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ROAD MANAGEMENT POLICIES FOR LOW VOLUME ROADS – SOME PROPOSALS

ROADEX II
NORTHERN PERIPHERY

THIS PROJECT IS BEING PART- FINANCED BY THE EUROPEAN UNION
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Road Management Policies for low volume roads

–

Some proposals

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PREFACE

This is a report from Phase III of the Roadex II project, which is a technical transnational cooperation project between the Highland Council, the Western Isles Council, and Forest Enterprise from Scotland; the Northern Region (formerly Troms district) of the Norwegian Public Roads Administration and the Norwegian Road Haulage Association; the Northern Region of the Swedish National Road Administration; and from Finland the Regions of Central Finland and Lapland of the Finnish Road Administration, as well as Metsähallitus Region of Eastern Lapland, the Forestry Centre of Lapland (Lapin Metsäkeskus), Stora Enso Metsä, and Metsäliitto, Procurement Area of Northern Finland. The Roadex project is partly financed by the Interreg IIIB Northern Periphery Programme. The lead partner in the project is the Highland Council from Scotland and project consultant is Roadscanners Oy from Finland. The Roadex II project Chairman is Ron Munro from the Highland Council and project manager is Timo Saarenketo from Roadscanners.

This report is based on knowledge, experiences and ideas coming from the work in Roadex I and Roadex II. The report gives some new proposals for road management policies in order to improve the conditions on low volume roads in rural areas. Using the proposals in practice will hopefully create better living conditions for people residing in rural areas. We hope also that the report will encourage road managers and politicians to develop new ideas for road management policies to develop a more inclusive social situation for people living in rural areas.

We want to thank Kristian Johansson for identifying the fragility indicators of Norrbotten and Kristofer Johansson for making GIS-maps of the fragile areas. Many thanks also to Kent Middleton who checked the language and to Virpi Halttu who did the editorial work. All of the aforementioned people are from Roadscanners. We also want to thank all other persons who, in one way or the other, have contributed to this report.

Finally the authors would like to acknowledge the Roadex II Steering Committee and the Road Condition Working Team for its encouragement and valuable guidance in this work.

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ABSTRACT

The aim of this report is to provide ideas and descriptions of new road condition management policies for low volume public, private and forest roads in the Northern Periphery area.

The process of introducing new Road Management Policies should be done step-by-step. The process consists of the following steps:

- Identify fragile areas
- Identify lifeline roads
- Identify road user needs
- Establish road condition standards – defining the service levels
- Defining procurement strategies and policies to secure the required service level
- Follow up.

The **first step** is to identify **fragile areas**. A fragile area is defined as an area where the community or a part of the municipality is in decline. To keep these areas alive there is a need to take extra care of the service level.

The **second step** is to identify **lifeline roads** which are defined as "A transport link which has no substitute, or where the substitute entails a considerable increase in time or money expenditures, where any diminution in the quality, reliability or availability of the former, is likely to have a significant impact on the social or economic viability of an affected community." A road in this category should be kept at a decent standard as they have a vital role in the survival of rural societies. The first two steps follow ideas from the Highlands in Scotland.

The **third step** is to identify the **road user needs** on the low volume roads. This is based on the needs of both the local people and business.

Based on the first three steps it is possible to arrive at a numerical value, which describes the need to have a good road standard. As a means of summarizing the social, economic and road user needs a **transportation need index (TNI)** has been developed.

The **fourth step** is to propose the lowest acceptable **road service levels** and the **intervention levels (trigger values)** for maintenance actions on each service level for the low volume paved and gravel roads. First the road service level priority is determined depending on road user needs. Then the intervention levels of the road condition are determined based on drive comfort, traffic safety, load restrictions and accessibility in four classes. The road user needs and the lowest acceptable **road service levels** or **intervention levels** for the forest roads are given separately.

The **fifth step** is to develop **procurement strategies** and **follow-up** procedures for the contracts. The procurement strategy is discussed using **performance contracts.** The next phase is the follow up. During this phase the road condition is monitored and road user needs and feedback are monitored and these results are used in setting up standards for the next maintenance contract as well as in decision making for extra allocations for road improvements.

The **sixth step** is to use **socio-economic models** adapted for use with low volume roads through the inclusion of **social benefit factors (SBF)**. The models should be used to define the road service levels.

KEY WORDS: Fragile Areas, Lifeline Roads, Roadex, Road Management Policies, Road Service Levels, Road User Needs.

1 Introduction

1.1 Roadex II Project overview

This report is a part of the Roadex II project, which is a co-operation project on low volume roads in the Northern periphery of Europe (see figure 1), partly financed by the European Union. The aim of the Roadex II project is to develop ways for interactive and innovative road management on low volume roads in the Northern region of the European Union. Regional road administration bodies in Scotland, Norway, Sweden and Finland participate in the project along with regional resource related industries like forestry and fishing.

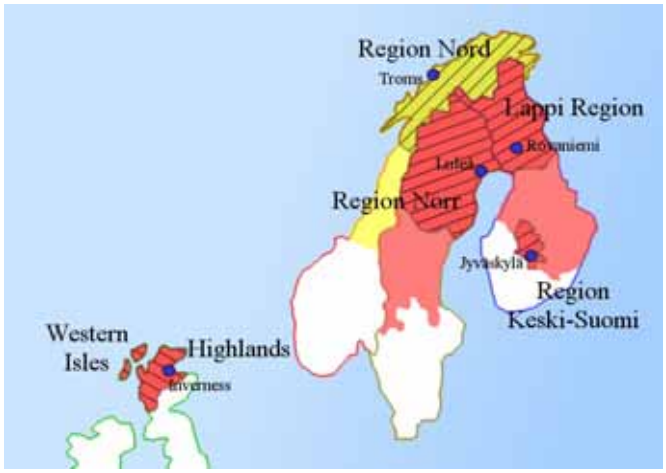

Figure 1. Geographic project area

The Roadex II project, which continues the work of the Roadex I pilot project 1998 – 2001, is divided into three phases, which have been carried out at the same time. The three phases are

- Phase I – identification of problems, fieldwork,
- Phase II – analysis of problems and identification their causes; and
- Phase III - new innovations.

Phase I included field tests in at least one selected small area in each participating country and a questionnaire was sent out to ascertain the road user needs and opinions on the road conditions in the selected areas.
Phase II included 7 different tasks:

- Permanent deformation
- Material treatment
- Spring thaw weakening
- Socio-economic impact
- Peat roads
- Drainage
- Environmental guidelines.

The task "Socio-economic impact" forms the basis for this report. The aim of the task was to improve the understanding of the significance of the low volume roads and the road conditions for people, organizations and companies in the rural areas of the Northern Periphery of Europe. The means to accomplish this was to collect information concerning the socio-economic impact of the road conditions from the literature, through interviews and through calculations with a model and to try and examine the consequences, for both industries and local residents, if funding for low-traffic rural roads is insufficient for ensuring the

serviceability of the local road network. Then this information should be disseminated to people on all levels of society, especially to politicians and road administrations, in order to have a better understanding of the need to increase the budgets for low volume roads and thereby create better living conditions for people in the rural areas of Northern Europe.

The work from this task produced a report (1) titled "Socio-economic impacts of road conditions on low volume roads – Results of literature studies, interviews and calculation with a model."

Some of the conclusions from the aforementioned report were:

Socio-economic impacts have to be considered in a wider context. There is a need to take a closer look at the improvement in living standard for people living in rural areas if the road conditions are improved.

In this report it was recommended that the Scottish example for identifying fragile areas should be followed. Then the lifeline roads, which are of critical importance to the people in the rural areas, should be defined. These results should then be presented to the politicians and used in the budget negotiations with the Transportation Departments in the partner countries in order to increase the awareness of the importance of low volume roads. Then the lifeline roads should be treated with special care in the maintenance and rehabilitation programs.

An interesting and important task would be to try and develop a policy for a common lowest acceptable road condition standard for all of the partner districts. It should be a minimum standard to which all of the available resources should be directed towards achieving ahead of any other needs.

