SUNRA
Sustainability – National Road Administrations

Sustainability Definitions for NRAs – Framework Part 1

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Executive summary

The SUNRA project

National Road Authorities (NRAs) across Europe continually strive to improve the performance of their road networks. This improvement has been underpinned by significant research in the optimisation of road planning, design, construction and maintenance, which has enhanced the understanding of the social, environmental and economic aspects of managing a road network. Whilst NRAs generally share an increasing awareness of some aspects of sustainability there is not a common understanding of, or approach to sustainability, as a whole.

The project 'Sustainability for National Road Authorities' (SUNRA) is tasked with identifying how NRAs can contribute to sustainable development. This involves three main tasks, addressed in three corresponding Work Packages (WPs)

1. Providing a common way of defining sustainable development within the context of European NRAs (WP1).
2. Identifying how to measure sustainable development at a strategic level and integrate sustainable development decision-making into key intervention points (WP2).
3. Developing a sustainability rating system framework that will enable NRAs to improve performance within the context of building and managing roads (WP3).

Through these three tasks SUNRA will produce a framework for NRA's, with each WP delivering one part of the framework. These frameworks will then go on to be trialled with several NRAs, before being widely disseminated.

Purpose and content

The purpose of this report is to describe the development of SUNRA Framework Part 1 "Sustainability Definitions for NRAs". The objective of this part of the framework is to support NRAs in developing and implementing definitions of sustainability.

The present report contains the *foundations* for the framework, including:

- The *methodology* adopted in the process of developing the framework.

- *Key observations* from literature on sustainable development, transport, and road management, which form the body of the framework, together with results of a workshop held with experts and stakeholders. The key observations lead to *recommendations* included in the framework.

- The *structure and logic* of the framework.

The framework itself is provided in a separate accompanying document "Sustainability Definitions for NRAs – Framework Part 1 FRAMEWORK".

Methodology

The work has included three main components: a literature review, a workshop involving stakeholders and experts, and the framework design process itself. These have been conducted in parallel. The framework development has been undertaken in close coordination with the work on the Framework Part 2 (measures to improve sustainability).

Key observations on sustainable development

Key literature covering normative, analytic and strategic perspectives on sustainable development is identified and reviewed. The key observations lead to a number of recommendations for European NRAs' aiming to define sustainability. NRAs may wish to:

- Begin by considering sustainable development from a comprehensive point of view before moving into specific transport or impact areas.

- Adopt the classic (WCED 1987) definition of sustainable development and the three pillars plus integration and participation as the basis for all further efforts.

- Reflect why they wish to engage with sustainability.

- Consider negative impact areas to be concerned with, and positive impact areas to promote, taking particularly into account European level strategies and goals.

- Take inspiration from notions formulated in research, such as the strong or weak sustainability approach, carrying capacity, or human well-being; and

- Formulate a set of principles to guide thinking and action based on the former points.

Key observations on sustainability and transport

In this section a review of sustainability as it relates to transport and road systems was undertaken. Three areas were addressed: sustainability impacts, sustainable transport policy, and sustainable transport definitions. It was generally found that sustainability challenges NRAs to think holistically in terms of the role of NRAs in the sustainability of the whole transport system. Key observations in each area include:

Sustainability impacts: Road transport has numerous impacts on topics of interest for sustainability and development, affecting all three pillars and the present and future dimension. The impacts affect endpoints in causal chains, with the road transport systems as the source. The impacts on sustainability and development stem from positive transport services as well as negative transport pressures. A summary of overall impact categories is provided. The impact on endpoints is indicative of positive or negative influence on sustainability. Some impacts occur by interaction of road transport and other modes or other sectors such as land use. The relationships between road transport and sustainability are therefore complex.

Sustainable transport definitions: Semantic definitions of 'sustainable transport' have been proposed by transport and road agencies and in research. Some are widely cited. However, to accurately define what 'sustainable transport' is, raises a number of difficulties. Some examples of definitions are critically reviewed. A valuable contribution to this discussion was made by Hall (2006) who proposed agencies to adopt a set of 'sustainable transportation' principles in addition to general sustainability ones to guide the action of transport agencies. NRAs are advised to consult these principles when they develop definitions of sustainability.

Sustainable transport policy: Sustainable transport has become an influential policy paradigm. According to this paradigm, major changes to present road transport planning are needed. Sustainability generally needs to be addressed at early stages of policy and planning with wide involvement of stakeholders. The European Union has defined a set of sustainable transport goals that European NRAs could refer to in their sustainability definitions.

Key observations on road management

This section reviews the roles and functions of NRAs and their implications for sustainability. Road management generally concerns the improvement, development, maintenance and operation of the road network. It is clear from the literature that the conduct and organisation

of road management has developed considerably and takes place in different ways across countries. While being aware of the wider context, NRAs need to identify where and how they can influence sustainability the most taking into account their specific leverage points and constraints. In working towards sustainability NRAs should aspire to:

- Identify and measure the sustainability impact performance associated with their assets and activities along the whole project cycle.

- Identify the key influence levers and intervention points they have for instigating change towards sustainability or to maintain desired level of performance.

- Seek ways to align influence mechanisms to prioritised impact endpoints; and

- Seek ways to expand their capacity of influence on critical impact areas, through for example renegotiation of mandates, acquisition of new resources, training, new tools, or strategic networking.

An overall message concerns the significance of the involvement of the board level of an NRA as this has the best possibility to govern the other strategic and operational levels, including to 'govern how they are governed'.

A way to conceptualise NRAs' opportunities to influence sustainability is provided, where available vehicles or 'mechanisms' for influence are grouped in the four categories of mandates, resources, priorities and activities. Each of these mechanism categories will conduct, enhance or constrain influence, and each will provide opportunities for specifications of sustainability.

Framework for sustainability definitions

The challenges for an NRA of defining sustainability are identified at the contextual, framework and definition levels. A framework for definitions of sustainability by NRAs is developed. It sets out the conceptual and procedural elements that enable an NRA:

- To recognise important principles and notions of sustainability and transport.

- To develop its own definition, taking into account already available ones; and

- To commit to its implementation through review and adjustment of existing frameworks and practices.

The resulting framework suggests a procedure with four steps. For each of the steps the framework suggests key elements to consider and specific outputs to deliver. The steps are:

1. *Interpretation of sustainability and transport.* Here the NRA appreciates the sustainability and transport principles and impacts and adopts a level of ambition for its sustainability principles.

2. *Impact and influence review.* Here the NRA considers relevant impacts of its assets and activities as well as the areas and mechanisms to influence sustainability, such as mandates, resources, priorities and activities.

3. *Commitment/definition.* Here the NRA crafts a definition and *strategic commitment* to sustainability.

4. *Implementation.* Here the NRA specifies what it will do with the commitment. For example, which existing or new NRA governance processes and documents it is to be connected to or integrated with.

The framework itself is contained in the accompanying stand-alone document, for easy reference for the NRAs.

Table of content

1 Introduction

1.1 Background

The focus of this report is to provide a framework that will support National Road Administrations (NRAs) in Europe in adopting definitions of sustainability, which can guide their sustainability efforts, and eventually help their strategic and project level activities to achieve more sustainable results. The main target group for the framework is strategic staff working at the European NRA board, headquarters or division offices.

This report is one of several being produced as part of the ERANET Road II project 'Sustainability for National Road Authorities' (SUNRA). It describes the methodology and basic components of the sustainability definitions framework (Framework Part 1), which itself is presented in a separate accompanying document.

The general background for this work is that the aim of sustainable development continues to raise significant strategic challenges - and opportunities - for all parts of society, including NRAs. Sustainability is a demanding concept, but one to which countries, the European Union, and numerous organisations and stakeholders around the world have repeatedly committed themselves (United Nations 2012; European Commission 2010; Council of the European Union 2006).

The notion of sustainability may seem elevated, but at the same time it is firmly tied in with the material and strategic reality in which NRAs operate.

Materially road systems are pervasive and indispensable for social and economic exchange and they jointly constitute one of the largest capital assets in any country. The environmental impacts from the construction, maintenance and operation of road networks are correspondingly diverse and extensive. Climate change is among the most alarming threats to sustainability, and its consequences will require significant mitigation as well as adaptation within road systems. Many NRAs are already addressing these challenges.

Strategically, the European Union and national governments have set out multiple policies and goals for sustainability that need to be pursued and implemented, many of which apply to the road transport sector. In addition, NRAs constantly engage with professional organisations, private companies and others, offering concepts, tools and projects that promise to deliver sustainable solutions. Many road authorities are thus engaged with strategic articulations of sustainability at various levels already.

NRAs are primarily responsible for designing, constructing and maintaining road networks. Substantial investments must continuously be undertaken and priorities made in ways which affect economic, social, and environmental balance sheets. New ways to cut costs, improve service, protect the surroundings, and gain support are in demand. This provides numerous leverage points for affecting sustainability within the activity range of NRAs. However, there are also significant limitations for what influence NRAs can exercise on the sustainability of road transport systems, let alone sustainable development as a whole.

So far, only a few NRAs appear to have adopted a fully comprehensive and integrated approach to sustainability. This contrasts with observations in literature according to which sustainability emphatically requires integrated management and decision-making efforts to become successful (Chai 2009; Dernbach 2004). Moreover, NRAs have so far not approached sustainability in a joint way across Europe. A common approach could allow NRAs to share experiences and investments, improve their performance, and set new standards together.

These combined challenges form an important background to the SUNRA project and the present report.

1.2 The SUNRA project

In the ERA-NET II Call "Energy: Sustainability and Energy Efficient Management of Roads" research proposals were invited to help "improve the common understanding and performance of sustainable development in the context of the road authorities".

The 'Sustainability for National Road Authorities' (SUNRA) project was selected to help achieve this goal. SUNRA is tasked with identifying how NRAs can contribute to sustainable development. The project includes three main tasks, divided among three Work Packages, (WP) and resulting in three parts of a sustainability framework:

1. Providing a common way to define sustainable development within the context of European NRAs (WP1 – resulting in 'SUNRA Framework Part 1').

2. Identifying how to measure sustainable development performance at a strategic level and integrate sustainable development decision-making into key intervention points (WP2 – resulting in 'SUNRA Framework Part 2').

3. Developing a sustainability rating system framework that will enable NRAs to improve performance within the context of road projects (WP 3 – resulting in 'SUNRA Framework Part 3').

Together the three parts of the framework will help NRAs comprehensively address sustainability from the strategic to the project level, and to strive for consistency in its overall approach to sustainability.

This present report describes the results of Work Package 1 (WP1).

1.3 Purpose

The aim of WP1 is to provide a framework for NRAs to adopt a definition of sustainability ('SUNRA Framework Part 1').

The objective of such a framework is to aid NRAs in understanding and committing to sustainability through adopting and applying appropriate definitions. The framework serves to guide an NRA through the definition process and give advice about key elements to include.

The following requirements for the definitions framework were set out in the project brief:

- To specify fundamental sustainability principles.

- To address strategic choice options and trade-offs connected with aggregation across impacts or dimensions.

- To identify the major sustainability impacts a road or road system can have; and

- To address how to map the impact that a road or road system can have to the various roles and functions of an NRA from strategic planning to construction and maintenance of highways.

The framework is also required to cover the environmental, societal and economic aspects of sustainability and development, and to build on existing definitions as far as possible.

The purpose of the present report is to describe:

- The methodology adopted to derive the framework.

- The theoretical foundations and conceptual building blocks of the framework; and

- The logic of the design and application of the framework.

The framework itself is contained in an accompanying shorter document 'Sustainability Definitions for NRAs – Framework Part 1'. However, the two documents should be used

together, with this report outlining the building blocks of the framework, explaining the key concepts in detail and also providing literature references.

1.4 Overview of the report

Section 2 of this report presents the methodology of the work undertaken in SUNRA WP1, including the general approach, the literature review, the workshop where NRA representatives and other stakeholders were engaged, and the process used for building the framework.

Section 3 draws key observations on sustainable development from the international literature and policy scene, including key political documents on sustainability and contributions from research that provide the core principles and concepts for defining sustainability in general, such as the economic, social and environmental pillars.

Section 4 makes key observations on sustainable transport. This identifies the main types of sustainability impacts that transport systems have, and presents a general understanding of how transport systems can be regulated and managed in order to ensure sustainability, according to 'sustainable transport' literature. Various definitions of 'sustainable transport' are also discussed in terms of their relevance for NRAs.

Section 5 brings together key observations on road management and the tasks of road administrations. This allows discussion on how NRAs can influence sustainability impacts at various level of management and various stages of the project cycle etc.

Section 6 reports from a workshop held jointly with WP2 in order to solicit ideas for the framework and conduct a reality check of preliminary observations from the literature.

Section 7 summarises the key challenges for defining sustainability in an appropriate and common way for European NRAs, as well outlining the advantages and limitations of various approaches to such a definition. It then explains how the framework is structured, the logic behind it, and its application.

Section 8 draws a number of conclusions.

Appendix A provides a glossary of terms.

Appendix B lists the workshop attendees.

Appendix C outlines the workshop agenda.

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2 Methodology

The methodology description begins with general reflections on how to approach the development of a framework for defining sustainability for NRAs. Then it proceeds to describe the literature review and a workshop which were used for developing the framework.

2.1 General challenges for the task

Building a common framework for defining sustainability across European NRA's has, from the outset, been recognised as a challenging task, with the following issues being identified:

- How to understand and define sustainability in general based on ideas, principles and goals of sustainable development that have been condensed, but also continuously elaborated and revised through several major international and national political and scientific discourses.

- How to understand the (positive and negative) contributions of the road transport sector to sustainability, taking into account that national road networks are closely intertwined with other transport systems, other sectors in society, and the natural environment itself.

- How to perceive the role of NRAs in regard to these contributions and interconnections, taking into account that NRAs:

  o Have multiple areas and levels of activity that affect sustainability.

  o Yet are limited in which road transport system components they can legitimately or effectively influence, and by how much.

  o Vary across Europe in terms of their mandates, responsibilities and available delivery mechanisms.

  o Undergo considerable changes to their organisation and technology over time; and

  o Differ with regards to their present level of exposure to, adoption of, and ambitions for, sustainability requirements or accomplishments.

Due to these and other challenges it was not considered advisable to simply pick one of the many existing definitions of sustainability, insert 'road' or 'NRA' into it, and then prescribe it for use by all NRAs. A definition of sustainability has little use if it is not assimilated by an NRA and transposed into other practices.

A key intention has therefore been to establish a framework that can engage and support NRAs in developing and implementing their own appropriate sustainability definitions, where general sustainability requirements as well as the NRA-specific context can be taken appropriately into account and negotiated in a commonly structured way. It has therefore been assumed that the framework must seek to:

- Identify, and activate the most important aspects from the general technical and political discourses on sustainability.

- Identify the key contributions of transport and road system on sustainability.

- Identify roles an NRA can play in regard to enhance sustainability; and

- Adopt and implement definitions in a suitable way taking into account internal and external contexts, and different levels of accomplishment and ambition.

2.2 The notion of a 'framework'

The next consideration concerns what is more precisely meant by providing a 'framework' for the task of defining sustainability.

A useful general definition of a framework is the following:

> *"...conceptual and procedural constructs that assimilate, process and give meaning to information"* (Assmuth & Hilden 2008).

According to this definition a framework provides certain elements ('conceptual and procedural constructs') that help to structure information, thinking, communication, and eventually action, which may bring consistency ('assimilation') between various strategies and interventions.

A framework can in this sense represent rigorous or more open ended, flexible formats for communication and action, ranging from, for example, a mere checklist of elements to address during a meeting (e.g. a standard agenda), to a strictly prescribed sequence of activities with specified content, participation, action points, and outputs (e.g. a certification process, or religious liturgy). The degree of rigour may refer to elements on both the conceptual and the procedural side.

As noted in the previous section a framework for defining sustainability with maximum rigour (e.g. the pre-specified definition prescribed for adoption at one particular decision point) may not be effective to ensure adequate NRA engagement with sustainability. On the other hand total flexibility may not help NRAs adopt approaches that are fully consistent with recognised sustainability principles, nor sufficiently consistent, and comparable across Europe.

The general solution has been to strive for a structured process format in which NRAs' are invited to construct, adopt and implement their own definition following a series of steps where appropriate conceptual building blocks of a definition are offered to them.

The framework aims to combine conceptual (structural) and procedural components in the following way:

The *conceptual* components refer to proposed common elements in a definition, including basic, essential principles of sustainability, a specification of how this is seen to apply to NRA responsibilities, and manifestations of the definition into various NRA activities and outputs. Deriving these components form the dominant part of the present report, using input from literature and a stakeholder workshop. These components appear in a much condensed form in the Framework itself.

The *procedural* components describe the recommended process through which the NRA acknowledges the principles of sustainability, appreciates its own role, and develops and finally adopts its definition and a commitment to pursue it; that is, the assimilation of the conceptual components. This process is derived and outlined in section 6, but is presented fully only in the accompanying framework document.

2.3 Description of the main elements

To derive a framework that is grounded in existing knowledge while aiming for strategic application within actual organisations, it was found useful with an approach combining two main elements: a literature review covering existing sustainability definitions, principles, and management systems in general and for NRAs, and a workshop where draft conceptual and procedural 'building blocks' could be discussed with stakeholders and ideas solicited for improvements. These two elements formed the key inputs to the ongoing framework development process, which also benefitted from consultations with other parts of the SUNRA framework development process (WP2 and WP3).

2.4 Literature review

In accordance with the project aims and initial framework ideas as stated above the literature needed to cover a broad field of enquiry ranging from general sustainability concepts and principles over transportation and road specific sustainability issues to the management of road sector agencies.

The material identified was grouped into the seven more detailed areas shown in Box 1.

> **Box 1: Areas of literature covered**
>
> - Sustainability and development in general (key international policy docs)
> - Sustainability concepts and frameworks (academic/technical)
> - 'Sustainable Transport' concepts, frameworks, impacts, strategies
> - Tools for transport, infrastructure and road sustainability assessment
> - Road administration functions, structures and tasks
> - Sustainability reports provided by or for individual transport or road agencies (limited selection)
> - Sustainability reports and frameworks in other relevant areas

Relevant literature was identified though the following sources:

- Pre-existing related literature reviews or collections of literature on sustainability assessment for transport agencies, such as found in Zietsman and Ramani (2011), Harmer and Bradbury (2010), and Amekudzi et al (2011).

- Material previously collected by Technical University of Denmark through involvement in other projects on sustainability and transport, especially the ERANET Road II project SBAKPI (2010-12), and the US Collaborative Highway project NCHRP 08-74 (2009-2011).

- Material identified though additional keyword searches on scientific literature databases and electronic library resources available through the Technical Information Centre of Denmark, such as ScienceDirect and Springerlink.

- Material identified at websites of road sector organisations such as PIARC and CEDR, and at individual transport or road agencies.

- Material submitted by other SUNRA project partners, NRAs and stakeholders.

The literature reviewed encompassed policy documents, academic research, and 'grey' literature, such as agency or consultant reports, various studies and presentations etc.

During the literature review bibliographical information for each reference was retrieved, and the following characteristics of each one were given:

'Scope' referring to geography (global, or specific to a nation or region); whether the reference is academic or practical; and whether it addresses sustainability in general and/or for some particular dimension or sector application.

'Significance' reflecting how important the reference is deemed to be for defining sustainability for NRAs, the categories 'High', 'Moderate', and 'Limited' were used.

Finally 'key points' were noted, meaning core information for the purpose of producing this report and building the framework, highlighting quotations, abstracts or illustrations.

The results of the literature review are summarised in the following sections of the report bringing together the key references and observations under three themes:

- Section 3 presents key observations from literature on sustainable development in general.

- Section 4 presents key observations from literature on sustainability and transport systems; and

- Section 5 presents key observations on sustainability of road management.

2.5 Workshop

A stakeholder workshop was held on 14th May 2012 in London, an early point in the work. It was attended by sustainability leads from within NRAs, consultants, academics and industry leads from across Europe, as well as the SUNRA project partners. The list of attendees can be found in Appendix B.

The workshop was held jointly with WP2, with half the session given over to each WP.

The main aims of the WP1 session of the workshop were to:

- Introduce the purpose of developing a framework for defining sustainability for NRAs.

- Stimulate discussions among NRA staff, researchers and SUNRA project participants present on ways to define sustainability for NRAs; and

- Collect experience and ideas on how to prepare a sustainability definitions framework that could be useful for several European NRAs.

A practical aim was to perform a 'reality check' of the first conceptual building blocks emerging from the literature review.

The content and outcomes of the workshop are described further in section 6.

The workshop agenda can be found in Appendix C.

