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ROADEX III
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Road condition management policies for low volume roads – tests and development of proposals

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PREFACE

This is a final report from Task B4 of the ROADEX III project, a technical trans-national cooperation project between The Highland Council, Forestry Commission Scotland and Comhairle Nan Eilean Siar from Scotland; The Northern Region of The Norwegian Public Roads Administration; The Northern Region of The Swedish Road Administration and the Swedish Forest Agency; The Savo-Karjala Region of The Finnish Road Administration; the Icelandic Road Administration; and the Municipality of Sisimiut from Greenland. The lead partner in the project is The Northern Region of The Swedish Road Administration and project consultant is Roadscanners Oy from Finland. ROADEX III project Chairman is Per-Mats Öhberg from The Northern Region of The Swedish Road Administration and project manager is Ron Munro of Roadscanners Oy.

The report was prepared by Svante Johansson and Kristofer Johansson, Roadscanners Sweden AB. Mika Pyhähuhta of Laboratorio Uleåborg designed the report layout.

The authors would like to express their gratitude to the data suppliers in the partner countries for their good work.

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CONTENTS

ABSTRACT

A main research task of the ROADEX II project investigated road user needs and socio-economic impact of road conditions on low volume roads across the European Northern Periphery (1, 2). Based on the research some proposals were presented for new road condition management policies for low volume paved roads, gravel roads and forest roads in the Northern Europe (3). This work was also published as an executive summary in ROADEX III (4).

In the ROADEX III-project, 2006-2007, a supplementary task was commissioned to further develop the new Road Condition Management Policies. Within this task it was decided that the "Transportation Need Index", described in the ROADEX II-report "Road Management Policies for Low Volume Roads – Some Proposals" (3), should be tested in some of the partner areas. The Transportation Need Index (TNI) is formed by adding:

- The fragility class of an area where a specific road section is situated
- The lifeline class of a the specific road section
- The class of road user needs for people using the specific road section
- The class of road user needs for business using the specified road section.

The tests were carried out in one geographical area of each of the Partner countries of Finland, Highlands, the Western Isles and Sweden to see how the new Index could work in practice. As a start we looked at the Fragile Areas in the geographical area that each partner had suggested. Through the data, described below and supplied by each partner, we tried to classify the fragile areas of the geographical test area. We processed the data and defined the most fragile area in each test area in each country. Then within that most fragile area of each country, we continued with classification of Lifeline Roads and Road User Needs for People and Business and the TNI was formed. The classification and the TNI were then used to specify proposals for Road Service Levels with different Intervention Levels for paved roads and gravel roads.

The tests have given some interesting results. GIS maps have been produced showing the classification of different parameters and from these it can be seen where fragility is high, which roads are real lifelines and what are the different transportation needs. These TNI maps show the roads with high fragility and high lifeline class that should be upgrade, as opposed to those where only the traffic volume determines road service levels.

The results show that the identification and mapping of fragile areas, lifeline roads and transportation needs for people and business is an effective way of showing rural road user needs. Combining fragility, lifeline class and accessibility needs for people and business to a Transportation Need Index, and using the information to set service levels, will give a better ranking for low volume roads. The use of service levels in different priority levels, and short average 'trigger values', will help the road users in rural areas to get better road conditions.

The tests have shown that it is possible to calculate the Transportation Need Index if all of the data is available but the classes used within the calculations should be adapted to suit the conditions in the actual area.

Other ways to show the importance of having the low volume road network in good condition could be to look at the vulnerability of the local society and to look at asset management.

Chapter 1 Introduction

1.1 THE ROADEX PROJECT

The ROADEX Project is a technical co-operation between roads organisations across northern Europe that aims to share roads related information and research between the partners. The Project was started in 1998 as a 3 year pilot co-operation between the roads districts of Finnish Lapland, Troms County of Norway, the Northern Region of Sweden and The Highland Council of Scotland and was subsequently followed and extended with a second project, ROADEX II, from 2002 to 2005 and a third, ROADEX III, from 2006 to 2007.

The partners in ROADEX III "The Implementation Project" comprised public road administrations and forestry organizations from across the European Northern Periphery. These were The Highland Council, Forestry Commission Scotland & Comhairle Nan Eilean Siar from Scotland, The Northern Region of The Norwegian Public Roads Administration, The Northern Region of The Swedish Road Administration and the Swedish Forest Agency, The Savo-Karjala Region of The Finnish Road Administration, the Icelandic Road Administration and the Municipality of Sisimiut from Greenland.

Figure 1 Northern Periphery Area and ROADEX III Partners

A priority of this Project was to take the collected ROADEX knowledge out into the Partner areas and deliver it first hand to practising engineers and technicians. This was done in a series of 14 seminars across the Partner areas to a total audience of 800. Reports were translated into the 6 partner languages of Danish, Icelandic, Finnish, Greenlandic, Norwegian and Swedish as well as English. ROADEX research continued through 5 projects: measures to improve drainage performance, pavement deformation mitigation measures, health issues of poorly maintained roads, road condition management policies, and a case study of the application of ROADEX methodologies to roads in Greenland. All of the reports are available on the ROADEX website at www.roadex.org.

1.2 PROPOSALS FOR ROAD MANAGEMANT POLICIES FOR LOW VOLUME ROADS

A main research task of the ROADEX II project investigated road user needs and socio-economic impact of road conditions on low volume roads across the European Northern Periphery (1, 2). Based on that research some proposals were presented for new road condition management policies for low volume paved roads, gravel roads and forest roads in the Northern area of Europe (3). This work is further developed in ROADEX III during 2006-2007 and the results were also published as an executive summary (4).

A supplementary Task was commissioned in the ROADEX III-project to further develop the new Road Condition Management Policies. Within the task it was decided that the Transportation Need Index, which was described in the ROADEX II-report "Road Management Policies for Low Volume Roads – Some Proposals" (3), should be tested in some of the partner areas. The Transportation Need Index (TNI) is formed by adding:

- The fragility class of an area where a specific road section is situated
- The lifeline class of a the specific road section
- The class of road user needs for people using the specific road section
- The class of road user needs for business using the specified road section.

The definitions of the different parameters are described down below. The tests were carried out in one geographical area in each of the partner countries Finland, Highlands, the Western Isles and Sweden to see how the new Index could work in practice. As our resources were limited we had to do this on a small scale and each Partner had to supply the necessary data.

As a start we looked at Fragile Areas in the geographical area that each partner had suggested. Through the data, described below and supplied by each partner, we tried to classify the fragile areas of the geographical test area. We processed the data and defined the most fragile area in each test area in each country. Then, within that most fragile area of each country, we continued with a classification of Lifeline Roads and Road User Needs for People and Business to for TNI. The classification and the TNI were then used to specify proposals for Road Service Levels with different Intervention Levels for paved and gravel roads.

This document should be regarded as a discussion document for road managers to find an alternative way to classify roads in a network giving the lifeline roads and roads in fragile areas a fairer ranking.

Chapter 2 Transportation Need Index (TNI)

2.1 INTRODUCTION

Road user needs are important factors in road management in all of the ROADEX Partner countries. Many surveys have been done to assess the road users' opinions on road surface condition, traffic safety etc and the traffic flow has always been a dominating parameter in local road management. In recent years more radical steps have been taken to examine road user needs from a wider perspective. More stress is now laid upon the survival of societies in rural areas, on their vulnerability and on the lifeline roads to rural societies. We suggest a "Transportation Need Index" (TNI) which includes fragility class, lifeline class and transportation need class for businesses and people. The use of this TNI will give low volume roads in fragile areas a better ranking in arguments for improvements in road standard and maintenance.

2.2 FRAGILITY (F)

2.2.1 Introduction

All of the ROADEX Partner countries have large rural areas where the fundamental social services are difficult to maintain due to limited local resources. The population in many of these areas may be in decline for reasons such as difficulties to find work in the neighbourhood, insufficient social services and long distances to different services, schools and cultural events. Road standard can also contribute to population decline as travelling on roads in bad condition can be very uncomfortable and the accident risks can be greater. The areas, which are suffering from this decline in population, can be deemed to be **fragile areas** (2, 3, 4).

Fragile areas are defined as **communities being in decline or in danger of decline**. The actual state of fragility is described by using fragility indicators as lined out in section 2.1. It must be emphasised that the fragility is a relative measure within the geographical area selected for the test.

The purpose with identifying fragile areas is to highlight rural areas which suffer from population decline. By showing these areas in GIS maps it should hopefully be easier to demonstrate the need for resources to politicians and maybe influence them to make direct measures to communities in decline. As the road network generally is a prerequisite for sustainability and development of rural areas one of the measures should be to keep the road network in a good condition.

2.2.2 Definition

Fragile areas are defined as communities being in decline or in danger of decline as a result of the following fragility indicators, principally according to a report from Highlands in Scotland (5):

- Social fragility – population
    - Population decline in % (latest 10-year period)
    - Population decline for age group 0-15 years in % (latest 10-year period)
    - Population density latest year in persons/km^2
    - People pensioned 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.

2.2.3 Social fragility – population

Population density latest year in persons/km^2.

The population density within the surveyed area is a critical figure. Low figures will make it difficult to get services within short distances.

Population change in % (latest 10-year period).

A decline could be a sign of the start of problems for a community. Take the latest 10-year period available.

Population decline for age group 0-15 years in % (latest 10-year period)

Young people are needed to keep schools open in the area and as the future entrepreneurs and workforce They are therefore critical for the long term survival of an area. Choose the latest 10-year period available.

People pensioned because of health or age, latest year in %

A large percentage of pensioned people will indicate less purchasing-power in the area and probably greater need for social care, which might result in movements to more urban areas. Take the latest figure of the share in % of the population in the actual area.

2.2.4 Economic fragility – unemployment

Long term unemployment rate – latest year in %

Unemployment means less money to spend and increases the risk of movement to another area. Choose the latest figure available in the statistics for unemployment more than 6 months.

Income support claimant rate – latest year in %

Income support means less money to spend and increased risk of population movement. Take the latest figure of the percentage of the total population in the actual area.

2.2.5 Accessibility indicator – to key services

Population residing outside of a 20 min one-way drive (25 km) to 5 key services

- Post Office
- Primary School
- Food Shop
- GP Surgery
- Petrol Filling Station

These services are critical for the survival of a society. If any of these key services is missing it might indicate the first signs of problems for the community.

