

# Accessibility study for road traffic in the STRING area

An analysis of the strategic impact of the fixed Fehmarn Belt link

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## 1. Introduction

The analyses in this report illustrates some of the more general - or strategic - consequences for road traffic due to a construction of a fixed Fehmarn Belt link.

The analysis has been prepared for and presented by PRODEC Planning Consultants at the STRING workshop 11-12 January 2000 in Sorø, Denmark.

The methodological approach has been to use a geographical information system (ArcInfo GIS) to model and illustrate the total traveltime and travelcost, both before and after a construction of a fixed Fehmarn Belt link as well as the potential changes.

The result of the analysis is presented in a number of thematic maps. These maps can be interpreted individually - but can also be interpreted in connexion and thereby form a broader basis for evaluating the strategic impacts of the link. Two different types of maps has been used in the analysis:

- Isocrones
- Isocost

**The isocrones** shows the distance in time to a certain city and thereby indicate how accessible the city is. In this analysis the distance in traveltime to Hamburg, Kiel, Copenhagen and Kristianstad is shown with isocrones.

**The Isocost** differs from the isocrones and shows the distance in travel cost to a certain city and thereby also indication of how accessible the city is. The interpretation of the isocost is a bit more complex than the interpretation of the isocrones. In this analysis the distance in travelcost to Kiel and Kristianstad is shown with isocost.

As the name implies the isocrones shows the distance in time relative to a location. In this analysis the isocrone is the same whether one travels to or from the location.

The isocrones has been calculated for a "Basic" scenario as well as for a scenario including a fixed Fehmarn Belt link. The fixed Fehmarn Belt link includes the following changes in the road network:

- The construction of a fixed Fehmarn Belt link
- An upgrade of the E47 to motorway standard between Ønslev and Sakskøbing
- An upgrade of the E47 to motorway standard between Puttgarden and Oldenburg

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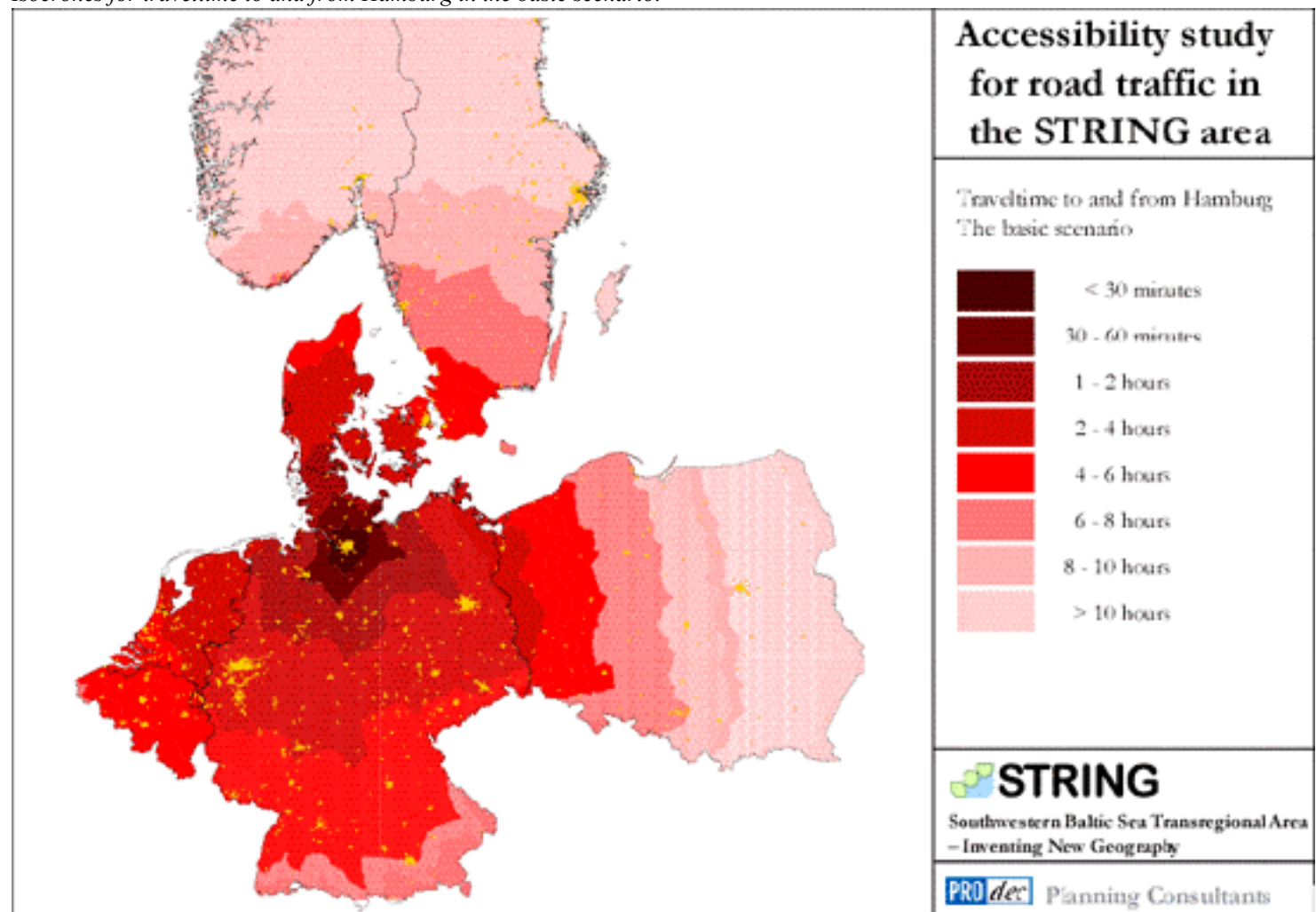
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## 2 The strategic impacts of the fixed Fehmarn Belt link

### 2.1 Isocrones

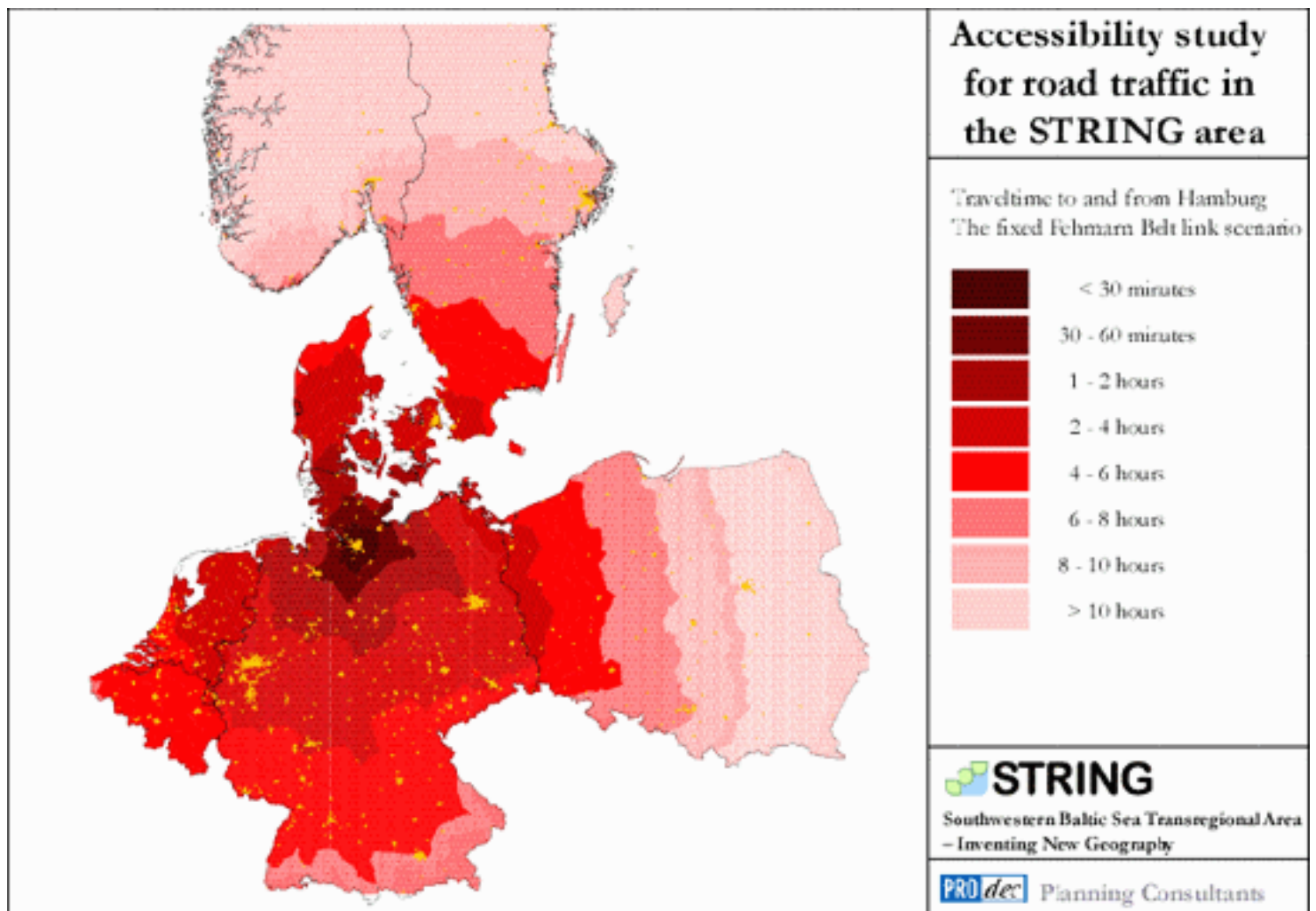
The first set of isocrones shows the traveltime to and from Hamburg before and after a construction of a fixed Fehmarn Belt link as well as the geographical distribution of the traveltime changes.

