability or landslides

- **Long term**
  - Automated / remote excavation equipment / methodologies for all types of rock / soil
  - Tools for environmental effects of infrastructures in operation at the design stage
  - Maintenance / renewal strategies minimizing traffic disruption, maximizing safety
  - Integrated asset management tools integrating relevant components of infrastructures at individual and network scale
  - Development of new concepts to minimize life-cycle costs of infrastructures and their elements (bridges, tunnels, other structures) integrating the environmental factors
  - Promote industrialization of infrastructure construction in order to reduce generalized environmental impact
  - New pavement surfaces that cooperate in the reduction of GHG emissions
    - by reducing rolling energy requirements
    - by capture of waterborne and airborne pollutants
  - Methodologies for measurement and assessment of GHG emissions related to Infrastructure construction and mitigation practices
2. Resources efficient Infrastructure

SOCIETAL NEED

- Sustainable growth needs to create efficient transport infrastructure networks
  - to complete the existing infrastructure network without increasing the occupied land
- Scarce land available
  - to upgrade existing infrastructure
- Make available proper waste management policies that ensure Best Practice and minimization of use of alternative natural materials
2. Resource efficient infrastructure

OBJECTIVES

Transport infrastructure:
- Develop improved procedures for proper:
  - management
  - maintenance
  - upgrading
  of existing infrastructures

New / non conventional materials:
- Improve performance of marginal materials
- Re-use construction and demolition waste on-site
- Search opportunities for treatment/disposal of other industrial waste in infrastructure work sites
2. Resource efficient infrastructure

IMPACTS

- **Medium term:**
  - Reduce of consumption of non-renewable resources
  - Improvement of use and service level of existing infrastructures
  - Improvement in quality, durability and performance of sustainable materials

- **Long term**
  - Make available new concepts, technologies and tools for retrofitting and upgrading existing infrastructures
  - Help in obtaining best value from industrial waste and in the implementation of efficient waste minimization and hazardous waste practices
• **Medium term:**
  - Techniques for re-use of marginal materials on site
  - Recycling of construction debris
  - Improved construction systems for infrastructure upgrading including traffic management tools
  - Improved maintenance and monitoring procedures for underground structures focused on upgrading and possible changes in use
  - Techniques for improvement of preventive maintenance of bridges and structures
  - Development of environmentally friendly techniques for construction, operation, maintenance and dismantling of infrastructure
  - Design methodologies taking into consideration future upgrading

• **Long term:**
  - Materials with low maintenance, high and predictable durability and low lifecycle environmental Impact
  - Extension of life-time of infrastructures by appropriate design, reutilization and retrofitting
3. Energy efficient Infrastructure

SOCIETAL NEED

• To break the transport system’s dependence on oil without sacrificing its efficiency and compromising mobility.

• To achieve a 20 % improvement in energy efficiency by 2020.

• Halve the use of conventionally fuelled cars in urban transport by 2020 and phase them out in cities by 2050

• 40% use of sustainable low carbon fuels in aviation
3. Energy efficient Infrastructure

OBJECTIVES

• Develop energy efficient construction equipment and methodologies

• Provide roads with low rolling resistance in order to reduce energy losses

• Provide infrastructure networks adapted for transport based on renewable energy sources (electric cars)

• Develop infrastructural systems focused on efficient intermodality

• Provide low maintenance infrastructures

• lighting…

• Embodied energy in materials
3. Energy efficient Infrastructure

**IMPACTS**

- **Short term:**
  - Cooperate in achieving EU targets in energy savings in the Transport sector

- **Medium term:**
  - Enhance energy efficiency of Infrastructure construction methodologies

- **Long term:**
  - Integrate renewable energies in Infrastructure construction and operation
  - Prepare Infrastructures for electric vehicles
  - Promote shifting of long range freight transport to railway or waterborne transport by developing appropriate infrastructural systems
3. Energy efficient Infrastructure

RESEARCH ITEMS

• Short term:
  • Develop new concepts of modal nodes focused on energy efficiency of transport chains
  • Efficient components of infrastructure for low energy consumption in operation:
    • Low energy lighting systems for roads and tunnels
    • Efficient ventilation systems for tunnels
    • Integrated energy management (efficiency + renewable) of road operation systems (signaling, safety, etc.)
    • Development of energy recovery systems for vehicles

• Medium term:
  • Pavements for energy efficient rolling without compromising safety

• Long term:
  • Energy efficient construction products and methodologies
  • Use of RES in construction
  • Infrastructures for electric cars
Thank you for your attention
2. Adapting the infrastructure to climate change

SOCIETAL NEED

Transport is fundamental to our economy and society. Therefore, the safety of use and supply and the reliability of Europe’s infrastructure networks under influence of climate change is of user’s and society’s prime concern. This includes a necessary reduction of the infrastructure repair time.
2. Adapting the infrastructure to climate change

OBJECTIVES

• With regard to the infrastructure behavior during it’s service life:
  
  • Enabling the assessment, following and prediction of the long-term performance of infrastructure network components subject to ageing and deterioration (under the influence of climate change).
  
  • Reliable and long-life systems are needed to monitor and control all security/safety parameters of infrastructures.

• With regard to infrastructure design, construction and retrofit, infrastructure networks vulnerable to (natural) hazards must be assessed and protected to meet new defined and harmonised European (safety) standards.

• Prevention, monitoring and reduction of the influence of climate change induced extreme events on the serviceability of multimodal transport.
2. Adapting the infrastructure to climate change

**RESEARCH ITEMS**

- Standards, models and databases to assess, follow and predict the time-variant performance of infrastructure components
- Development of NTD methods (sensors, techniques, data processing techniques) for monitoring
- Harmonized guidelines and codes for performance-based and innovative retrofitting and design related to natural hazards (mitigation and response)
- Resilient infrastructures
- Tools for natural hazards risk modeling focused on long term evolution of climatic agents

**IMPACTS**

Reduction of the increasing cost of the effects of natural hazards on the built environment
8. Reducing the impact in runoff and water courses and bodies

**SOCIETAL NEED**

- Improve quality of water bodies (EU Water Framework Directive)
- Avoid catastrophic floods
- Take into consideration climate change in drainage of infrastructures
OBJECTIVES

• Minimize water pollution caused by construction equipment and activities
• Prevent water contamination from infrastructures in operation
• Prevent reduction of water evacuation capacity of natural water courses due to temporary and permanent infrastructure works
• Consider flood risk under a Life Cycle Assessment scheme including effect of climate change
8. Reducing the impact in runoff and water courses and bodies

RESEARCH ITEMS

- Water contamination due to construction activities, especially in sensitive areas (wetlands, coastal, etc.)
- Best Practices for handling water contaminants in construction sites
- Design and construction of road and railway infrastructure for prevention of water pollution caused by normal operation and accidental spills
- Criteria for risk based consideration of the effect of permanent and temporary works on hydrology and capacity of water courses and bodies with special focus on flood risk
- Consideration of the effect of climate change in the flood risk generated by infrastructures
- Development of mathematical and physical modeling tools for analysis of water-infrastructure interaction
- Develop solutions for drainage improvements in existing infrastructures

IMPACTS

- Make infrastructure play a significant role in pollution prevention
- Reduce flood risk and use infrastructures as a tool for mitigation of the effects of natural disasters
- Help in facing climate change challenges