2.2.6 Remoteness indicator – from the main service centre (City)

Population residing outside of a 1,5 hour one-way drive from city.

Long drives take time and cost money and can influence the propensity to move. The remoteness factor can be critical e.g. for getting access to education, cultural events and social services.

2.2.7 Comments on the indicators

We felt that the statistics for the 'social' indicators were fairly easy to obtain. There were some minor differences between the Partner countries concerning pensioned people.

The 'economic' indicators were a little more difficult. The statistics for unemployment and income support are subdivided in different ways so it can be difficult to get the comparable corresponding figures for the different Partner countries. This does not matter however as the comparison is made within each country.

The accessibility indicators are slightly more complicated. The social indicators and the economic indicators are from specified areas whereas the accessibility indicators are from smaller localities within these areas. Ranking this indicator between the specified areas is a challenge. One possibility is to estimate the number of people who have good accessibility in the locality and to calculate the percentage of the total amount of people within the specified area who have good accessibility. The ranking could then be done by the percentage. We have not been able to do this in the project as we did not have sufficiently detailed data.

The 'remoteness' indicators have the same problem. The percentage of the people in a specified area living within 1,5 hour drive could be estimated and the areas could be ranked. We have not been able to do that either because of lacking detailed data.

2.2.8 Assessing fragility

The suggested method for assessing the Fragility indicators is as follows. Select the smallest geographical area of the 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 fragility indicator. Assign the value 1 to the best and the value 'n' for the worst of each indicator. Add the indicators to obtain a sum for each geographical area as shown in table 1. Select 33 % of the geographic areas 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 fragility group. The

remaining 67 % will be 'class 1', no fragility. In our proposal from the ROADEX II report we used 25 percent of the highest fragility ranked (see table 2) but now we have reverted back to the figure of 33 % used in the original concept in the Scottish Highlands. As our statistics are from rather large areas, this will give a better ranking possibility. Use a GIS computer program, e.g. Arc View, to show the results on a map and attach a specific colour to each fragility class. Start with a light colour for the best and then use increasingly darker colours as shown in the example in figure 2.

Table 1 Ranking table for fragility indicators

	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**

The accessibility and remoteness indicators should be defined using good local knowledge and maps, or some computer program. A radius of 25 km for the accessibility, and 125 km for remoteness, could be used to simplify the procedure as we have done in the example. The places with good accessibility can then be designated as urban areas and marked as white areas on the GIS map as shown in figure 2. The areas within the remoteness distance of 125 km have been changed to one class less of fragility. Now the fragility can be classified into 5 different classes as shown on the GIS map in figure 2 and in table 2. Urban areas have been included in this map, as our statistics are on commune level, so only 4 fragility classes have been given in the test case, which is shown in table 3.

Table 2 Old ranking table for fragility (3)

0.	Urban area	Areas with good accessibility
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.

Table 3 New ranking table for fragility

Class 1, 67 % of the surveyed areas regarded as not fragile
Class 2, the highest rated third of the fragility group
Class 3, the medium rated third of the fragility group
Class 4, the lowest rated third of the fragility group

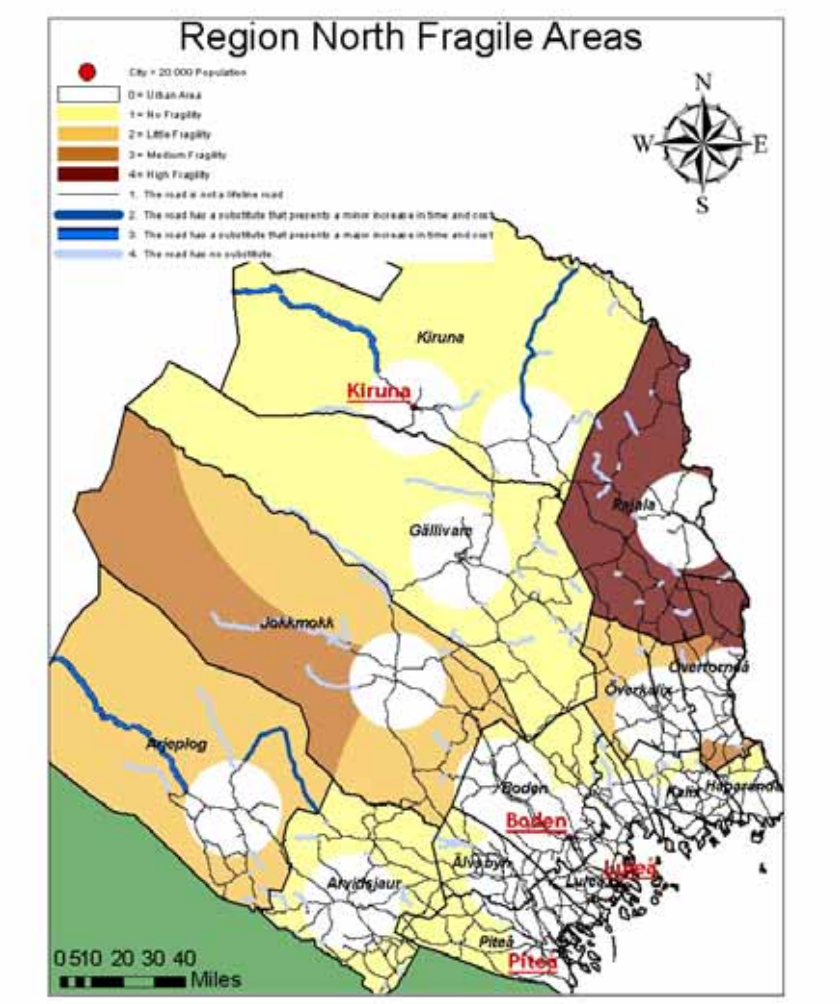

Figure 2 Ranking of fragile areas and lifeline roads in Norrbotten, Sweden

2.3 LIFELINE ROADS (L)

2.3.1 Introduction

The concept of 'Lifeline Rural Roads' was developed by The Highlands and Islands Strategic Transport Partnership, (HITRANS) and described in the report "Investments in Lifeline Rural Roads" (6). The report defines a '**lifeline road**' 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.*" The aim of the HITRANS study was to investigate the causal link between the condition, or availability of the lifeline road, and the social and economic vitality of a particular community. The final goal was to support the campaign for further investments in lifeline rural roads.

2.3.2 Classification of lifeline roads

The classification suggested in the ROADEX II report (3) depends on the uniqueness of the lifeline roads, as shown in table 4.

Table 4 Old classification of lifeline roads (3)

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.

It was however difficult to obtain this data from the Partners, possibly as the classification was too vague. We carried out a manual test from a map on a road network and came up with an alternative proposal as shown in table 5. The proposal gives the opportunity to choose between travel time and road length and there are computer programs in the market to handle this.

Table 5 New classification of lifeline roads.

Class 1 The road section has a substitute which is < 25 % longer or more cost and time consuming
Class 2 The road section has a substitute which is 25-100 longer or more cost and time consuming
Class 3 The road section has a substitute which is > 100 % longer or more cost and time consuming
Class 4 The road section has no substitute

2.3.3 Presentation of results

We recommend that the identified lifeline roads should be presented on a GIS-map showing the fragile areas. These roads should be marked in a specific colour so they are easily discernable. The roads should have different colours depending on the lifeline class. This type of map can be very useful e.g. in budget discussions in conjunction with details of the road conditions of the lifeline roads or for determining winter maintenance standards.

The lifeline roads from the primary example are shown in figure 2. The example is far from complete however. The map shows only state roads and commune roads and is given only to provide a better understanding of the possibilities of this method.

2.4 ROAD USER NEEDS FOR PEOPLE (P) AND BUSINESS (B)

2.4.1 Introducion

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 differing priorities depending on the reasons for travelling. For people, transportation to schools and workplaces are examples of urgent transport needs and, for business, daily postal services and other scheduled transportation services are examples of high priority needs. The classification of road user needs should be done for each road section by people with the knowledge of the local area and the road users, e.g. people working with the routine maintenance of the road network in the actual area.

2.4.2 Road user needs for people

The proposed classification for road user needs for people, outlined in the ROADEX II report (3), is shown in table 6.

Table 6 Old classification of road user needs for people (3)

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

Again in the test it was difficult to get results from the Partners for the test areas. The reasons for this could be that the necessary data was not available, that the existing data was too complicated to process and extract the local data, or that the classification was not sufficiently precise. We think the classification is useful as it describes the most urgent needs for people, and should be used if statistical data are available.

After some consideration however, we can also suggest that the transportation need for people could be described by the traffic of personal cars on the actual road section. After all the traffic intensity should indicate a transportation need, and traffic flow is measured regularly in most countries. The classification must however depend on the traffic intensity on the actual road section. The classification shown in table 7 is suited for a Finnish fragile area. We recommend that the classification is adjusted to the traffic situation in the area where the TNI is intended to be used. For higher or lower traffic intensities there might be a need for other class limits to get a good spread between the classes.

Table 7 New classification of road user needs for people

Class 1, ADT Personal cars < 100
Class 2, ADT Personal cars 100-500
Class 3, ADT Personal cars 501-1000
Class 4, ADT Personal cars > 1000

2.4.3 Road user needs for business

The suggestion for classification of the transportation needs for business from the ROADEX II report (3) is shown in table 8.

Table 8 Old classification of transportation needs for business (3)

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

As an alternative to this, as in 2.4.2 above, we suggest the use of heavy vehicle statistics for business needs to simplify the classification. Of course some business needs will be also in the category of personal cars, but e.g. taxis represent maybe more a personal need than a business need. The proposal in table 9 is adapted to the traffic flows in the most fragile area in the Finnish survey area. The classification should be adapted to the traffic conditions in the actual country or area so it can give sensible results.

Table 9 New classification of transportation needs for business.

Class 1, ADT Heavy 0
Class 2, ADT Heavy 1-5
Class 3, ADT Heavy 6-10
Class 4, ADT ADT Heavy > 10

2.5 THE TRANSPORTATION NEED INDEX (TNI)

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) based on the formula:

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

The classes are equally weighted, which means that a high fragility has the same value as high traffic. Using this index for setting road standards, and ranking maintenance candidates, will give fragile areas and lifeline roads a better rating compared with the situation today. The index can vary between 4 and 16. The higher the value, the more urgent is the need for transportation.