*Isocrones for traveltime to and from Hamburg in the basic scenario.*



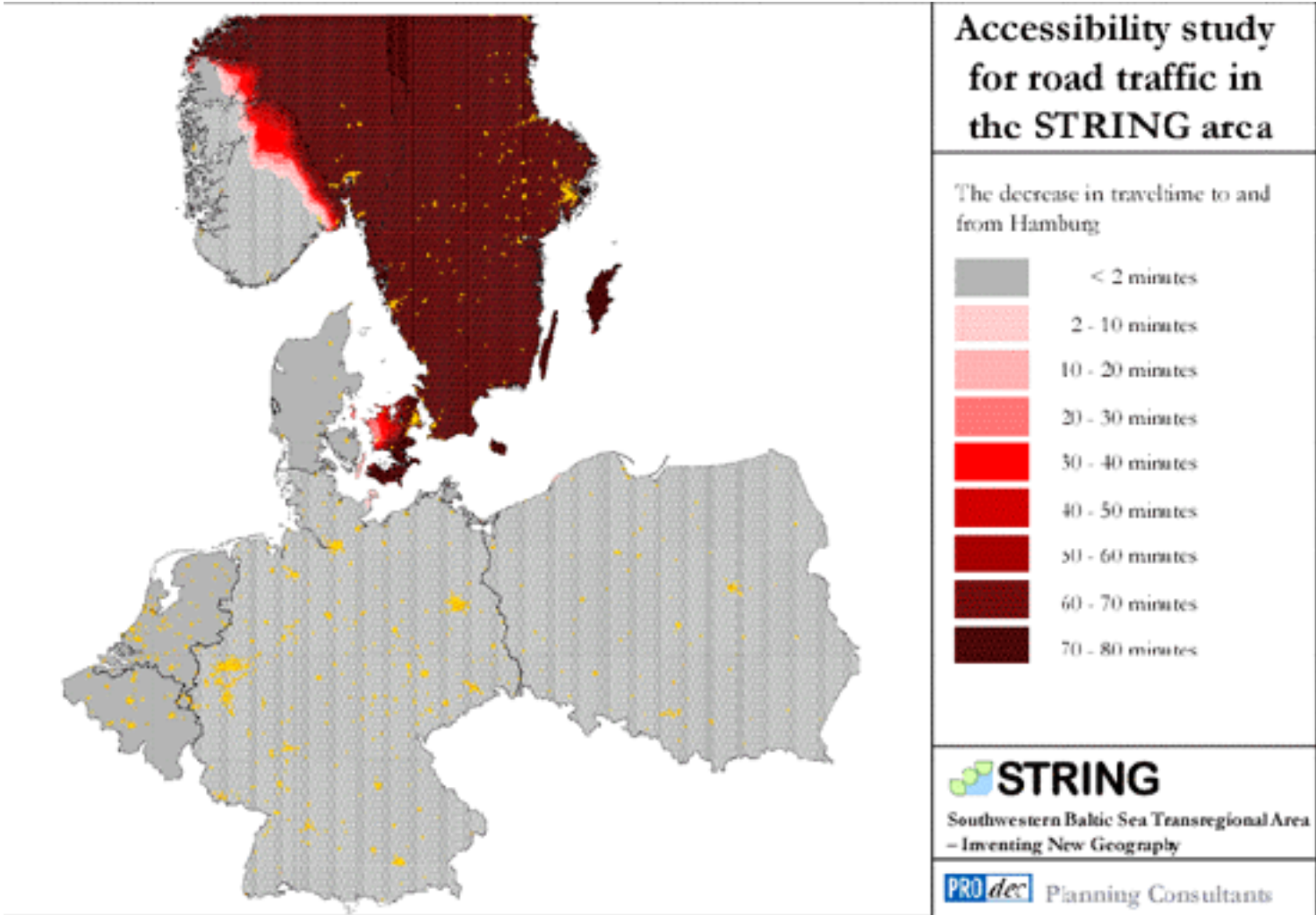
It may appear as if the isocrones originating in Hamburg more or less like concentric circles. However, the shapes of the isocrones corresponds to the general directions of the motorway network. The differentiation of the speed on the road network can be seen when comparing the isocrones in Germany and Poland. Especially the width of the 4-6 hours band indicates the difference in the expected travelling speed in the two countries.

*Isocrones for traveltime to and from Hamburg in the fixed Fehmarn Belt link scenario.*