2.6 Framework development

The framework was developed by DTU, in consultation with other SUNRA partners, following the identification of the key conceptual and procedural elements through the literature review and at the workshop

A few key references deserve to be mentioned as particularly important sources in the overall shaping of the framework. Firstly, a major inspiration for the work was the US National Cooperative Highway Research Program sponsored project on Sustainability Performance Measurement for Transportation agencies, reported in NCHRP Report 708 (Zietsman et al 2011). That project undertook a similar task of developing a sustainability framework for the US State and Metropolitan transport agencies, and included a process for the definition of sustainability as an auxiliary element in its framework. DTU took part in that project.

Other key sources for shaping the framework include the following:

- Bond et al (2012). Strategic Benchmarking and Key Performance Indicators. Final Project Report. ERAnet Road. TRL, Crowthorne, UK

- The European Union's Sustainable Development Strategy (Council of the European Union 2006)

- Hall (2006), a massive MIT thesis on understanding and applying the concept of sustainable development to transportation planning and decision-making in the U.S.

- COST 356 on environmental sustainability indicators for transport (Joumard and Gudmundsson 2010).

- Pei, et al (2010). Performance Measurement Frameworks and Development of Effective Sustainable Transport Strategies and Indicators

- Rand Europe et al. (2004). The SUMMA project on operationalising sustainable transport and mobility

- Banister et al (2000). European Transport Policy and Sustainable Mobility. E & FN Spon, London

- Work undertaken on sustainability for Transport Scotland by Halcrow in the UK in 2010 onwards (unpublished).

The outcome of the framework development process is presented and explained in Section 6. The framework itself is presented in the accompanying document.

2.7 External review

A draft of the report and framework were externally reviewed by two independent experts, one representing an NRA (Stephen Thomson, Transport Scotland) and one representing academia (Dr. Josias Zietsman, Texas Transportation Institute, Texas A&M University System).

Useful comments were received from the external reviewers, as well as members of the Project Executive Board and as a result numerous changes were made to the text and the outline of the framework. One particularly useful recommendation was to separate the background material (this report) from the actual framework that NRA's are supposed to apply. This recommendation has been implemented.

 The SUNRA team is extremely grateful for the time and effort given by the reviewers.

2.8 Final observations

This report and the accompanying framework will be trialled with pilot NRAs. It is likely that this will lead to adaptations and improvements to this present version.

Finally a note about how the term 'sustainability' is used in this report and in the accompanying framework. First of all a broad view of sustainability is adopted where all pillars, dimensions, etc. are considered. Secondly, the core notion is seen to be 'sustainable development', meaning the *combination* of development (referring to improvement from the present perspective) and 'sustainability' (referring to the preservation of conditions for fulfilling future needs)[1]. It is this combined or joint notion that allows true integration of the different dimensions. Nevertheless the report will for convenience often follow the general use of terminology, where 'sustainability' is short form for both elements. For example when speaking of 'sustainability definitions' for NRAs, what is actually meant is definitions embracing sustainable development.

These notions will be discussed in more detail in Section 3 of this report. Further terminology can be found in the glossary (Appendix A).

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[1] This is in accordance with the World Commission on Sustainable Development (WCED 1987) introducing the concept to the wider world, and several other sources (e.g. Stieglitz et al 2009).

3 Key observations on sustainable development

3.1 Overview

This section provides those key observations from the history of, literature on, and policy for, sustainability and development, which are deemed most important and helpful for European NRAs in adopting an overarching view on, and definition of, sustainability.

While much of the debate on sustainability may be well known to NRAs it is nevertheless essential to recall and observe basic concepts, research insights, and policy agreements from this field, when an overarching view is to be adopted, if sustainability work is to have a firm, common grounding. It is particularly relevant to reflect how these concepts are framed in the context of European policy making related to sustainability, in order to support European NRAs in seeking to adopt a joint and coherent approach.

However, it must also be observed that the sustainability arena is characterised by a multitude of different perspectives, which are not necessarily fully aligned, and which, moreover, continue to evolve with further research and practice. This diversity can neither be fully captured in this review, nor can it be completely ignored. This is because choices need to be made as soon as the most elementary and consensual definitions are to be applied for planning, management and decision-making purposes.

Hence, this section will seek to strike a balance between condensing what are deemed as the most important concepts and ideas of relevance, and reflecting a variety of additional notions from the sustainability discourse, which may be helpful to put more 'meat on the bones', but may also more easily be contested or discarded.

The section is structured in a way that covers three fundamental perspectives on the notion of sustainability, i.e. the normative, the scientific, and the strategic perspectives (inspired by Becker et al (1997), as follows:

- The *normative* perspective deals with the global processes (e.g. from Rio to Rio+20), where the basic definitions and distinctions of the sustainable development concept originates, and where the key principles have been formulated (section 3.2).

- The *scientific* or analytic perspective refers to contributions from research in economics, environmental sciences and social sciences, which suggest conditions that must be fulfilled if sustainability and development are to be secured (section 3.3).

- The *strategic* perspective refers to more concrete planning and decision-making towards sustainability, for example through instruments such as sustainability goals and strategies, assessment frameworks, and reporting mechanisms (section 3.4).

The section ends with a summary discussion with key points for informing the strategic commitment of the framework.

3.2 Sustainable development as a normative concept

3.2.1 Origins

The notion of sustainable development has received the widest worldwide political support over the last two decades. It is conceived by joining two semantic components 'sustainable' and 'development', which each bring its own set of meanings, and 'political histories' to the joint concept. The first component refers to a long standing international debate on social and economic development (including poverty eradication in the 'third world'). The second component refers to the more recent debate on threats arising from depletion of natural resources and widespread environmental destruction (Becker et al 1997).

The joint term was coined in 1980 by the International Union for Conservation and Nature and Natural Resources (ICN), which stated that sustainable development:

> *"...takes account of social and ecological factors, as well as economic ones; of the living and non-living resource base; and of the long term as well as short term advantages and disadvantages of alternative actions*" (IUCN et al. 1980, p. 18).

This was not the first attempt to realign economic, social and environmental development aims, but was the first widely known expression of the particular term.

3.2.2 Present and future needs

The United Nations took the concept on board around 1984 and initiated a process to bring the reconciliation of the two agendas forward. The most widely accepted definition of sustainable development is the one provided in 1987 by the UN appointed World Commission on Environment and Development (WCED),[2] in the Brundtland report, named after its Chairman, former Prime Minister of Norway Ms. Gro Harlem Brundtland.

The core definition is:

> "*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* (WCED 1987, p. 43).

This assertion most clearly states that both present needs and future needs should be considered in any developing activity. It is an important corrective to development thinking and practice, which is often primarily occupied with the present, ignoring, or over-discounting the future. Future needs may not be known today, but at least the *ability* to fulfil human needs should be ensured. This ability is widely perceived to require protection of environmental 'life-support' systems and resources, as well as economic and social ones.

The definition is first and foremost a normative statement for inter-generational equity, with 'development' representing the present and 'sustainability' the future side of this equation.

For the interpretation it is also important to observe the two 'key concepts' which WCED attaches to its definition:

> *"The concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and*

> *The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs." (WCED 1987, p. 43).*

Hence, sustainable development should give particular priority to the needs of the poorest, and should particularly observe environmental limits for human activity, which are however dependent on e.g. technology, organisation etc.

Important is also the observation of sustainable development as a *process* rather than a stable end state, namely,

> *"... a process of change in which exploitation of resources, the direction of investments, the reorientation of technology development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations. (WCED, p 46)".*

3.2.3 Rio Summit 1992

The notion of sustainable development was first endorsed as an overarching global aspiration at the United Nations' Summit in Rio in 1992. The key mechanism was the Rio Declaration, a short set of 27 *principles* which were adopted by the General Assembly

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[2] Appointed by the United Nations' General Assembly.

(heads of states and governments), and Agenda 21, an extensive document providing guidance to nations, organisations, and citizens on how to pursue sustainable development.

Some of the most important principles in the Rio Declaration are shown in Box 2, including principles on integration, participation, and precaution on behalf of the environment.

Box 2: From the Rio Declaration (extracts) (United Nations 1992)

Principle 1
Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

Principle 4
In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.

Principle 8
To achieve sustainable development and a higher quality of life for all people, States should reduce and eliminate unsustainable patterns of production and consumption…

Principle 10
Environmental issues are best handled with participation of all concerned citizens, at the relevant level.

Principle 15
In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Equally as significant outcomes of the Rio summit were the adoption of two major environmental conventions, namely the global Climate Convention (UNFCC), and the Biodiversity Convention (CBD).

3.2.4 The three pillars or dimensions

The global process culminating at the Rio summit spawned a number of other concepts and ideas of significance for present sustainability practice. Probably the most important one is that sustainable development is seen as having *three pillars* or *dimensions*, environmental, economic, and social, which need to be considered jointly.

Importantly, an authoritative definition of what exactly belongs to each pillar does not exist; however the content can be broadly characterised as follows:

- The economic pillar refers to income, savings, capital assets, resources, investments, and other manifestations of and contributors to economic wealth, well-being, and performance at the individual, national and global levels.

- The environmental pillar refers to the natural environment that surrounds and sustains human life, in terms of immediate life conditions (water, air, food etc.), as well as 'life-support' systems (ecosystem, climate system, agricultural systems etc.) which enable the survival and development of mankind and society.

- The social pillar refers to social relations and interactions among people and the social conditions (such as education, health, safety, opportunity), which constitute the quality of life and the coherence of society.

It is important to note the following characteristics of these pillars:

- There are strong interdependencies between them (e.g. environmental resources and social relations are necessary for economic outputs); this may lead to unexpected reactions to developments or interventions in one dimension.

- There are overlaps between them (e.g. biological resources are both 'environmental' and 'economic'); this may lead to 'win-win' situations but also 'double counting'.

- The relationships between the pillars can be interpreted in widely differing ways, potentially giving rise to diversion, confusion or conflict.

Figure 1 illustrates different ways of looking at the three pillars. A competitive or trade-off view (to the left) is for example often dominant when economic and environmental interests clash. The grey area can illustrate battlefields or compromises. In the concentric view (the middle), the environmental pillar is seen as fundamental for the social pillar and that again for the economic pillar, hence priority to the environment is assumed. The overlapping spheres (to the right) can for example suggest win-win-win possibilities, or an opaque bureaucracy, at the centre.
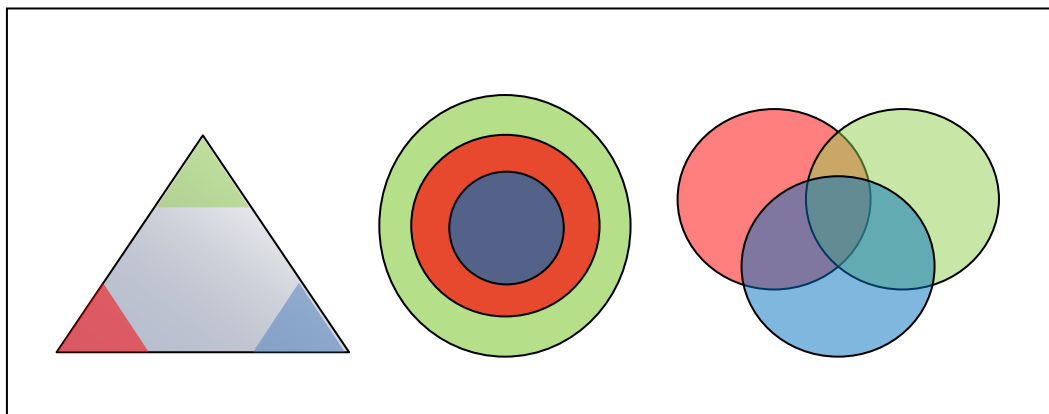
Figure 1: Pillars of Sustainable Development seen as competing (trade-off), concentric (hierarchy), or reinforcing (overlapping).

The notion of 'pillars' is thus a hugely simplified view that may conceal great complexity. Yet it is also a clever and appealing reflection of interdependencies and diversity of the foundations for human development. It offers a useful platform for debate, interdisciplinary research, measurement and reporting[3]. However, the notion may communicate stronger messages if an explicit understanding on how the pillars are related is adopted.

3.2.5 The institutional dimension

The Rio Summit also strongly emphasised what has been called a fourth, institutional dimension to sustainable development. It concerns how policy, governance and management should be conducted to support sustainable development as a process.

Two of the key assertions are:

- The need for extensive and continued stakeholder involvement in sustainable development decision-making - not least including so-called "major groups" (women, ethnic minorities, NGO's, business, etc.).

- The need to ensure that environmental protection efforts are integrated into decision-making processes in all sectors of society rather than being 'added on' (Rio Declaration Principle 4).

The rationale for wide participation is that sustainable development and environmental impacts affect all, whilst the magnitude of required change is too abounding to be fully contained in formal governmental processes. Hirschi et al (2002) observe:

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[3] The three pillars are echoed in various other concepts, such as the 'Triple Bottom Line" used for accounting purposes, or the dictum 'People – Planet – Profit' ascribed to John Elkington, formerly with SustainAbility Ltd.

"Because of the different problem dimensions, the plurality of goals that are subsumed under the concept, and the heterogeneity in political and societal actors' involvement in negotiations, there is a stronger need for cooperation and consultation in sustainability than is true for some other policy goals."

An obvious rationale for the integration principle is the cost efficiency gains from incorporating environmental impacts as an upfront decision parameter, instead of ex post mitigation or repair. This is labelled EPI for Environmental Policy Integration. The notion of integrated decision-making is by some considered as the most important 'institutional key' to sustainable development (Dernbach 2004). Early integration can help avoid contradictory or self-defeating decisions at all levels and all domains.

3.2.6 Rio+20 and a Green Economy

Twenty years after the first summit governments met again in 2012 at Rio+20 to take stock of progress and renew their commitment to Sustainable Development. The summit document reconfirms much of the WCED and 1992 summit lore of sustainability, including the concepts of present and future needs, the three dimensions, and the institutional aspects of integration and participation. It urges governments, organisations and businesses to continue the quest towards sustainability without hesitation (see Box 3).

Box 3 From the Rio+20 resulting document (United Nations 2012)

"1. We, the Heads of State and Government (...) **renew our commitment** to sustainable development and to ensuring the promotion of an economically, socially and environmentally sustainable future for our planet and for present and future generations

56. ….we consider **green economy** in the context of sustainable development and poverty eradication as one of the important tools available for achieving sustainable development and that it could provide options for policymaking but should not be a rigid set of rules.

76. We (…) resolve to strengthen the institutional framework for sustainable development, which will, inter alia: (…) Promote the balanced integration of the three dimensions of sustainable development; (…) Enhance the participation and effective engagement of civil society and other relevant stakeholders … ((i) Promote the review and stocktaking of progress in the implementation of all sustainable development...

132. We note that **transportation and mobility** are central to sustainable development. Sustainable transportation can enhance economic growth and improve accessibility. Sustainable transport achieves better integration of the economy while respecting the environment. We recognize the importance of the efficient movement of people and goods, and access to environmentally sound, safe and affordable transportation as a means to improve social equity, health, resilience of cities, urban-rural linkages and productivity of rural areas. In this regard, we take into account road safety as part of our efforts to achieve sustainable development."

The conference also adopted a new global aspiration for a *'green economy'* as a way to promote sustainability or 'in the context of sustainable development and poverty reduction' as it is defined. The United Nations' Environment program explains this as an economy "*...whose growth in income and employment is driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services*" (UNEP 2012).

'Green economy' is strongly related to the notion of 'Green growth' promoted by the OECD (2011).[4] Simply put the idea is that there is money to earn from going green; the transition to systems with low carbon emission, resource use, and pollution can be a significant source of growth and jobs. Many 'green growth' initiatives in fact centre on the transport sector where the need and potential for green transitions (and profits) is seen as particularly large (Perkins

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[4] "Green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies" (OECD 2011)

2011). The concept of green growth thus adds a more entrepreneurial, self-interest driven spirit to the sustainability agenda.

'Principles for a green economy' are currently being drafted by groups of NGO researchers and business stakeholders (see Box 4), although more detailed guidance would seem necessary if the concept is to help create real jobs and growth through green investments.

Box 4 Draft Green Economy Principles. (Green Economy Coalition et al. 2012)

A resilient and inclusive economy that provides a better quality of life for all within the ecological limits of the planet:

1. It delivers sustainable development

2. It delivers equity - The Justice Principle

3. It creates genuine prosperity and wellbeing for all - The Dignity Principle

4. It improves the natural world - Earth Integrity and Precautionary Principle

5. It is inclusive and participatory in decision-making - The Inclusion Principle

6. It is accountable - The Governance Principle

7. It builds economic, social and environmental resilience - The Resilience Principle

8. It delivers sustainable consumption and production - The Efficiency Principle

9. It invests for the future - The Intergenerational Principle

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Also at Rio+20 the topic of *transport and mobility* was – for the first time – explicitly recognised by the General Assembly level of the United Nations as a priority for sustainable development (see Box 3). Hope is expressed that 'sustainable transportation' respecting the environment will enhance economic growth and improve accessibility. Transport should become "environmentally sound, safe and affordable".

A stipulated next step is the formulation of global sustainable development goals, possibly for adoption by 2015.

The early definitions and principles crafted in the 1980's and 1990's however still stand as foundations for much subsequent work.

3.3 Sustainability as a scientific concept

Researchers from many scientific disciplines devote their efforts to study and analyse sustainable development. The focus is not simply on *defining*, but more importantly to identify *which conditions must be fulfilled* if human development is to follow a sustainable course.

The following section will briefly review selected contributions from research in these areas:

- Economics (emphasising sustainable development conditions related to capital, income, savings, etc.; and distinguishing between 'weak' and 'strong' sustainability).

- Natural sciences (emphasising sustainable development conditions related to global warming, ecosystem limits, etc.); and

- Social sciences (emphasising sustainable development conditions related to quality of life, social capital and stability etc.).

3.3.1 Economic concepts

The economic notions of *capital* and *income* are especially significant for understanding the sustainability of economic activities.

Economically speaking, development can be sustainable if society avoids depleting the capital base from which it draws its income. It should only 'harvest the rents', and reinvest income to compensate for the occurring depreciation. Conversely there is no development, if too much is taken out for future expansion. Hence, over the long run well-being may decline by either over- or underinvestment in capital.

The simplest economic definition thus is:

> *"Sustainability …requires that the use of resources today should not reduce real incomes in the future..."* (Pearce et al 1988).

Two different ways to obtain this involves 'genuine savings' and 'preserving natural capital'.

Genuine Savings: Societies can continue to develop and grow, even if they exploit depletable natural resources. Simply put, the rents acquired should be reinvested in renewable substitutes at the same rate as depletion, such as bio-energy for rents from using oil for transport. To count a nation's 'genuine savings' all factors that contribute to economic well-being and development should be counted in, including non-monetised environmental and human capital (e.g. education, research, Pillarisetti 2005). The measure assumes that various forms of capital and savings can be substituted for another at a rate defined by their market or estimated economic value. If genuine savings in aggregate are shown to be positive, development has been sustainable.

Natural capital: Precisely the issue of *substitution* between the different types of capital and savings has occupied economic thinking on sustainability. In particular it is asked whether environmental assets (resources, or ecosystem services), also called 'natural capital', can in fact be replaced with artificial or man-made equivalents without loss of income or well-being in the long term. The puzzle arises because "natural capital" - besides yielding tangible financial income - has unique features that are not easily found in the market place; for example the photosynthesis and biodiversity functions provided by forests, which are not necessarily reflected in the price of wood.

"*Can more sawmills compensate for a lack of wood*?", ecological economist Herman Daly rhetorically asked, suggesting the invalidity of mixing all forms of capital in one count, as assumed in 'genuine savings'. Instead he formulated the following criteria for a sustainable development that respects the special conditions of natural capital:

(1) Renewable resources should not be used faster than their regeneration rates;

(2) Non-renewable resources should not be used faster than substitutes become available;

(3) Pollution should not exceed the assimilative capacity of the environment (Daly 1990).

Natural capital should be kept constant (or increase with population growth), otherwise development is not likely to be sustainable. This position is known as "*strong sustainability*". The strong position requires the status of social, economic and environmental assets to be accounted for separately, rather than being aggregated into a single number[5].

In contrast, the "*weak sustainability*" of mainstream economics, as in the genuine savings doctrine, allows depletion of natural capital as long as it is replaced with produced or human capital of equivalent value. Under this assumption it is possible to judge the sustainability of development based on a proper assessment of the total marginal economic value of all resources involved jointly.

The adoption of a weak or a strong view may have clear implications in road planning - Imagine for example a natural resource such as a wetland being sacrificed as part of the project. From a strong position compensation may be required in the form of a biophysical

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[5] Or more precisely: "the sustainability requirement is for non-negative changes in the stock of natural resources such as soil and soil quality, ground and surface water and their quality, land biomass, water biomass, and the waste assimilation capacity of receiving environments." (Pearce et al 1988).

equivalent area rather than using a direct pecuniary compensation, as is acceptable in a weak position. In some cases legislation determines what to do, but not always

Section 4 will show how the strong sustainability position has been most influential in efforts to define 'sustainable transport'.