If the prevailing socio-economic models are to be used for the whole road network then low volume roads should be in a category all of their own. Some sort of "social factor" for lifeline roads could be used to influence the budget distribution and to sort out the candidates for maintenance and rehabilitation.

Finally Phase III includes the following tasks:

- Basis of Road Management Policies
- Tools for focusing Actions
- Structural Innovations
- Monitoring communications.

Roadex II was started in 2002 and will be finished during 2005.

This report is a part of Phase III "Basis of Road Management Policies." The ideas and descriptions herein are based on the results and experiences obtained during the Roadex I and Roadex II projects.

1.2 Aim

The aim is to provide ideas and descriptions of new road condition management policies for low volume public, private and forest roads in the Northern Periphery area.

1.3 Limitations

This report primarily looks at existing low volume roads and the condition of these roads. The condition, in this case, does not include the width of the road or the vertical and horizontal alignment even though these properties are very important to the road user and should always be considered in any road rehabilitation work. Winter maintenance is not a part of this report.

2 Process of Introducing New Road Management Policies

The process of introducing new Road Management Policies should be done step-by-step. The process is described in figure 2. The process consists of the following steps:

- Identify fragile areas
- Identify lifeline roads
- Identify road user needs
- Establish road condition standards – defining the service levels
- Defining procurement strategies and policies to secure the required service level
- Follow up.

The **first step** is to identify **fragile areas** (2). A fragile area is defined as an area where the community or a part of the municipality is in decline. To keep these areas alive there is a need to take extra care of the service level. This is described in chapter 3.

The **second step** is to identify **lifeline roads** (3) which are defined as "A transport link which has no substitute, or where the substitute entails a considerable increase in time or money expenditures, where any diminution in the quality, reliability or availability of the former, is likely to have a significant impact on the social or economic viability of an affected community." A road in this category should be kept at a decent standard as they have a vital role in the survival of rural societies. The first two steps follow ideas from the Highlands in Scotland. This process is described in chapter 4.

The **third step** is to identify the **road user needs** on the low volume roads. This is based on the needs of both the local people and business. This is described in chapter 5.

Based on the first three steps it is possible to arrive at a numerical value, which describes the need to have a good road standard. As a means of summarizing the social, economic and road user needs a **transportation need index (TNI)** has been developed, which is described in chapter 6.

The **fourth step** is to propose the lowest acceptable **road service levels** and the **intervention levels (trigger values)** for maintenance actions on each service level for the low volume roads. First the road service level priority is determined depending on road user needs. Then the intervention levels of the road condition are determined based on drive comfort, traffic safety, load restrictions and accessibility in four classes. The proposals for the road service levels are given in chapter 7.

The road user needs and the lowest acceptable **road service levels** or **intervention levels** for the forest roads are given in chapter 8.

The **fifth step** is to develop **procurement strategies** and **follow-up** procedures for the contracts. The procurement strategy is discussed using **performance contracts.** The next phase is the follow up. During this phase the road condition is monitored and road user needs and feedback are monitored and these results are used in setting up standards for the next maintenance contract as well as in decision making for extra allocations for road improvements. These matters are discussed in chapter 9.

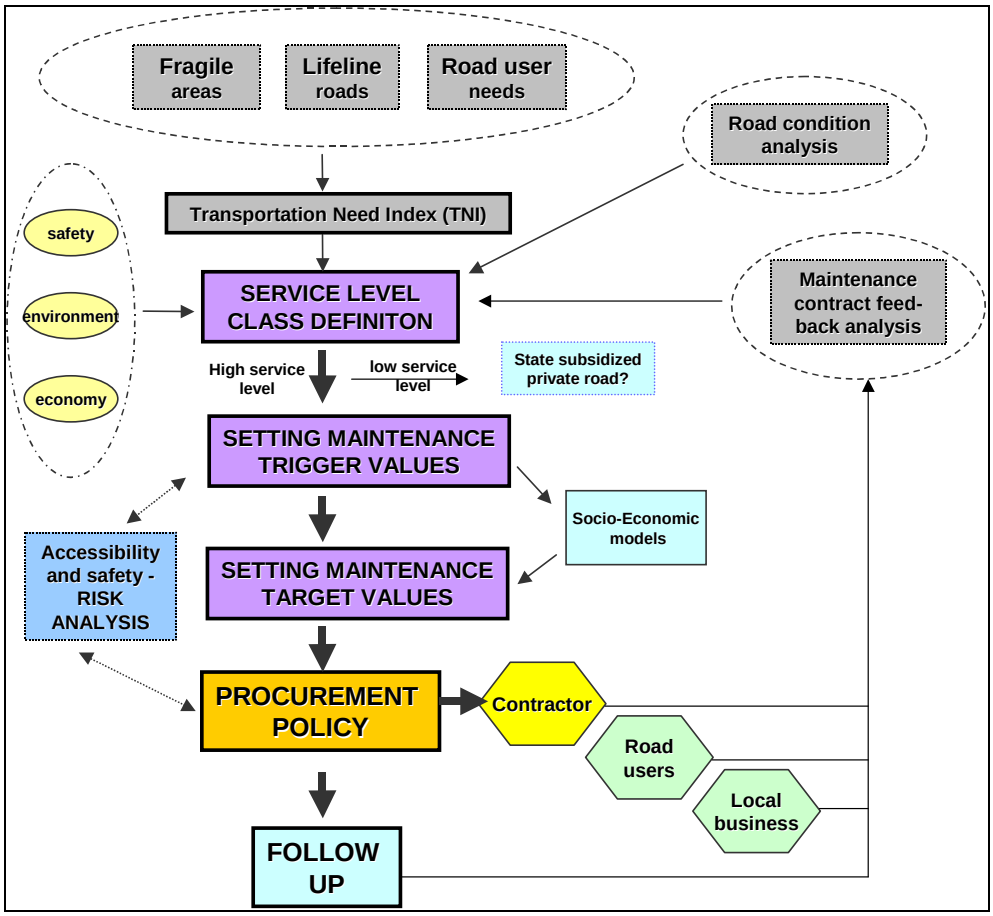

Figure 2. Road Management Principles for routine and planned road maintenance.

The **sixth step** is to use **socio-economic models** adapted for use with low volume roads through the inclusion of **social benefit factors**. The models should be used to define the road service levels. A discussion of the model adaptation of the socio-economic models is given in chapter 10.

3 Fragile Areas

3.1 Introduction

All of the Roadex partner countries have large rural areas where the fundamental social services are difficult to maintain due to the limited resources of the society. Sometimes statements such as "The whole country shall have possibilities to live" are made in political forums. But in reality it is difficult to implement such ideals and for both economic and social reasons people are moving from rural areas to urban areas. There is a risk that some areas will be left unpopulated unless the political will, to direct more resources towards keeping people living in rural areas, increases. The areas, which are suffering from this decline in inhabitants, could be deemed **fragile areas** (2).

3.2 Definition

Fragile areas are defined as communities being in decline or in danger of decline as a result of the following fragility indicators:

- Social fragility – population
  - Population decline in % (latest 10-year period)
  - Population decline 0-15 years in % (latest 10-year period)
  - Population density latest year in persons/km^2
  - People retired because of health or age latest year in %
- Economic fragility – unemployment
  - Long term unemployment rate – latest year in %
  - Income support claimant rate – latest year in €/person/month
- Accessibility indicator – to key services
  - Population residing outside of a 20 min one-way drive to 5 key services
    - Post Office
    - Primary School
    - Food Shop
    - GP Surgery
    - Petrol Filling Station
- Remoteness indicator – from the main service centre (City)
  - Population residing outside of a 1,5 hour one-way drive from city.