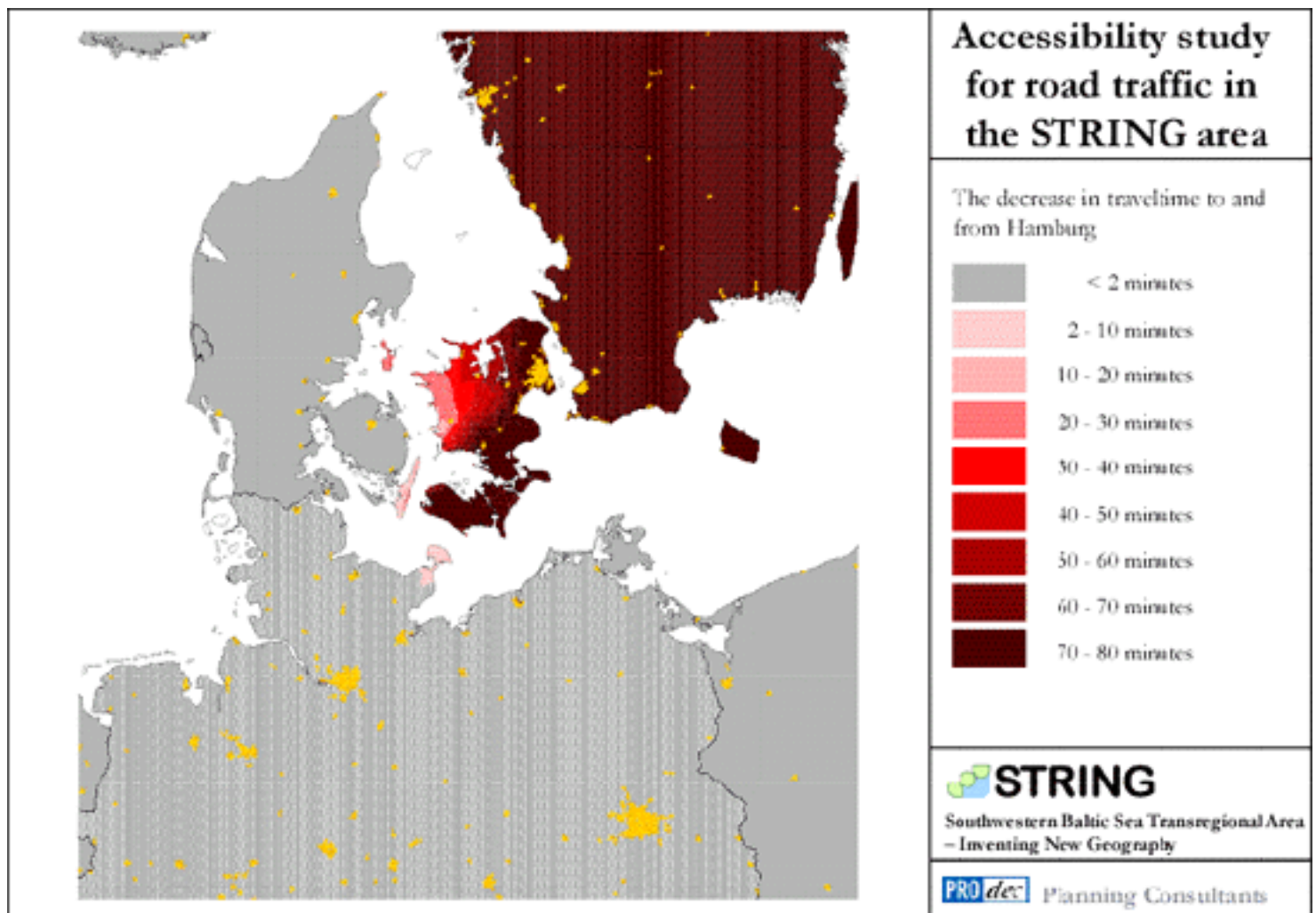


The change in traveltime or the possible traveltime savings, are found on Lolland-Falster and Zealand in Denmark as well as in Sweden. This becomes evident on the following map.

*The decrease in traveltime to and from Hamburg as a consequence of a fixed Fehmarn Belt link*



*The decrease in traveltime to and from Hamburg as a consequence of a fixed Fehmarn Belt link.*

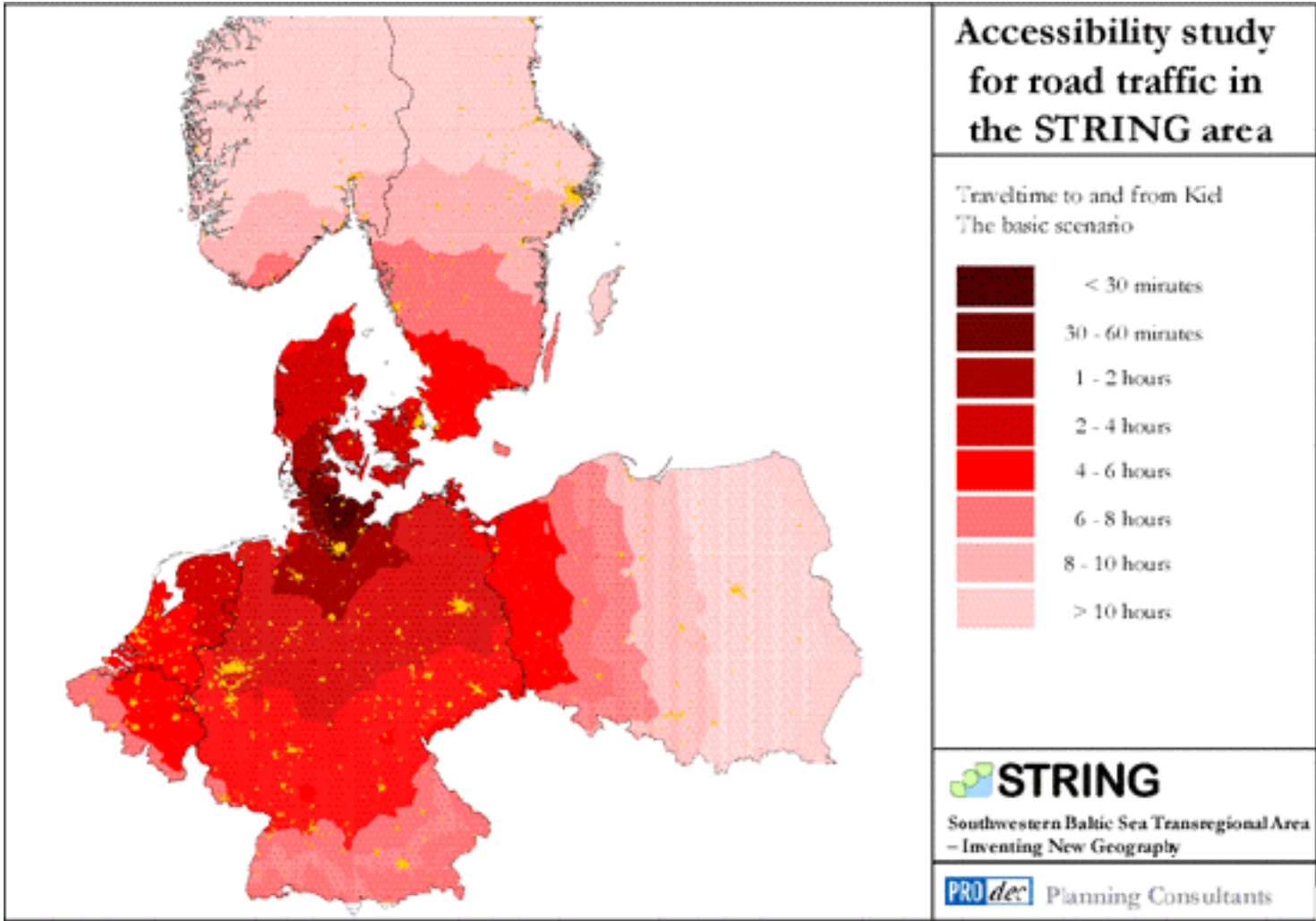


When interpreting the difference map one has to bear in mind that the relative consequences of the traveltime savings depends of the origin and the destination of a trip. The longer the trip, the less are the relative traveltime savings.

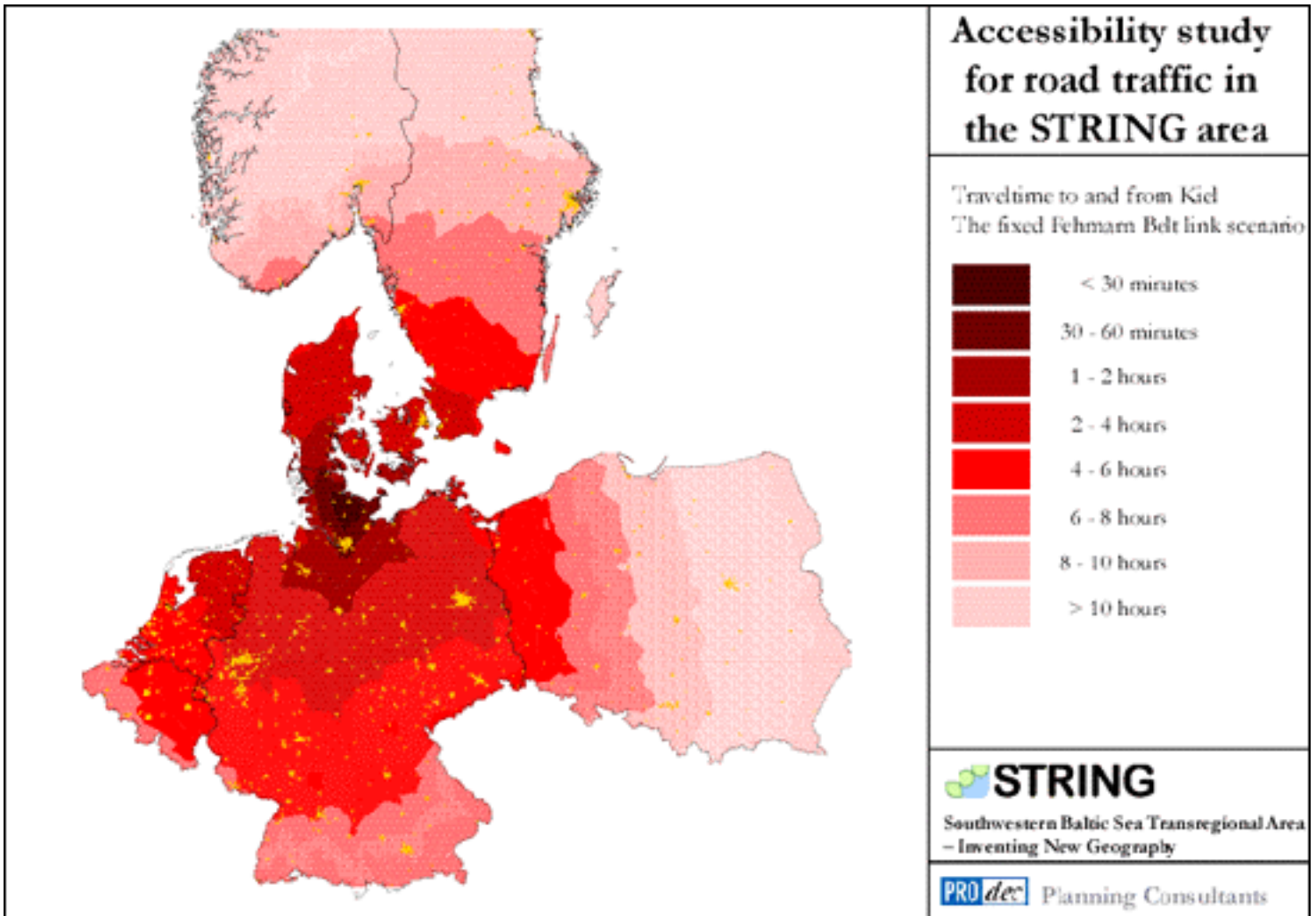
The greatest reduction on the total travelling time of up to 80 minutes to and from Hamburg are found on Lolland-Falster, most of Zealand and in Sweden. The competition stemming from the Great Belt Bridge is seen in west-Zealand where the traveltime savings are decreasing.