Chapter 3 Tests of TNI in partner areas

3.1 INTRODUCTION

Tests have been performed in selected areas in four Partner countries. It was found that for practical reasons some parameters and classifications had to be changed to facilitate the use of the Transportation Need Index. A basic consideration has been that the Index has to be easy to calculate and use. If it is too complicated and time consuming it will not be used. In the following clauses the tests carried out in Sweden, Finland, Highlands and Western Isles will be described.

3.2 TEST WITH DATA FROM SWEDEN

The Swedish test area was Norrbotten, which is the most northern part of Sweden. The statistical data used were from commune level. There are 14 communes in Norrbotten. All data is from December 200,6 except income support which is from December 2005, and the fragility ranking is shown in table 10.

Table 10 The fragility ranking in Norrbotten, Sweden

	Commune		Population dens 06		Pop diff, 96-06		Pop diff 0-15år, 96-06		Pension 061231		Unemployed 2006		Income support 05		Sum
Rank	Id	Name	Rank	*Pers/km2*	Rank	*%*	Rank	*%*	Rank	*%*	Rank	*%*	Rank	*%*	
1	2581	Piteå	2	*13,3*	2	*0%*	2	*-10%*	3	*24,9%*	5	*4,3%*	4	*3%*	**18**
2	2580	Luleå	1	*40,6*	1	*3%*	1	*-7%*	1	*21,5%*	7	*4,8%*	10	*4%*	**21**
3	2582	Boden	5	*6,5*	4	*-6%*	3	*-18%*	4	*25,9%*	1	*3,7%*	11	*4%*	**28**
4	2584	Kiruna	9	*1,2*	7	*-9%*	5	*-19%*	2	*23,6%*	2	*4,0%*	6	*3%*	**31**
5	2583	Haparanda	3	*11,1*	3	*-4%*	7	*-20%*	8	*29,4%*	13	*5,7%*	5	*3%*	**39**
6	2523	Gällivare	11	*1,2*	9	*-13%*	9	*-27%*	5	*28,5%*	4	*4,2%*	3	*3%*	**41**
7	2514	Kalix	4	*9,7*	5	*-7%*	6	*-20%*	7	*29,0%*	12	*5,3%*	9	*4%*	**43**
8	2560	Älvsbyn	6	*5,1*	6	*-7%*	4	*-18%*	6	*29,0%*	10	*5,2%*	14	*7%*	**46**
9	2518	Övertorneå	7	*2,2*	11	*-14%*	11	*-30%*	12	*32,7%*	11	*5,3%*	2	*3%*	**54**
10	2505	Arvidsjaur	10	*1,2*	8	*-12%*	8	*-23%*	10	*31,2%*	8	*5,0%*	12	*5%*	**56**
11	2513	Överkalix	8	*1,4*	12	*-14%*	13	*-35%*	13	*35,3%*	9	*5,2%*	1	*3%*	**56**
12	2506	Arjeplog	14	*0,2*	10	*-13%*	12	*-31%*	11	*32,4%*	6	*4,7%*	7	*4%*	**60**
13	2510	Jokkmokk	13	*0,3*	13	*-16%*	14	*-35%*	9	*29,8%*	3	*4,2%*	8	*4%*	**60**
14	2521	Pajala	12	*0,8*	14	*-16%*	10	*-29%*	14	*36,5%*	14	*6,2%*	13	*5%*	**77**

The classification of fragile areas is shown on a GIS map in figure 3. The map shows that Pajala commune is the most fragile area in Norrbotten. The commune Pajala, which had the highest fragility ranking, was selected for lifeline classification, for classification of transportation need for people and business, and for the final determination of Transportation Need Index. The lifeline classification is shown in figure 4 and the transportation needs for people and business are shown in figures 5 and 6 respectively. The lifeline classification was made by measuring road lengths on map, and the transportation needs were based on traffic intensity. The classification for the Transportation Need Index for Pajala commune was arrived at, by adding the classes for fragility, lifeline and transportation need for people and business. This is shown in 4 classes in figure 7 and in ranking figures in figure 8.

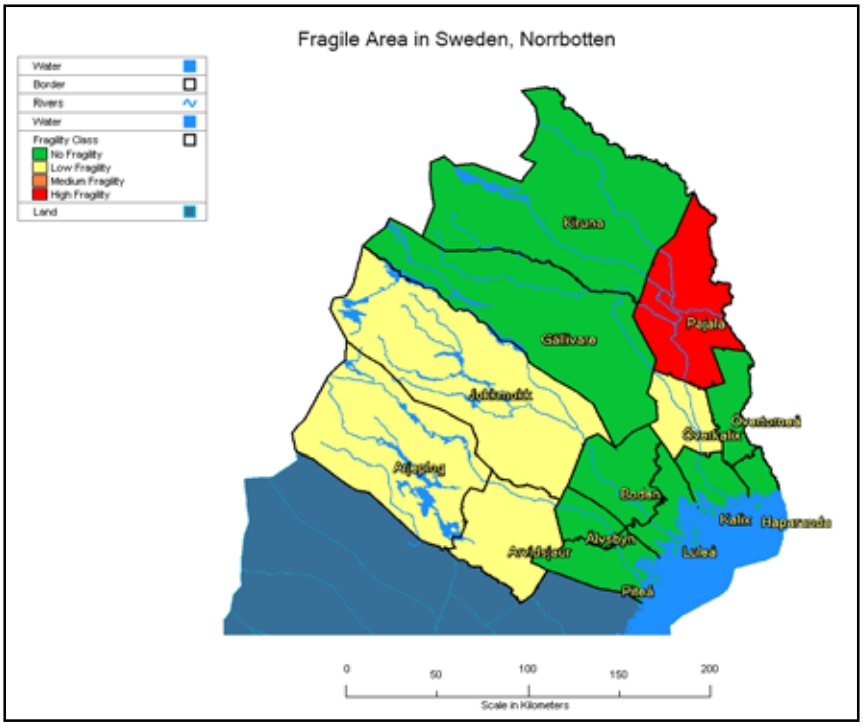

Figure 3 Fragility classification in Norrbotten, Sweden

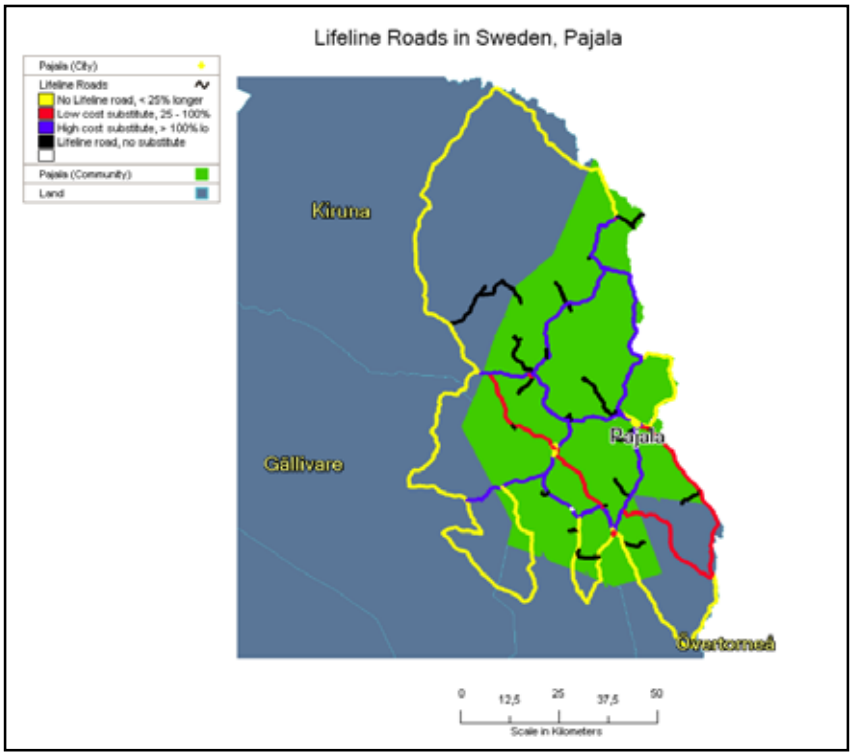

Figure 4 Lifeline classification in Pajala commune, Sweden

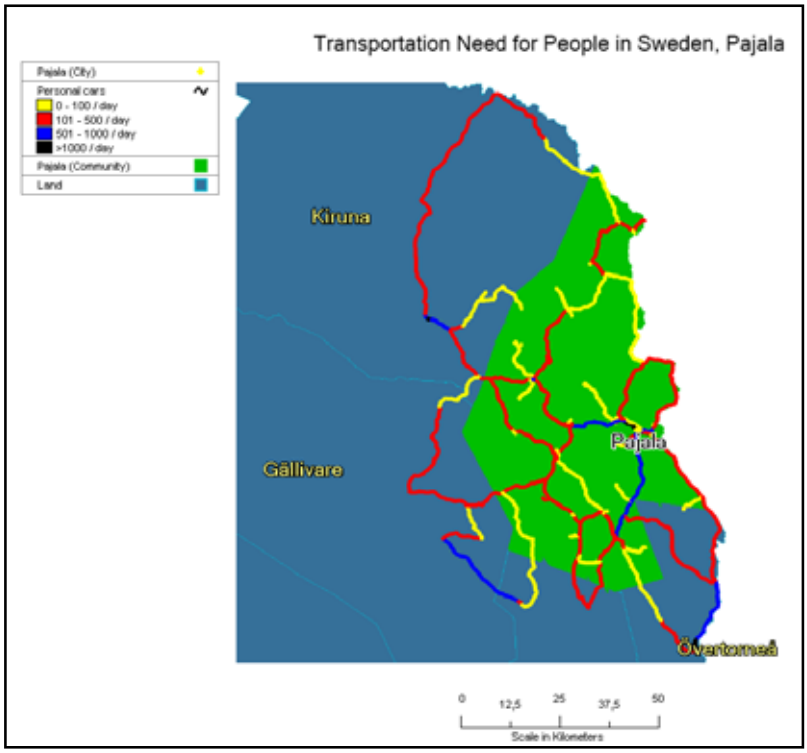

Figure 5 Classification of transportation need for people in Pajala commune, Sweden