3.3.2 Natural science based concepts

Environmental sustainability is a hugely diverse research field, with the diversity stemming from the sheer variety of natural assets and processes with different biophysical properties and multiple impact endpoints, from human health to climate change. While biology and ecology offer plenty of possible value for NRA sustainability practice, particularly at the project design level, we will only look at some of the most general approaches here.

Climate change research: The most important contribution to making sustainability operational in recent years arguably comes from climate science. Especially important are comprehensive assessments conducted by the Intergovernmental Panel on Climate Change (IPCC), most recently in the Fourth Assessment Report from 2007 (Pachauri and Reisinger 2007). The IPCC analyses global warming related effects due to greenhouse gas (GHG) emissions and other factors, and also provides evidence on adaptation needs and mitigation options in various sectors such as transport.

Article 2 in the UN Climate Convention specifies that the ultimate aspiration is to stabilise *"….greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system"* (UNFCCC 1992). According to the assessment of IPCC, this level seems to be around '+2 degrees' above pre-industrial levels, resulting from a concentration stabilising around 450 ppm CO_2 equivalents.

This forms the basis for a range of possible emission reduction scenarios that governments have been asked to consider. Climate change research also informs strategies for adaptation to climate change. In Denmark and many other countries strategies for adaptation to the road system are under implementation, as illustrated in Figure 2.

Figure 2 'Blue Spot' mapping used in climate adaptation in Denmark (Hansson et al 2008)

Ecosystems and limits: Natural resource management sciences have long been aware of limits as to how much humans can exploit specific natural resources and systems without risking a gradual or sudden collapse (=unsustainability). Some of the oldest rules for sustainable exploitation go back to the 18th century forest management (Wiersum 1995). Concepts such as 'maximum sustainable yield', 'carrying capacity', 'safe minimum standards' and 'critical loads' broadly reflect similar insights across areas of ecology and resource management. Such limits are especially important for ecosystems that are difficult to restore to their former condition, when certain thresholds are crossed (Haines-Young et al. 2006).

However, a general specification of ecological limits for sustainable development is hindered by the complexity of the systems, the variance of local conditions, and a lack of scientific

knowledge (Munasinghe and Shearer 1995). A more welcoming approach may be to measure the 'ecosystem services' (such as food, photosynthesis, and health) that nature offers to society, and review how various production and consumption activities affect each of them positively and negatively (Millennium Ecosystem Assessment 2005).

Box 5 defines a range of key terms used in environmental sciences to underpin a sustainable exploitation of natural resources and ecosystem services.

Box 5 Concepts related to ecological systems and limits

Carrying Capacity
The level of use of a natural resource system beyond which undesirable changes will happen to the system, for example, the size of a species population that can be sustained by a particular eco-system.

Safe Minimum Standards
Used within the context of economic analysis as the point at which it becomes unacceptable to trade-off environmental losses against economic gains because unacceptable changes will occur in natural resource systems.

Critical Loads and Levels
The amount of "pollutant" that an ecosystem can absorb before there is a change in the natural resource system and/or in a particular ecological process. For example, critical loads are used to specify the maximum rates of annual deposition of oxides of sulphur and nitrogen emissions permissible while avoiding adverse effects on soils and/or freshwater systems

Ecosystem services
Ecosystem services are the benefits people obtain from ecosystems. These include *provisioning* services such as food, water, timber, and fibre; *regulating* services that affect climate, floods, disease, wastes, and water quality; *cultural* services that provide recreational and aesthetic, benefits; and *supporting* services such as soil formation, photosynthesis, and nutrient cycling.

(Roderick 2011; Millennium Ecosystem Assessment 2005)

Ecosystem limits is a useful concept at two levels. At the general level it helps to maintain an awareness of the possibility of system collapse and loss of ecosystem integrity due to pollution and intrusion. A precautionary approach can therefore be generally defended, in accordance with the Rio principles. More specific environmental thresholds in relation to for example road transport systems are better assessed at the micro– or meso-scale in connection with detailed studies of localised projects, rather than some form of overarching sustainability assessment.

The Natural Step. A particularly influential contribution to sustainability assessment based in natural science (i.e. thermodynamics) is the sustainability principles and strategies known as 'The Natural Step' (TNS). Coined in Sweden by Karl-Henrik Robert this principle has inspired numerous businesses and authorities around the world (Robert 2002; 2000).

The basis for the TNS framework is four 'system conditions' for sustainability, three derived from the laws of physics and the fourth from the WCED definition. The physical conditions refer to the following outcomes that must be *avoided* if a process is to contribute to sustainability:

(1) Increasing concentrations of substances extracted from the Earth's crust (minerals etc.).

(2) Increasing concentrations of substances produced by society (emissions, waste, etc.).

(3) Physical impoverishment by over-harvesting, or other forms of ecosystem manipulation; and

(4) In addition, resources must be used fairly and efficiently in order to meet basic human needs worldwide.

The TNS approach has been applied in the transport sector. An example is the STARS sustainability analysis tool, where the TNS system conditions are used as a framework to identify sustainability impacts of transport plans and projects (Leigh-Fischer 2011).

3.3.3 Social and policy science based approaches

The social pillar of sustainable development is probably the least explored in research (Vallence et al 2011). However, social sciences have established a rather comprehensive basis for evaluating at least social *development*, using concepts such as human well-being, and quality of life, which embody a number of underlying aspects.

According to Stiglitz et al. (2009) key constituents to human well-being are generally considered to be:

- Health

- Education

- Income (general), and freedom of poverty (in particular)

- Features of personal activity (such as job access and. employment), and

- Political rights.

Of particular relevance for NRAs are the health aspects, which for example means that traffic safety is often addressed as part of the social pillar. Similarly access and mobility are often seen as enablers of well-being in the social dimension, even if they are also factors of substantial economic significance.

Concerning social *sustainability* there is much less agreement. It is sometimes defined as the social conditions under which a society can remain coherent, and develop in peace and harmony instead of falling apart in conflict, unrest, civil war or isolation. The term 'social capital' is occasionally used to characterise the extent to which a society possesses sufficiently strong social networks and trust among its citizens allowing it to thrive and develop in the future (= being socially sustainable) (Currie and Stanley 2008).

Another important topic discussed in social sciences is distribution of income and well-being, or equity. While there is no international agreement about the level of equity that is desirable or critical, it is widely recommended to keep track of how change in income and quality of life is distributed across income groups, gender, regions or minorities. Growing inequality in the distribution of well-being components are seen as measures of negative social development (Stieglitz et al 2009).

3.4 The strategic perspective

The strategic perspective concerns what can actually be done to move development in a sustainable direction (Becker et al 1997). The strategic perspective is pragmatic, trying to move towards sustainability even if there may be disagreement about values and knowledge.

Various policy-making bodies, organisations and stakeholder groups contribute by designing strategies, goals, reporting guidelines and assessment tools for sustainable development. The available material of this kind is very extensive and rapidly growing.

This section highlights a few contributions that could be helpful for NRAs by pointing them towards joint criteria and goals for sustainability. These include an assessment framework from the OECD and sustainable development strategies adopted by several countries and the European Union.

3.4.1 OECD – strategic sustainability assessment

The Organisation for Economic Development and Co-operation (OECD) has recently provided a comprehensive guide on sustainability assessment (OECD 2010). The guide presents a framework for evaluating sustainability assessment tools. A comprehensive list of 42 sustainable development impacts is shown in Table 1. Note the crosscutting impact category referring to certain attributes which are pertinent for impacts on sustainable development, such as distribution across population groups (e.g. rich/poor; present/future generations), spatial scale, and reversibility (see also Rio Declaration principle 15, Box 2).

This list could serve as a checklist of topics for NRAs to potentially consider in the adoption of a broad definition of sustainability, aiming to move beyond the level of the three pillars. Note that such list does not distinguish between the level of importance of each impact for sustainable development. This is however included in the sustainable development strategies, which we turn to next.

Table 1 General impact categories to consider in Sustainability Assessment (Sustainability A-test project, cited in: OECD 2010)

1 - Economic		3. Social/societal	
	1.1 Economic growth		3.1 Social cohesion
	1.2 Effects on public authority budgets		3.2 Employment quality
	1.3 Human capital formation and employment		3.3 Public health
	1.4 Economic cohesion		3.4 Health systems and security
	1.5 Innovation		3.5 Social protection and social services
	1.6 International performance		3.6 Consumer interests
	1.7 Market structure		3.7 Education
	1.8 Microeconomic effects on enterprises, non-profit organizations		3.8 Social capital
	1.9 Effects on households		3.9 Liveable communities
	1.10 Global partnership		3.10 Equality of opportunity and entitlement
2. Environment	2.1 Air, water, soil or climate		3.11 Culture
	2.2 Renewable of non-renewable resources		3.12 International co-operation
	2.3 Biodiversity, flora, fauna		3.13 Governance and participation
	2.4 Land use		3.14 Fundamental human rights
	2.5 Natural and cultural heritage		3.15 Security, crime or terrorism
	2.6 Waste production/generation or recycling		3.16 Ageing of society and pensions
	2.7 Human safety or health	**4. Cross-cutting Aspects**	Inter-generational effects
	2.8 The likelihood or scale of environmental risks		(De-)coupling
	2.9 Mobility (transport modes), or the use of energy		Adaptability
			(Ir-)reversibility
			Distributional effects
			Global dimension
			Spatial scale

3.4.2 Sustainable development strategies

One of the key strategic mechanisms for delivering sustainable development is national Sustainable Development Strategies (SDS).

In 2010, governments of 106 countries (plus the European Union) reported to have a national SDS adopted or in development. This included all of the SUNRA project countries (Netherland's SDS was reportedly still under development)[6]. These strategies generally build on the sustainability principles adopted in the global processes as described before, although the more concrete goals tend to reflect national political priorities[7]. These SDS' may play a more or less dominant role in national policy-making, and NRAs may be more or less aware of them. In the UK the national SDS has for example been translated into strategy documents for the Highways Agency (Kerwick-Chrisp 2010).

However, in Europe, the SDS of the European Union has a special position as it provides all member states within a common framework of principles, challenges and goals. The first EU strategy was adopted in 2001. After a major revision in 2006 and a reconfirmation in 2009, this document stands as the current European strategy.

A set of seven challenges and associated objectives are outlined in the EU SDS, as shown in Box 6.

Box 6 European Union Sustainable Development Strategy (SDS) (CEC 2006)

Challenges and objectives

Climate change and clean energy
Overall objective: To limit climate change and its costs and negative effects to society and the environment.

Sustainable Transport
Overall objective: To ensure that our transport systems meet society's economic, social and environmental needs whilst minimising their undesirable impacts on the economy, society and the environment.

Sustainable consumption and production
Overall objective: To promote sustainable consumption and production patterns.

Conservation and management of natural resources
Overall objective: To improve management and avoid overexploitation of natural resources, recognising the value of ecosystem services.

Public health
Overall objective: To promote good public health on equal conditions and improve protection against health threats.

Social inclusion, demography and migration
Overall objective: To create a socially inclusive society by taking into account solidarity between and within generations and to secure and increase the quality of life of citizens as a precondition for lasting individual well-being.

Global partnership
Overall objective: To actively promote sustainable development worldwide and ensure that the European Union's internal and external policies are consistent with global sustainable development and its international commitments.

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[6] UN DESA (2010). National Sustainable Development Strategies. [Last update: 4/15/2010] URL:http://www.un.org/esa/dsd/dsd_aofw_nsds/nsds_index.shtml
[7] A process to define global Sustainable Development goals was agreed upon at Rio +20

They include objectives for areas including climate change, sustainable consumption and production, natural resources, public health, and social inclusion, and also particularly for sustainable transport. As can be seen most of the emphasis of the strategy is placed on the environmental pillar of sustainability, although other pillars are also addressed. The strategy is monitored through a set of indicators which are reported bi-annually by EUROSTAT.

The set of challenges and goals of the EU SDS provides common directions for sustainable development policy in Europe. It could therefore also serve as a signpost for European NRAs aiming to define sustainability in a way that reflects political priorities. All of the EU SDS goals could be seen as related to what occurs in the road transport sector. Compliance with existing goals could serve as a basic level of aspiration. Adaptation to, or anticipation of future goals, could indicate a higher level of aspiration.

The specific sub-objectives within *sustainable transport* in this strategy are obviously of particular interest for European NRAs, and these will be discussed in section 4 of this report

It should be noted that the current EU SDS is not the most up to date of documents and is not necessarily the only relevant strategic framework contributing to defining sustainability at a European level. Other European strategies include climate action plans, environmental actions plans, and the overarching so-called 'Europe 2020' Strategy, emphasising that growth must be 'smart, sustainable and inclusive', where sustainable specifically means 'resource efficient, green and more competitive' (European Commission 2010). Specific transport and infrastructure policies are addressed in section 4.

3.5 Summary and recommendations

The review has stressed that fully understanding sustainable development requires the adoption of normative principles, the appreciation of scientific knowledge, as well as strategic action. Without any of these, sustainable development may be hard to achieve. Sustainable development must therefore be seen as a complex process in which these domains of enquiry are allowed to evolve and interact, rather than being likened to a race towards a predefined endpoint.

Normatively speaking, the most widely accepted and lasting outcome of the 'sustainable development' discourse so far is the assertion of the WCED (1986) according to which future generations' needs is to carry the same weight as the present ones in social and economic development. This is also named 'equity among generations'. While it may not be possible to specify what all future generations' needs will be, it is particularly recognised that there are environmental limits to which kinds of economic and social developments that can be sustainable, given existing technology. In this way the preservation of environmental systems and unique resources hold strong normative value, even if humans and their needs, and not the environment per se, remain at the centre of concerns for sustainable development (as reflected in Rio Declaration principle 1, United Nations, 1992).

It has become popular and convenient to summarise the requirements for sustainable development by the three pillars, representing the economic, social and environmental foundations of human activities. This 'triple bottom line' has some underpinning in normative, analytic as well as strategic domains of sustainable development enquiry, even if its origin is a bit unclear. It is recommended the NRAs follow the convention of adopting these pillars as part of the understanding of sustainability. However it must also be stressed that acknowledging the three pillars does not alone guarantee that actions become sustainable, since:

- The joint concern for present and future generations remains more fundamental.

- The three pillars are not independent in reality; impacts on one pillar may influence others.

- The institutional framework can strongly influence the balance among the pillars; an integrated and participatory governance approach should be pursued in order to minimise contradictory decisions and reinforce legitimacy.

At the *analytical* level, research has sought to identify and measure conditions that must be fulfilled to speak of development and/or sustainability in the various dimensions.

Conditions for *development* are primarily measured as improvements in conditions for human well-being, which have been studied and made operational in various economic, social, environmental, and other (including health and safety) terms and units. Some aggregate concepts of human development have been formulated, but more typically a variety of indicators are used.

Conditions for *sustainability* have often been proposed in the form of rules for maintaining critical resources, systems, or services that support human survival, livelihood or economic opportunity into the future. Examples are ecosystems, biodiversity, climatic stability, natural capital, man-made assets, human skills and knowledge, and others. 'The Natural Step' , and ecological economics are attempts to formulate relatively rigorous principles for environmental sustainability, 'Genuine Savings' is equally so for the economic pillar, while conditions for 'social sustainability' have proven to be particularly elusive to conceptualise and measure. An important observation is that scientific concepts for sustainability mostly apply to a 'systems' or macroscopic levels of interactions. This means that the 'sustainability' (or not) with regard to a local marginal impact, for example effects on wildlife of expanding a road may be impossible to establish. Nevertheless, impacts that may affect conditions for sustainability positively or negatively should be observed and measured with at least the same diligence as indicators of development, even if each impact may not infringe sustainable system level thresholds.

At the *strategic* level, policy concerns, goals, and strategies for sustainability have been formulated. These may form significant reference points also for NRAs; especially European strategies as common benchmarks for European NRAs. Climate change is one area where particularly strong efforts have been made to formulate important strategic goals. However these should not overshadow other significant sustainability concerns, such as resource efficiency, biodiversity, genuine savings, social inclusion, quality of life, social cohesion, etc. National and European Sustainable Development Strategies form such broader frameworks.

Finally, the recent notion of 'green growth' adds to the variety and potential power of strategic perspectives that NRAs could adopt. This notion points to potentially innovative and profitable investments which may be one way to foster higher synergy between economic growth, job creation, poverty reduction, and sustainability. However evidence of such feasible synergies is yet sparse.

All in all the following recommendations to NRAs are given:

- NRAs should begin by appreciating the fundamental components, namely the WCED definition, the notion of the three pillars, and the general significance of integrated and participatory governance as part of the basis for sustainable development, as noted above. These are the most well founded notions of sustainable development.

- NRAs should formulate a set of sustainability principles. Principles can serve to frame the selection of more specific topics to be concerned with and to shape subsequent strategies, choices and actions. The principles should build on the fundamental components above.

In its formulation of sustainability principles, the NRA should further consider especially the following elements:

- Reflect *why* the NRA currently wishes to engage with sustainability, for example:
  - Because of a voluntary commitment to aspirations for or principles of sustainable development;

- o Because of (existing or anticipated) requirements to comply with regulations or expectations of external bodies;

- o Because of expectations of gains (cost savings, innovations, 'green growth' opportunities; strategic advantages obtained via system transformations); or

- o Combinations of these or other factors.

- Take inspiration from concepts formulated in research, such as the strong or weak sustainability approach, carrying capacity, critical loads, life cycle view, quality of life, the Natural Step principles, Quality of Life, Genuine savings, etc., being aware of possible limitations to and contradictions between them.

- Consider which topic and impact areas within the present/future/three pillars scheme to focus on, taking particularly into account European (and national) level sustainable development strategies and goals, as well as own priorities. The European Union's Sustainable Development Strategy is currently the most prominent common strategic expression of key sustainability concerns and aspirations in Europe and should therefore be given particular attention in the present context. The EU SDS topics are illustrated in Figure 3.

The above refers to NRA engagement with sustainability as the most overarching level.

How to take into account sustainability issues particularly associated with transport and road systems will be addressed in the following sections 4 and 5.
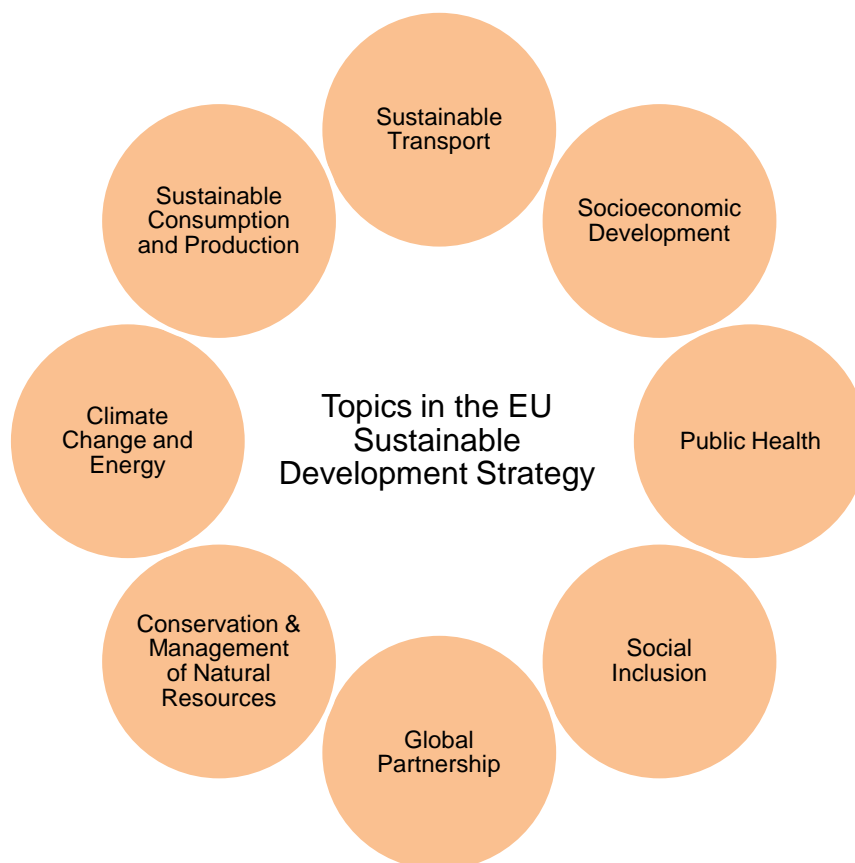
Figure 3. Topics in the EU SDS (European Council 2006)

4 Key observations on sustainability and road transport

4.1 Overview

This section will address ways to define and characterise sustainability of *transport and road systems*. Addressing this topic will provide an important stepping stone from the basic concepts of sustainable development discussed in section 3 to the sphere of road management discussed in section 5. The basis for the review is selected policy and academic literature.