The second set of isocrones shows the traveltime to and from Kiel before and after a construction of a fixed Fehmarn Belt link as well as the geographical distribution of the traveltime changes.

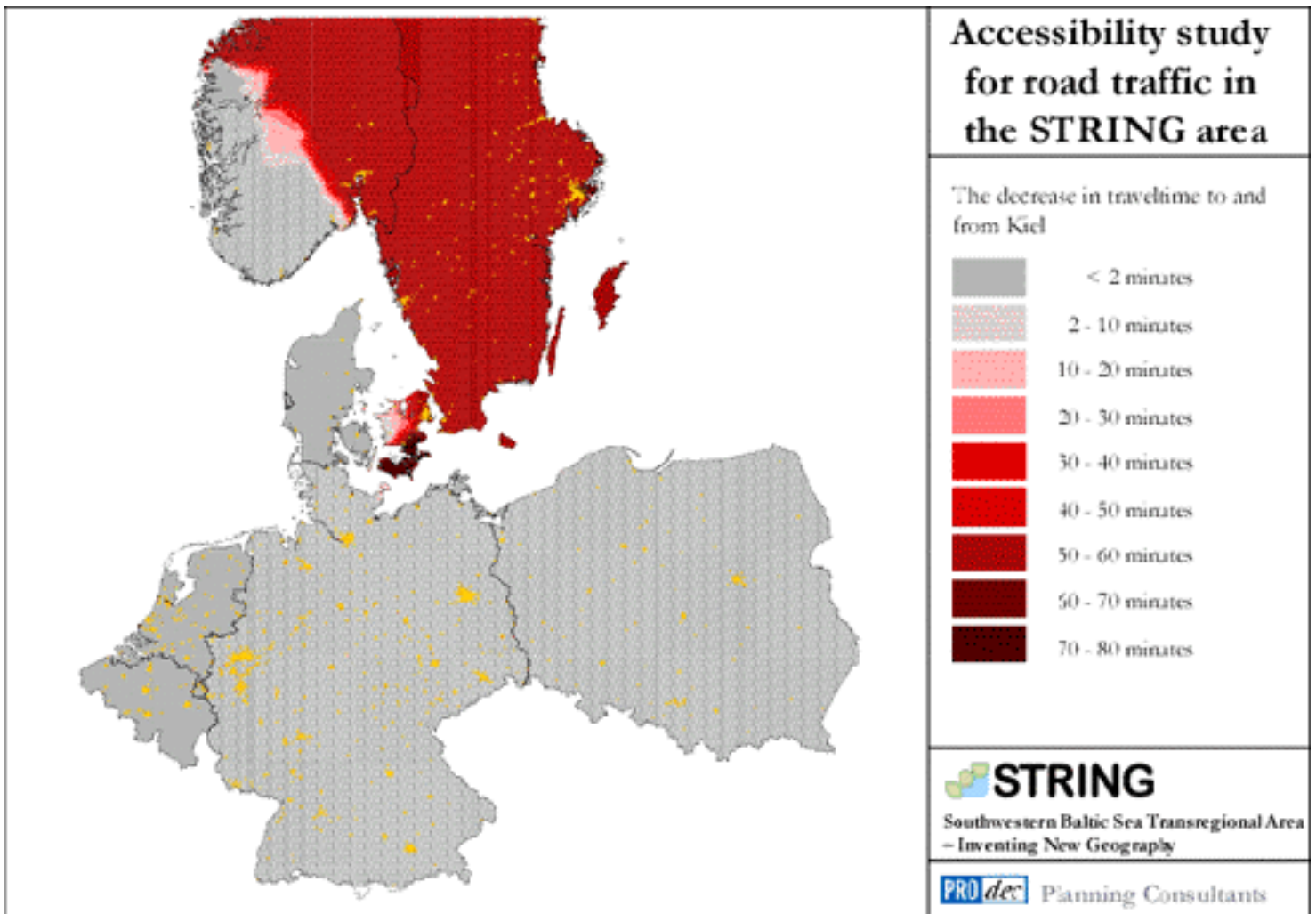
*Isocrones for traveltime to and from Kiel in the basic scenario.*



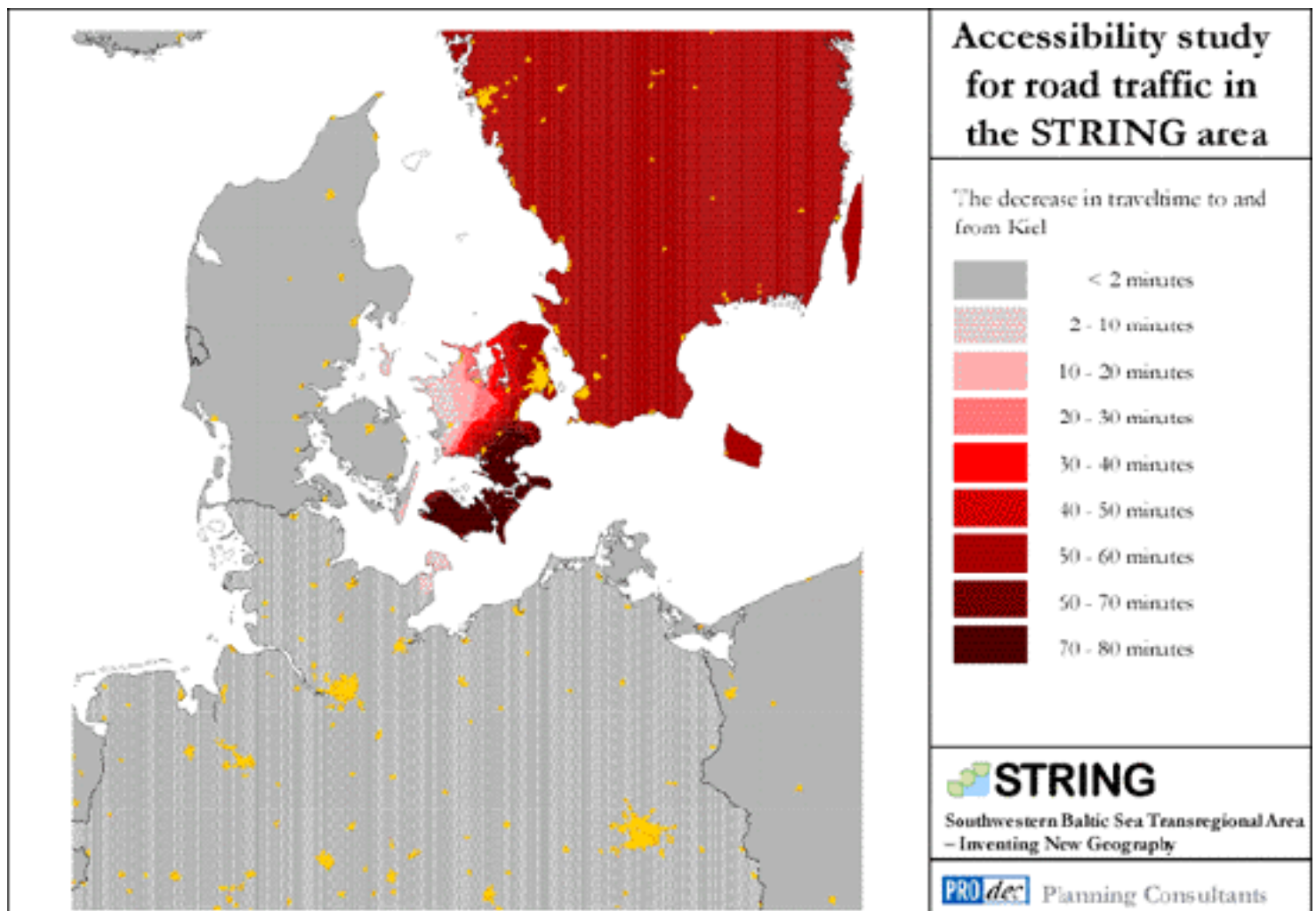
*Isocrones for traveltime to and from Kiel in the fixed Fehmarn Belt link scenario.*