3.3 Processing fragility (F)

Choose the smallest identifiable geographical area of a county or region from which statistical data regarding the social and economic fragility indicators can be identified. Collect information regarding the selected indicators and enter the results in a table e g in Excel. Rank the results in order of size for each fragile indicator as in table 1, which shows our example for the county Norrbotten in Region North in Sweden (Table 1). Assign the value 1 to the best and then the value n for the worst of each indicator. Use a GIS computer program, e.g. Arc View, to show the actual map and attach a specified colour to each ranking value. Start with a light colour for the best and then use increasingly darker colours as shown in the example in figure 3. Select 25 % of the communities with the highest fragility ranking. Regard them as fragile areas and then divide them into 3 groups, equally sized, ranging from the lowest to the highest within the fragility group. The remaining 75 % will be class 1, no fragility. Then use the GIS program to identify the accessibility and remoteness indicators. A radius of 25 km for the

accessibility and 125 km for remoteness has been used in the example to simplify the procedure. Then the places with good accessibility have been designated as urban areas and marked as white areas on the GIS map as shown in figure 4. The areas within the remoteness distance of 125 km have been changed to one class less fragility. Now the fragility can be classified into 5 different classes shown on the GIS map in figure 4 and in the table below (Table 2).

Table 1. Example of an evaluation of fragility data from county Norrbotten.

	Communes													
Fragility indicators	**Arjeplog**	**Arvidsjaur**	**Boden**	**Gällivare**	**Haparanda**	**Jokkmokk**	**Kalix**	**Kiruna**	**Luleå**	**Pajala**	**Piteå**	**Älvsbyn**	**Överkalix**	**Övertorneå**
Population density 2003, persons/m^2	13) 0	8) 1	5) 7	8) 1	3) 11	13) 0	4) 10	8) 1	1) 34	8) 1	2) 13	6) 5	8) 1	7) 2
Population decline in %, 93-03	9) -12,63	8) -11,82	5) -7,71	11) -14,46	3) -5,40	12) -14,57	6) -7,85	7) -10,97	1) 3,50	13) -15,64	2) -0,36	4) -6,50	14) -15,74	10) -14,35
Population decline 0-15 years in %, 93-03	11) -25,18	7) -16,89	4) -15,90	9) -23,32	8) -20,22	12) -26,05	6) -16,74	5) -16,16	1) -1,95	10) -23,54	2) -8,68	3) -11,65	13) -26,58	14) -27,08
Long term unemployment in % during 2003	2) 4,4	7) 5,6	1) 3,3	4) 4,8	12) 7,7	3) 4,6	11) 6,7	10) 6,3	6) 5,4	13) 8,2	4) 4,8	7) 5,6	9) 6,1	14) 9,3
Income support claimant rate in % during 2003	11) 4,66	13) 4,94	7) 4,02	5) 3,63	3) 3,06	14) 5,18	6) 3,77	4) 3,10	8) 4,05	9) 4,13	2) 3,05	12) 4,68	1) 2,91	10) 4,18
People retired in % during 2003	10) 33,69	9) 31,33	4) 25,74	5) 28,43	12) 35,93	6) 28,74	8) 30,28	2) 24,08	1) 21,71	14) 37,86	3) 24,53	7) 29,54	13) 37,09	11) 34,53
Total fragility index	*56*	*52*	*26*	*42*	*41*	*60*	*41*	*36*	*18*	*67*	*15*	*39*	*58*	*66*
Ranking	**10**	**9**	**3**	**8**	**6**	**12**	**6**	**4**	**2**	**14**	**1**	**5**	**11**	**13**

Table 2. Ranking table for fragility indicators.

0.	Urban area	Omitted areas in the survey
1.	No fragility	75 % of the surveyed areas regarded not fragile
2.	Little fragility	The highest rated of the three groups
3.	Medium fragility	The medium rated group
4.	High fragility	The lowest rated group.

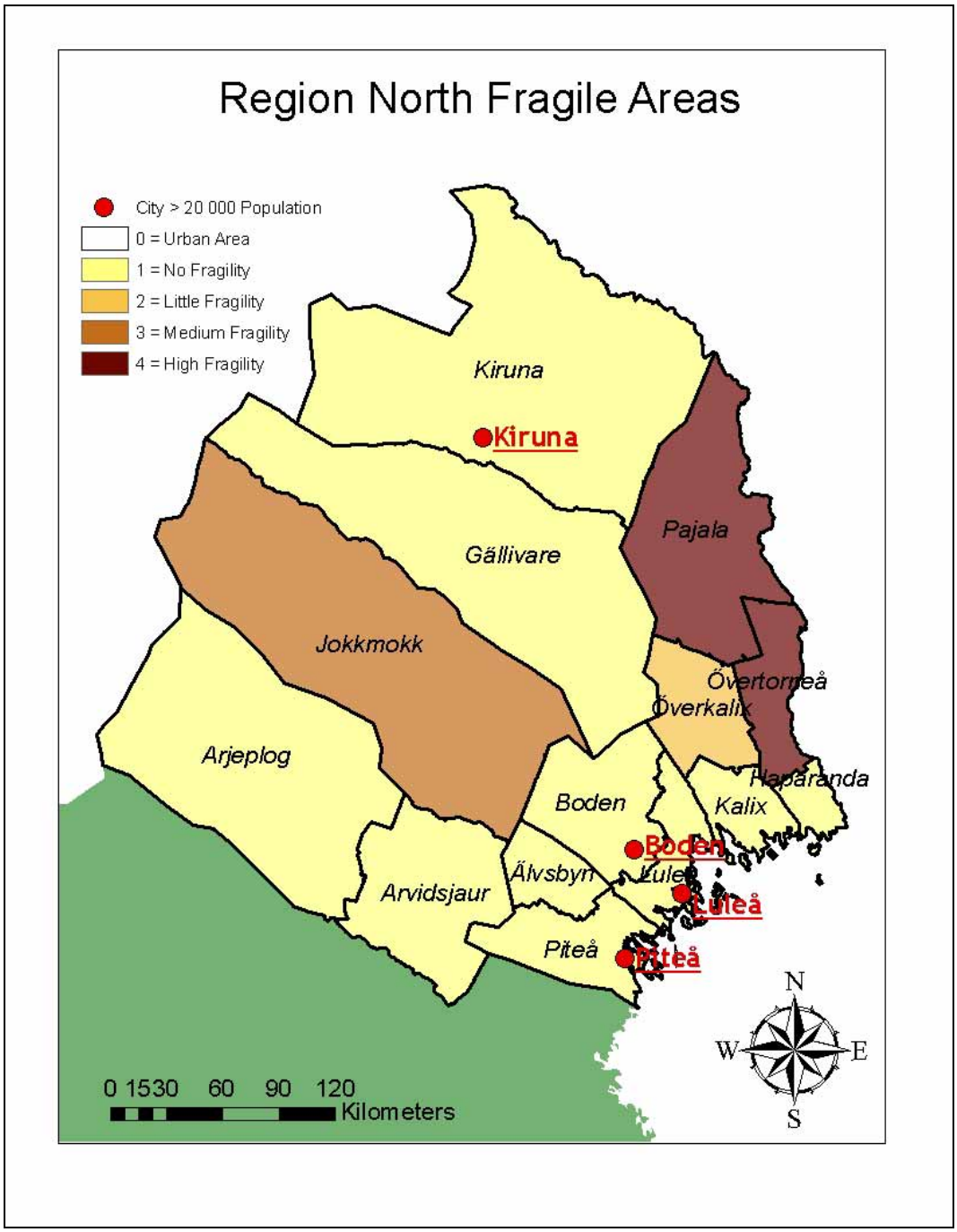

Figure 3. Fragile areas in Norrbotten 2003, social and economic fragility.