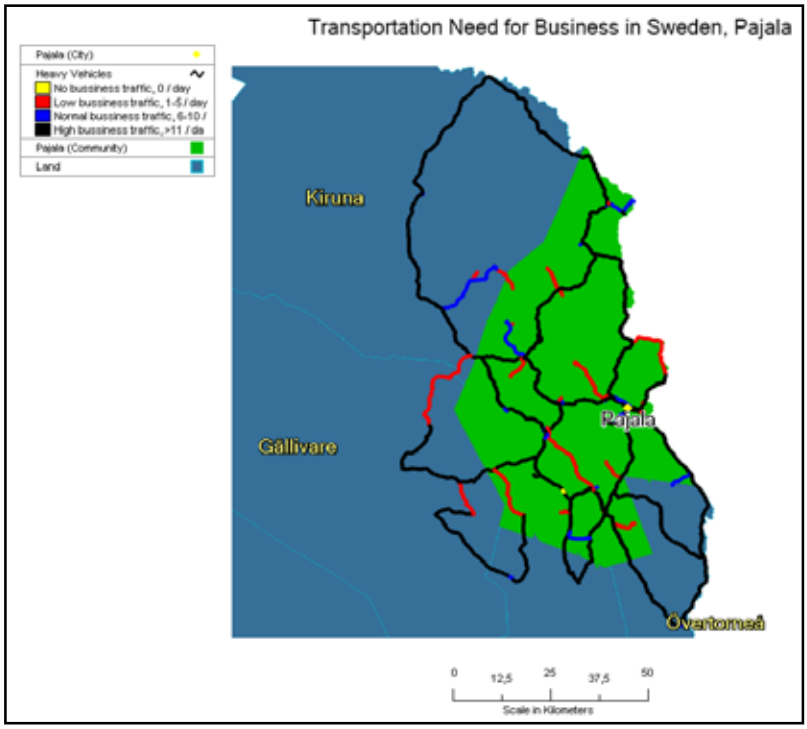

Figure 6 Classification of transportation need for business in Pajala commune, Sweden

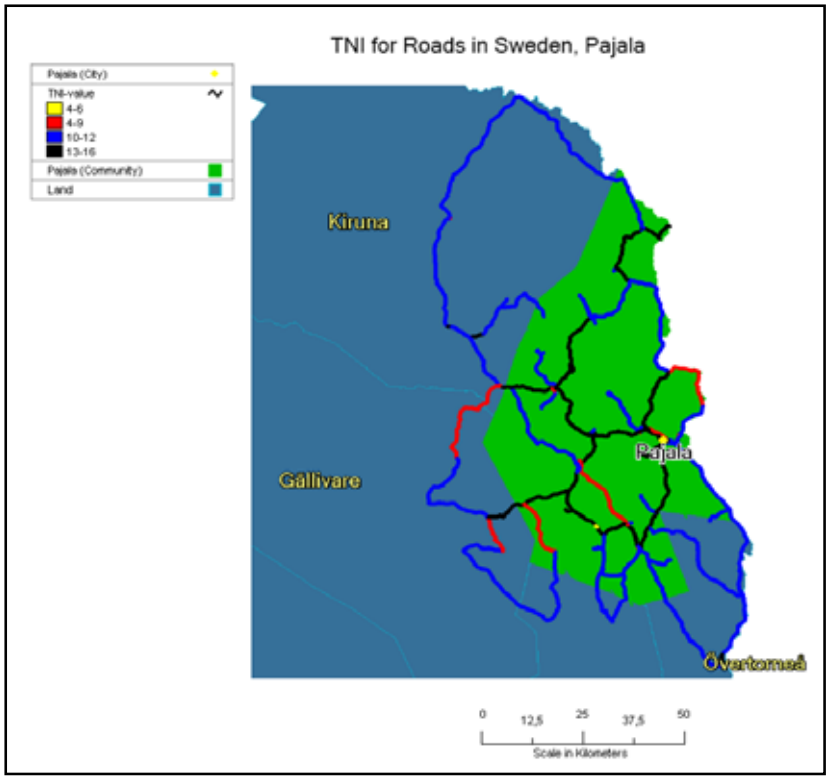

Figure 7 Classification of Transportation Need Index in 4 classes, Pajala commune, Sweden

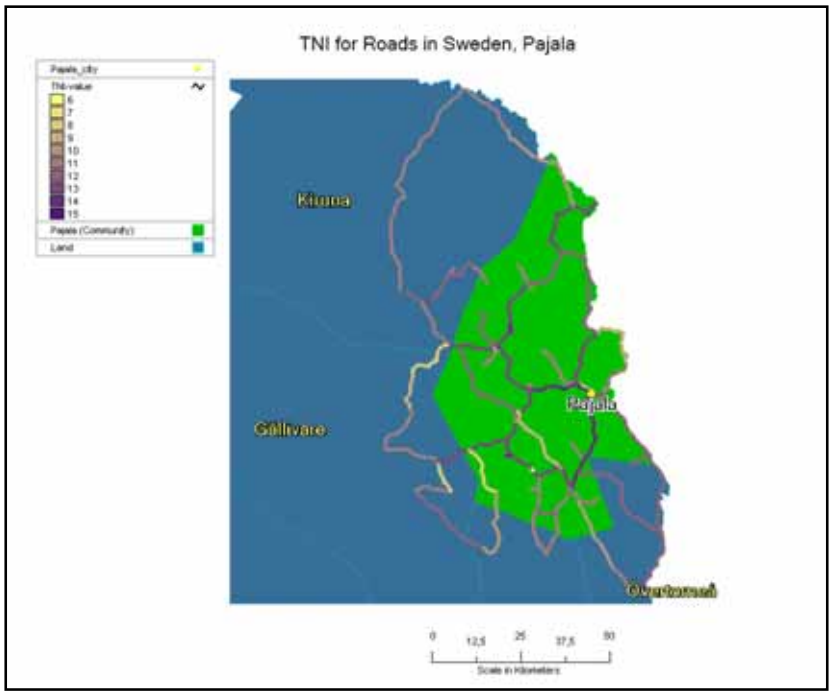

Figure 8 Classification of Transportation Need Index in Pajala commune, Sweden

3.3 TEST WITH DATA FROM FINLAND

The Finnish test area is situated in the south-east part of Finland. The statistics used were based on commune level. The indicator for the change in population of young people is based on age group 0-12 years over a period of 11 years, in stead of age 0-15 over a period of 10 years. The fragility ranking is shown in table 11.

Table 11 The fragility ranking in the south-east of Finland

Rank	Com. Code	Community	Population / km2	*Rank*	Population change 96-06	*Rank*	*Pop 0-12 change 95-06*	*Rank*	Unemployed 06	*Rank*	Pensioned 06	*Rank*	Income support (€)/habi.	*Rank*	RANK SUM
1	276	Kontiolahti	16,2	*5*	18,13%	*1*	-1,65%	*1*	11%	*1*	17%	*1*	50	*3*	**12**
2	426	Liperi	16,3	*4*	1,42%	*4*	-2,08%	*2*	11%	*1*	25%	*4*	50	*3*	**18**
3	632	Pyhäselkä	28,3	*2*	7,91%	*2*	-2,94%	*3*	12%	*3*	18%	*2*	76	*10*	**22**
4	167	Joensuu	49,4	*1*	3,17%	*3*	-3,81%	*7*	15%	*5*	21%	*3*	111	*14*	**33**
5	260	Kitee	11,2	*6*	-11,82%	*6*	-3,96%	*8*	16%	*8*	28%	*5*	64	*5*	**38**
6	248	Kesälahti	6,8	*8*	-11,82%	*7*	-4,49%	*12*	14%	*4*	33%	*10*	39	*2*	**43**
7	607	Polvijärvi	6,1	*11*	-13,09%	*9*	-3,98%	*9*	15%	*5*	31%	*7*	68	*8*	**49**
8	45	Eno	7,2	*7*	-10,14%	*5*	-3,02%	*4*	18%	*14*	30%	*6*	127	*15*	**51**
9	309	Outokumpu	17,4	*3*	-12,33%	*8*	-4,47%	*11*	16%	*8*	31%	*7*	141	*16*	**53**
10	176	Juuka	4,0	*13*	-14,67%	*11*	-3,41%	*6*	15%	*5*	34%	*13*	68	*8*	**56**
11	848	Tohmajärvi	6,4	*10*	-14,16%	*10*	-4,46%	*10*	19%	*15*	31%	*7*	65	*6*	**58**
12	541	Nurmes	5,6	*12*	-14,80%	*12*	-4,96%	*13*	16%	*8*	33%	*10*	67	*7*	**62**
13	707	Rääkkylä	6,5	*9*	-15,82%	*13*	-3,19%	*5*	17%	*12*	35%	*15*	80	*11*	**65**
14	911	Valtimo	3,2	*15*	-21,43%	*16*	-7,40%	*16*	16%	*8*	34%	*13*	33	*1*	**69**
15	422	Lieksa	4,0	*14*	-17,64%	*14*	-5,06%	*14*	20%	*16*	33%	*10*	94	*13*	**81**
16	146	Ilomantsi	2,3	*16*	-18,10%	*15*	-5,71%	*15*	17%	*12*	37%	*16*	87	*12*	**86**

This shows that the communes of Ilomantsi and Leiksa are the most fragile communes in the area and this is shown on a GIS map in figure 9. The commune Ilomantsi, which had the highest fragility ranking, was selected for lifeline classification, for classification of transportation need for people and business, and for the final determination of Transportation Need Index.

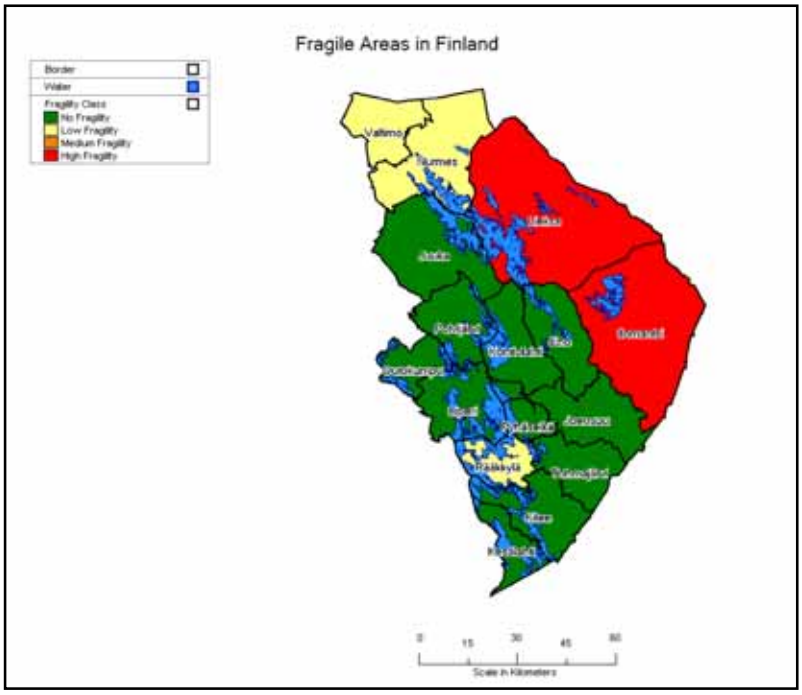

Figure 9 Fragility classification in the south-east of Finland

The lifeline classification was done by measurement from a map on a computer screen and the results are shown in figure 10.