*The decrease in traveltime to and from Kiel as a consequence of a fixed Fehmarn Belt link.*



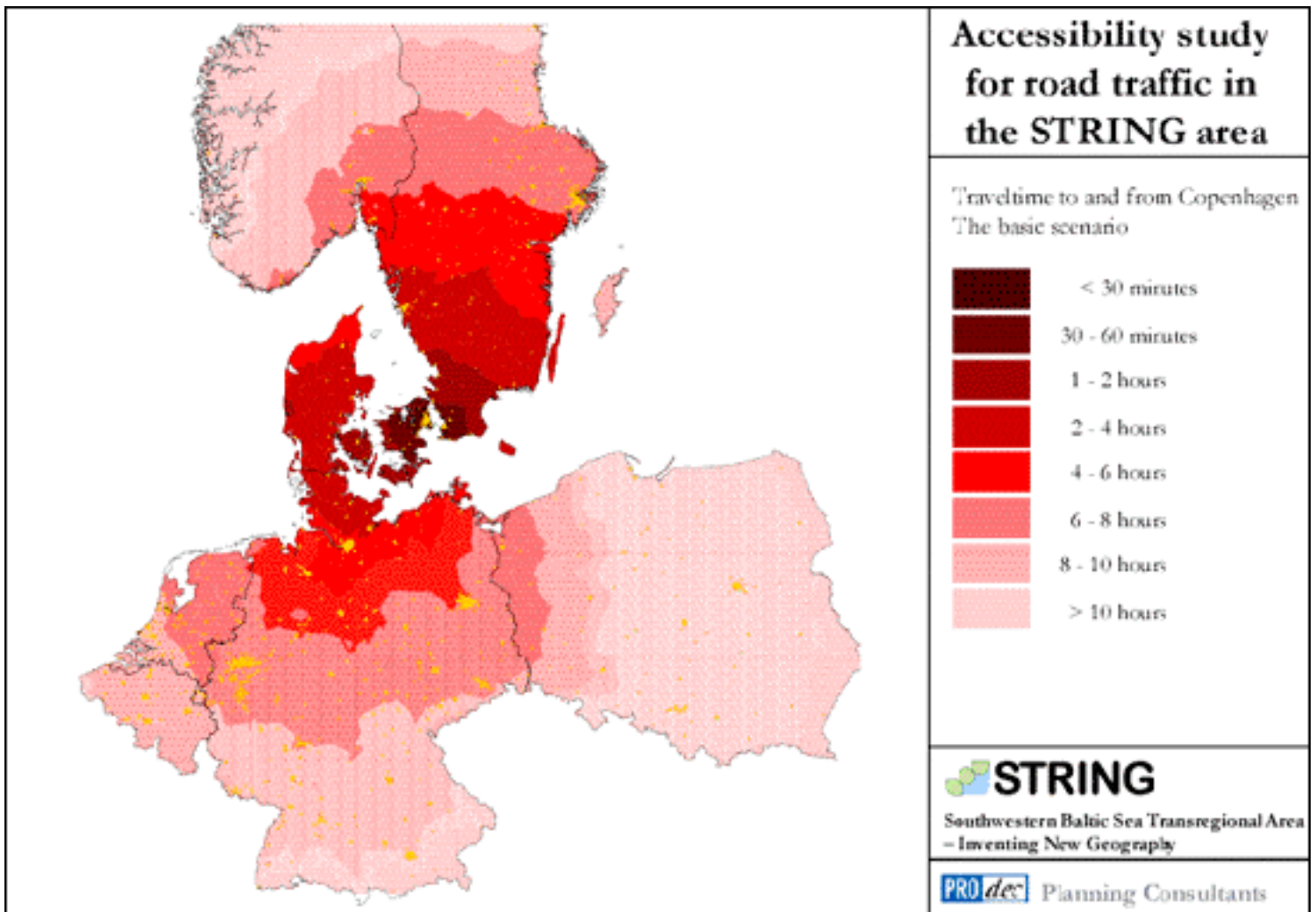
*The decrease in traveltime to and from Kiel as a consequence of a fixed Fehmarn Belt link.*



The same structure in the area effected by the fixed Fehmarn Belt link as for Hamburg can be seen. The general level of time saving is though lower due to the fact that Kiel is situated closer to Jutland and the Danish motorway system, such that the Great Belt link is a faster transport option than from Hamburg.

The third set of isocrones shows the traveltime to and from Copenhagen before and after a construction of a fixed Fehmarn Belt link as well as the geographical distribution of the traveltime changes.

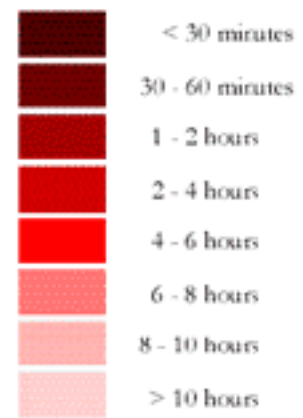
*Isocrones for traveltime to and from Copenhagen in the basic scenario.*



*Isocrones for traveltime to and from Copenhagen in the fixed Fehmarn Belt link scenario.*

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Traveltime to and from Copenhagen  
The fixed Fehmarn Belt link scenario



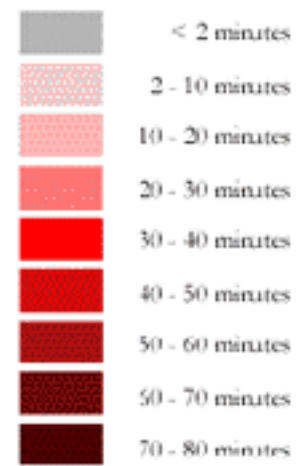
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*The decrease in traveltime to and from Copenhagen as a consequence of a fixed Fehmarn Belt link.*