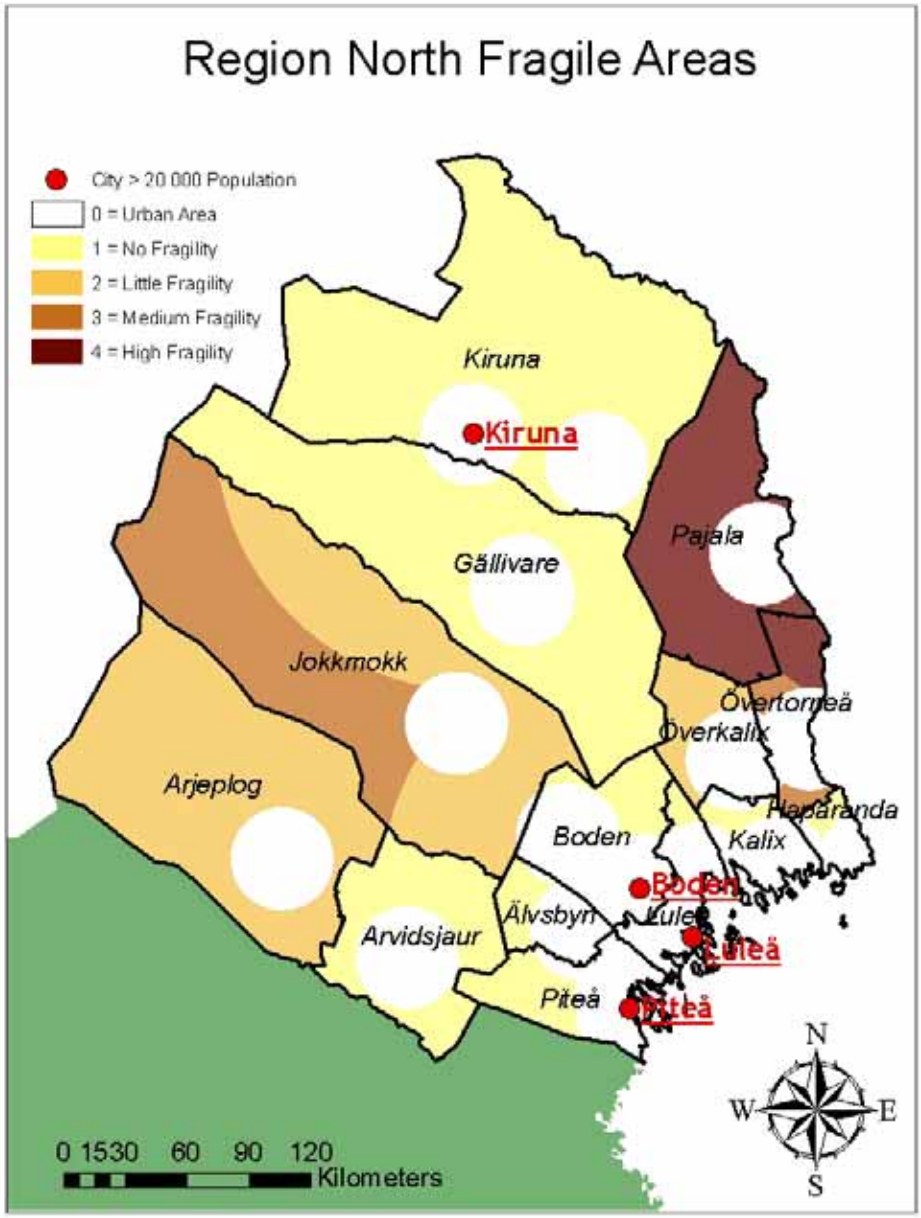

Figure 4. Fragile areas in Norrbotten 2003, total fragility.

4 Lifeline roads in rural areas

4.1 Introduction

Low volume roads in rural areas are often the only means for small communities and villages to transport people and goods. The road is needed in order to access local business, health care, education, cultural events etc. The distance is often long and if the road condition is also bad it places an extra burden on people living in rural areas. Much attention has been given to achieving better road conditions for people in such areas in Scotland by examining fragile areas of the country with decreasing population, long-term unemployment and high levels of income support. The transport links to such areas are named **lifeline roads** (3), which are the vital arteries for those areas.

4.2 Definition

A lifeline road is defined as (3):

"A transport link which has no substitute, or where the substitute entails a considerable increase in time or money expenditures, where any diminution in the quality, reliability or availability of the former, is likely to have a significant impact on the social or economic viability of an affected community."

4.3 Identification of lifeline roads

The roads connecting the fragile areas, defined in chapter 3, to the closest city or a bigger road must be regarded as lifeline roads. There may also be potential candidates within the 75 % of the areas that were surveyed in chapter 3 but were not regarded as being fragile areas. Lifeline roads could also be roads connecting factories and industries to their raw materials and customers. The same goes for forest roads or links to forest roads from forest areas. A complete survey should be done to detect any lifeline roads.

4.4 Classification of lifeline roads (L)

The following classification should be done depending on the urgency of the lifeline roads (Table 3):

Table 3. Classification of lifeline roads (L).

1.	The road is not a lifeline road
2.	The road has a substitute that presents a minor increase in time and cost
3.	The road has a substitute that presents a major increase in time and cost
4.	The road has no substitute.

4.5 Presentation of results

The identified lifeline roads should be placed on a GIS-map showing the fragile areas. These roads should be marked in a special colour so they are easily discernable. The roads should have different colours depending on the lifeline class. This can be a very useful tool to use e.g. together with details concerning the road conditions of the lifeline roads in budget discussions or for determining the winter maintenance standards.

The lifeline roads from the primary example are shown in figure 5. The example is far from complete. The map shows only state roads and commune roads. Private roads and forest roads should be added. Then the lifeline class should be determined for each road section by people who have good knowledge of the location of settlements, industries and raw material supplies. The map in figure 5 serves only to give a better understanding of the possibilities with this method.

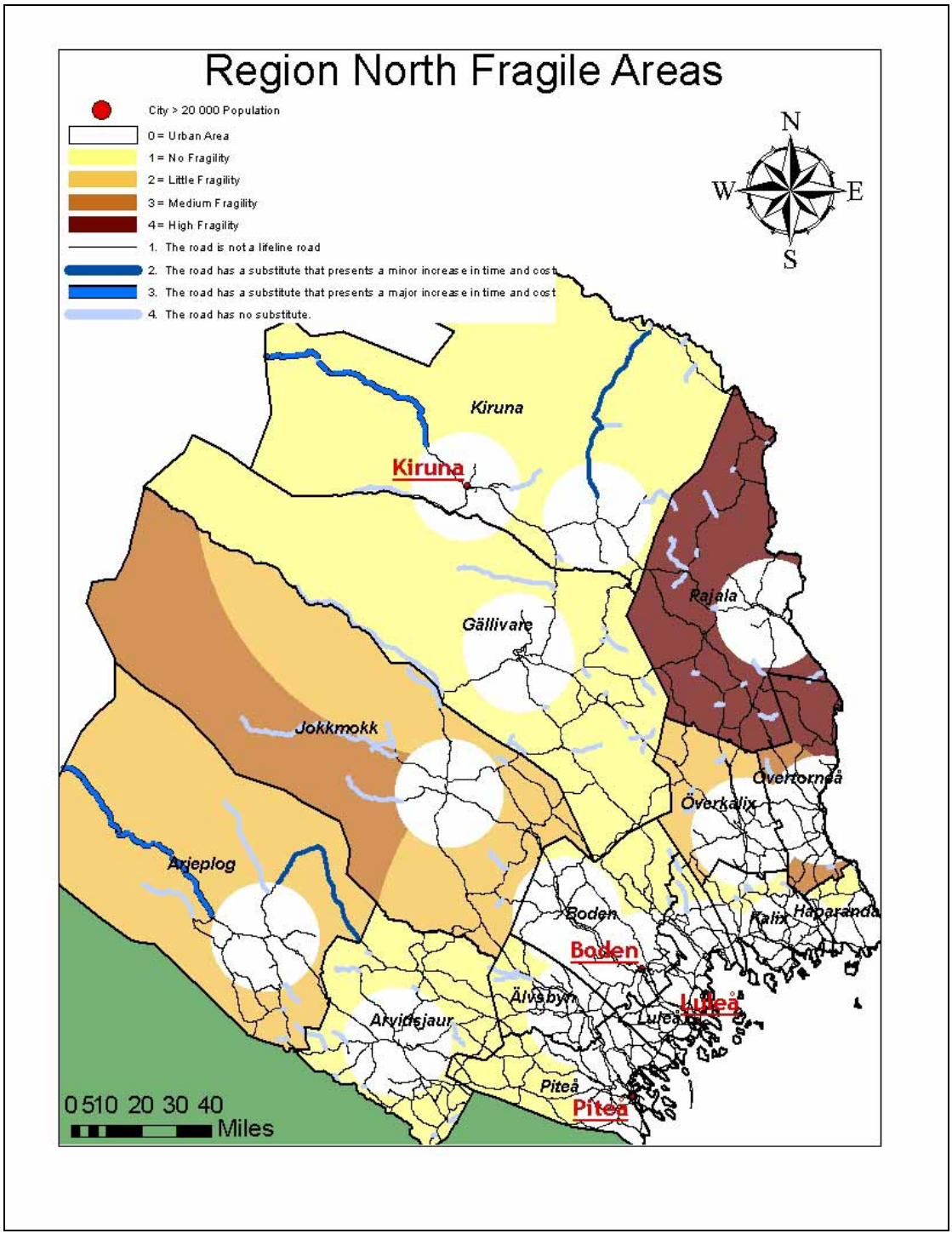

Figure 5. Fragile areas and Lifeline roads in Norrbotten.