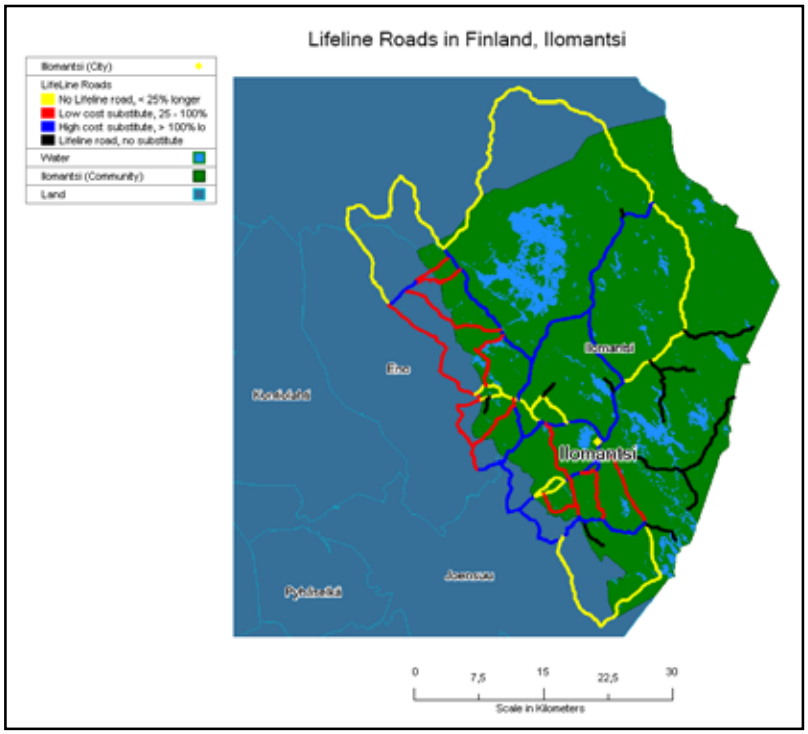

Figure 10 Lifeline classification in Ilomantsi, Finland

The transportation need for people, measured by the ADT of motorcars, is shown on a map in figure 11, and for business ADT of heavy traffic, shown in figure 12.

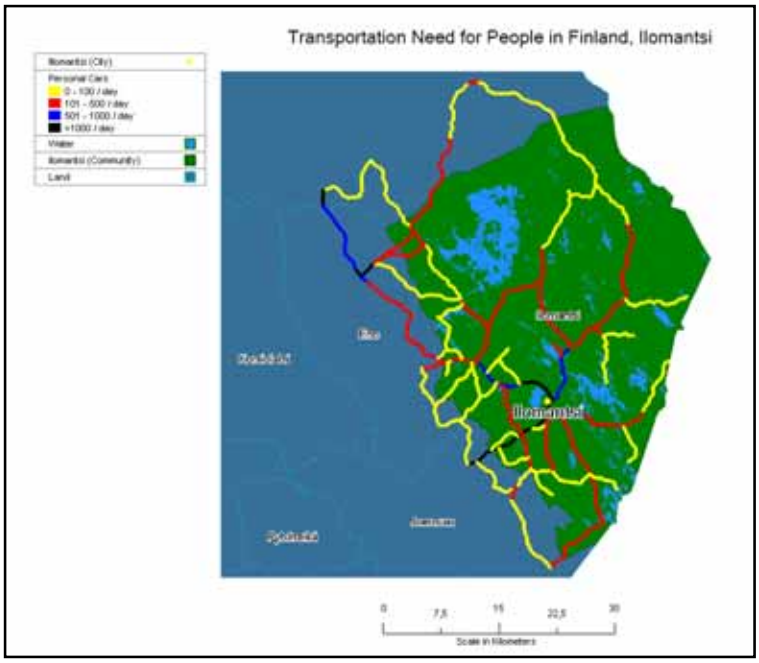

Figure 11 Classification of transportation need for people in Ilomantsi, Finland

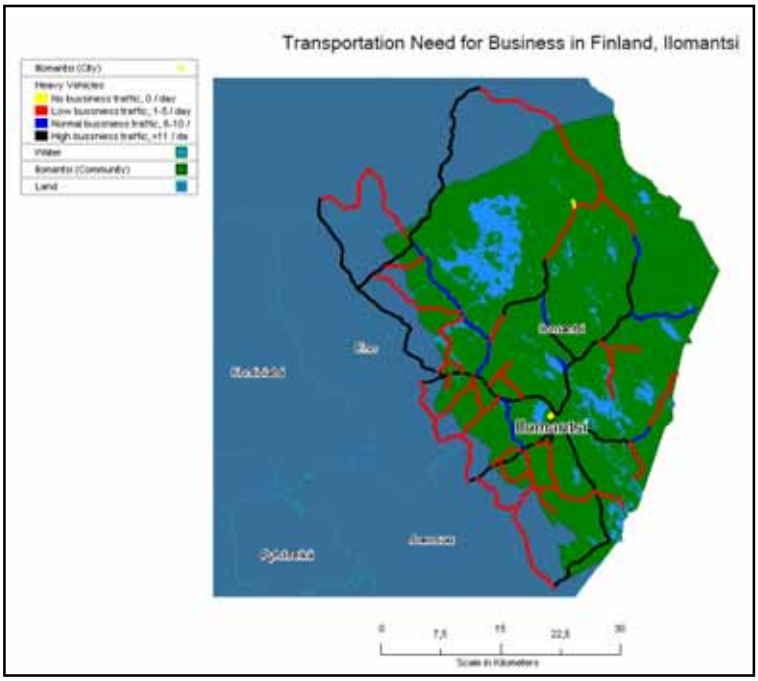

Figure 12 Classification of transportation need for business in Ilomantsi, Finland

The summarized TNI-value for Ilomantsi road network has been calculated by adding the classes for fragility, lifeline and transportation need for people and business. The TNI is shown in figure 13 in four classes and in figure 14 in TNI values.

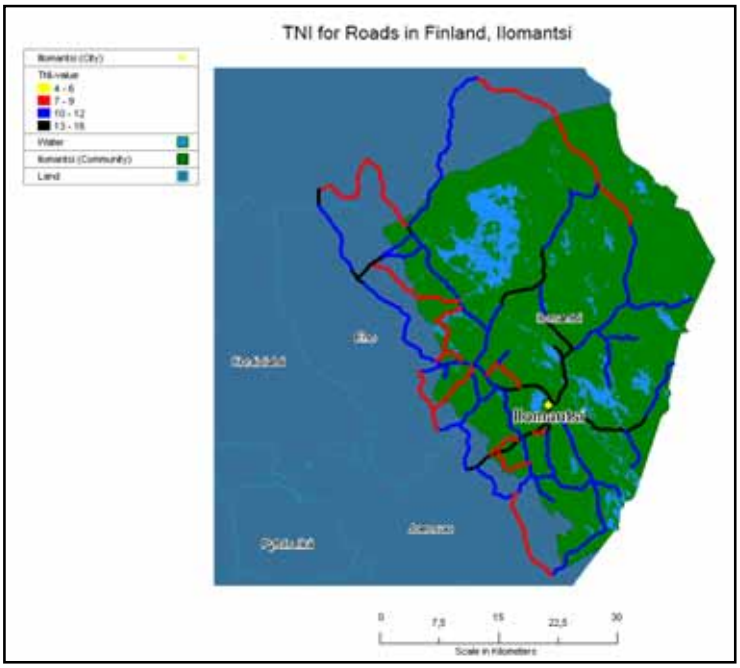

Figure 13 Classification of Transportation need index in 4 classes in Ilomantsi, Finland

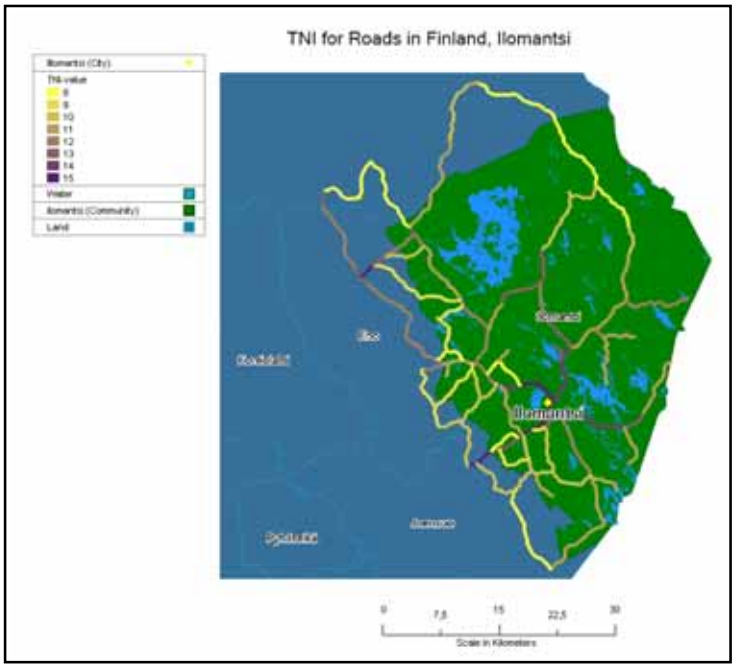

Figure 14 Classification of Transportation need index in Ilomantsi, Finland

3.4 TEST WITH DATA FROM HIGHLANDS

The test area in the Highlands was situated in the west coast. The first set of data from the Highlands is demonstrated in table 12. The values for Long Term Unemployed are not included, because of poor quality data. Population Difference and Difference of young people from 0-15

years is only over 5 years, and not 10 which was the aim. All data is not from the same year, or the same month, but each fragility indicator is from the same time period for all areas.