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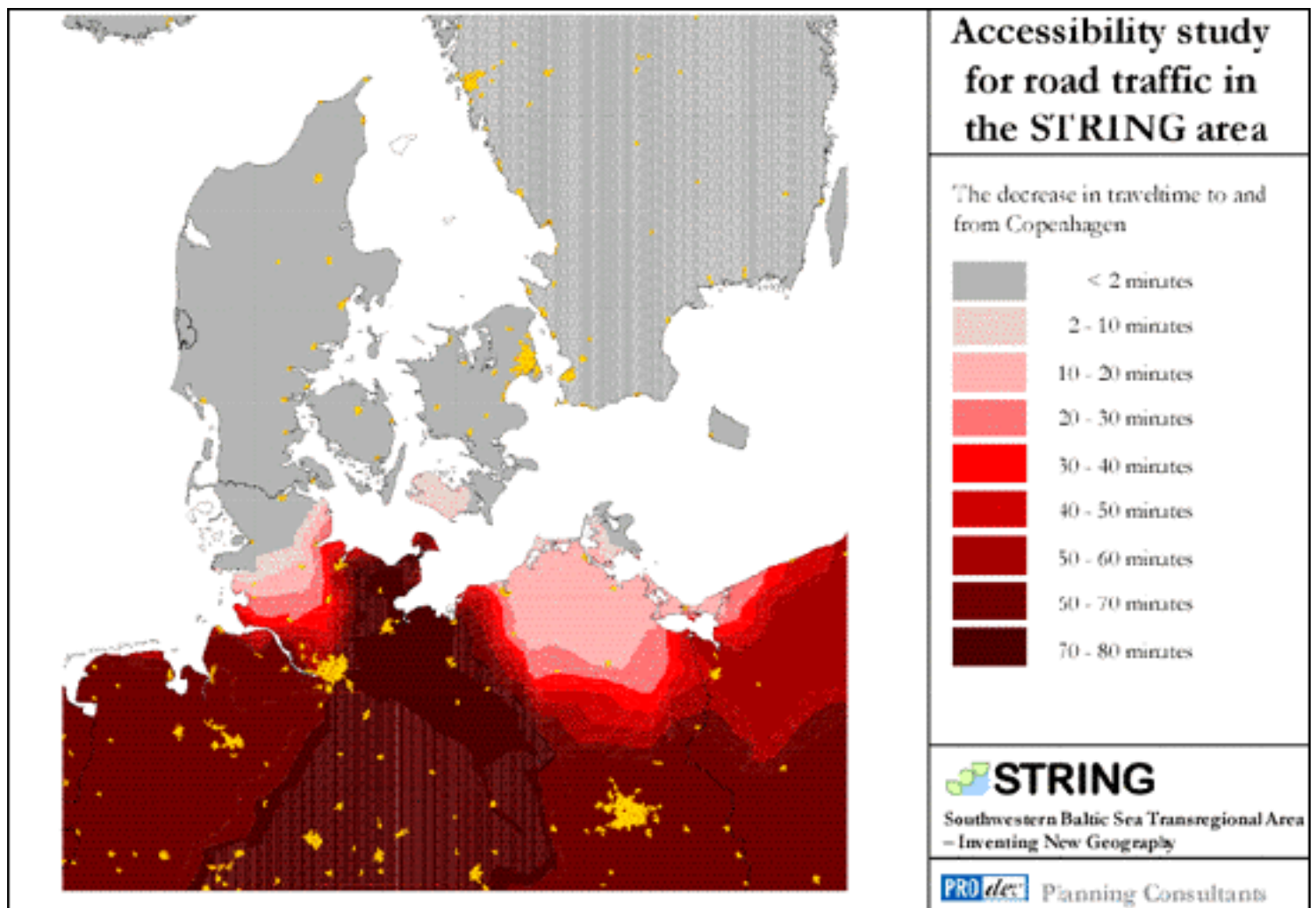
The decrease in traveltime to and  
from Copenhagen



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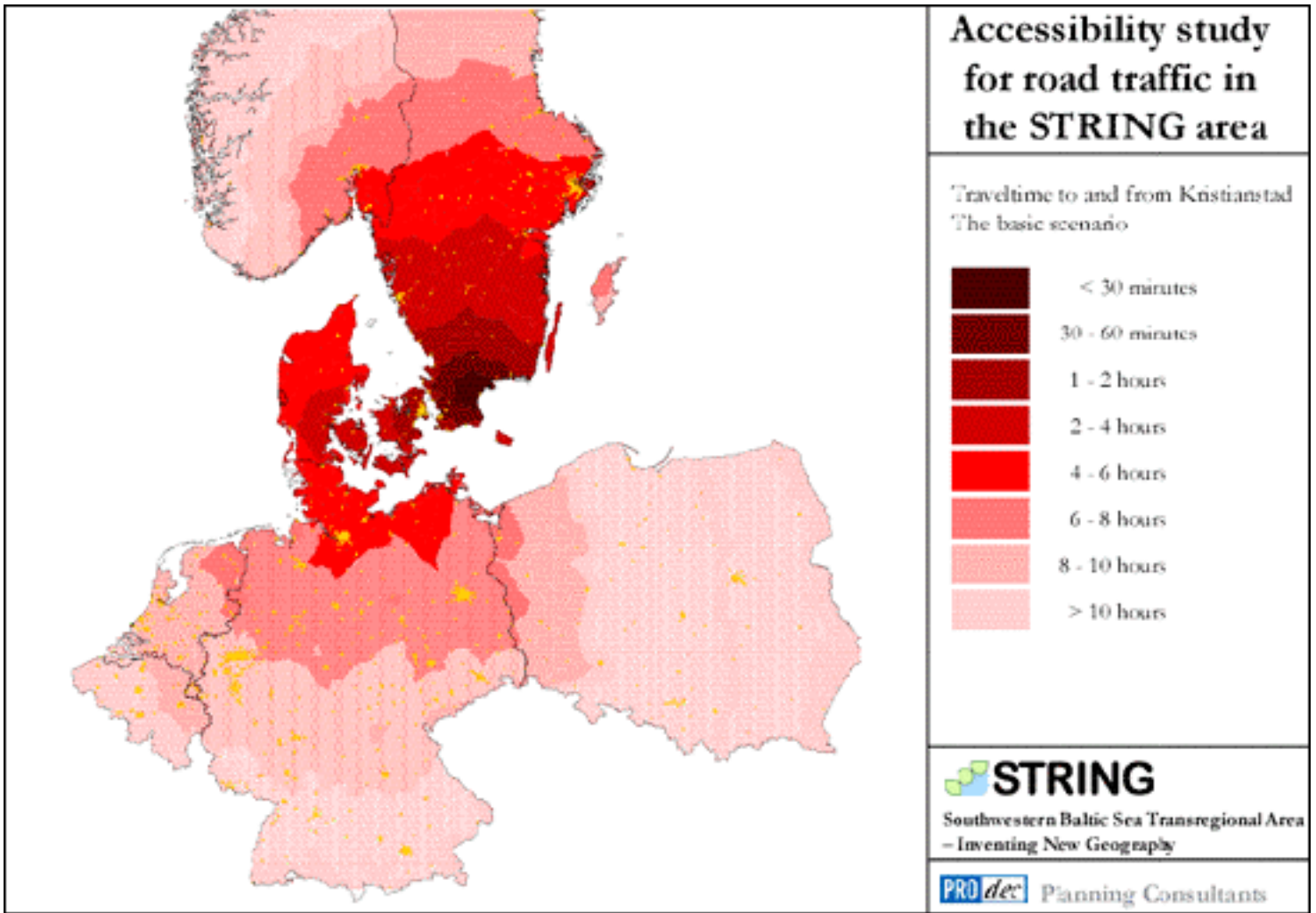
*The decrease in traveltime to and from Copenhagen as a consequence of a fixed Fehmarn Belt link.*