5 Road user needs

5.1 Introduction

Two main types of road transportation needs can be distinguished from the two primary categories of road users:

- People
- Business.

Both categories have transportation needs of a different priority depending on the reasons for travelling. For people, transportation to schools and workplaces are examples of urgent transport needs and, for business, daily mail and other scheduled transportation services are examples of high priority needs.

5.2 Transportation need for people (P)

The transportation need for people depends on the number of road users that use the actual road section. But it also depends on the road users' aim with the travelling the road. A classification based on the aforementioned parameters is shown below (Table 4):

Table 4. Transportation need for people (P).

1.	Few road users, only temporary use
2.	There are only a few permanent residents with no time scheduled access need
3.	School children and commuters
4.	High priority use (school children, commuters, daily bus routes)

5.3 Transportation need for business (B)

The importance of business traffic is independent of whether it is an urban or a rural road. The frequency and accessibility are factors influencing the priority classification. For roads with seasonal variations in traffic, like tourist traffic and timber haulage, the classification should be done according to the busy season. The classification is shown below (Table 5):

Table 5. Transportation need for business (B).

1.	No business traffic
2.	Only a few businesses with no need for regular daily transportation
3.	Few businesses with needs for regular daily transportation
4.	Several businesses requiring daily transportation service with high accessibility needs

6 Transportation Need Index (TNI)

6.1 Introduction

Road user needs are naturally important factors in road management in all the partner countries. Many surveys have been done to assess the road users' opinions on road surface condition, traffic safety etc. In later years more radical steps have been taken to examine road user needs from wider perspectives. The use of the Scottish Transport Appraisal Guide (STAG) and the Finnish Planning Cube (see fig 6) are examples of a new approach. Using these tools may lead to the formation of new policies for rehabilitation and maintenance of low volume roads in the future.

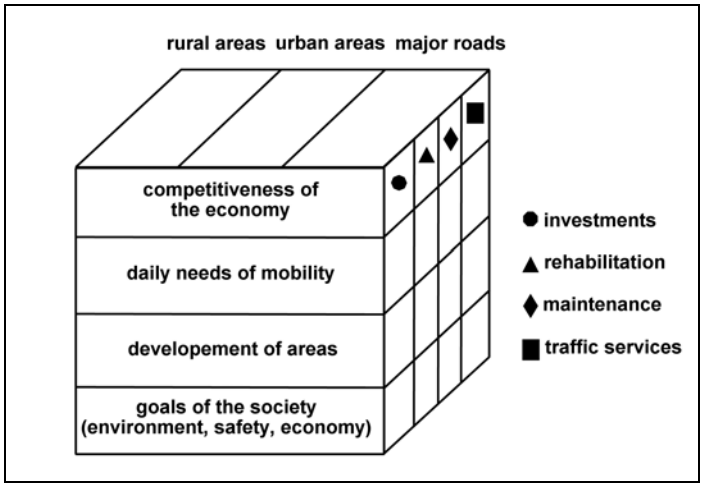

Figure 6. The Finnish "planning cube".

There are many questions to answer when looking at road user needs especially if future needs are also considered. Here are some questions awaiting answers:

- Competitiveness of the economy
  - How does the maintenance of a road project affect the economy in the area?
  - Can it provide cheaper transportation?
  - Can it create new jobs in the area?
- Needs of mobility
  - What are the needs of mobility for the people and industries in the road project area?
  - Daily? Weekly?
- Development of areas
  - What are the possibilities for the area to develop?
  - Are there possibilities to develop tourism?
  - Are there possibilities to develop industries?
- Goals of society
  - What are the goals set by the politicians concerning
    - Environment?
    - Safety?
    - Economy?
    - Social inclusion?

Going through this matrix to create policies for low volume roads would be very helpful for every road manager. It should create a good tool to use at budget discussions, choice of road candidates and choice of road condition levels.

For practical reasons, a simple Transportation Need Index (TNI) based on fragility, lifeline roads and road user needs for people and business in rural areas has been developed for this presentation.

6.2 Defining the Transportation Need Index

From the first three steps, presented from chapter 3 to chapter 5, it is possible to arrive at a numerical value, which describes the need to have a good road standard. Through a summary of the social, economic and road user needs a **transportation need index (TNI)** has been developed. The index is a summary of the classifications of fragility (F), lifeline urgency (L) and the road user needs for people (P) and business (B):

TNI = fragility class + lifeline class + people road user needs + business road user needs.

The TNI-value, ranging between 4 and 16, can be used as a ranking figure for choosing between maintenance and/or rehabilitation candidates. The highest figure indicates the highest transportation need. Some examples are given in table 6. In this case Rv 476-03 with TNI = 12 is the most preferential candidate due to the fragility and the lifeline class. This candidate should be selected for maintenance or rehabilitation if money is available.

Table 6. Examples of ranking for maintenance or rehabilitation candidates.

Road	Fragility (F)	Lifeline (L)	People's need (P)	Business needs (B)	Transportation need index (TNI)
Rv 476-02	1	2	3	1	7
Rv 476-03	4	4	2	2	12
Rv 486-01	2	3	3	3	11

7 Road Service Levels

7.1 Introduction

Many low volume roads are often in bad and inhomogeneous condition. Some roads are extremely poor especially in the springtime because of frost damage. One way to improve this situation could be to introduce specified standards for the road condition named **service levels**.

The service level of a specified road project would be determined based on the TNI classification defined in chapter 6. It also depends on if it is a paved road, a gravel road or a forest road.

The described service levels should be regarded as the lowest acceptable limits or "trigger values" indicating that a maintenance or rehabilitation measure should be taken. The target road service level is a much higher standard and, as such, it should be used in setting goals for maintenance contracts.

7.2 Road service levels

The road service level priority is divided into four levels based on transportation needs (Table 7):

Table 7. Road Service Level Priority.

ROAD SERVICE LEVEL PRIORITY	
1. Lowest priority: lowest accessibility, quality can be close to the "shame value"	Classes F1, L1, P1, B1 and government subsidised private road
2. Standard priority (no fragile areas, medium lifeline, medium user need)	Classes F2 and/or L2, P2 and/or B2.
3. Raised priority (area development has great weight) (high fragility, high life line points)	Classes F3-F4, L3-L4, and/or P3, B3.
4. Highest priority (high road users and business needs), should have: good ride comfort and high accessibility	Classes P4 and/or B4

This priority gives the roads in high fragility areas and lifeline roads a better position than they would have if only the traffic figures were used as a priority indicator but it also provides higher priority to those roads that have high road user and business needs.

This system for defining fragile areas and lifeline roads and giving them a higher service level to make them more attractive might also be used in other areas, e.g. for winter maintenance and rural tourism investments.

7.3 Intervention levels for paved roads

In any situation where the identified defects can be a danger to people or vehicles, danger signs should be placed without delay. For paved roads 4 different service levels based on drive comfort, traffic safety, load restrictions and accessibility are suggested (Tables 8, 9, 10 and 11). For driving comfort the roughness trigger values presented in 10 m average values were selected. This will increase the likelihood of finding the bad single spots, which can be dangerous and unpleasant for road users. If longer averages had been used the bad spots might have been hidden in the average.