Three topics are reviewed in this section, namely sustainable transport impacts, sustainable transport definitions, and sustainable transport policy.

Sustainable transport impacts: Section 3 identified a broad range of impacts associated with sustainable development in general. Section 4.2 will describe in what way transport systems contribute to sustainability impacts, and which particular sustainability impacts are associated with road transport.

Sustainable transport definitions: The identification of impacts does not in itself provide an answer to what a sustainable road transport system is. In section 4.3 we undertake a critical examination of some of the existing definitions of 'sustainable transport'; some of which are displayed in the framework as examples of inspiration to NRAs. However, rather than directly recommending any existing definition of sustainable transport, NRAs are advised to draw on the underlying principles, which are also identified

Sustainable transport policy: Sustainable transport is the headline of a 'new' policy paradigm that has shaped the transport agenda over the last two decades. This paradigm has relevance for NRAs for two reasons. First it seeks to place the road system in the wider context of planning for mobility and access in society. Sustainability cannot be achieved simply by improving the road network alone, it is argued. Secondly the European Union has proposed a set of specific transport objectives as part of its SDS; these can serve as a common reference for NRAs. This is addressed in section 4.4.

Section 4.5 provides a summary discussion and recommendations.

This section does not focus on which of the transport system impacts NRAs can or particularly should seek to influence, or which mechanisms NRAs have at their disposal to pursue sustainability. This is the subject of section 5.

4.2 Transport impacts

This section will introduce the logic of the concept of impacts, categories of transport impacts, and the interrelationships between transport systems and sustainability impacts. It will illustrate the extension and complexity of the links between transport and sustainability and finally identify overall transport system impacts according to literature.

4.2.1 Impacts and causal chains

In this report an 'impact' is understood as being an effect or consequence of something considered to be of some value or interest. The effected valuable entity can be called the target or *endpoint*. Impacts may also be referred to as *outcomes of interest* (Rand 2004) if the impact is the result of an intervention.

An impact can be seen as the final point in a *chain of causality* (Joumard & Gudmundsson 2010). The concept of the causal chain provides a simple stylised approach to structure the concept of transport impacts, which is explained in the following sections and illustrated in Figure 5.
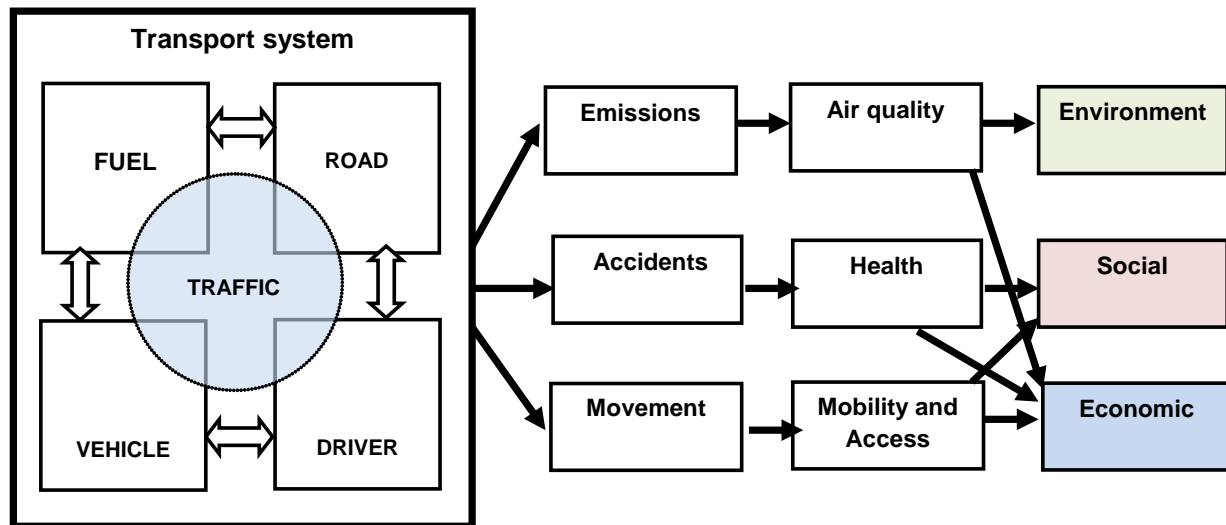
Figure 4 Simplified concept of 'causal chains'. The transport system generates traffic which causes some direct outputs (pressures/services), which then causes changes in certain valued endpoints, which can be classified more or less uniquely according to the three pillars of sustainability (own conception).

4.2.2 The transport system as a source

The starting point of the chain is the *source* of the impact. The *road transport system* can be seen as a source, or a group of sources of various positive as well as negative impacts.

A road transport system can more specifically be described as a system of interactions between vehicles, infrastructure and equipment, energy, and the drivers. The actual source of the impact can be one particular element in the transport system (e.g. the engine of the car making noise, or the road surface sealing off the soil). Most often the source is the interaction of several or all system elements, producing movement, traffic and subsequent effects.

4.2.3 Services and pressures

The source generates a *service,* which is a positive output from the system. The typical kind of service is some form of transport of persons or goods, but it can also be mobility (potential to move), accessibility, storage, or other services.

The transport system also generates *pressures*, which are a *negative output* from the transport system such as emissions, accidents, or waste, or *negative input* to it, such as material extraction, land take or – in the economic pillar - financial resources consumed.

The services and pressures lead to changes in the *state* of the transport system and in other systems surrounding it. Traffic builds up, persons are brought to destinations, pollution is accumulating in the air, accident risk levels rise or fall. These are intermediate state changes at or near midpoint in the causal chain.

4.2.4 Impact

The state changes may have an *impact.* As noted above impacts are the valued effects on the endpoint of the chain. While the change of state may be a mere fact, it is the impact that is ultimately of interest from a sustainable development perspective. Impacts can for example be positive, involving savings in time, cost or enhanced social interaction, or negative such as when noise or pollution is affecting health, or expenditures are depleting available funds.

Impacts on *development* (associated with improvement for the present generation) could be interpreted simply as any positive or negative increment due to a transport service in any endpoint of interest. For example, shorter journey times that increase wealth is a positive development impact, whereas more noise affecting well-being is a negative development.

Impacts on *sustainability* (associated with a long term systems perspective) are generally harder to specify and interpret. Environmental, social and economic endpoints may have thresholds or breakpoints. Overload of a pollutant may for example cause an ecosystem to collapse; cost overruns may cause a consortium to go bankrupt; shortage of fuel may trigger a major social disruption. Each of these types of impact is unsustainable in some sense, namely that they disallow the continuation of an activity. Each has its own unique response profile, recovery rate, etc. It is not possible to generalise such effects very much. Moreover, a small addition to the pressure on each of these categories may not trigger any collapse; hence each contribution to pressure may not be unsustainable per se. It is rather the sum or intensity of pressures or reliefs that matter. Positive contributions to sustainability may be interpreted as contributions that reinforce or save critical resources, whereas negative ones are further pressures on endpoints with a potential for extended or system-wide collapse. Endpoints that may suffer large-scale, near irreversible damage (such as the climate system) are generally a greater concern from a sustainability viewpoint, as the consequences are massive, destructive, and pervasive (Munasinghe and Shearer 1996).

4.2.5 Multiple chains

Causal chains are only isolated in theory. In reality they are intertwined as causal networks (Niemeyer and de Grout 2008). One source element (for example fossil fuel use) can have effects through different chains and lead to several impacts (for example contributing to climate change, air pollution and to a lesser degree soil contamination). Similarly, one type of impact (for example loss of biodiversity) can be the result of several sources in the transport system working through different chains.

Figure 5 illustrates the latter by the impact of traffic and infrastructure on the loss of biodiversity as traced through a range of causal chains, described in ecologic literature.
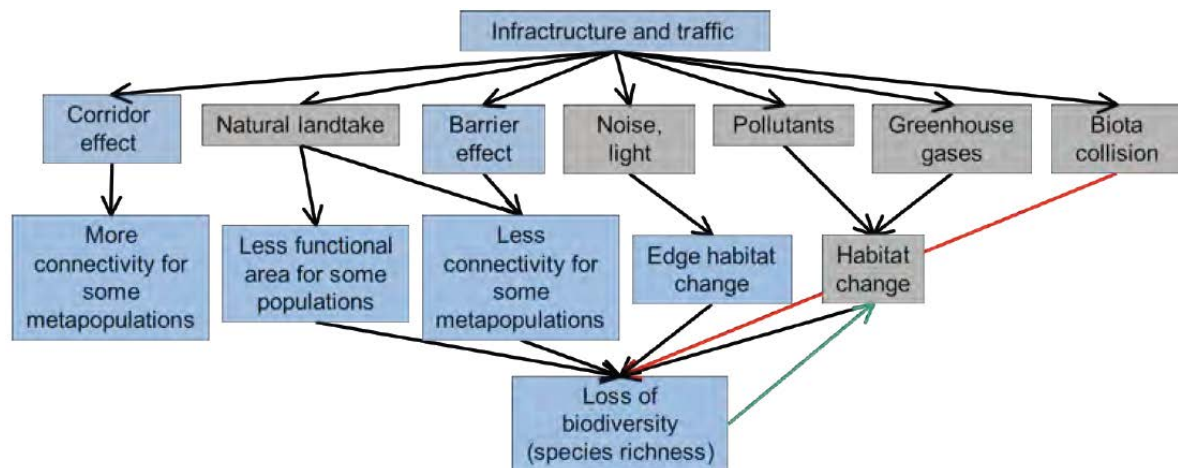
Figure 5: Illustration of impact causal chain concept for infrastructure and biodiversity (Ortega Pérez, in Joumard & Gudmundsson, 2010)

4.2.6 Life cycle perspective

It is obviously not only the operation of the road transport system (or the traffic) that creates impacts on development or sustainability. Each material element in the system goes through a life cycle from the extraction of raw material to production or construction, through use and maintenance to decommissioning or disposal. Each phase will involve its own causal chains with potential impacts on different environmental, economic and social endpoints. It could be

argued that the sustainability of the road transport system would ultimately depend on the interaction between and sum of all of these impacts.

A life-cycle view can be applied to individual system components (such as a road project) or to the whole system. At the component level there are standardised methods to evaluate environmental impacts using Life-Cycle Analysis (LCA), and economic impacts using Life Cycle Costing (LCC). More recently also social lifecycle assessment has been introduced, although this is (as yet) less standardised (Kloepfer 2008). Some NRAs are adopting a life cycle approach to project design, procurement, or maintenance strategies, often with a focus on key impacts such as climate change, material use or life cycle costs.

Figure 6 illustrates the multitude of interactions and impacts arising from looking at the whole transport system in a life-cycle perspective.

Figure 6: A life cycle perspective on road transport system impacts on environmental, social and economic endpoints (own conception for this report).
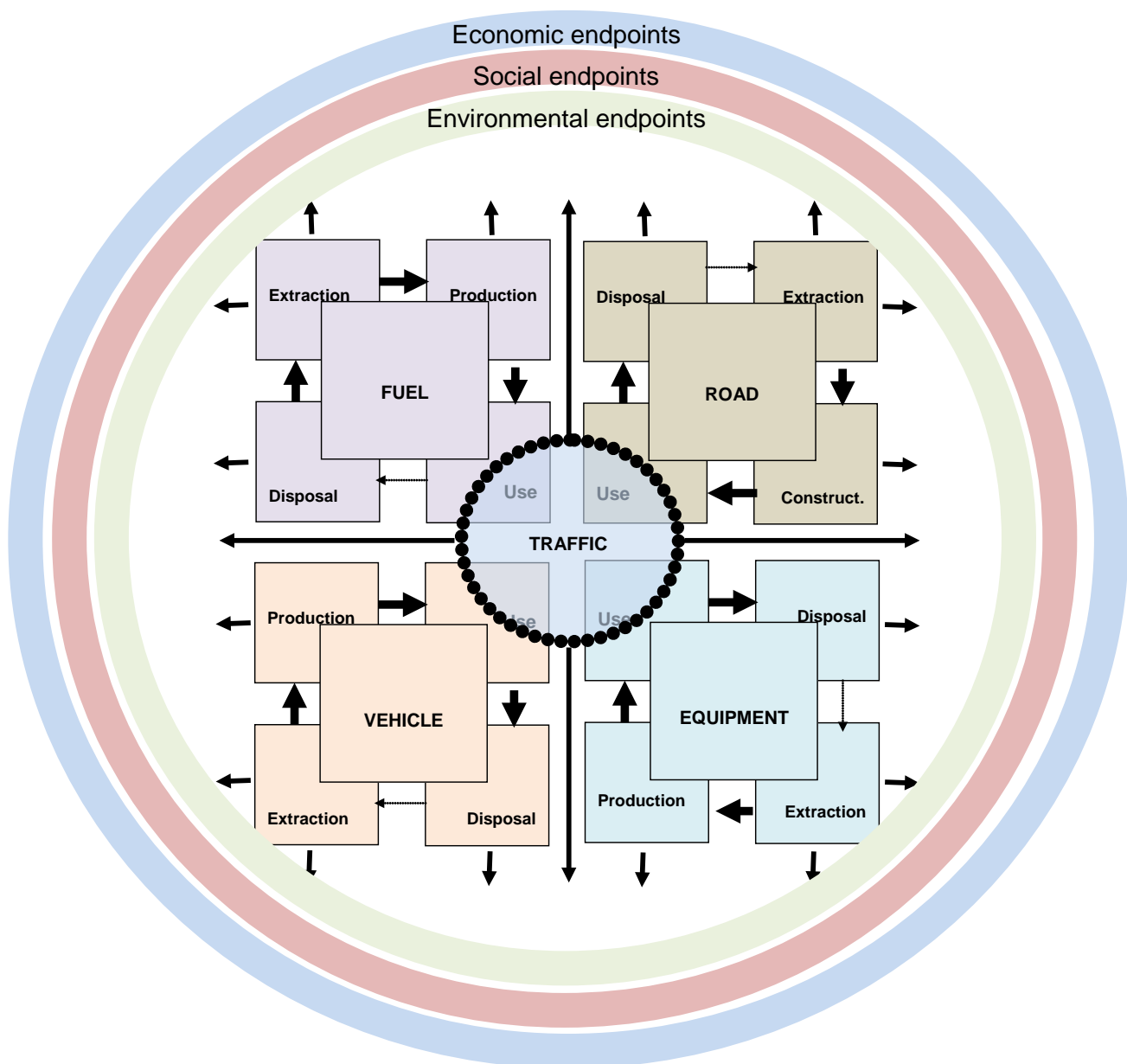
System level life cycle studies are much more complicated to perform and as a result rarely undertaken (see Chester and Horvath 2009 for an example). A full life cycle review of the road transport system as a whole for all three pillars could theoretically provide the most comprehensive basis for defining sustainability of the road transport system. However due to the considerable methodological difficulties involved, it would be extremely difficult to operationalise and follow-up on such a definition. Moreover NRAs would only have limited options to influence several of the causal chains involved anyway.

Not even the full life cycle systems view would necessarily provide a total picture of road transport sustainability impacts. There will also be *indirect* causation, where transport services produce changes in the activities of others sectors, which then again impact on additional endpoints. For example, transport induced housing development may lead to uptake of more land with impacts for biodiversity known as 'ribbon' effects on biodiversity (Dolan et al 2006), or positive economic agglomeration effects for example due to higher accessibility. Such indirect or extended effects of transport are not currently well understood, even if they may be highly significant from a sustainable development perspective.

Defining the sustainability of the road transport system will always be dependent on an assumption of system boundaries. However it is not absolutely clear what a proper system boundary would be from an NRA's point of view.

In this section 4 we focus on the direct impacts of the road transport system. However NRAs are advised to maintain an open view towards the wider systemic impacts that they may be able to influence (see section 5).

4.2.7 Transport system impact types

To provide an overview of which sustainability impacts most directly relate to road transport a simple three-step review was undertaken. The first step was to consult recent studies or synthesis on transport impacts addressing one or more of three sustainability pillars. A general list of three-pillar focussed impact endpoint categories was established by matching and aggregating the categories used in these studies.

The second step was to seek to characterise these impacts as to whether they affect the present or the future generations (or both). A horizon of 25 years was assumed to form the distinguishing point. The assessment is indicative, based on subjective judgment.

Finally, it was noted whether the impact of the transport system was negative or positive. In most cases this is obvious, but in several cases the impact can go both ways, and the net effect is not known. This assessment also has a subjective basis. Note that the evaluation does not consider the outcome of *interventions* to the transport system, such as to build a by-pass or introduce emissions limits. The studies consulted were the following:

- Litman & Burwell (2006); on sustainable transportation.

- COST 356 (Joumard & Gudmundsson 2010) with a detailed identification of environmental impacts of transport systems including 49 so-called 'impact chains'.

- COST 350 (Calderon et al 2009), identifying indicators of relevance for strategic environmental assessment of traffic and transport infrastructure.

- SUMMA (Rand Europe 2004), which aimed to define a comprehensive set of indicators for sustainable transport across all three dimensions for the EU level.

- The ERANET ROAD2 project SBAKPI (Bond et al 2012) identifying key strategic impacts of road transport systems in the social and environmental domain; and

- The NCHRP 708 project on sustainable transportation performance indicators (Zietsman and Ramani 2010).

Table 2 to Table 4 list the impacts identified in the overall impact categories which are mentioned, after overlaps have been eliminated. These impacts will need to be taken into account as by NRAs as they start to define sustainability. It should be noted that within each general impact category there will also be several specific impact subtypes, which are not considered here.

Table 2. Major environmental impact categories of transport and sustainable development

ENVIRONMENTAL		
Impact type	**Sustainable development endpoints**	**Sign of impact**
Noise	Present	Negative
Air pollution (humans)	Present	Negative
Air pollution (nature)	Present/Future	Negative
Climate Change - transport impact on climate (mitigation-related) - climate impact on transport (adaptation-related)	Future Future/Present	Negative Negative/Positive
Soil and water pollution	Present/Future	Negative
Land take	Present/Future	Negative
Habitat fragmentation	Future	Negative
Non-renewable resources	Present/Future	Negative
Waste	Present/Future	Negative
Cultural heritage/visual intrusion	Present/Future	Negative
Invasive species due to transport	Future	Negative
Light pollution	Present	Negative/Positive

Table 3 Major economic impact categories of transport and sustainable development

ECONOMIC		
Impact type	**Sustainable development endpoints**	**Sign of impact**
Accessibility as an economic function	Present	Positive
Transport operation costs	Present	Negative
Transport facility costs	Present/Future	Negative
Productivity/Efficiency	Present/Future	(Positive)
Costs and benefits to the economy	Present/Future	Positive/Negative
Affordability	Present	Positive/Negative
Economic viability	Present/Future	(Positive)

Table 4 Major social impact categories of transport and sustainable development

SOCIAL		
Impact type	**Sustainable development endpoints**	**Sign of impact**
Accessibility as a social function	Present	Positive
Safety	Present	Negative
Health and fitness	Present	Positive/Negative
Livability	Present	Negative
Social cohesion	Present/Future	Positive/Negative
Diversity	Present	Positive/Negative
Security	Present/Future	Positive/Negative

The impacts are presented here at a relatively high level of aggregation. Each one may be broken down to more detailed levels at earlier stages in the associated causal chains, or aggregated to higher-level endpoints. NRAs may find it useful to redefine, split or aggregate these impact categories in various ways. However, the most common impacts that are potentially relevant for road system sustainability are represented in the impact categories, which could therefore serve as a point of reference for NRAs' sustainability definitions.

The listing may seem biased towards the environmental pillar (which has more impacts listed). This rather captures a greater variety of impact endpoints in this pillar, but is also a reflection of the different scientific approaches. Economic analysis tends to use a more unified measurement framework, whereas social sciences generally have less developed conceptualisations of sustainability. The number of impacts does not indicate relative importance.

Detailed descriptions of the impacts can be found in the references listed above.

4.3 'Sustainable transport' definitions

4.3.1 About defining the sustainability of road transport

Having looked at the logic of road transport system impacts in general, and having identified and classified a broad range of these impacts with regard to the three pillars and the two dimensions of present and future needs, we will now address how to potentially define what sustainability of transport systems is.

Numerous definitions of 'sustainable transport' have been proposed in policy and academic literature. However there is limited agreement on how valid any of the existing definitions actually are, how helpful it is to try to define 'sustainable transport' in the first place, and whether a common definition of it could ever be conceived (Nijkamp et al 2004).

The problem has been pinpointed by David Greene in the following way:

> "*Sustainability pertains to the responsibility of an entire generation of society to future generations; whether it can meaningfully be applied to a single area of human activity such as transportation has been a subject of debate. That is, sustainability must be satisfied by the integral activities of a society and so, in this sense, it is not possible to judge whether one sector of society is sustainable on its own" (*Greene 2001).