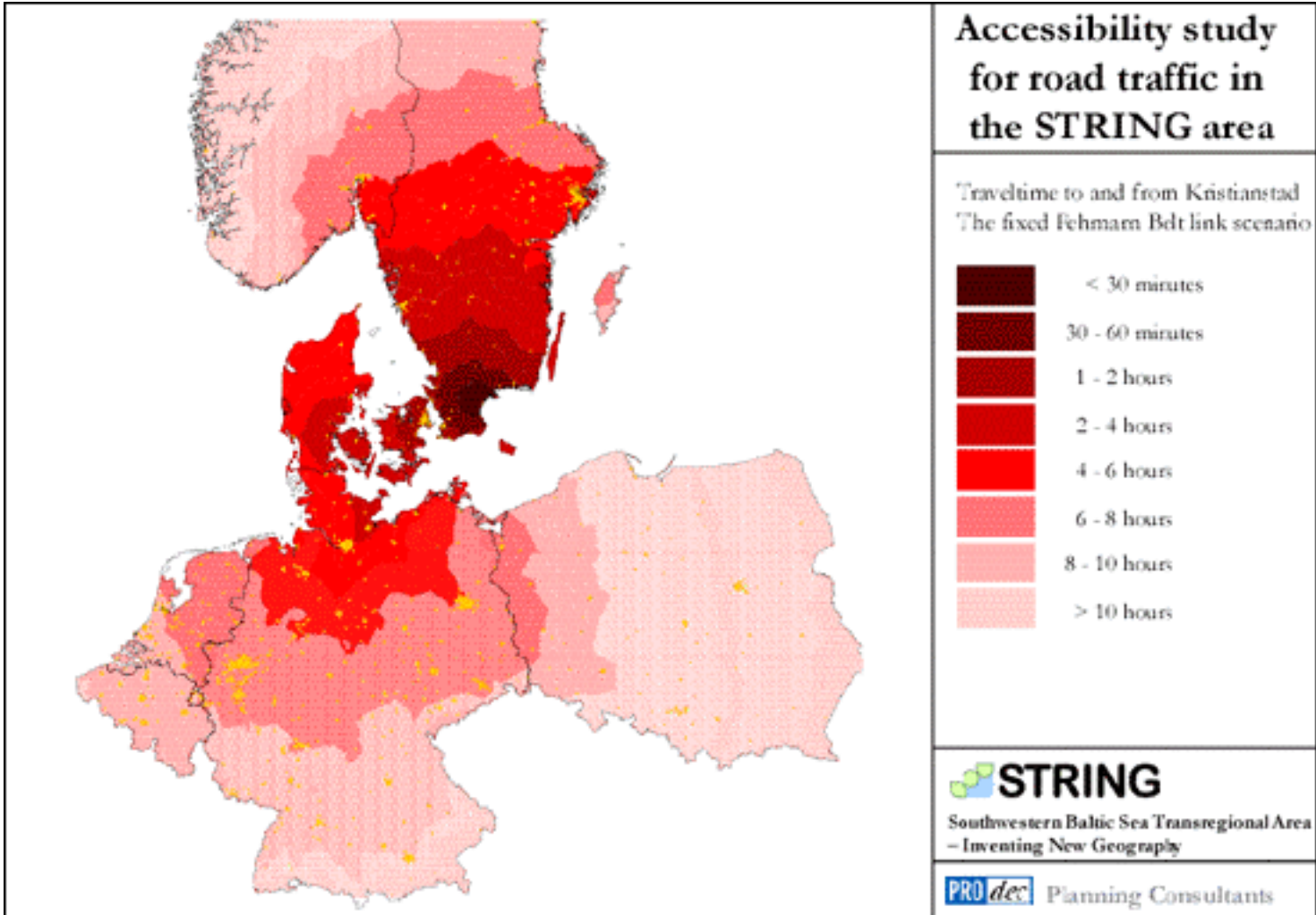
Most interesting on these maps is the competitive borders between the different access ways from Copenhagen to the regions in Northern Germany. The Great Belt fixed link provide access via Jutland and the fixed Øresund link (Øresundsbron) provides access via Trelleborg to Sassnitz. An interesting point is that the Polish road network is strongly east-west oriented and provides fast access from Northern Germany into Poland. Northern Schleswig is seen to gain relatively little from the fixed Fehmarn Belt link.

The final set of isocrones shows the traveltime to and from Kristianstad before and after a construction of a fixed Fehmarn Belt link as well as the geographical distribution of the traveltime changes.

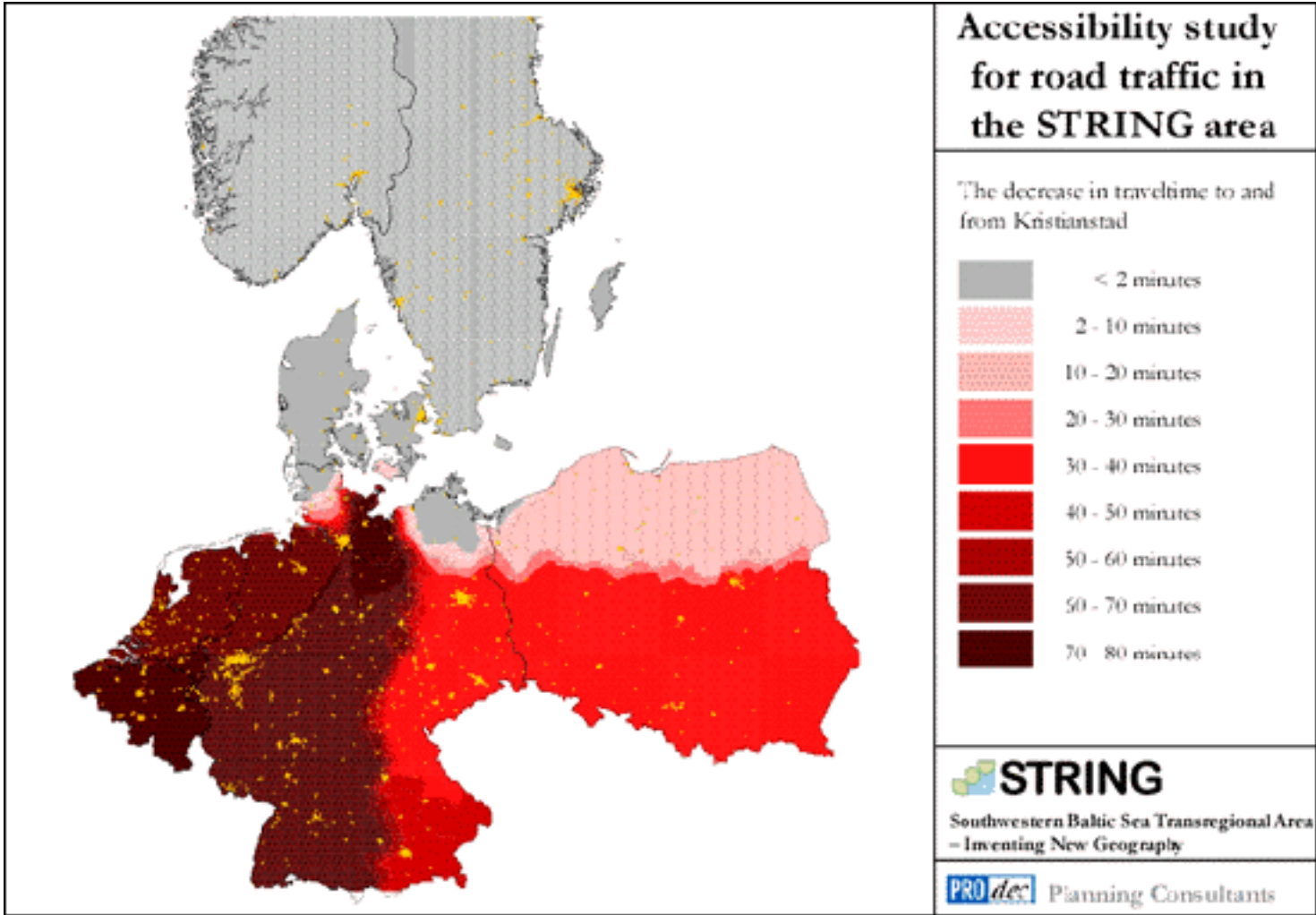
*Isocrones for traveltime to and from Kristianstad in the basic scenario.*