In the future there is likely to be other measures of roughness, e.g. vertical acceleration measured with accelerometer as shown in paragraph 7.4 also for paved roads. The measurement equipment is very cheap and easy to handle for people in the field.

Table 8. Trigger Values For Service Level Priority 1, Paved Roads.

TRIGGER VALUES FOR SERVICE LEVEL PRIORITY 1, PAVED ROADS		
Drive comfort	Speed > 100 km/h	10 m average IRI < 13 mm/m
	Speed 80-100 km/h	10 m average IRI < 15 mm/m
	Speed < 80 km/h	10 m average IRI < 17 mm/m
	No potholes	
Traffic safety	Surface friction	> 0,5
	Rutting	20 m average < 50 mm
Load restrictions	Temporary load restrictions allowed	
Accessibility	Lowest maintenance standard	

Table 9. Trigger Values For Service Level Priority 2, Paved Roads.

TRIGGER VALUES FOR SERVICE LEVEL PRIORITY 2, PAVED ROADS		
Drive comfort	Speed > 100 km/h	10 m average IRI < 12 mm/m
	Speed 80-100 km/h	10 m average IRI < 14 mm/m
	Speed < 80 km/h	10 m average IRI < 16 mm/m
	No potholes	
Traffic safety	Surface friction	> 0,5
	Rutting	20 m average < 40 mm
Load restrictions	Temporary load restrictions allowed	
Accessibility	Standard maintenance standard	

Table 10. Trigger Values For Service Level Priority 3, Paved Roads.

TRIGGER VALUES FOR SERVICE LEVEL PRIORITY 3, PAVED ROADS		
Drive comfort	Speed > 100 km/h	10 m average IRI < 10 mm/m
	Speed 80-100 km/h	10 m average IRI < 12 mm/m
	Speed < 80 km/h	10 m average IRI < 14 mm/m
	No potholes	
Traffic safety	Surface friction	> 0,5
	Rutting	20 m average < 30 mm
Load restrictions	Temporary load restrictions allowed during severe spring thaw conditions	
Accessibility	Raised maintenance standard	

Table 11. Trigger Values For Service Level Priority 4, Paved Roads.

TRIGGER VALUES FOR SERVICE LEVEL PRIORITY 4, PAVED ROADS		
Drive comfort	Speed > 100 km/h	10 m average IRI < 9 mm/m
	Speed 80-100 km/h	10 m average IRI < 11 mm/m
	Speed < 80 km/h	10 m average IRI < 13 mm/m
	No potholes	
Traffic safety	Surface friction	> 0,5
	Rutting	20 m average < 20 mm
Load restrictions	No load restrictions allowed	
Accessibility	Highest maintenance standard	

When the service level of a road has become substandard according to the priority level the road will be a maintenance or rehabilitation candidate. Then the Transportation Need Index, calculated according to the method presented in chapter 6, can be used to select the road from the candidates, which have the highest priority to be maintained/rehabilitated.

7.4 Intervention levels for gravel roads

The intervention levels for gravel roads can be defined in different ways. It can be done by specifying levels of road surface defects, by using some sort of a comfort value for a specified length of road or by a combination of defects and a comfort value. Two ways to describe the riding comfort are given in an Australian manual (4). One way is to measure the roughness with an accelerometer and, in that way, create a measure of the roughness (R). Another way is to look at the driving speed of a designated vehicle immediately after the road has been graded, driven in a safe manner, which will not cause damage to people, goods or vehicle. Then that driving speed can be compared to the speed driven by the same vehicle, on the same road length, from a safe ride done under different road conditions and then the reduction of the driving speed can be calculated as a percentage. The intervention levels can then be decided depending on the roughness or speed reduction as shown in principle in figure 7.

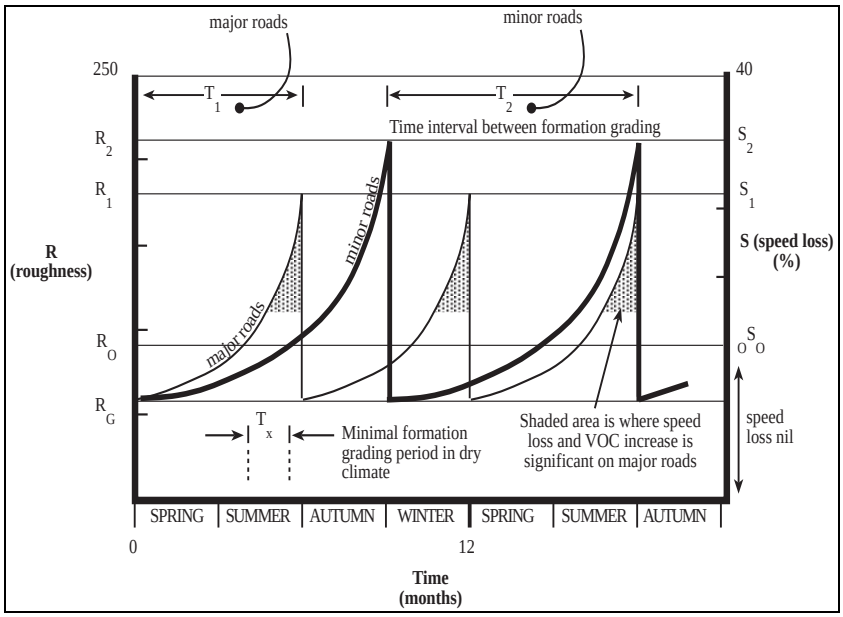

Figure 7. Intervention Policy for Major and Minor Unsealed Roads (4).

Measurement of the roughness using an accelerometer has begun in Sweden and Finland on a trial basis. Roughness is described as the vertical acceleration of a vehicle wheel axle measured in m/s^2 at a specified vehicle speed. The equipment and principle for the measurements are shown in figure 8 and 9. The results are promising and a tentative proposal for values on gravel road roughness has been submitted by Dr Anssi Lampinen, from Finland (5). These roughness values have been added as trigger values in the tables for gravel roads. The roughness should be measured at a speed of 80 km/h for the gravel roads and at 50 km/h on the forest roads, but the measurement speed should not be higher than the speed the roads are designed for. The suggested levels should be regarded as a first rough draft. This method will be more common in the future and there are plans to develop this further in Roadex III. Then new trigger and intervention levels can be defined.

In any situation where the identified defects can be a danger to people or vehicles, danger signs should be placed without delay. For gravel roads it is suggested here that 4 service levels based on drive comfort, traffic safety, load restrictions and accessibility are used (Tables 12, 13, 14 and 15).

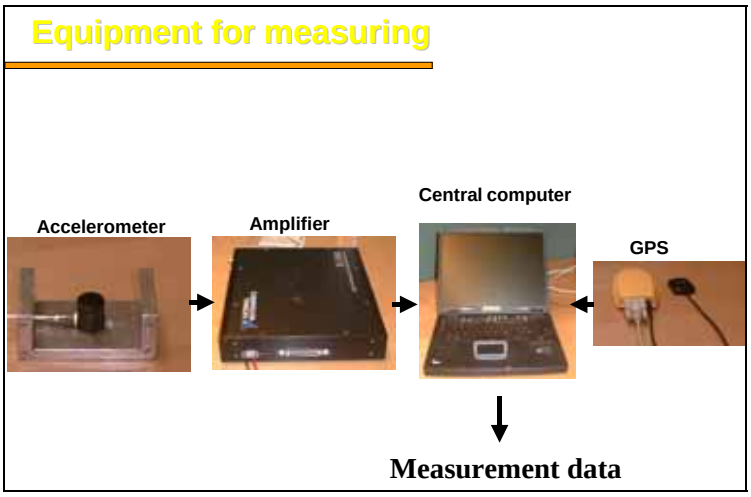

Figure 8. Equipment for roughness measurements with accelerometer (from Lars Forslöf et al)