The message here is that transport is only a (small) part of society. Sustainability is determined by what road transport and several other sectors jointly do to society and its environment. This obviously makes it difficult to evaluate the sustainability of transport 'in itself', and to hence define it meaningfully.

However, it is hardly more meaningful to avoid the concern for sustainability at a lower level than 'society as a whole', since each sector obviously *does* contribute to this whole. A definition can therefore – rather than assuming that transport is isolated - be a reflection of these contributions; that is, how for example the road system should behave with regards to those impacts that are of general importance for sustainability and those goals that have been set for them (see section 3). With a subtle distinction we could suggest that defining the *sustainability* of (road) transport would be more appropriate than defining '*sustainable road transport*'. However, as we shall see it is more often the latter terminology that is used.

4.3.2 Reviewing ways to define sustainability of transport

In the following section a few of the many definitions that have been proposed by policy making institutions, researchers, think tanks and others are critically reviewed. The purpose of the review is not only to collect examples to provide inspiration for NRAs but also to inform NRAs of the 'colouring', limitations, or even distractions that some definitions may entail.

The following parameters, derived from the overall principles identified in section 3, are used in the assessment of each definition:

(1) Does the definition address development (needs of the present) jointly with sustainability (needs of the future)?

(2) Does it cover one or more pillars of sustainable development (environment, social, economic; even institutional)?

(3) Does it suggest holistically embracing wide system impacts or does it focus narrowly on the transport system?

(4) Does it help feed into integrated strategies and implementation?

OECD 1996: One of the earliest and most influential definitions of sustainable transport was made by the OECD for its project on Environmentally Sustainable Transport (EST) in the second half of the 1990's. A sustainable transport system was initially defined as one that:

"Does not endanger public health or ecosystems and meets mobility needs consistent with (a) use of renewable resources at below their rates of regeneration and (b) use of non-renewable resources at below the rates of development of renewable substitutes" (OECD 1996)*.*

This definition is based on the strong sustainability principles, as presented by Herman Daly and others, which do not allow the trade-off of natural capital with other goods (see section 3.3.1). These principles are here applied directly to the transport sector, assuming that each sector must follow the same principles to become sustainable. The focus is primarily on the environmental pillar although 'mobility needs' are recognised. Environmental concerns for both present and future generations are loosely covered. This definition was subsequently transposed into quantitative limits for a number of direct environmental impacts of the transport system and these were then used as part of a large scenario exercise, where hypothetical national strategies were evaluated for their environmental sustainability (OECD 2000). Hence the definition was linked to strategies, but did not address the institutional dimension and was not followed by implementation.

The OECD also organised a major international conference on sustainable transportation in 1996 (OECD 1997). A wide review was undertaken in a variety of fields pertinent to defining, measuring and planning for sustainable transport. Definitions were discussed but a common one was not adopted. Instead a set of *principles* was put forward to guide decision-making in a way so transport could become (more) sustainable (see Box 7).

Box 7 Draft Principles for Sustainable Transportation (OECD 1997)

Principle #1: Access. People are entitled to reasonable access to other people, places, goods and services, as well as responsible information that empowers them towards sustainable transportation.

Principle #2: Equity. Nations, states and the transportation community must strive to ensure social, interregional and inter-generational equity, meeting the basic transportation-related needs of all people including women, the poor, the rural, and the disabled. Developed economies must work in partnership with developing economies in fostering practices of sustainable transportation.

Principle #3: ***Individual and Community Responsibility***. All individuals and communities have a responsibility to act as stewards of the natural environment, undertaking to make sustainable choices with regard to personal movement and consumption

Principle #4: ***Health and Safety.*** Transportation systems should be designed and operated in a way that protects the health (physical, mental and social well-being) and safety of all people, and enhances the quality of life in communities.

Principle #5: ***Education and Public Participation***. People and communities need to be fully engaged in the decision-making process about sustainable transportation, and empowered to participate. In order to do this, it is important that they be given adequate and appropriate resources and support, including information, about the issues involved, as well as the benefits and costs of the array of potential alternatives.

Principle #6: ***Integrated Planning***. Transportation decision makers have a responsibility to pursue more integrated approaches to planning.

Principle #7: ***Land and Resource Use***. Communities should be designed to encourage sustainable transportation and enhance access, as a contribution to providing comfortable and congenial environments for living. Transportation systems must make efficient use of land and other natural resources while ensuring the preservation of vital habitats and other requirements for maintaining biodiversity.

Principle #8: ***Pollution Prevention.*** Transportation needs must be met without generating emissions that threaten public health, global climate, biological diversity or the integrity of essential ecological processes.

Principle #9: ***Economic Well-Being.*** Taxation and economic policies should work for, and not against, sustainable transportation, which should be seen as contributing to improvements in economic and community well-being. Market mechanisms should support fuller cost accounting, reflecting the true social, economic and environmental costs; both present and future, in order to ensure users pay an equitable share of costs.

The 'principles' take inspiration from wide areas of the sustainability debate (i.e. from pollution to equity to education), as well as key concerns in transport policy making. It is a somewhat peculiar mix of principles for things to protect or provide ('Access', 'Health and safety'), things to regulate ('Land and resource use'...) and principles for activities ('Community responsibility', 'Integrated planning', 'Pollution prevention').

The principles cover the present and the future dimension, the three pillars and also the institutional side. It is noteworthy for being quite comprehensive and holistic, albeit conceptually disorganised. The OECD principles are widely referred to in literature; however the extent to which they are applied in strategic practice is not well known.

The Centre for Sustainable Transportation: The Centre for Sustainable Transportation in Canada synthesised the OECD contributions into the following definition (Gilbert 2005):

"*A sustainable transportation system is one that:*

- *Allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations.*

- *Is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy.*

- *Limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise.*"

This definition is much more comprehensive compared to the OECD EST one, in terms of covering impacts within all the three dimensions and taking into account impacts during the present as well as in the future. It includes economic parameters such as 'affordability', 'efficiency' and a 'vibrant economy', in addition to social ('access needs', 'safety', 'human health', 'choice of modes') and environmental ones.

The definition refers to *access* needs in an effort not to elevate transport or mobility demand to *needs* as such, thus inviting a more strategic planning approach. Its 'system boundary' is nevertheless primarily the transport system with inputs and outputs. The definition is transport-centred to the extent that the transport sector is even required to reuse and recycle its own waste. There is no agency or institutional perspective; the criteria address sustainability conditions in the transport system, not how it is managed.

The European Union: The European Union had previously committed to sustainable transport and mobility, but had failed to define it. The Canada-based definition was recognised and reviewed by a European Union appointed expert group. The group proposed a definition only very slightly modified with respect to the Canadian one. This was then adopted as an official policy statement at the highest political level, namely the European Council in 2001 (see Box **8**).

Interestingly the EU has never applied this definition to much in its policy work, not putting it into its goals or indicators. Neither was it connected to the work in the Sustainable Development Strategy, (SDS), nor followed up in the same way as the strategy was. This demonstrates that a definition may serve more of a symbolic function than an operational one.

Box 8**: European Council (Transport and Telecommunications) (2001)**

A sustainable transport system:

"Allows the basic access and development needs of individuals, companies and society to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations.

• Is affordable, operates fairly and efficiently, offers a choice of transport mode and supports a competitive economy, as well as balanced regional development

• Limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land and the generation of noise."

The definitions developed in the EU and Canada have nevertheless both been widely cited, and used or modified by a broad range of organisations, including road and transport authorities around the world (Gilbert 2005).

NYSDOT: The New York State Department of Transportation (NYSDOT) is one of those organisations that have adopted but also further modified the Canadian/European definition (Nelson et al 2011).

An important nuance is that the NYSDOT definition does not speak of a 'sustainable transportation system' but of 'a transportation system which supports a sustainable society'. This corresponds very well to the recommendation for a holistic approach given in section 4.3.1. Another refinement is that the NYSDOT definition assumes an active obligation to seek to *improve* the environment, not only to protect it; the transport system...

"....Protects and preserves the environment by limiting transportation emissions and wastes, minimizes the consumption of resources and enhances *the existing environment as practicable."* (Nelson et al 2011; emphasis added)

The modification also means that original 'strong sustainability' language, referring to "the planet's ability to absorb" emissions and waste, and the use of resources "at or below the rates of development of renewable substitutes" are abandoned.

Most important perhaps is that the definition is connected to a comprehensive agency wide effort, where sustainability is incorporated into management at the strategic, tactical and operational levels, including its incorporation into vision and mission statements, agency strategies, and extending to the tool GreenLITES used for sustainability rating of individual projects.

Sweden: A quite different approach to defining sustainable transport has been adopted in transport policy in Sweden. Rather than defining sustainable transport as such, the overall aim of transport policy itself is defined as "...to ensure the economically efficient and sustainable provision of transport services for people and businesses throughout the country" (Ministry of Enterprise and Communications 2009). This objective is broken down into two objectives, the so-called F*unctional objective of* Accessibility, and the *Impact objective to protect health, safety and environment*. These objectives are further broken down into seven and five sub-goals respectively, as shown in Box 9. Some of the objectives have quantitative targets.

Box 9: Sweden's transport political goals (Ministry of Enterprise and Communications 2009)	
FUNCTIONAL OBJECTIVE: Accessibility	**IMPACT OBJECTIVE : Health, safety and environment**
Travel for people will be improved through increased reliability, security and convenience. Transport quality for the business sector will be improved and will strengthen international competitiveness. Accessibility will be improved inside and between regions as well as between Sweden and other countries. The working methods, implementation and outcomes of transport policy will contribute to a gender-equal society. The transport system will be designed to be accessible for people with disabilities. Opportunities for children to travel independently and safely using the transport system, and be present in traffic environments, will be enhanced. Public transport, pedestrian and cycling options will be easier to choose.	The number of road fatalities will be halved and the number of serious injuries will be reduced by a quarter between 2007 and 2020. The number of commercial shipping and pleasure boat fatalities will be reduced continuously and the number of serious injuries will be halved between 2007 and 2020. The number of rail and air fatalities and serious injuries will be reduced continuously. The transport sector will contribute to the achievement of the environmental quality objective, reduced climate impact, by gradually increasing energy efficiency in the transport system and decoupling from dependence on fossil fuels. By 2030, Sweden should have a vehicle fleet that is independent of fossil fuels. The transport sector will contribute to the achievement of other environmental quality objectives and lower levels of ill health. Priority is given to the targets of environment policy where the development of the transport system plays an important role in the achievement of the set objectives.

The definition and objectives cover all three dimensions although they focus more on the social and environmental ones than the economic one, which is only addressed in one or two sub-goals. This seems somewhat unusual in transport policy. The time horizon is specified for some sub-goals, referring mostly to the present generation, but for instance goals to turn the Swedish transport sector fossil free and contribute to fulfil environmental quality objectives will also arguably benefit the future.

The goals are monitored and followed-up in annual reports to the Government and Parliament of Sweden, and they are also required to be used by transport agencies such as the (former) Swedish Road Agency, and the (present) Swedish Transport Agency in their strategies and business plans, where they are broken down to annual performance measures in connection with the budget appropriations. In this way the definition serves both a 'system condition' and the 'agency' level. The definition and overall objectives are mostly transport centred, but require transport authorities to collaborate with environmental authorities in fulfilling several environmental objectives.

4.3.3 A comprehensive summary review

Hall (2006) provided a comprehensive academic review of sustainability and transport definitions. He conducted a synthesis of several of the existing definitions into one joint definition structured according to the three dimensions as they would apply to a transport agency. He divided the definition into separate components that each could be elaborated and reinforced with specific indicators, targets and possibly intervention points. The outcome is shown in Table 5. Halls definition is the most comprehensive attempt found, in terms of including various impacts across the dimensions and pillars.

Table 5: Components in a definition of sustainable transport for a transport agency (Hall 2006)

Environment	
Health & environmental damage:	Minimizes activities that cause serious public health concerns and damage to the environment
Standards:	Maintains high environmental quality and human health standards throughout urban and rural areas
Noise:	Minimizes the production of noise
Land use:	Minimizes the use of land
Emissions and waste:	Limits emissions and waste to levels within the planet's ability to absorb them, and does not aggravate adverse global phenomena including climate change, stratospheric ozone depletion, and the spread of persistent organic pollutants
Renewable resources:	Ensures that renewable resources are managed and used in ways that do not diminish the capacity of ecological systems to continue providing these resources
Non-renewable resources:	Non-renewable resources: Ensures that non-renewable resources are used at or below the rate of development of renewable substitutes
Energy	Is powered by renewable energy sources
Recycling	Reuses and recycles its components
Equity/Society	
Access	Provides access to goods, resources, and services while reducing the need to travel
Safety	Operates safely; ensures the secure movement of people and goods
Intra-generational equity	Promotes equity between societies and groups within the current generation, specifically in relation to environmental justice
Inter-generational equity	Promotes equity between generations
Economy	
Affordability:	Is affordable
Efficiency:	Operates efficiently to support a competitive economy
Social cost:	Ensures that users pay the full social and environmental costs for their transportation decisions

Hall however also critiques this very effort of seeking to define 'sustainable transport' as being too 'transportation centred'. This approach overlooks the significance of interactions with other sectors and misses the opportunities for strategic thinking and action outside the normal and limited set of transport policy variables assumed in Table 5.

Hall therefore recommends the adoption of a broader set of principles (see Table 6). As opposed to the 'bare' definition of sustainable transport the principles also address the institutional dimension describing principles for governance directly applicable for practice (Hall 2006). Also included are principles urging the transport agency to be pro-actively seeking new business opportunities and collaborations, thus anticipating the 'green growth' debates (see section 3.2.6).

Hall concludes that both 'transportation-centred' and 'holistic' approaches have advantages and disadvantages. The former is useful because it can help to define sustainability criteria/goals directly for transport decision-making, while the holistic approach is more 'correct' in deriving sustainability at the level of society as a whole, which however also makes it harder to apply in transport decision-making (more complex information is required).

Table 6: Principles to guide decision-making with regard to transport (Hall 2006, p 478)

Environment	Society	Economy	Governance
Adopt - A precautionary and preventative approach to decision-making **Avoid** - Irreversible impacts - Global climate change - Pollution **Encourage** - Remanufacturing/reuse and recycling of transportation vehicles and equipment **Ensure** - The proper disposal of transportation related toxic materials and waste **Protect** - Habitats/ecosystems and operate within their assimilative and regenerative capacities - Biodiversity - Environmental Aesthetics	**Enhance** - Safety - Human health - Social wellbeing/ quality of life **Promote** - (Equity/distributional Fairness) - Access and choice - Environmental justice - Individual and community responsibility - Meaningful employment in the transportation sector	**Ensure** - Transportation services are affordable - Transportation is cost-effective - Natural and financial resources are used efficiently - Negative social and environmental costs are internalized - i.e., the polluter pays principle **Support** - Trade and business activity that enhances productiveness and contributes to development	**Encourage** - Technological innovation **Ensure** - Transparency and accountability - Public and stakeholder participation **Establish** - Goals and performance objectives **Support** - Comprehensive and long-term planning - Interagency and international cooperation - The integration and co- optimization of policy

It will be a recommendation to NRAs that the principles summarised by Hall be used for the process of defining sustainability as part of the framework.

4.4 The 'sustainable transport' paradigm

Before concluding this section we will briefly highlight some important strategic perspectives regarding the definition of sustainability for NRAs, which are offered from the so-called sustainable transport (or sustainable mobility) paradigm[8]. The main messages are the need to widen the scope for action above the level of infrastructure provision, and an invitation to consider what NRAs could do to contribute to a shift in the balances in the transport system as a whole. A concrete focal point is the sustainable transport goals defined by the European Union as part of its SDS.

Significant literature on the strategic implications of sustainability for transport planning, policy and management is now available. In his seminal paper, Banister (2008) suggests that sustainability entails a fundamental challenge to current transport planning, requiring a 'new approach'. Table 7 explains the main differences between the conventional and the new sustainable mobility paradigms.

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[8] Sustainable mobility is sometimes understood as having a wider reference than 'transport'; involving not only actual movements of passengers and goods (transport) but also the potential or capacity to move. 'Mobility' therefore tends to suggest a wider strategic scope that involves also activity patterns, land-use, cultural issues, virtual mobility etc.

Table 7 Contrasting approaches to transport planning according to Banister (2008)

'Conventional approach'	'Sustainable mobility approach'
• Physical dimensions	• Social dimensions
• Mobility	• Accessibility
• Traffic focus, particularly on the car	• People focus, either in (or on) a vehicle or on foot
• Large in scale	• Local in scale
• Street as a road	• Street as a space
• Motorised transport	• All modes of transport often in hierarchy with pedestrian and cyclist at the top and car users at the bottom
• Forecasting traffic	• Visioning on cities
• Modelling approaches	• Scenario development and modelling
• Economic evaluation	• Multi-criteria analysis to take account of environmental and social concerns
• Travel as a derived demand	• Travel as a valued activity as well derived demand
• Demand based	• Management based
• Speeding up traffic	• Slowing movement down
• Travel time minimisation	• Reasonable travel times and travel time reliability
• Segregation of people and traffic	• Integration of people and traffic

The main assertion is that a hitherto dominant focus on technological and infrastructural improvements is no longer sufficient to solve transport problems and make transport sustainable. The risk that further expansion of the networks may induce further demand is strongly noted (Banister, 2011 Goodwin 2005). Emphasis is put on the need to plan for alternatives to increased demand for car travel. Transport policy and planning needs to 'manage demand rather than 'promote' it (Schiller et al, 2010; Himanen et al 2004).

According to this paradigm, sustainable transport policies must involve four types of actions, namely:

- Reduce the need to travel (fewer trips);

- Encourage modal shift (away from the car).

- Reduce trip lengths; and

- Encourage greater efficiency in the transport system (including technical efficiency, environmental efficiency, increased load factors etc.).

The overall paradigm is supported by a number of scenario studies on climate change and low-carbon transport strategies (Banister 2011; Bakker and Huizengha 2010; EEA 2010; Dalkmann and Brannigan 2007). According to these studies effective policies combining 'Avoid-Shift-Improve' measures need to be adopted, where:

- 'Avoid' refers to avoiding the need to travel, e.g. by the integration of land use and transport policies.

- 'Shift' refers to shifting travel to the most efficient mode, which may be non-motorized, public, rail, or water transport; and

- 'Improve' refers to existing motorised transport, to be improved through introduction of less fuel and carbon-intensive engines and fuels.

Other studies point to a need for a more developed participatory framework, because such combined strategies are likely to be more complex and controversial, than simply expanding the networks. Meunier (2012) emphasises that finding sustainable transport solutions cannot

be reduced to a traditional process of 'mono-thematic optimization' as in cost-benefit appraisal or an 'impact minimization' as in environmental assessment. Rather it is "...a search for paths where the main balances of the dynamic system would be more likely to be maintained or strengthened..." (Meunier 2012 p 3071).

The World Road Association (PIARC) emphasises similar points in their study on how to apply the concepts of sustainable development to road transport (PIARC 2007). Taking account of sustainable development for roads differs from impact studies, sustainability needs to be addressed at an early stage of development, such as the level of policies, plans and programs, and not just projects. The aims of sustainability can only be achieved through a set of enlightened and negotiated compromises jointly considering environmental, economic and social impacts. The way towards integration must go through a thorough interactive participatory effort to discover viable solutions.

4.4.1 The European policy level

As already noted 'sustainable transport' has been adopted at the European level of policymaking. This underscores the broader significance of this paradigm.

In section 3 of the report, the goals of the European Sustainable Development Strategy were suggested as a possible basis for a common focus for European NRAs in their adoption of a sustainability approach. The same is considered here for the sustainable transport part of this strategy.

In the sustainable transport chapter of the SDS the EU has adopted some of the ideas in the sustainable transport paradigm including the concern for managing rather than stimulating the growth in transport volumes, expressed a need to 'decouple' economic growth from transport growth, and the aim to shift passenger transport from road and air to public and no-motorised modes.

There are 8 goals in the 'sustainable transport' strategy as illustrated in Figure 7. Some of the goals have quantified targets associated with them and they are all monitored and regularly reported by EUROSTAT.