Table 12 The fragility ranking for the test area in Highlands

Rank	Datazone id	Datazone name	PopDens 0506		Pop Diff, 01-05		PopDiff 0-15year, 01-05		Pensioned 0608		Long Term Unemployed 0701		Income Support 0608		Sum
			Rank	pop/km2	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	
1	S01003955	Ullapool South	1	1891,7	6	5,1	2	6,5	9	34,4	0	0,0	2	1,3	20
2	S01003956	Ullapool North	2	1165,5	3	9,1	11	-26,0	1	21,8	0	1,2	4	2,3	21
3	S01003948	Ullapool Rural & Dundonnell	10	0,9	1	11,0	6	-9,7	4	30,3	0	0,0	1	1,2	22
4	S01003933	Poolewe & Badachro	6	1,8	2	10,4	1	11,0	6	31,6	0	1,2	11	4,8	26
5	S01003946	Gairloch	3	10,7	5	5,4	8	-16,3	8	33,8	0	0,0	6	2,9	30
6	S01003869	Applecross, Shieldaig & Torridon	9	1,3	4	7,4	10	-25,8	7	33,1	0	1,2	3	2,3	33
7	S01003967	Lochinver & Elphin	7	1,6	8	0,6	9	-21,7	2	26,8	0	1,5	7	3,0	33
8	S01003963	Achiltibuie	8	1,3	10	-6,7	3	1,0	3	28,5	0	1,7	9	3,4	33
9	S01003846	Lochcarron	5	2,2	11	-7,8	4	-2,2	11	40,2	0	1,3	5	2,7	36
10	S01003953	Aultbea	4	9,1	7	0,7	7	-15,2	10	38,6	0	1,6	8	3,2	36
11	S01003915	Garve, Achnasheen & Kinlochewe	11	0,5	9	-5,0	5	-7,6	5	31,0	0	0,0	10	3,8	40

The fragility classification is shown in a GIS map in figure 15.

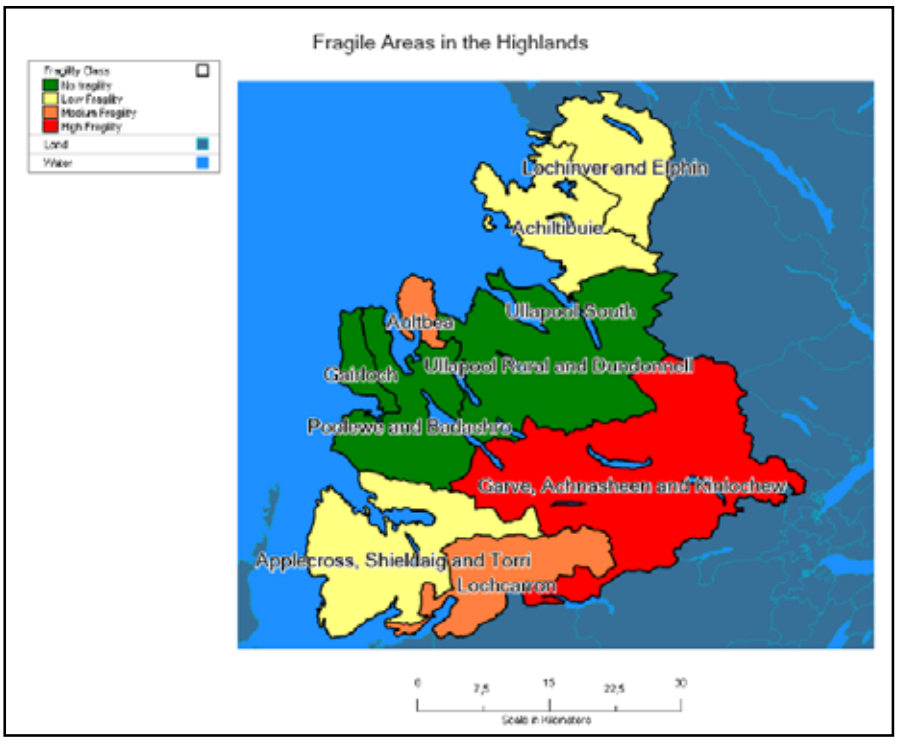

Figure 15 Classification of Fragility in the west coast area of Highlands

Later in the project new data was obtained, including accessibility and remoteness indicators as shown in table 13.

Table 13 The fragility ranking for the test area in Highlands including accessibility and remoteness indicators

Rank	Datazone id	Datazone namn	PopDens 0506		PopDiff, 01-05		PopDiff 0-15year, 01-05		Pensioned 0608		Income Support 0608		Accessibility, Drive time overall score		Remoteness indicator		Sum
			Rank	*pop/km2*	Rank	*%*	Rank	*%*	Rank	*%*	Rank	*%*	Rank		Rank	*Miles*	
1	S01003955	Ullapool South	1	*1891,7*	6	*5,1*	2	*6,5*	9	*34,4*	2	*1,3*	1		2	*56,1*	**23**
2	S01003956	Ullapool North	2	*1165,5*	3	*9,1*	11	*-26,0*	1	*21,8*	4	*2,3*	2		3	*56,2*	**26**
3	S01003948	Ullapool Rural & Dundonnell	10	*0,9*	1	*11,0*	6	*-9,7*	4	*30,3*	1	*1,2*	9		4	*58,5*	**35**
4	S01003946	Gairloch	3	*10,7*	5	*5,4*	8	*-16,3*	8	*33,8*	6	*2,9*	4		7	*70,6*	**41**
5	S01003933	Poolewe & Badachro	6	*1,8*	2	*10,4*	1	*11,0*	6	*31,6*	11	*4,8*	10		8	*70,7*	**44**
6	S01003846	Lochcarron	5	*2,2*	11	*-7,8*	4	*-2,2*	11	*40,2*	5	*2,7*	6		5	*61,0*	**47**
7	S01003869	Applecross, Shieldaig & Torridon	9	*1,3*	4	*7,4*	10	*-25,8*	7	*33,1*	3	*2,3*	8		6	*69,2*	**47**
8	S01003915	Garve, Achnasheen & Kinlochewe	11	*0,5*	9	*-5,0*	5	*-7,6*	5	*31,0*	10	*3,8*	7		1	*31,1*	**48**
9	S01003953	Aultbea	4	*9,1*	7	*0,7*	7	*-15,2*	10	*38,6*	8	*3,2*	3		9	*76,9*	**48**
10	S01003967	Lochinver & Elphin	7	*1,6*	8	*0,6*	9	*-21,7*	2	*26,8*	7	*3,0*	5		11	*86,8*	**49**
11	S01003963	Achiltibuie	8	*1,3*	10	*-6,7*	3	*1,0*	3	*28,5*	9	*3,4*	11		10	*78,5*	**54**

The data from table 13 is shown in another fragility classification map in figure 16.