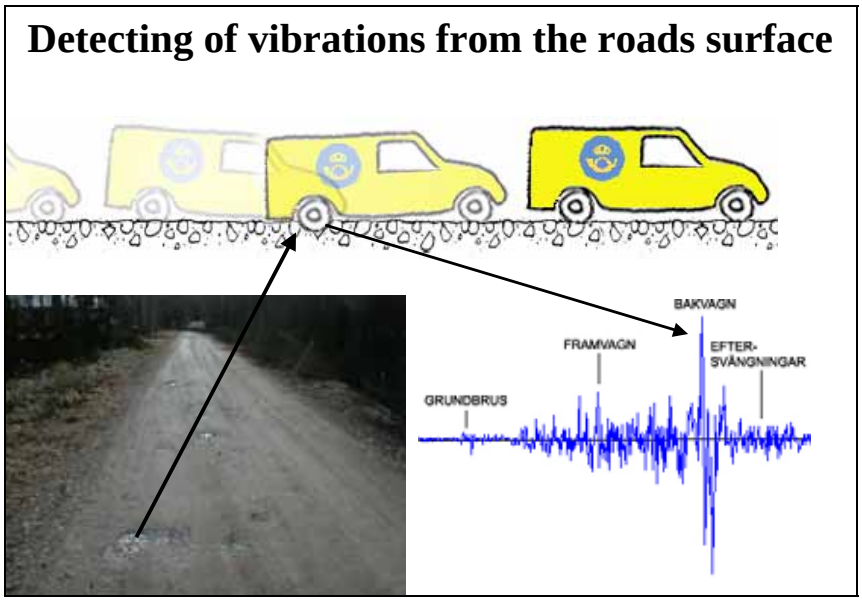

Figure 9. Measurement principles for roughness measurements with accelerometer (from Lars Forslöf et al)

Table 12. Trigger Values For Service Level Priority 1, Gravel Roads.

TRIGGER VALUES FOR SERVICE LEVEL PRIORITY 1, GRAVEL ROADS	
Drive comfort	The road has in general good cross fall and the surface is in most areas firm and even Larger areas of deformation, potholes and corrugations (washboarding) can occur but not for more than seven days. Roughness measured by accelerometer 10-15 m/s^2
Traffic safety	Loose gravel may be found on the surface and along the roadway Dust is rather frequently generated by the vehicles.
Load restrictions	Temporary load restrictions allowed
Accessibility	Lowest maintenance standard

Table 13. Trigger Values For Service Level Priority 2, Gravel Roads.

TRIGGER VALUES FOR SERVICE LEVEL PRIORITY 2, GRAVEL ROADS	
Drive comfort	The road has in general good cross fall and the surface is in most areas firm and even Larger areas of deformation, potholes and corrugations (washboarding) can occur but not for more than three days. Roughness measured by accelerometer 6-10 m/s^2
Traffic safety	Loose gravel may be found on the surface and along the roadway Some dust is generated by the vehicles.
Load restrictions	Temporary load restrictions allowed
Accessibility	Standard maintenance standard

Table 14. Trigger Values For Service Level Priority 3, Gravel Roads.

TRIGGER VALUES FOR SERVICE LEVEL PRIORITY 3, GRAVEL ROADS	
Drive comfort	The road has in general good cross fall and the surface is in most areas firm and even
	Unevenness and potholes exist in some areas
	Roughness measured by accelerometer 3-6 m/s^2
Traffic safety	Loose gravel may be found on the surface and along the roadway
	Some dust is generated by the vehicles.
Load restrictions	Temporary load restrictions allowed during severe spring thaw conditions
Accessibility	Raised maintenance standard

Table 15. Trigger Values For Service Level Priority 4, Gravel Roads.

TRIGGER VALUES FOR SERVICE LEVEL PRIORITY 4, GRAVEL ROADS	
Drive comfort	The road has necessary cross fall and the surface is firm and even
	Some potholes may occur
	Roughness measured by accelerometer < 3 m/s^2
Traffic safety	Some loose gravel may be found on the surface.
	Not much dust is generated by the vehicles.
Load restrictions	No load restrictions allowed
Accessibility	Highest maintenance standard

8 Forest roads

8.1 Introduction

Forest roads differ from other paved and gravel roads in that they are designed and constructed for a specific business requirement. Their purpose is to enable access to forests to assist in general management, timber extraction and recreation. The class of road is directly related to the business need linked to the forest and the challenge is to construct a road capable of carrying large and heavy vehicles while meeting all of the environmental criteria at a cost commensurate with the quality and volume of the timber produced. The forest road is a key component of the supply chain to the timber industry and as the industry moves towards "just in time" stock control many forest roads must remain serviceable throughout the year in all weather conditions even during the spring thaw period.

8.2 Accessibility

Forest roads can be divided into different classes (Table 16) dependant on road user access need. Primarily forest roads are aimed for the extraction of timber and use by heavy vehicles but throughout the Northern Periphery area recreational use is increasing and demands are being made to keep forest roads serviceable throughout the year.

Table 16. Forest Road Accessibility Classes.

ACCESSIBILITY CLASSES FOR FOREST ROADS	
Class A	The road shall be able to carry traffic from heavy vehicles and personal cars throughout the year.
Class B	The road shall be able to carry traffic from heavy vehicles the whole year except for the spring thaw period. The road shall be able to carry personal cars throughout the year.
Class C	The road shall be able to carry traffic from heavy vehicles the whole year except for the spring thaw period and periods with heavy rainfall. The road shall be able to carry personal cars throughout the year except for the spring thaw period.
Class D	The road shall be able to carry traffic from heavy vehicles mainly when the road structure is frozen. The road shall be able to carry personal cars also in the summer.

8.3 Intervention levels

The intervention levels (Tables 17, 18, 19 and 20) are based on type, severity and extent of defects. The roughness values from the Finnish proposal (5) are introduced as trigger values in the tables for gravel roads. The roughness measurement shall be done at a speed of 50 km/h. but if the design speed is lower the measurement shall be done at the design speed. The suggested levels should be regarded as a first rough draft.

Table 17. Intervention Level 1 For Forest Roads.

INTERVENTION LEVEL 1 FOR FOREST ROADS		
Defect	**Extent intervention level**	**Activity**
a) Depth of wearing course gravel 0 mm	On > 20 % of sub-length.	Resheeting of pavement including supply and placing of imported material
d) Roughness measured with accelerometer	20-30 m/s^2	

Table 18. Intervention Level 2 For Forest Roads.

INTERVENTION LEVEL 2 FOR FOREST ROADS		
Defect	**Extent intervention level**	**Activity**
a) Defect depth > 150 mm or water ponds	On > 20 % of sub-length.	Heavy formation grading including watering and compaction.
b) Crossfall < 3 % or > 7 %	On > 20 % of sub-length.	
d) Roughness measured with accelerometer	10-20 m/s^2	

Table 19. Intervention Level 3 For Forest Roads.

INTERVENTION LEVEL 3 FOR FOREST ROADS		
Defect	**Extent intervention level**	**Activity**
a) Crossfall < 3 % or > 7 %	On > 20 % of sub-length of 1 km	Medium formation grading including watering and compaction
b) Ruts, potholes and corrugations > 50 mm deep	On > 20 % of sub-length of 1 km	
c) Roughness measured with accelerometer	5-10 m/s^2	

Table 20. Intervention Level 4 For Forest Roads.

INTERVENTION LEVEL 4 FOR FOREST ROADS		
Defect	**Extent intervention level**	**Activity**
a) Soft or slippery areas; loose material	On > 5 % of a sub-length of 1 km.	Light formation grading. Restoring of general defects.
b) Safe travel speed < 80 % of safe driving speed	On > 20 % of sub-length	
c) Ruts, corrugations, potholes < 50 mm depth	On > 20 % of sub-length.	
d) Roughness measured with accelerometer	< 5 m/s^2	

8.4 Road standard priority levels

In any situation where the discovered defect is a danger to people or vehicles, danger signs should be placed without delay. Where a sign is required, the time taken to erect the sign depends on the road accessibility class. Some forest roads are not open to private cars and the priority level can be decided solely on business needs. The road standard priority is described in four levels based on transportation need and intervention level (Table 21). It describes the acceptable response time between the reporting that an intervention level has been reached and action taken to restore the actual defects.

Table 21. Road Standard Priority Levels On Forest Roads.