It can be noted that the set of goals represents only a narrow selection among the many of sustainability impacts presented in Table 2 – 4. The EU SDS goals have a priority to focus on environmental impacts such as climate change, noise and pollution, safety in the social pillar, and then economic goals for public transport efficiency, decoupling, and modal balance. Notably the economic goals hardly acknowledge the traditional function of NRAs as providers of increased capacity in the road transport sector. One interpretation of this is that NRAs would need to adjust their role so they emphasise more what they can do support public transport, and limit the transport volumes if they are to contribute to sustainability, in exact accordance with the propositions in the sustainable transport paradigm. To engage with these new goals NRAs would likely need to partner with other agencies and wider groups of stakeholders. It is recommended that NRAs keep these strategic directions in mind when they define sustainable transport, and in particular consider the sustainable transport goals of the EU SDS, which are in principle common aims across EU member states.
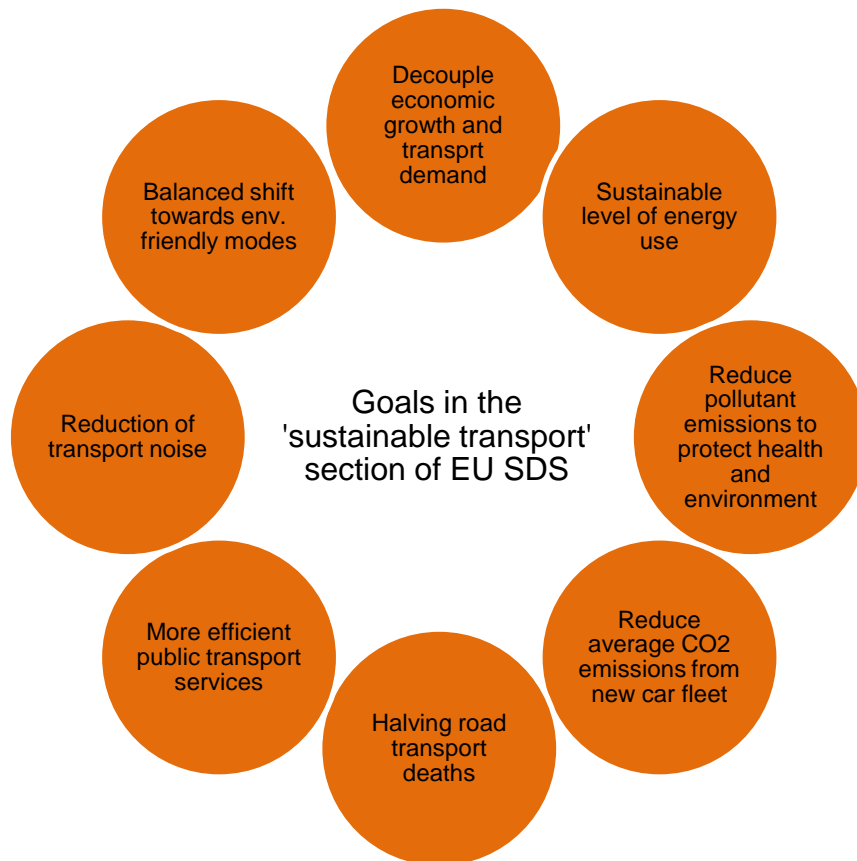
Figure 7: Goals for sustainable transport in EU SDS (Council of the European Union 2006).

It should be noted that more recent transport policies have been proposed with slightly different priorities (European Commission White Paper 2011). Emphasis on traffic safety, CO2, and multi-modality remains strong, while less emphasis is put on decoupling. In addition there is more focus on European networks and ICT. Current strategies for sustainability in the transport sector would likely seek to reflect these latest developments.

4.5 Summary and recommendations

Road transport systems consist of a number of components (infrastructure, vehicles, fuels and drivers) that interact to jointly produce movement and traffic. The movement provides a range of positive services to society which supports its development and potentially its economic and social sustainability. At the same time the construction, maintenance, operation, and disposals of each of the transport system components require economic and environmental inputs that consume resources and produce a broad range of negative pressures on the environment. While an overall logic for the linkages between road transport systems and sustainable development can be established using concepts such as causal chains, sources, pressures/services, endpoints, impacts and a life-cycle view on environmental, social and economic factors, the altogether numerous positive and negative impacts involving dynamic and indirect effects outside the transport sector render the total contribution to sustainable development from transport over time to be highly complex to establish. This also raises severe challenges for defining sustainability for road transport systems and eventually NRAs. What scale and system boundary to consider? Which impacts are important? How to define 'sustainable transport'?

A simplified approach which focuses on contributions from the road transport system to impacts related to sustainability and development is recommended. 27 categories of positive and negative impacts of transport were identified from the literature, covering impacts for the present and future generations distributed across the three pillars. Since road transport is

only one of the sectors contributing to each impact it is not obvious that specific 'sustainable' levels exist for each contribution to the impact. The contribution should be considered with regard to the desirable direction of change for the impact endpoint (increase/decrease) while special attention should be given to impacts where general critical limits in jeopardy. Endpoints that may suffer large-scale, irreversible damage (such as the climate system) are generally a greater concern from sustainability point of view. When adding 'transport context' to their general sustainability definitions NRAs should be aware of and consult the list of the 27 impact categories, although NRAs may not find all of them significant, or may wish to aggregate or further disaggregate them along the causal chain of each impact.

NRAs are nevertheless also advised to consult existing definitions of 'sustainable transport'. These may serve as sources of inspiration as they are often the results of some degree of contextual analysis, while they can also be instructive in terms of possible limitations NRAs may wish to consider whether any existing or new definitions:

- Address development jointly with sustainability concerns?

- Cover all pillars of sustainable development?

- Holistically embrace wide system impacts or focus narrowly on the transport system?

- Help feed into integrated strategies and implementation?

Finally the 'sustainable transport' policy paradigm provides a context that invites NRAs to consider their role for sustainability in a broader sense, beyond designing, constructing and maintaining road networks. Sustainability of the transport system may require efforts to manage mobility and even reduce the need for transport. In this regard it is strongly emphasised, also by road sector organisations, that NRAs engage with other stakeholders at an early stage in the planning process before particular solutions or projects have been defined. NRAs may take such strategic considerations into account when shaping their definition of and approach to sustainability. More specifically, the European Union's SDS section on sustainable transport defines eight goal areas that may serve as a minimum or 'core' set of issues to refer to in this regard.

5 Key observations on sustainability and road management

5.1 Overview

This section will address ways to map the impacts that a road system can have to various functions of an NRA. This will help identify and discuss the key roles NRAs play in relation to sustainable development. This is the final step in completing the review of literature forming the foundations for the framework.

A general illustration of the problem has been developed as part of SUNRA Framework Part 2, as illustrated in Figure 8. The figure suggests an almost inverse relationship between the environmental/social impacts of a road and the influence of an NRA. The bulk of the impact is caused by road use, which NRAs cannot influence very much. In contrast the NRA has strong control over its own office buildings etc., which however only have a minor impact. These relationships will be explored further in this section.
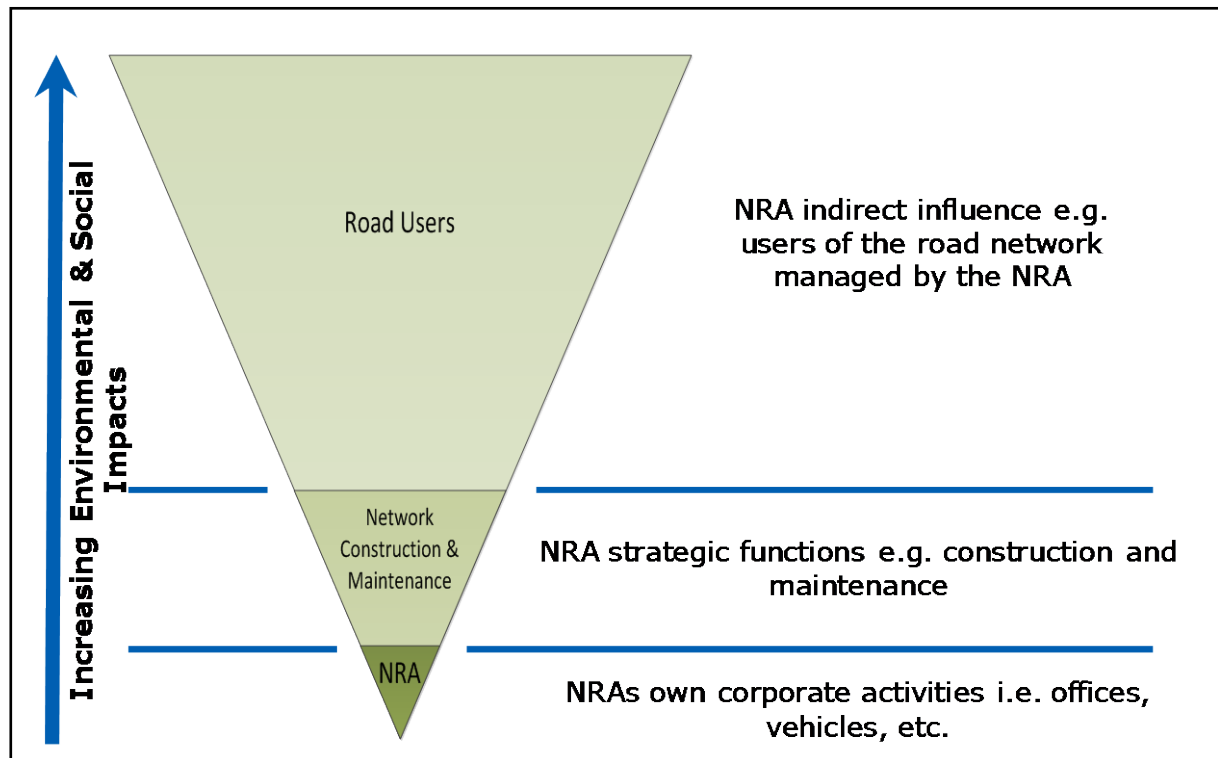

Figure 8 NRA levels of influence (from SUNRA Framework Part 2)

Section 5.2 will suggest a general conceptualisation of the linkages between organisations such as NRAs and sustainability, divided into three distinct categories, namely attribution of impact, influence, and responsibility.

Section 5.3 presents a review of different perspectives on road management and the functions of NRAs, including planning levels; governance issues and the project life cycle will be described. An overall integrated schematic for these functions will be developed.

Finally in 5.4 a 'mapping' exercise that seeks to link organisational and planning levels to aspects of sustainability will be conducted. This should help to indicate relevant channels of influence. It must be noted, however, that knowledge is not available in this area to provide such 'maps' in any detail. The exercise is nevertheless useful for considering how to implement an NRA's sustainability definitions.

5.2 General interrelationships – attribution, influence, responsibility

The linkages between NRAs and sustainable development are conceptualised here as three levels of interrelationships, called impact, influence and responsibility.

The *first interrelationship* is based on the causal chain concept (see section 4). This refers to the (material) impacts an NRA's assets and activities have on environmental, social, and economic endpoints and thereby eventually sustainability. The NRA's assets are principally the road network, pavements, bridges etc. These are constructed, used, maintained and operated and thereby affect their surroundings. Often the NRA asset (say a particular stretch of highway) is only one out of several sources that affect sustainability (say, for wildlife in the area). The impact on sustainability depends on the *significance* of the effect, and then the *share* of the total effect attributable to the NRA assets, as part of total impact. The *attribution* is important because the role of the NRA depends on how much impact is objectively attributable to an NRA's assets or activities as understood within a cause and effect context.

The *second interrelationship* addresses how NRAs can *create* positive or *minimize* negative impacts, or otherwise foster change towards sustainability. This is conditioned by the resources, capacities and mandates an NRA has, as well as by the creativity, commitment and support it is able to mobilise. This interrelationship is named *influence*, because it sees the NRAs as an acting subject with intentions and strategies, rather than as a mechanical cause and effect system (as in the first interrelationship). Obviously the influence is not solely determined by the NRAs intentions. It is conditioned by the objective relationships (objective attributions), as well as by factors in the context of the NRA, such as economic conditions, political priorities, and mandates given to the NRA.

Obviously, there is not a total disconnect between these two interrelationships, but a certain degree of correspondence. An NRA influences the impacts it has through its assets or activities, such as replacing crash barriers to maintain safety, or shifting to a renewable energy source for lighting. The magnitude of the impact is however not necessarily proportional to the influence. An NRA asset may be an objective contributor of a certain impact, which the NRA however currently has no mandate, resources or capacity to influence. For example the road network owned by the NRA is a major cause of mobility-induced services to users, but also of greenhouse gas emissions. Yet, an NRA may have little or no mandate to for example substantially restrict access to this network, should it wish to do so. Conversely, vehicle emissions taking place outside of the NRA network may not be attributable to it. Nevertheless it may be able to influence these emissions, for example by joining general campaigns to limit driving during air pollution incidents in an area. Whether an NRA is objectively attributable in each of these cases or not, should be discussed.

The 'overlap' can be thought of as the part of the *attributable* impact that the NRA can *influence*, which can be called its area of main concern or its *responsibility*. This responsibility may be more or less clearly specified, for example in legislation or mandates, but this is not necessarily the case. The responsibility as understood here is not always an objective fact, but something that may be discussed, adopted, imposed, or negotiated.

The suggested terminology is intended to emphasise a distinction between impact and influence, and to reserve the term 'influence' to forward looking measures of improvement.

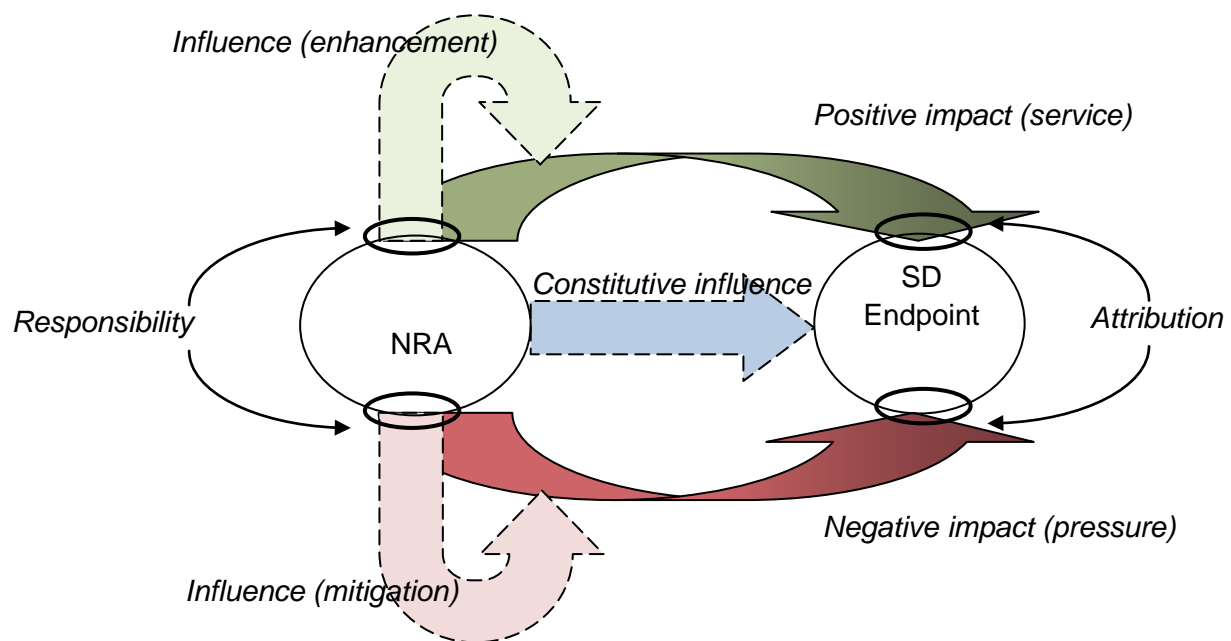The linkage concepts are illustrated in Figure 9.

Figure 9. Suggested terminology to characterise interrelationships between NRA possessions or activities and sustainability impacts.

5.3 The roles, functions and activities of NRAs

As noted the responsibilities of an NRA with regard to road management contribute to defining which aspects of sustainability it can influence, how, and by how much.

NRAs are however not identical across countries in terms of for example responsibilities, organisational structures or available delivery methods, not to mention goals and objectives. The distribution of responsibilities to NRAs has also developed considerably over time (ECMT 2004, PIARC 2004). There is no common 'model' describing what exactly an NRA in Europe does, or how it does it.

The following sub-sections provide different perspectives on the NRA's roles and functions before an overall scheme is devised.

5.3.1 Road management in general

Road management' can be used as an overall term for the types of activities to which a NRA is mainly committed. The Department for Transport in the UK uses the term road management for "improvement, development, maintenance and operation of the road network"[9].

Road management is the primary responsibility of an NRA, with regard to the network owned by national (or sometimes regional) governments.

The principal purpose of the road network has traditionally been considered as providing access and mobility. The predominant vision has been to bridge the gap between needs and satisfaction, by building and extending roads (ECMT 1997).

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[9] URL: http://www.dft.gov.uk/topics/road-management

Lay (2009) presents an updated and wider scope for NRA responsibilities (see Figure 10). The provision of facilities to meet future travel needs remains a key task, but so does minimising the need for property acquisition, saving of construction costs, saving of maintenance and operation costs, and maintaining road condition. The functions extend even further to ensuring that the road system meets non-transport objectives for community welfare, the environment and sustainability. Some NRAs also have some responsibility for vehicle and traffic regulations, or are integrated into multi-modal administrations. Decentralisation to regional level management also seems to be a widespread trend.

Figure 10. Road administrations' contextual organisation, adapted from Lay (2009)

CEDR, the European Road Directors' organisation, emphasises NRAs increasing role in reaching political goals set by governments (Ingvarsson and Holmen 2008). Currently goals most commonly include traffic safety, environmental improvements, increasing accessibility and mobility, and effective road management in order to ensure value for public money (reduced service life costs).

Another significant change is the growing utilisation of private contractors, partnership consortia or alliances for delivering key strategic functions such as the building, operation, or maintenance of networks or projects. Several of these functions may be integrated. A reduction in cost is often a key driver for these practices.

Hence a dual view on NRAs seems appropriate (Figure **11**). On the one side they constitute distinct organisational units with an often well-defined asset base as well as clear mandates to plan, design, procure, maintain, operate, and monitor road networks. On the other hand NRAs share responsibilities for the transport systems and its performance with other bodies, and they increasingly need to be open towards external partners, clients, users, goals, etc.
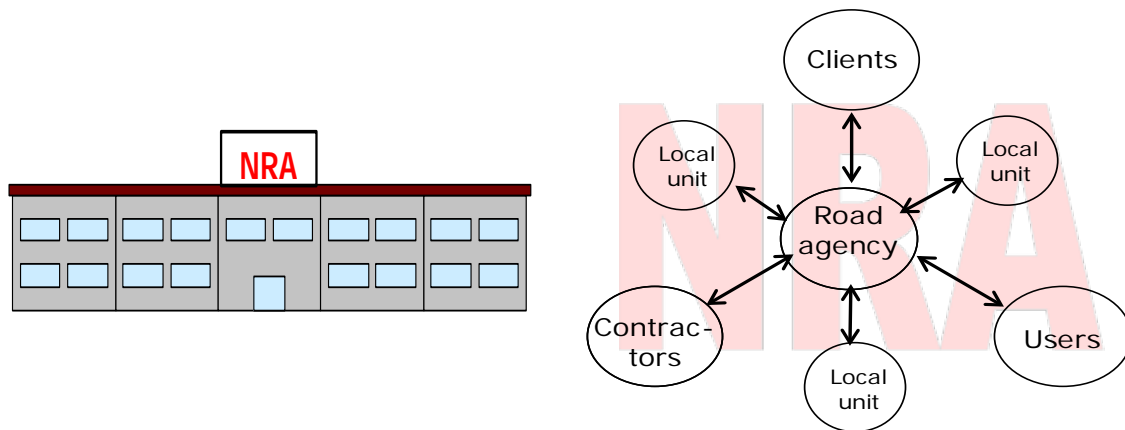
Figure 11**: Illustrating two views of an NRA – unitary and relational**

5.3.2 Levels of decision-making

The shared responsibilities are also evident from a hieratical view on road and infrastructure development. The most classic distinction is between policy, planning, programming and project levels (although these categories are in fact not always used in the same way).

The World Road Association PIARC places road management within a broader framework of strategic and policy planning (PIARC 2003). At the strategic level deliberations over issues like transport CO_2 emissions and public transport versus highway construction take place. Accessibility and landscape are addressed at the planning and programming level, while more specific environmental impacts are dealt with at the project level (see Table 8).

Table 8 Levels of road decision-making concerning sustainability with examples (PIARC 2003)

	Typical Examples	Typical Audiences	Typical Issues
Strategic and policy	• Long range transport plan defining travel • modes and corridors	• Public • Community groups • Environmental groups • Business community	• Transport contribution to greenhouse gas • Provision of public transport versus motorways
Planning and programming	• Planning study for a specific corridor to be developed in the future • Prioritisation of multiple projects for budget purposes	• Community groups, environmental groups, business leaders and affected businesses	• Accessibility for industry and commerce • Landscape and habitat fragmentation
Project	• Specific transport project to be constructed in the near future	• Neighborhood groups • Local businesses • Environmental groups • Travellers	• Local impacts such as traffic noise and affects on air quality • Road safety • Inconvenience to commuters during construction

The PIARC report emphasises that the involvement and integration of the values and needs of the public in road transport decision-making is the cornerstone of sustainable transport decisions. For road projects the participation by the community is seen as important as managing the technical sides of a project (PIARC 2003, p 77).