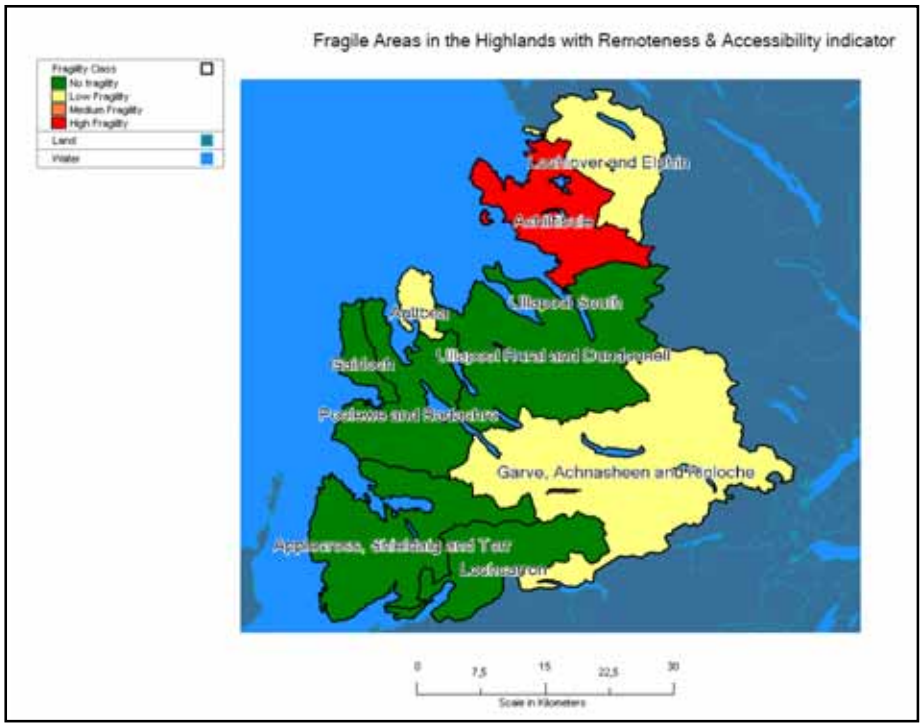

Figure 16 Classification of Fragility in the west coast area of Highlands

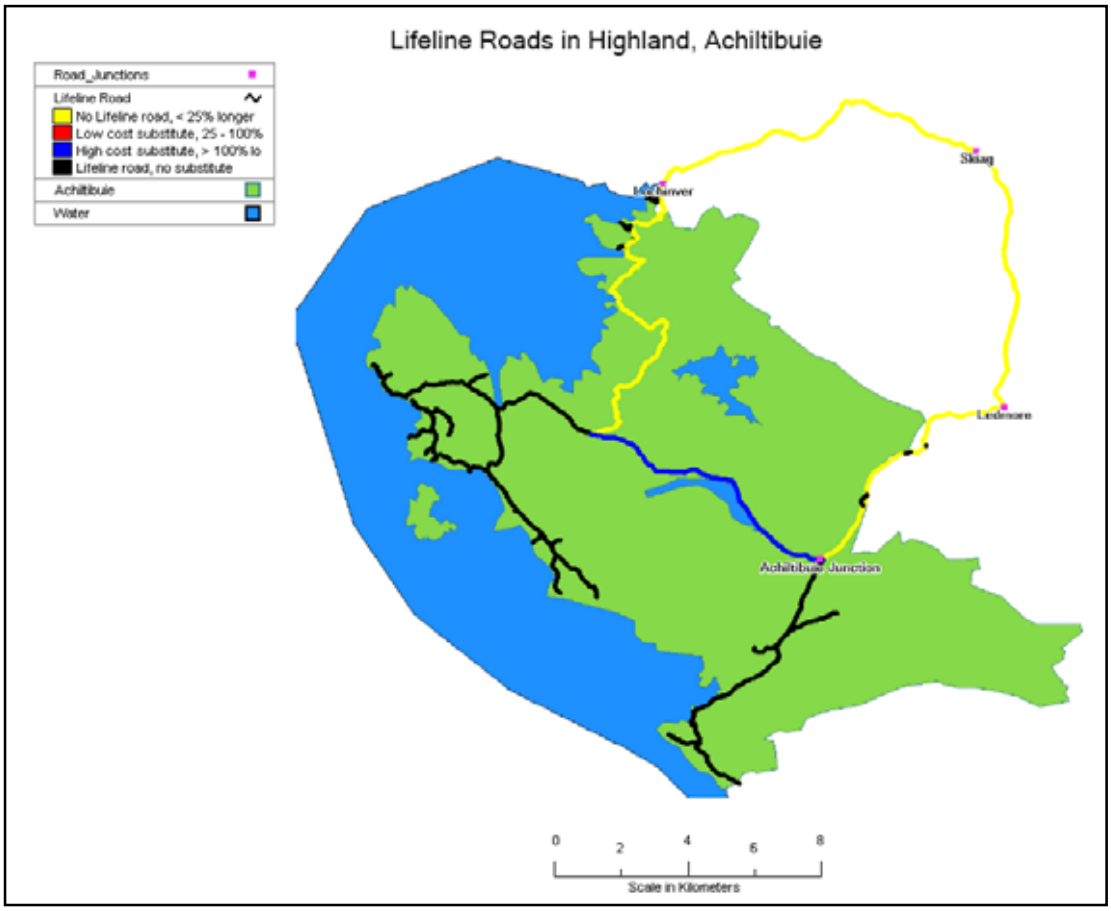

Figure 17 Classification of lifeline roads in the west coast area of Highlands

Some road data was delivered as shp-files from Highlands together with some traffic figures, but these were confined to main roads only. It was only therefore possible to carry out a schematic lifeline classification. A complete TNI was not possible. The lifeline classification produced is shown in figure 17.

3.4 TEST WITH DATA FROM WESTERN ISLES

Data from Western Isles was from the start obtained from the homepage www.sns.gov.uk, Scottish Neighborhood Statistics, and the data is shown in table 14. By means of this data a fragility map was created shown in figure 18. The data includes the accessibility indicator but the remoteness indicator was left out as we had no data.

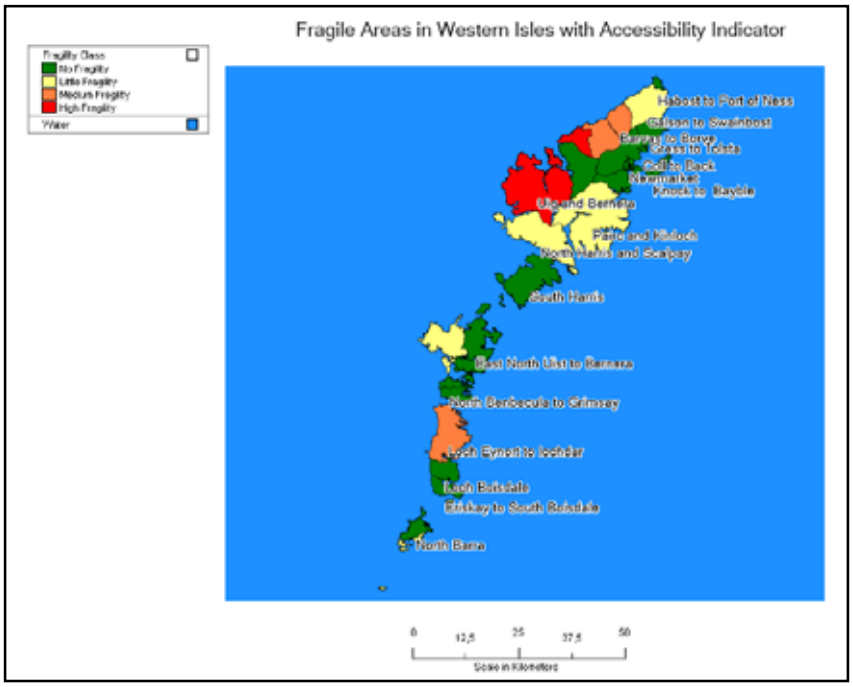

Figure 18 Classification of Fragility in the Western Isles with data from Highlands' homepage

Later data arrived from the Western Isles with somewhat different values for the fragility indicators as shown in table 15. By means of these new values another fragility classification map was created shown in figure 19.

Table 14 Fragility indicator data of the Western Isles from Highlands' homepage

		PopDens 05		PopDiff, 01-05		PopDifff 0-15år, 01-05		Pensioned 05Q2		Workless 05		Claimant 05Q4		Accessib. Drivetim 06	Sum
Rank	Name	Rank	Pop/ sqkm	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	
1	Newmarket	10	163	2	12,6%	1	31,7%	8	6%	10	11,1	4	2,6	20	55
2	Coll to Back	9	194	9	4,5%	8	6,4%	11	7%	5	10,5	7	3,0	13	62
3	Central Stornoway	5	1365	4	8,2%	5	10,0%	26	11%	20	12,8	24	5,6	2	86
4	North Benbecula to Grimsay	17	30	6	6,3%	6	8,2%	1	4%	13	11,5	14	4,3	33	90
5	Springfield	4	2518	1	16,9%	21	-5,1%	12	7%	15	11,6	26	6,0	11	90
6	Melbost to Braighe	11	103	16	-0,1%	16	-2,2%	5	6%	7	10,7	3	2,3	35	93
7	Gress to Tolsta	19	11	3	11,9%	3	11,5%	17	8%	12	11,2	13	3,9	30 §	97
8	Coulegrain to Stenish	7	234	18	-1,2%	20	-4,9%	6	6%	21	12,8	21	5,4	6	99
9	Marybank to Newvalley	8	208	13	2,6%	9	5,5%	4	5%	16	11,8	28	6,2	25	103
10	Knock to Bayble	12	65	19	-1,2%	13	2,1%	18	9%	17	12,0	2	2,3	29	110
11	Tong to Upper Coll	26	6	8	4,9%	11	5,2%	9	7%	23	13,0	19	4,9	17	113
12	Sheshader to Tiumpan Head	14	53	11	3,5%	7	6,9%	7	6%	32	16,1	18	4,7	27	116
13	Garrabost	15	52	32	-7,9%	24	-9,3%	15	8%	4	10,5	10	3,7	18	118
14	North Barra	20	11	14	1,3%	30	-14,6%	22	11%	9	11,0	20	5,1	5	120
15	Habost to Port of Ness	13	65	10	4,0%	2	21,5%	35	15%	22	12,9	5	2,8	36	123
16	South Harris	28	5	5	6,6%	14	1,6%	23	11%	14	11,6	12	3,9	28	124
17	Eriskay to South Boisdale	23	10	28	-5,7%	33	-18,5%	30	12%	3	10,5	1	1,8	7	125
18	Newton to Plasterfield	6	824	24	-2,9%	15	-0,6%	13	8%	18	12,3	30	6,4	23	129
19	North Lochs	18	13	23	-2,5%	19	-3,9%	29	12%	19	12,4	8	3,3	14	130
20	North Manor Park	2	3386	17	-0,4%	27	-11,9%	2	4%	35	16,8	36	8,7	19	138
21	Loch Roag	31	4	12	3,2%	17	-3,2%	21	10%	25	13,6	35	7,3	1	142
22	South Benbecula	24	9	36	-15,0%	28	-11,9%	3	4%	6	10,6	11	3,8	34	142
23	East North Uist to Berneray	29	5	25	-3,6%	22	-7,6%	19	9%	1	8,0	15	4,3	32	143
24	Loch Boisdale	22	10	7	6,0%	31	-14,9%	16	8%	33	16,2	25	5,7	12	146
25	North Harris and Scalpay	33	4	26	-4,8%	35	-24,3%	33	14%	11	11,2	6	3,0	3	147
26	Vatersay to Castlebay	16	33	27	-5,2%	23	-8,5%	14	8%	28	14,9	27	6,2	16	151
27	North Bayhead	3	3159	31	-7,8%	10	5,4%	31	13%	30	15,1	34	7,2	10	149
28	West North Uist to Baleshare	30	4	34	-8,7%	36	-38,2%	20	10%	2	10,1	22	5,5	8	152
29	Goathill	1	3892	22	-2,1%	25	-11,3%	28	12%	27	14,4	33	7,0	15	151
30	Galson to Swainbost	32	4	20	-1,3%	12	2,2%	36	16%	8	10,9	17	4,5	31	156
31	Pairc and Kinloch	35	2	35	-9,0%	18	-3,6%	25	11%	31	16,0	16	4,3	4	164
32	Bragar to Bru	27	6	21	-1,4%	4	10,1%	24	11%	34	16,5	31	6,7	24	165
33	Loch Eynort to Iochdar	34	4	33	-8,5%	32	-17,6%	10	7%	26	14,1	9	3,5	26	170
34	Barvas to Borve	21	10	15	0,4%	34	-19,5%	27	12%	29	14,9	32	6,8	21	179
35	Carloway to Shawbost	25	8	30	-7,0%	29	-12,2%	32	13%	36	17,5	23	5,5	9	184
36	Uig and Bernera	36	2	29	-6,3%	26	-11,7%	34	15%	24	13,4	29	6,3	22	200