ROAD STANDARD PRIORITY LEVEL ON FOREST ROADS		
Accessibility class	**Intervention level**	**Priority**
A	4	Action against substandard within 3 days.
	3	Action against substandard immediately.
B	4	Action against substandard within 7 days.
	3	Action against substandard within 3 days.
	2	Action against substandard immediately.
C	4	Action against substandard within 14 days.
	3	Action against substandard within 7 days.
	2	Action against substandard within 3 days.
D	3	Action against substandard within 14 days.
	2	Action against substandard within 7 days.
	1	Action against substandard within 3 days.

9 Procurement Strategies and Follow up

9.1 Introduction

During recent years in the Roadex II partner regions routine road maintenance has gone from entirely in-house work to almost all contracts being open to tender on the market. This has created a necessity of describing every task in detail or to describe a performance based specification with intervention levels or "trigger values". In both cases it is difficult to make an all-encompassing description of the maintenance work. In this report the authors have chosen to make performance-based descriptions.

9.2 Performance specification

Performance specifications for normal low volume paved roads and gravel roads are given above in chapter 7 and for forest roads in chapter 8. These requirements are still far from being sufficient for a performance based maintenance contract. The specifications only include the road surface conditions and are directed towards keeping the road surface in proper condition so as to provide the road users with a reasonable service level and traffic safety. Other parameters like drainage, uneven frost heave, erosion control and vegetation control must, of course, also be added. To produce a complete universal procurement document will take a great deal of time and resources and, as such, it cannot be done within this project.

One important thing with regard to the performance contracts is that the different performance parameters should be measurable according to specified methods and method descriptions. Otherwise there is risk for future disagreements.

9.3 Follow up

For the client, but also for the contractor, it is of the greatest importance that intervention levels and any maintenance performed are followed up. For the client it is necessary to check that he has received the requisite level of quality, that his costs are within the budget and to see if something needs to be changed for the next tender period. The follow up has to be done continuously during the contract period through measurements and visual inspections. A dialogue should be kept open with the contractor as well as with the road users. Regular meetings with local people and professional transportation companies can often yield good solutions to road condition problems and improved performance specifications for the future.

10 Socio-Economic models

10.1 Introduction

Conventional socio-economic models for road user costs generally do not include the costs and benefits of comfort, influence on the standard of living and influence on industrial production and investments. These types of costs and benefits are difficult or even impossible to calculate. The road user cost (RUC) models usually deal with accident costs, vehicle operation costs and travel time costs. Traffic is a significant factor affecting the road user costs. A major improvement in the road condition of a low volume road will result in a small reduction of road user costs for the whole society. A minor improvement on a highly trafficked road will produce a big reduction for the whole society. An optimization of the socio-economic costs on network level will minimize the total annual costs consisting of road management costs and road user costs (see figure 10). A network model will therefore give priority to good road conditions on highly trafficked roads in order to keep the total costs on the lowest level.

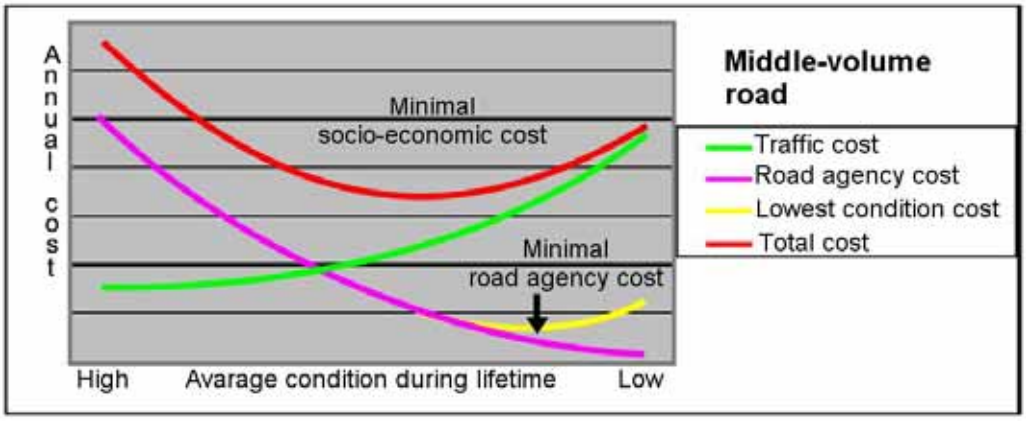

Figure 10. Principles for minimising the socio-economic costs for road maintenance.

10.2 The use of models

One way to illustrate the socio-economic profitability for different types of investments is by using the net present value quotient method. The net present value quotient (NNK) is defined as **summarized benefit minus summarized cost capitalized to present values over a time period, divided by the costs.**

Costs in this case are related to the amount of resources required to maintain a certain standard on a road project, which in this case, means the **costs for maintenance measures** and **costs for routine maintenance** and possible **costs for rest values.**

The benefit in this case can be described as a reduction in traffic costs through a maintenance measure or a maintenance strategy, which improves the surface standard in terms of:

- Reduced time costs
- Reduced vehicle costs
- Reduced accident costs

Maintenance measures or maintenance strategies for road projects are judged by the SNRA to be profitable when NNK > 0,9. Then the projects should be performed if funds are available and no other projects have a better NNK.

The use of the Swedish Excel model on a project level for low volume roads has shown the following roughness levels, expressed as IRI, to be profitable in relative comparisons:

- ADT about 15 IRI between 5 – 6 mm/m
- ADT about 150 IRI between 4 – 5 mm/m
- ADT about 360 IRI about 4 mm/m.

The effect models included in the Swedish Socio-economic Excel model are based on IRI- and rutting values averaged over 400-500 meters. That, as such, is why it is not possible to evaluate whether using the suggested trigger values based on 10 m averages for the paved roads is sensible from a socio-economically calculated point of view. The HIPS model, used by the Norwegian and the Finnish Road Administrations, uses 100 m averages in their effect models. The authors are not aware of any formulas for converting 10 m averages into other average distances for road surface condition parameters but formulas are needed to compare road surface conditions from different average distances.

10.3 A new model approach

As can be seen in the results from the report concerning Socio-economic Impact from Roadex II (1) most of the calculation models for minimizing socio-economic costs will only work on a network level. If those models are also to be utilised for low volume roads there is a definite need to add a social benefit factor to the user benefits. Use of the Transportation Need Index from chapter 6 is of potential benefit to rural low volume roads. It is suggested here that the TNI-value be converted to a **Social Benefit Factor (SBF)** for the road user benefits. The factor can be used to multiply the sum of the road user benefits in the models. The following conversion is suggested:

TNI	**SBF**
4-6	1,25
7-9	1,50
10-12	1,75
13-16	2,00

The low volume roads should be calculated in separate networks and in the calculations the SBF-factor should be used in the model. This will increase the profitability of maintenance on the low volume roads and thereby the possibility of receiving additional resources for the low volume roads.

11 Conclusions

This report will give some new proposals for Road Management Policies to be used in order to create better living conditions for people residing in rural areas. Some conclusions from the report are:

- Identifying fragile areas and lifeline roads is a good way to illustrate rural road user needs
- Combining fragility, lifeline class and accessibility needs for people and business to a Transportation Need Index will produce a better ranking of the low volume roads
- Defining service levels in different priority levels and short average 'trigger values' helps the road user to obtain better road conditions
- The new proposals for objective 'trigger values' for roughness measured with an accelerometer should be tested and adjusted in Roadex III and then trigger and target values can be adjusted
- Following up on maintenance contracts is very important in order to secure the quality and to improve the performance requirements
- The use of a Social Benefit Factor in the socio-economic models will improve the possibility of having a more fair allocation of resources between high and low volume roads.

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Roadex Publications

ROADEX II

- ROADEX II - Focusing on Low Volume Roads in the Northern Periphery DVD
- User Perspective to ROADEX II Test Areas' Road Network Service Level
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- New material treatment techniques
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- Socio-economic impacts of road conditions on low volume roads
- Dealing with bearing capacity problems on low volume roads constructed on peat
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- Environmental guidelines, pocket book
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