Similar observations were made by experts gathering at a workshop on sustainable infrastructure in Washington DC in January 2012 (Volpe/DVS 2012). It was emphasised that planning for sustainability must occur both strategically and operationally and that there is a need to connect those levels. Strategic considerations on sustainability include elements such as definitions, mission statements, programs, goals, and standards, while operational considerations for sustainability planning include tracking progress and measuring performance.

5.3.3 Management and governance levels within the NRA

Decision-making hierarchies are also essential features within NRAs. A structure for the decision-making that fits reasonably well to several NRAs includes the three levels, 'Board', 'Program' and 'Project' (see also SUNRA WP2, Deliverable 4).This structure and what each level broadly involves is set out in Figure 12.
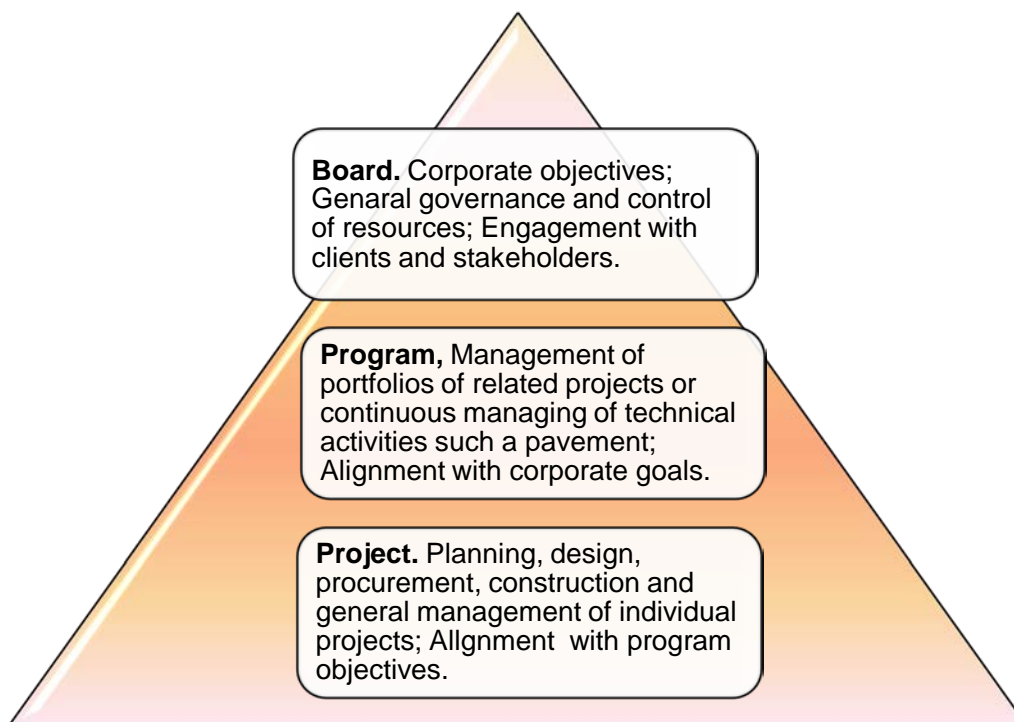

Figure 12. Levels of NRA management and governance.

The **board** is the top level of the agency which usually has control of the management, property, business, funds and any other resources. It often works under some form of annual performance-based scheme with the client/owner (government) and is conducting its management through strategic and business level plans defining the obligations, strategies, performance targets, and procedures of the NRA. Oversight over the programme level is another key function. The board may be executive, non-executive or advisory with a corresponding variety in its formal clout (World Bank 2011).

The **programme level** manages strategic areas of specialised ongoing activities, such as bridge maintenance or road safety, or groups of similar or related projects. Programme management has been defined as 'coordinated organisation, direction and implementation of a portfolio of projects and activities that together achieve outcomes and realise benefits that are of strategic importance' (Cabinet Office 2011). Prioritising among projects and delivering on strategic objectives of the organisation are key tasks at this level.

The **project level** concerns the planning, design and construction of individual road projects, as well as maintenance projects. The project level also needs to align with programme

objectives. The project level includes large scale projects which are often complex and have multiple impacts, and possibly network effects, as well as smaller, more limited projects.

At each level, there is growing attention not only to management but also to the *governance* of projects, programmes and the corporate level. This is not least due to experiences of widespread and occasionally massive cost and time overruns for major projects across the world, largely due to inadequate management frameworks (see e.g. Flyvbjerg et al. 2003). This emphasis on governance is not related to the technical side of projects but to the structures and processes for how decisions are made and how performance is controlled, in order to ensure programme and project delivery and performance according to requirements.

Dunovic defines project governance as the area where corporate governance and project management meet and integrate (Dunovic 2010). The board may therefore assume the overall responsibility for the governance of project management in the organisation (although obviously not the management itself). Key to successful project governance includes availability of necessary skills, experience, resources and tools, and a clear identification of accountability for performance toward program and corporate levels.

What emerges from this view is a hierarchical relationship within an NRA but also a strong need for integration to ensure delivery and performance. It is clear that for sustainability to be taken into account in a governed road management context, the notions need to be represented as clear principles, goals and performance measures within the governance framework of an NRA. Well-integrated governance architecture may on the other hand conceivably provide an expedient mechanism for the 'injection' of sustainability into the organisation in general, provided it is entered from the higher (Board) level, and the frameworks are adequately integrated.

5.3.4 Project life cycle

Finally the project life cycle is an essential component in a road management framework. It partly overlaps with the hierarchical decision models, but it is just as much a physical and material process as it is a management one. The possibilities for influencing sustainability vary greatly among the different stages of the process.

The actual project stages followed by NRAs vary between countries and may include numerous in-between posts and checks. The following general stages are often distinguished (combining models from Potutec and Lang 2004; Lay 2009; Highways Agency 2008, and Zietsman and Ramani 2011). For each of the stages or for several of them jointly, contractors, partnerships or alliances may be conducting the actual work.

- Strategic conception. This concerns the pre-project stages where problems, needs, concepts and projects ideas are reviewed. It may involve road project analysis as well as maintenance or other alternatives. To move to the next phase will usually require the definition of a clear, geographically localised project option.

- Project planning and programming. The project is developed, alternatives are investigated, including route selection and dimensions. Project impact assessment is conducted. The project may be subject to programming where timing of investments and works for the project is phased into a portfolio.

- Design. Detailed requirements for project performance are specified. Detailed design is undertaken with regards to alignment, material, equipment, environmental mitigations, pedestrian facilities, etc.

- Construction. The road is physically built, including excavations, landscaping, leveling paving, drainage, possibly also vegetation, noise barriers, wildlife crossings etc.

- Use/operation. The road is open for traffic and used by motorists etc. Traffic is managed, e.g. with congestion mitigation or incident management.

- Maintenance. Road pavements, bridges and equipment are maintained, replaced or recycled as needed according to resources and priorities.

- Decommissioning. Road surface may be partly decommissioned; roads may be downgraded and potentially taken out of service, if an alternative has been put in place.

5.4 Mapping sustainability to the wider road management area

The different perspectives on road management discussed in section 5.3: Decision-making, management and governance, and project life cycle, offer different sets of entries to the work on sustainability. An attempt has been made to fit all of them into a more overarching comprehensive view, as shown in Figure 13. The purpose is to 'map' the various options in a coherent way.

At the upper left hand side the overall governmental functions are included, such as general sustainability and transport policies. Towards the lower right hand side the practical NRA functions are included, such as road maintenance and network operations. The columns represent the distinctions between governance, management and project life cycle view on road transport. The rows are generally tiers of decision-making.

The red colouring suggests areas which could be key concerns for the *attribution* view on road transport and sustainability (see section 4). This means areas where the focus is to identify direct or indirect impacts of the road transport system or projects, emphasising the project life cycle or use of the road network.

The blue colouring suggests areas where strategic possibilities to *influence* sustainability may be concentrated. This means NRA functions or activities where there are major opportunities to plan for sustainability, and integrate it into frameworks for subsequent steps in this direction, in connection with conception, planning, design, construction, etc. The emphasis is particularly at the governance level, since governance is conceived as the 'regulatory framework' for delivering performance within the respective activity areas.

The area of 'tools' is emphasised for its essential functions to both types of mapping.

The chart should assist an NRA in defining how it wishes to implement its definition of sustainability.

Both types of processes – impact analysis; influence mapping - should be undertaken, connected within an overall approach. Attention should be given to uncovering impacts as well as creating influence mechanisms, and ways to align these to one another for maximum results.

Road management in an integrated context				
1 Overarhing Frameworks	**2 Road Governance Level**	**3 Road Managem. function**	**4 Road Project Life Cycle**	**5 Tools etc**
Sustainable development strategy national/EU level	**Government level**			
Sustainable transport policy (multimodal)				
National Road policy	**Board/Corporate level**	**Road network and business strategy**	**Pre-project**	
	Program level	**New major road program**	**Project conception**	**Inventories**
		Asset managem. program		**Management systems**
		Operations program		
Government-wide Assessment and Procurement Frameworks	**Project level**	**New road project**	**Project planning**	**Appraisal tools**
			Project design	**Procurement contracts**
			Project construction	
		Pavement maint. project	**Maintenance**	**Design manuals**
		Bridge maint. Project		
		Equipment maint.project		**Reporting Frameworks**
			Decommissioning	
	Operational level	**Traffic and incident management**	**Network operation**	
		Office & fleet managemant		

Figure 13 integrated view on road management

5.5 Summary and recommendations

NRAs are key organisations within a wider transport and road management area. There are considerable differences between NRAs in terms of how their specific roles and functions are organised. NRAs' management activities are usually clearly divided into levels between the board level and strategic areas such as programme and project development. A sustainability definition is most logically adopted at the board level, from where it can be filtered and contextualised further into each programme area.

The project life cycle is a dominant feature in road management along with network management and other functions. NRAs assets can have *impacts* on many economic social and environmental endpoints of potential significance for sustainability throughout the project life cycle. NRAs can *influence* sustainability impacts through a range of governance and

management mechanisms, which may be only partly corresponding to the types and levels of impacts associated with the assets. NRA *responsibility* for sustainability reflects attributable impacts, as well as available influence.

In order to prepare, adopt and implement a definition of sustainability an NRA is generally recommended to:

- Identify and measure the sustainability impact performance associated with their assets and activities along the project cycle, to identify significant positive as well as negative impacts.

- Identify key influence levers and intervention points for instigating change towards sustainability goals adopted at European, national and agency level, and to maintain desired levels of performance.

- Seek ways to align influence mechanisms to significant impact endpoints.

- Seek ways to expand capacity of influence in critical impact areas, through for example negotiation of mandates, acquisition of new resources, and development of tools, procurement strategies, training, or strategic networking.

An important overall message to re-iterate is the significance of the involvement of the board level. The board obviously has the opportunity to govern the other levels, and to 'govern how they are governed' including which overall principles, goals and priorities that trickle down into lower tier frameworks through measures such as principles, goals, resource allocations, scorecards etc.

For the sake of wider sustainable transport objectives it is recommended that the board also considers exercising its influence through engagement in the overarching governance of sustainable transport policy and the instigation of strategic pre-project conceptualisation efforts (as indicated in section 4), although this may be out of scope for the board level in some countries/NRAs.

A way to conceptualise the opportunities to influence sustainability is provided in Table 9 where available vehicles or 'mechanisms' of influence are grouped in the four categories of mandates, resources, priorities and activities. Each of these mechanism categories will somehow conduct, enhance or constrain influence, and each will provide opportunities for specifications of sustainability.

Mandates may for example require the NRA to report on certain (sustainability) issues; NRAs are normally involved in negotiating such mandates. *Resources* such as skills may be available to measure and report certain impacts or may have to be procured or developed; *Priorities* may be expressed as goals or principles the NRA aspires to achieve and which are basically at the discretion of the Board; and *activities* will involve numerous procedures (such as programming or procurement) that could be adapted to support sustainability practices such as life-cycle analysis or stakeholder involvement in project ranking.

Ideally, these mechanisms would be aligned to reflect a common overall understanding and definition of sustainability. If not so, the implementation of such an understanding is likely to be barred by diversions or dead ends.

On the other hand any definition of sustainability would obviously have to consider limitations stemming from exiting mandates, resources, priorities and activities, even if the strategy forward will involve efforts to adjust, expand or negotiate any of these.

Table 9. Examples of influence mechanisms that will enable or constrain an NRA in realising and implementing any understanding of sustainability

Mandates	Resources	Priorities	Activities
Requirements by law/legal requirements	Road assets	Mission/vision statement	Strategic planning
Requirements instated in steering documents by clients	Funding sources and levels	Corporate values	Programming
Strategic decisions by the Board	Personnel	Goals	Major construction projects
	Skills/knowledge	Objectives	Networks maintenance
	Office buildings, equipment	Principles used for selection, trade-off and prioritisation	Operations
	Tools		Corporate activities
	Networks (social, technical, policy)		Communication

6 Workshop

As mentioned in section 2.5 a workshop was conducted in order to supplement the information drawn from literature.

The workshop, where stakeholders and experts, including NRA staff were invited, was held in the early phase of the framework development process. The specific aim was to solicit viewpoints on how to design a framework for defining sustainability, which assumptions it should be based on, and which factors to be aware of in its applications. Issues were introduced for debate in the workshop presentation.

6.1.1 Workshop presentation

The introductory presentation covered two main components.

The first component addressed was *Sustainability concepts, terminology and definitions.*

There are a number of definitions of sustainability and sustainable transport available. Some are well received and accepted (e.g. the Brundtland definition, and the 'three dimensions'); others are new or more disputed. Few are directly applicable to NRAs without some adaptation to context. A literal definition of 'a sustainable NRA' is not the only possible approach; other useful defining elements include ones such as sustainability principles, goals, and impacts/outcomes.

The second component dealt with *mapping sustainability concepts to NRA anatomy and context.*

NRAs have a number of typical tasks and responsibilities, which are delivered through accompanying organisational designs and procedures. In addition they have crucial relations to external partners, such as government departments, contractors, and users. NRAs have similarities in these regards but are far from identical in function or organisation. Each element of NRA responsibilities, functions, activities, and organisational units may be potential carriers of some aspect of sustainability. It is therefore relevant to consider various ways to look at NRA 'anatomy' and context as different points for 'anchoring' overall definitions of and commitment to sustainability.

Based on these two themes the participants were invited to:

- Consider the relevance of various ways to define sustainability.

- Consider ways to look at NRA anatomy and context.

- Consider ways to connect these in a suitable way; and

- Suggest ideas, experience, or material to include in the framework.

6.1.2 Workshop discussion

The discussion centred mostly on the second and third question, although other important topics were also raised. The strongest discussion nodes proved to be the following:

- How can sustainability be anchored in the NRA?

- Challenges and risk factors.

- The wider roles of an NRA in sustainability.

The exact wording of comments is not reported, although the following section provides a summary of the discussion.

How can sustainability be anchored in the NRA?

It was emphasised that sustainability should connect operational practice on the ground to the strategic level. The notion of sustainability needs to be firmly anchored in practice to have

influence. The question is where to start. Each level has its own tasks and therefore their own issues with sustainability.

Starting from the board level could mean that the notion would be better received throughout the organisation. Focus could be on seeking to change the values or culture of the organisation, and then to work downwards toward specific practice areas. A way to allow that could build on lead principles to streamline a view across the organisation.

An opposing view was that there are enough high level statements already that do not get implemented on the ground in practice. Such statements may not obtain buy-in at the design or operational levels. In this view it could be necessary to involve the project level more from the start. Sometimes it can even be an advantage if initiatives do *not* come from the top. Engineers look at what the building standards say; this is where engineers start when asked what they think about sustainable development.

Yet again it was recognised that a harmonised integrated view across the organisation can hardly arise without involvement and some steerage from the board level.

It was observed that follow-up with performance measurement is important to keep sustainability in focus. One agency reported having recently re-written a strategy applying the notion of sustainable development without this leading to current measuring of this aspect, which meant it was likely to lose momentum again.

NRAs are not all at the same level, and some may be unsure how ambitious it is advisable and feasible to be. A stepwise approach was recommended to find a starting level of ambition above what is legally mandated but still realistic. The 'ladder of sustainability' (idea) was proposed as a stepwise upgrading toward higher ambitions and better accomplishments throughout the organisation, building on experience from more limited efforts.

In terms of the whole road network level it was suggested that maintenance and management are becoming more important as many countries do not have much construction taking place. There is a need to pay more attention to the impacts of the further cycle stages rather than just the impacts of the initial construction.

Procurement is an important option to consider. However, it was observed that a risk involved in relying on procurement is to only get the solutions that are asked for, not what could possibly be developed. NRAs need to be careful so as to defining specifications in a way that is clear while still allowing for innovation. NRAs can significantly influence contractors through the procurement processes.

Challenges and risk factors

The overall problem is that sustainability is a broad topic that easily gets lost in a process where several specific requirements from clients, suppliers and stakeholders compete for attention, commitment and resources. Sustainability can easily end up being perceived as the responsibility of 'someone else', as opposed to more specific topics, which are easier to take ownership of. Accounting for carbon dioxide emissions alone will for example be comparably easier than for sustainability as a whole.

A related challenge is how to define sustainability in a few words. The risks seem to be to either oversimplifying it, or losing coherence with too many words, or watering down.

The social side of sustainability is the hardest to define, and it may be a difficult area for NRAs to address. However, it is important that they consider how their activities impact on this side of life, not least considering equity and justice

The wider role of NRAs in sustainability

A possibility is to involve stakeholders in the discussion of how to define sustainability. This raises the question of how the process to define sustainability of an NRA should actually be.

A wide open approach may well lead on to a discussion about whether road building is always the right thing with respect to sustainability. The question was raised if NRAs could

become more like advocates for sustainable transport, and consider such strategic issues more extensively than is the case today, or if they should stay close to their traditional role. It was noted that it may be hard for NRAs to assume a broader political role if the client/government is not interested in the advice from NRAs in such matters.

Notwithstanding this it was noted that NRAs could engage in such broader issues as part of strategic planning; for example addressing whether to improve public transport, improve existing roads, or build new roads in particular cases. Such options would be included in for example concept studies to compare projects with alternatives before they are started, rather than necessarily assuming the need for a new road project in advance. Such kinds of reviews are even a requirement within the mandates of some NRAs today.

6.1.3 Workshop summary

Generally the discussion did not question the relevance of sustainability for NRAs. A number of opportunities, challenges and possible limitations to adopting a definition and providing a common framework were indicated.

The predominant view was that a sustainability concept should be comprehensive for the organisation and its activities. A definition should not only be adopted at a general level but also used to inform the different activity areas within the NRA and the NRAs relations to stakeholders, clients, contractors etc. This suggests the engagement of the Board and strategic level staff.

Mechanisms, such as strategic documents (mission, vision, goals etc.), engineering standards, and procurement contracts, especially on the maintenance side, could be important vehicles to carry a sustainability definition further into the organisation. The link to practice; 'something useful', seems crucial. A 'ladder' approach, meaning that an NRA should be helped to climb from a simpler to a more elaborate application of sustainability, was especially recommended.

The discussion thus ended with an open question as to how strict and structured a definition framework should be. There was a wish for something flexible, stepwise and open to NRAs at different stages. Yet a definition should be true to sustainability principles, and able to help NRAs to move beyond more general statements only, that is to assume a degree of rigour.

One important observation is that sustainability discussions may be difficult to maintain in a vigorous state over a longer period of time when there are competing agendas or shifting political priorities. This suggests a framework should be developed that in itself does not require a long time effort before a definition is adopted - although of course the rationale for the framework itself would be to anchor the notion of sustainability firmly – and irreversibly - within the organisation over a long time.

The following section 7 describes how the material from the literature review and the input from the workshop were used in the final conception of the framework.

7 Providing a framework for defining sustainability

7.1 Overview

This section restates what a framework is understood to be, revisits the challenges associated with defining sustainability for NRAs, presents the elements of the framework that will assist NRAs in this process, and explains how it is to be applied.

The section also addresses how to fulfill the four requirements to the framework specified in the project brief (although in a revised order), namely to:

- Specify fundamental sustainability principles.

- Identify the major sustainability impacts a road or road system can have.

- Address how to map the impact that a road or road system can have to the various roles and functions of an NRA; and

- Address strategic choice options and trade-offs connected with aggregation across impacts or dimensions.