Table 15 Fragility indicator data of the Western Isles from Western Isles

Data Zone	Eqivalent Area Name	Popn Density Pper km2 2001	Rank	% Change 1996-2005 Overall Popn	Rank	% Change 1996-2005 Children (0-15 yrs)	Rank	% of Popn of Pensionable Age 2005	Rank	SIMD Employment Deprivation Rank 2006	SIMD Income Deprivation Rank 2006
S01002354	Melbost to Braighe	102,7	11	-2	9	6	4	23,27	15	4	1
S01002366	Newmarket	146,1	10	14	2	-16	17	13,76	3	15	2
S01002368	Coll to Back	185,7	9	10	4	-3	8	19,91	12	5	11
S01002357	Springfield	2156,8	4	24	1	-17	19	24	16	13	9
S01002361	Coulegrain to Stenish	239,7	7	-7	15	-5	9	17,26	8	16	8
S01002363	Marybank to Newvalley	203	8	-8	16	-18	21	17,39	9	9	3
S01002353	Knock to Bayble	65,7	12	6	6	-17	18	17,57	10	14	4
S01002371	Gress to Tolsta	10	23	8	5	-8	12	24,76	20	3	14
S01002362	Garrabost	55	14	-9	21	-25	24	15,53	5	8	13
S01002360	North Bayhead	3431,4	2	-13	23	13	2	30	34	17	23
S01002342	Loch Boisdale	9,2	24	-5	12	4	5	25,15	21	24	5
S01002345	North Benbecula to Grimsay	28,5	17	-25	36	-9	14	12,76	1	11	6
S01002344	South Benbecula	10,2	21	-23	35	-2	7	16,11	6	6	12
S01002364	North Manor Park	3404	3	-15	29	-18	20	15,19	4	36	20
S01002367	Tong to Upper Coll	6,1	27	13	3	-32	30	16,5	7	22	7
S01002355	Newton to Plasterfield	846,8	6	-8	17	-34	33	24,15	18	10	28
S01002356	Central Stornoway	1277,6	5	-7	14	-26	25	28,66	30	27	17
S01002339	Vatersay to Castlebay	34,6	16	-17	31	-6	10	19,44	11	23	26
S01002365	Sheshader to Tiumpan Head	51,1	15	1	7	-28	26	22,6	14	34	15
S01002359	Goathill	4015,1	1	-12	22	-32	31	37,98	36	18	25
S01002372	Barvas to Borve	10,2	22	-6	13	-1	6	25,69	24	30	27
S01002346	East North Uist to Berneray	4,8	29	-9	18	-21	23	26,29	26	2	10
S01002348	South Harris	4,5	30	-2	10	16	1	27,08	28	20	22
S01002358	Loch Roag	4,2	31	-1	8	-8	11	24,14	17	29	29
S01002347	West North Uist to Baleshare	4,9	28	-17	30	-8	13	28,15	29	7	19
S01002352	North Lochs	12,9	18	-3	11	-20	22	26,67	27	19	33
S01002374	Habost to Port of Ness	62,6	13	-9	19	-30	27	29,33	32	25	34
S01002341	Eriskay to South Boisdale	10,2	20	-17	32	-32	29	29,11	31	1	24
S01002340	North Barra	10,6	19	-9	20	-35	34	25,78	25	26	18
S01002369	Carloway to Shawbost	8,3	25	-14	25	-14	16	25,36	22	35	32
S01002370	Bragar to Bru	6,4	26	-14	24	-30	28	21,52	13	33	30
S01002343	Loch Eynort to Iochdar	4	33	-19	34	-37	35	13,45	2	28	16
S01002350	Pairc and Kinloch	2,3	35	-15	26	-11	15	24,26	19	32	31
S01002373	Galson to Swainbost	4,1	32	-18	33	-34	32	25,49	23	21	35
S01002349	North Harris and Scalpay	4	34	-15	28	-52	36	31,82	35	12	21
S01002351	Uig and Bernera	1,6	36	-15	27	9	3	29,65	33	31	36

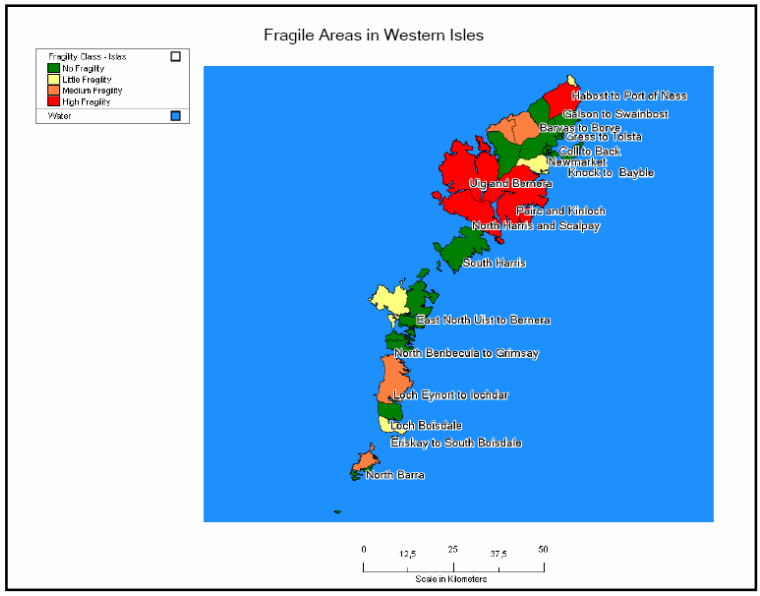

Figure 19 Classification of Fragility in the Western Isles with data from Western Isles

We did not get any shp-files for the roads in Western Isles, or traffic figures, so we ended up with only fragility classification maps.

3.5 DISCUSSION ABOUT TESTS AND TEST RESULTS

The tests have shown that the statistical data for economic and social fragility was fairly easy to get, even if the data was from rather big areas. It was more difficult to get accessibility and remoteness data as the geographical spread of people in an area was not generally clearly defined. A difficulty arose in deciding from where the distances for accessibility and remoteness should be measured. To do this correctly the calculation should be made from each dwelling to the five key services, and to the nearest city center, and use the actual speed limits. In practice this could be handled by finding centre points for the population, e.g. in villages in each statistical area, and calculate from there.

The lifeline classification is also slightly complicated to do manually but there are computer programs to compare different routes in an area to solve this. We did this by hand in our tests.

To obtain the transportation need for people according to the original ROADEX II concept calls for detailed data on where school children and commuters live and work. And to obtain the transportation need for business we need to know where the business is and where their transports go. If this detailed statistical data can be obtained we think that it is a good way to describe the need. If the information is not readily available we have to use something else to show the transportation need. We have suggested ADT for personal cars for personal transportation need, and ADT for heavy vehicles for business transportation need. The traffic figures will show the transportation need, even though they will not tell exactly the aim of the transport.

The tests have given some interesting results. By looking at the GIS maps it can be seen where the fragility is high, which roads are real lifelines and the transportation needs. The TNI maps show the roads with high fragility and high lifeline class that should be upgraded as opposed to those where of only traffic volume for determine road service levels.

Chapter 4 Road service levels and intervention levels for paved roads and gravel roads

4.1 INTRODUCTION

The use of fragility (F) and lifeline (L) class, transportation need for people (P) and business (B), and TNI, can improve the potential for funding for the roads with high fragility and high lifeline class compared with the situation today. The ROADEX II report (3) sets out proposals for the service levels of the various classes of paved roads and gravel roads considered.

4.2 ROAD SERVICE LEVELS

The road service levels proposed in the ROADEX II report (3) are shown in table 16.

Table 16 Road standard levels for paved roads and gravel roads

ROAD SERVICE LEVEL PRIORITY		TNI
1. Lowest priority: lowest accessibility, quality; can be close to the "shame value"	Classes F1, L1, P1, B1 and government subsidised private road	4-6
2. Standard priority (no fragile areas, medium lifeline, medium user need)	Classes F2 and/or L2, P2 and/or B2.	7-9
3. Raised priority (area development has great weight) (high fragility, high life line points)	Classes F3-F4, L3-L4, and/or P3, B3.	10-12
4. Highest priority (high road users and business needs), should have: good ride comfort and high accessibility	Classes P4 and/or B4	13-16

This priority system gives roads in high fragility areas and lifeline roads a better ranking than they would have if only traffic volumes were used and it also provides a higher priority to those roads that have high road user and business needs.

The TNI-value can thereafter be used as a ranking tool when choosing between maintenance candidates

4.3 INTERVENTION LEVELS FOR PAVED ROADS

The intervention levels for paved roads from the ROADEX II report (3) are listed in the following tables. Intervention level 1 is the lowest level. The application of these intervention levels to the roads with high fragility class and high lifeline class will give an improved case for better service standard for these roads.

Table 17 A-D, Trigger values for paved roads and gravel roads, priority 1-4

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	

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	Moderate maintenance standard	

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	

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	

4.4 INTERVENTION LEVELS FOR GRAVEL ROADS

The intervention levels for gravel roads from the ROADEX II report (3) are listed in the following tables. Intervention level 1 is the lowest standard level. We have not been able to test the accelerometer in this project and these standards are the same as in the ROADEX II report (3).

Table 18 A-C Trigger values for gravel roads, priority 1-3

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 (wash-boarding) 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

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	Moderate maintenance standard

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 18 D Trigger values for gravel roads, priority 4

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

4.5 DISCUSSION

As far as we know the road service levels and intervention levels described above and in the ROADEX II report (3) have not been tested in practice. We do not know if the trigger values set in the different service levels are at the right level. Future tests in Partner areas are needed to calibrate the suggested values. There is also a need to test the accelerometer values we have suggested as we have not had the possibility to test any equipment within the project.

Chapter 5 Conclusions

The identification and classification of fragile areas, lifeline roads and transportation needs for people and business, showing the results on GIS map, is a good way to show rural road user needs.

Combining fragility, lifeline class and accessibility needs for people and business to a Transportation Need Index, and using it for setting service levels, can give a better ranking for low volume roads. The use of service levels in different priority levels, and short average 'trigger values', can help road users in rural areas to get better road conditions.

Tests have shown that the Transportation Need Index can be calculated if all data is available but the classes should be adapted to the conditions in the actual area.

Other ways to show the importance of having the low volume road network in good condition could be to look at the vulnerability of the society and to look at asset management.

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ROADEX III
NORTHERN PERIPHERY

ROADEX III PUBLICATIONS

Developing Drainage Guidelines for Maintenance Contracts

Tyre Pressure Control on Timber Haulage Vehicles

Understanding Low-Volume Pavement Response to Heavy Traffic Loading

Health Issues Raised by Poorly Maintained Road Networks

Road condition management policies for low volume roads – tests and development of proposals

Policies for Forest Roads – Some Proposals

Road Construction in Greenland - The Greenlandic Case

SKOGSSTYRELSEN
SWEDISH FOREST AGENCY

VEGAGERÐIN

The Highland Council

Forestry Commission Scotland

FINNISH ROAD ADMINISTRATION

ROADSCANNERS

Statens vegvesen

Vägverket