The framework itself is contained in the accompanying document "Sustainability Definitions for NRAs – Framework Part 1 FRAMEWORK".

7.2 The concept of sustainability frameworks and definitions

According to the notion of a *framework* derived in section 2.2 it is to be understood as a set of interrelated conceptual and procedural elements used to shape and guide thinking and practice and thereby help to bring consistency between various strategies and interventions.

A *definition of sustainability for NRAs* is more than a semantic definition of the term sustainability; it is to be seen as a *strategic commitment* an NRA would make to adopt and pursue a certain understanding and definition of sustainability, and to implement this understanding within those areas of activity and those levels of aspiration where the NRA can and wishes to make a difference. Definitions should therefore not stand alone but must become part of the NRAs general governance and management frameworks.

A '*framework for definitions of sustainability*' is a set of interrelated conceptual and procedural elements to help NRAs accomplish this. The elements enables an NRA to recognise important sustainability principles and notions, to develop their own definition, taking into account strengths and weaknesses of already available ones, and to commit to its implementation through review and adjustment of existing frameworks and practices.

The framework is *successful* if NRAs feel:

- Inspired and able to enter and evolve the definition process.

- Informed of what needs to be included in the definition.

- Confident in making their strategic commitment to sustainability; and

- Empowered to use the definition to identify an appropriate scope and level of ambition for its sustainability efforts.

It is also useful if the framework helps to build a shared understanding across European NRAs, thereby enabling NRAs to share experience, add value, and jointly formulate a clear position with regard to sustainability nationally and in Europe.

7.3 Challenges in defining sustainability for European NRAs

The analysis of literature and workshop uncovered a number of challenges that the framework ideally needs to be able to address. The challenges are here divided into three levels: context, definition, and framework.

Context level challenges

NRAs are at widely different stages with regard to the adoption of a common understanding of sustainability. There are differences in the national policy priorities, the responsibilities and organisational features or in the individual NRAs, the physical and economic conditions of the road network assets themselves, and most likely the NRAs own interests in making a strategic commitment to sustainability.

These different positions suggest that there are several different possible routes towards such an adoption if and when it occurs. Each route would reflect different angles, filters, emphasis, or blind spots to the understanding of sustainability, for example if shaped by environmental policy frameworks, climate strategies, transport assessment schemes, stakeholder input, or general governmental performance management systems.

Figure 14 is an attempt to illustrate some of this variety of perspectives and trajectories through which a NRA could travel when developing a definition.
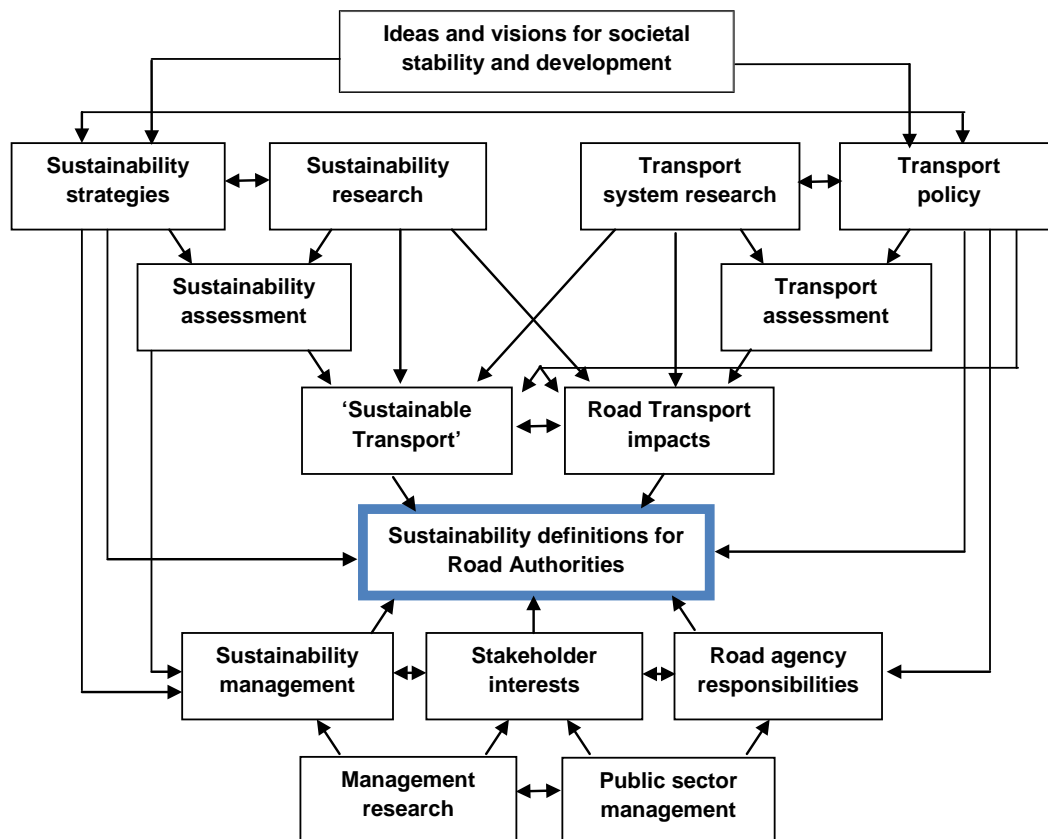
Figure 14: Different trajectories towards sustainability definitions for NRAs. Source: own conception for this report

This challenge suggests that the context in which each NRA operates should be taken into account within the process of applying the framework. It also calls for flexibility of the framework, with tiers allowing it to be used by NRAs with higher or lower levels of experience and sustainability ambitions, or with a shorter or longer, richer trajectory behind it.

Definition level challenges

There are many ways to define sustainability, sustainable development and sustainable transport systems. Choosing a definition raises some challenges as has also been observed in previous research (Zietsman and Ramani 2011), principally:

- A definition of *sustainability* can be abstract and of little use, it is not further applied.

- A definition of *sustainable transport* may support an illusion that transportation is a closed system that is sustainable in itself.

- A definition may in general be a compromise that includes conflicting elements. If these are not addressed the definition may not help the subsequent processes as much as hoped; and

- A short and lean definition may be appealing, but may omit essential principles and aspects of sustainability for ease of communication.

These challenges are addressed by providing guidance on which conceptual elements as a minimum to include in a definition, and on how to apply and implement it.

Framework level challenges

Challenges involved in specifying the framework include:

- To decide on the essential elements needing to be included in a definition of sustainability for an NRA, from of the vast material available. This challenge has been addressed through the literature review and summary of key observations as described in sections 3 to 5.

- To take into account the limited elaboration of links between the different sustainability impacts and specific NRA roles and functions as reflected in section 5.4). The framework will guide NRAs to elaborate these links themselves to the degree it helps them reach a suitable definition.

- To conceive a process for the adoption and application of a definition that does not seem overly complex, or rigid, or assuming too much uniformity across NRAs. The response is in this case to suggest a staged process that can be conducted in greater or lesser detail.

7.4 The requirements to the framework

The SUNRA project plan defines a set of requirements that the framework should fulfill. These requirements are outlined below, along with how they are fulfilled in the framework.

Specify fundamental sustainability principles

NRAs are advised to adopt general sustainability principles to guide their activities. The recommended principles are derived from the analysis in sections 3 and 4, and presented in a table and text in the first part of the framework. Four levels of ambitions are suggested, within NRAS being invited to aim for the most appropriate level.

Identify the major sustainability impacts of a road or road system

The major impact categories have been developed in section 4 and will be presented as reference for the NRAs in text and tables in the framework. Once identified, the impacts should help NRAs further specify goals and detailed impact areas to focus on.

How to map impacts to roles and functions of NRAs

This is the most challenging part of the task for which only general guidance can be given. NRAs are first advised to distinguish between *impact attribution* (a passive reflection of services and pressures offered by the NRA's assets and activities) and *influence* (an active

notion of the NRA's abilities and ambitions to intervene). There is not necessarily a good match between these two. The impacts may be traced most directly to stages in the project life cycle and network operations, whereas influence is channeled through governance and management structures.

A general chart of strategic road management is provided in Table 8 to assist NRAs in the mapping of influence to different governance and management levels. In Table 9 four types of mechanisms that enable or constrain the influence on sustainability are identified: mandates, resources, priorities, and activities. NRAs are invited to undertake a review within each of these areas to align them with their adopted level of ambition for sustainability principles.

Address strategic choice options and trade-offs connected with aggregation across impacts or dimensions.

Aggregation of impacts will be necessary for making decisions which affect multiple impact endpoints. At the project and programming levels such aggregation is often performed via cost-benefit analysis or sometimes multi-criteria decision-making methods.

Sustainable development ethics and also some sustainability research such as ecological economics impose limits for aggregation. For example, a trade-off between the needs of the present and of the future is generally not allowed without violating the ethics of the sustainable development notion itself. Certain principles of sustainability may be set as 'non-negotiable', such as the protection of environmental and ecological life support systems; and a priority to the poor when it comes to development. The position of strong sustainability in ecological economics imposes limits on aggregation of 'natural capital' jointly with manufactured capital, whereas a weak sustainability position requires exactly such an aggregation. Most definitions of 'sustainable transport' that have been adopted are based on a strong view, where different impact categories are kept separate rather than aggregated. On the other hand similar pressures on a particular endpoint (for example biodiversity) are often treated in an aggregate way.

In the framework, NRAs are advised to follow a cautious approach, with essentially no aggregation across generations; and limited or no aggregation across the social, economic and environmental impact domains assumed, unless when well-established monetary valuations exist for each impact. A way to apply such an approach is to require projects or programmes to fulfill certain criteria in each domain in order to go forward, hence a score below a threshold in one domain cannot be traded off by a high score in another domain.

In the end it is up to the NRA to specify allowable and non-allowable trade-off ranges appropriate to its context, but such a specification should be made explicit, which is one of the functions a definition can have.

7.5 Outline of the proposed framework

The framework consists of a number of conceptual, procedural and structural components as outlined below.

The *conceptual* components are:

1. A summary table of essential and other important principles of sustainable development, drawing from the key observations in section 3.

2. A summary table of important principles for sustainability and transport drawing from key observations in section 4.

3. A suggested set of levels of ambitions regarding sustainable development principles for NRAs to commit to – four levels are distinguished, using full commitment to the European SDS goals as the highest level.

4. A list of major impacts of transport systems the NRA could consider including in its definition and review process.

5. A summary table of the mechanisms that enable and constrain sustainability influence of an NRA, grouped under the categories mandates, resources, priorities, and activities.

6. A suggested set of levels of ambitions to apply in a review of these influence mechanisms.

7. An integrated road management diagram for support in the review process.

8. A selected set of examples of 'sustainable transport' definitions the NRA could consider adapting when developing its definition, and one more evolved example of a definition adapted into mission and vision statements.

The *procedural* components include *four principal steps* an NRA is advised to take in order to work its way through the eight conceptual elements listed above towards adopting a strategic commitment. Each step would produce an output in the form of a memo or strategic note.

The four steps are:

1. *Interpretation of sustainability and transport.* Here the NRA appreciates the sustainability and transport principles and impacts (conceptual elements 1 – 4 above are applied) and then adopts a level of ambition for its sustainability principles. This can be is stated in memo 1.

2. *Influence review.* Here the NRA considers the areas and mechanisms to influence sustainability, such as mandates, resources, priorities and activities. These are reviewed taking the sustainability principles as starting point (conceptual elements 5-7 are applied). The NRA tentatively defines a level of ambition for its influence review, which stipulates the areas of influence it will work with. This can be stated in memo 2.

3. *Commitment/definition.* Here the NRA crafts a strategic definition of and commitment to sustainability, combining input from memos 1 and 2.

4. *Implementation.* Here the NRA specifies what it will do with the definition and commitment. For example, which existing or new NRA governance processes and documents will be connected to or integrated with the definition.

These procedural steps form the recommended approach. However the NRA may wish to work with the concepts in another way, with fewer or different steps. The NRA should adopt the process that it finds most appropriate, and describe that.

The *structural elements* are the suggested outputs (memos or similar).

The output memos should however not be the only or final written outcome. Ideally the results will be integrated in appropriate steering documents (strategies, plans etc.) across the NRA.

8 Conclusions

This report has moved through a number of steps in order to produce a framework that can assist NRAs in their strategic efforts to address sustainable development. The framework focuses on devising a process where NRAs can develop, adopt and implement a definition forming part of their strategic commitment to sustainability.

The work began with observing the need for and potential advantages of such a framework. One observation was that European NRAs are already engaged with sustainability on many fronts, and could potentially benefit from jointly adopting a more comprehensive approach. Another observation was that simply proposing a standard definition of a 'sustainable NRA' would not necessarily inspire NRAs to commit to sustainability. It was assumed that fundamental principles would need to be acknowledged in order to connect with general, internationally shared ideas and strategies for sustainability.

The report has reviewed key literature on sustainable development, sustainable transport, and road management. In each area a number of recommendations to NRAs were derived and fed into the framework. While there is great deal of consensus on key concepts and principles of sustainable development, more diversity is found with regard to scientific 'schools of thought' underpinning the notion. Economic and ecological theories nevertheless offer useful ways in which sustainability and development can be given more operational definitions, for example by reference to rules for preserving natural resources and enhancing human development. At the political level the goals of the European SDS provides a possible shared reference for European NRAs.

With regard to the relationship between road transport and sustainability there is not a fully shared understanding among scholars and policymakers; some apply general sustainability criteria directly to the transport system, while others are hesitant to accept that a notion such as 'sustainable transport' even makes sense. The recommended approach is to frame a definition as concerning 'the sustainability of road transport', rather than necessarily 'sustainable road transport', by focusing on road transport's relative (incremental) contributions to relevant impact categories, and to adopt principles pertinent to transport as well as to the wider social, environmental and economic systems.

As regards the role of road management and NRAs it was observed that NRAs have limited - but differentiated - control over the full range of sustainable development impacts. A conceptual distinction was suggested between the impact attribution of NRAs and the influence they may exercise through their mandates, resources, priorities, and activities. A mismatch between the two is generally detrimental to the ability of NRAs to commit effectively to sustainability if unobserved. The different functions, roles and decision levels of NRAs were mapped in order to identify leverage points for NRA governance and action.

A workshop was held in order to seek advice from experts and stakeholder on ways to define sustainability for NRA's and how a definition could be anchored within an NRA. While the workshop did not deliver unanimous views it was helpful especially in highlighting the need to anchor sustainability at the top as well as in practical tiers in the organisation, and also by pointing out risks such as sustainability not being anyone's particular responsibility, and the challenge to balance the wording between what is understandable, what is appropriate and what is feasible. The results underpinned the idea to adopt a flexible framework combining procedural steps with conceptual building blocks.

A framework with four steps called *Interpretation of sustainability and transport; Influence review*; *Commitment/definition, and Implementation* was prepared. In each step conceptual building blocks based in the recommendations from the literature review is presented for NRA contemplation and potential application.

The framework is offered in a separate document to allow easy access and use for NRAs. The framework is planned for trial by pilot NRAs. This is expected to lead to recommendations for further improvements to the framework.

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Appendix A: Glossary

Attribution	The impact or share of an impact on sustainability or development that is objectively attributable to NRA possessions or activities
Delivery methods	System used by an agency or owner for organising and financing design, construction, operations, and maintenance services for a structure, facility or service by entering into legal agreements with one or more entities or parties (e.g. Design-Bid-Build (DBB), Design-Build-Operate-Maintain (DBOM)).
Economic pillar	Refers to income, savings, capital assets, resources, investments, and other manifestations of and contributors to economic wealth, well-being, and performance at the individual, national and global level.
Endpoint	A direct marker used to describe an effect; the final object or item being affected.
Environmental pillar	Refers to the natural environment that surrounds and sustains human life, in terms of immediate life conditions (water, air, food etc.), as well as 'life-support' systems (ecosystem, climate system, agricultural systems etc.) which enable the survival and development of mankind.
Framework	Set of principles, rules or ideas which can be used to deal with problems or to decide what to do.
Impact	Direct, indirect, negative or positive effect on an endpoint of interest.
Influence	The change an NRA can instigate with regard to an impact on sustainability or development.
Institutional dimension	Concerns how policy, governance and management should be conducted to support sustainable development as a process.
Key Performance Indicator (KPI)	A Key Performance Indicator is a measure of the performance of an activity that is critical to the success of a project or organisation. Key Performance Indicators need to be quantifiable measures agreed to beforehand.
Life cycle analysis	Tool for integrated assessment of impacts in the environmental dimension, seeking a full description of impacts in connection with the production use and disposal of a product. Defined in ISO Standard 14040.
Life cycle costing	Economic assessment considering all agreed projected significant and relevant cost flows over a period of analysis expressed in monetary value. The projected costs are those needed to achieve defined levels of performance, including reliability, safety and availability.
National road administration (NRA)	Any organisation at a national or regional level authorised by a Government to take responsibility for developing and maintaining some of or the entire national or regional road network. The organisational characteristics of NRAs can vary considerably, for

	example, some NRAs may be responsible for managing other transport networks such as rail. Some NRAs may be directly part of the national or regional Government or they may be a separate agency required to meet government objectives.
Programme level	At the programme level an NRA will be required to deliver the strategic objectives set by the board.
Project level	At the project level an NRA will be required to deliver projects that make up a programme. Project practices will need to align to corporate priorities.
Resilience	The capacity of a system to absorb disturbance and reorganise while undergoing change, so as to retain essentially the same function, structure, identity and feedbacks.
Responsibility	Part of an NRA's impacts that it can influence with its given mandates, resources etc.
Road Management	Improvement, development, maintenance and operation of the road network.
Social pillar	Refers to social relations and interactions among people and the social conditions (such as education, health, safety, opportunity), which constitute the quality of life and the coherence of society.
Strategic function	The strategic function of an NRA is to manage the construction, maintenance and operation of its network. Often these activities are carried out by a supply chain.
Strong sustainability	In total the natural capital should be kept constant (or increase with population growth), otherwise development is not likely to be sustainable.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs
SDS	Sustainable Development Strategy – strategy adopted by countries and the European Union
Transport system	Facility consisting of the means and equipment necessary for the movement of passengers or goods – key components are vehicle, infrastructure, energy and operator
User	User of the road network.
WCED	World Commission on Environment and Development, also known as the Brundtland commission
Weak sustainability	Allows depletion of natural capital as long as it is replaced with produced or other capital of equivalent value.

Appendix B: List of workshop attendees

Name	Organisation	Country
Dean Kerwick-Chrisp	Highways Agency	England
Geoff Richards	Department for Transport	UK
Åsa Lindgren	Swedish Transport Administration	Sweden
Susanna Toller	KTH	Sweden
Jon Krokeborg	Norwegian Public Roads Administration	Norway
Vincent O'Malley	National Roads Authority	Ireland
Jos Arts	Ministry of Infrastructure and Environment	Netherlands
Douwe van de Wall Bake	DHV BV	Netherlands
Dave Arran	Transport Scotland	Scotland
Stephen Thomson	Transport Scotland	Scotland
Sophie Cariou	Sétra	France
John Dent	Jacobs	UK
Simon Price	Rambol	UK
Ben Harris	TRL	UK
Clare Harmer	TRL	UK
Suzanne de Vos-Effting	TNO	Netherlands
Lennart Folkeson	VTI	Sweden
Henrik Gudmundsson	DTU	Denmark
Donald Bell	Halcrow Group Limited, a CH2M HILL COMPANY	UK
Chris Sowerby	Halcrow Group Limited, a CH2M HILL COMPANY	UK

Appendix C: Workshop agenda

Agenda

Defining Sustainability for National Road Administrations

14th May 2012

America Square Conference Centre
1 America Square
17 Crosswall
London EC3N 2LB

Time	Item	Speaker
13.30	**Welcome (Tea & Coffee)**	**All**
14.00	**Introduction** National Road Administrations have an important role to play in sustainable development. Ben will explain how the SUNRA project will help to define that role.	**Ben Harris, TRL**
14.15	**Defining Sustainability for NRA** The contribution of an NRA to sustainable development is defined by its sphere of activity. Henrik will introduce a summary of current research which defines the responsibilities and limits of an NRA's contribution.	**Henrik Gudmundsson, DTU**
14.45	**Break Out Session** Attendees will be asked to comment on the indirect and direct contribution of NRAs to sustainable development.	**All**
15.30	**Break**	
15.45	**The Role of Metrics and Measures** Measuring performance enables continual improvement. Ben will summarise research into how NRAs currently report on sustainability and discuss the priority areas for NRAs to report.	**Ben Harris, TRL**
16.15	**Break Out Session – KPIs** Attendees will be asked to review the key gaps between what is currently being reported and the recommendations of research in this area.	**All**
16.45	**Summary & Questions**	**Ben Harris, TRL**
17.00	**Close**	