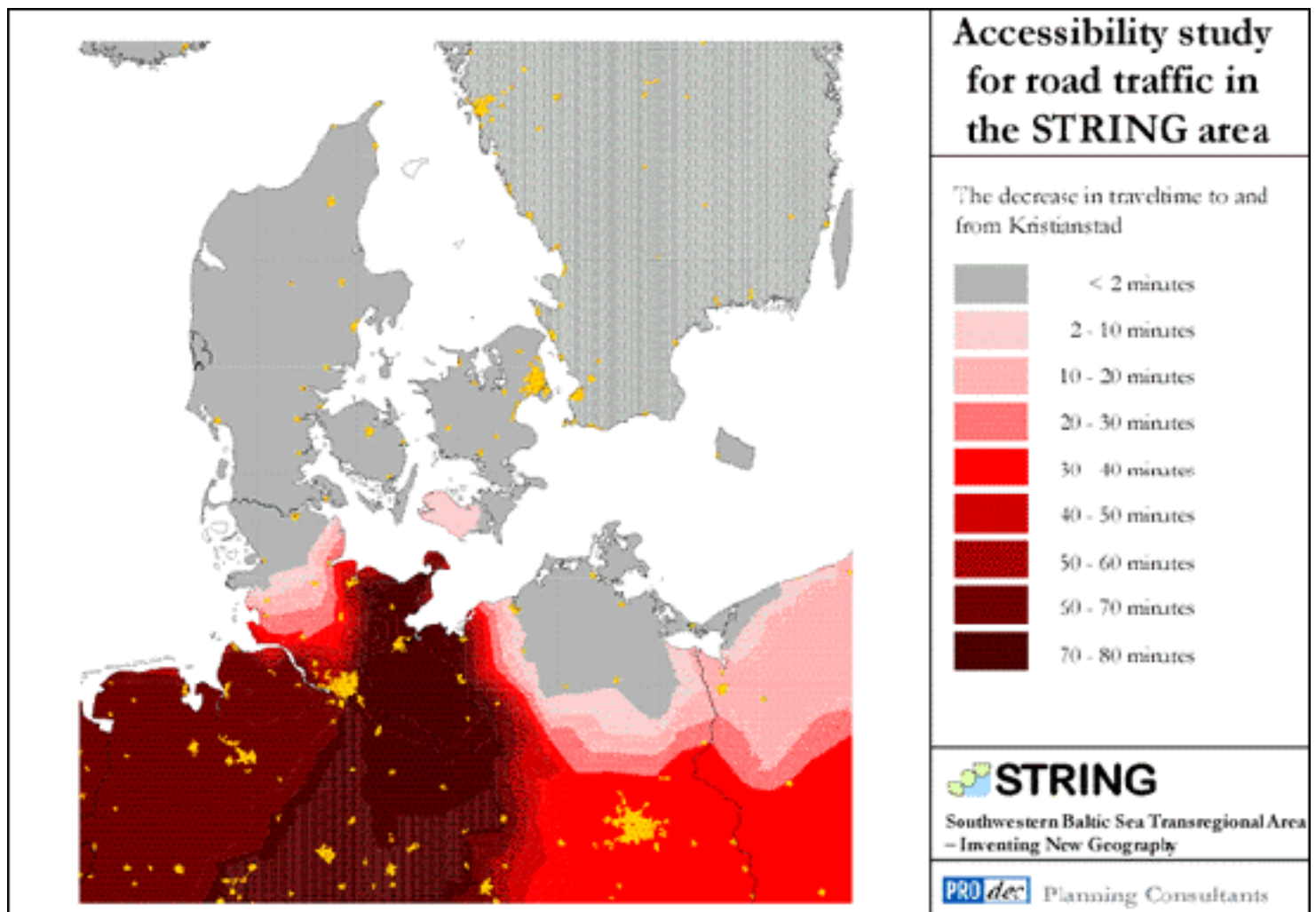
*Isocrones for traveltime to and from Kristianstad in the fixed Fehmarn Belt link scenario.*



*The decrease in traveltime to and from Kristianstad as a consequence of a fixed Fehmarn Belt link.*



*The decrease in traveltime to and from Kristianstad as a consequence of a fixed Fehmarn Belt link.*



The same structure for the change due to the fixed Fehmarn Belt link scenario as for Copenhagen can be seen on the figure. The most significant difference is the lack of decrease in traveltime due to the Trelleborg - Sassnitz ferry.

## 2.2 Isocost

As the name implies the isocost shows the distance in cost relative to a location. In this analysis the isocost is the same whether one travels to or from the location.

In order to calculate the isocost bands a generalised cost has to be calculated. This generalised cost represents the impedance in the network and is a function of time, driving cost and tolls. The generalised cost for passenger cars ( $GC_{car}$ ) used in this analysis is on each link defined as:

$$GC_{car} = T \cdot V_T + L \cdot V_L + Toll$$

Where;	$T$	Travel time
	$V_T$	Value of time
	$L$	Link length
	$V_L$	Cost pr. km
	$Toll$	Toll (e.g. ferries or bridges)

This analysis has been calculated with a value of time focused on business travel. It is of course possible to run the model with any combination of value of time and tolls.

$V_T$	$V_L$
20.11 EUR/ h	0.15 EUR/ km

The toll depends on the price for using e.g. ferries and bridges. For all ferries the toll used is the price without any discount and for one car and the driver. The cost of using toll roads has not been included in this analysis.

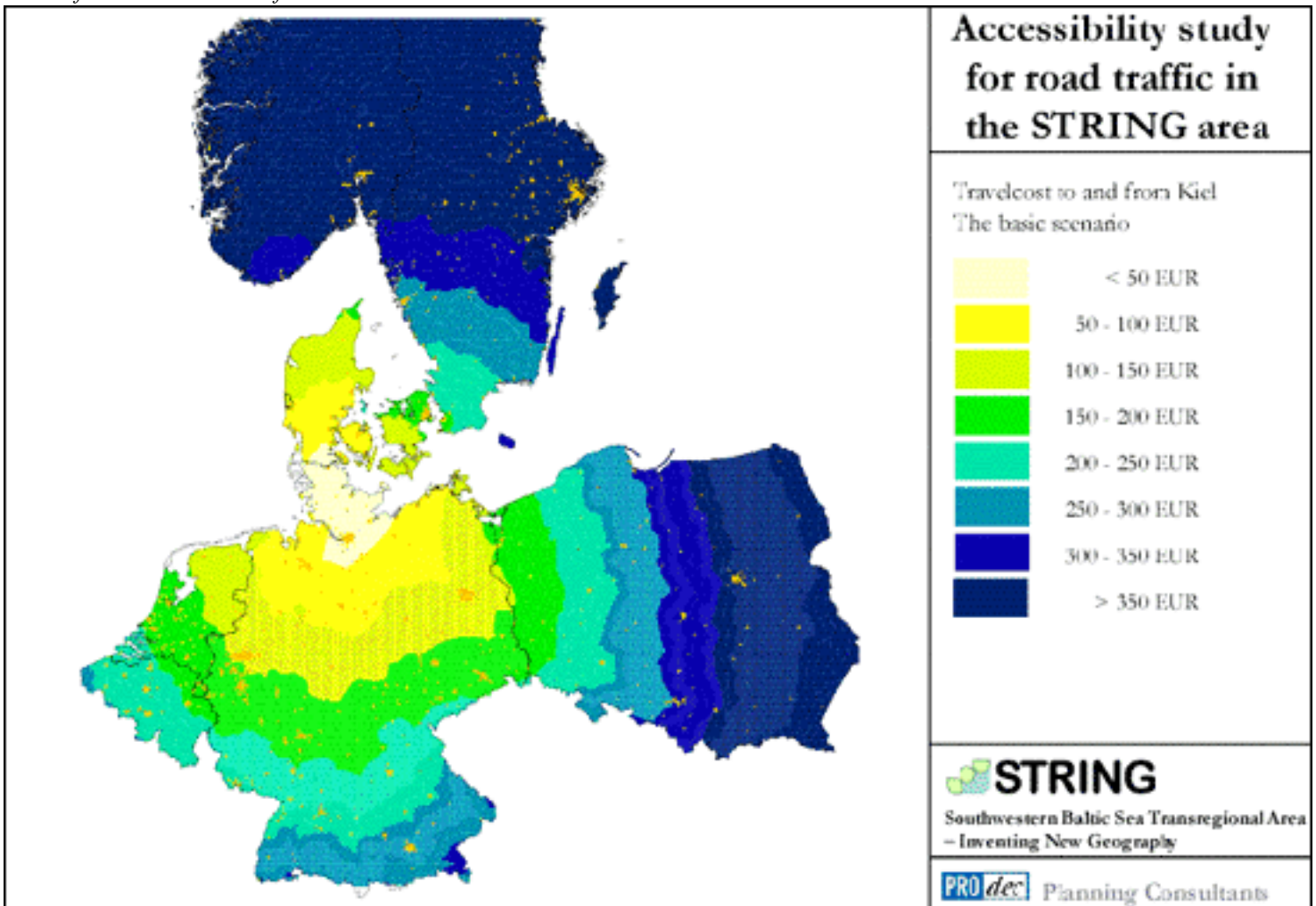
As for the isocrones the isocost has been calculated for both the "Basic" scenario as well as for the fixed Fehmarn Belt link scenario.

*The cost of crossing Fehmarn Belt in the two scenarios.*

	"Basic" Scenario	Fixed link Scenario
Toll	41.55 EUR	58.31 EUR
Time cost	25.14 EUR	3.35 EUR
Driving cost	0 EUR	1.50 EUR
Total	66.69 EUR	63.16 EUR

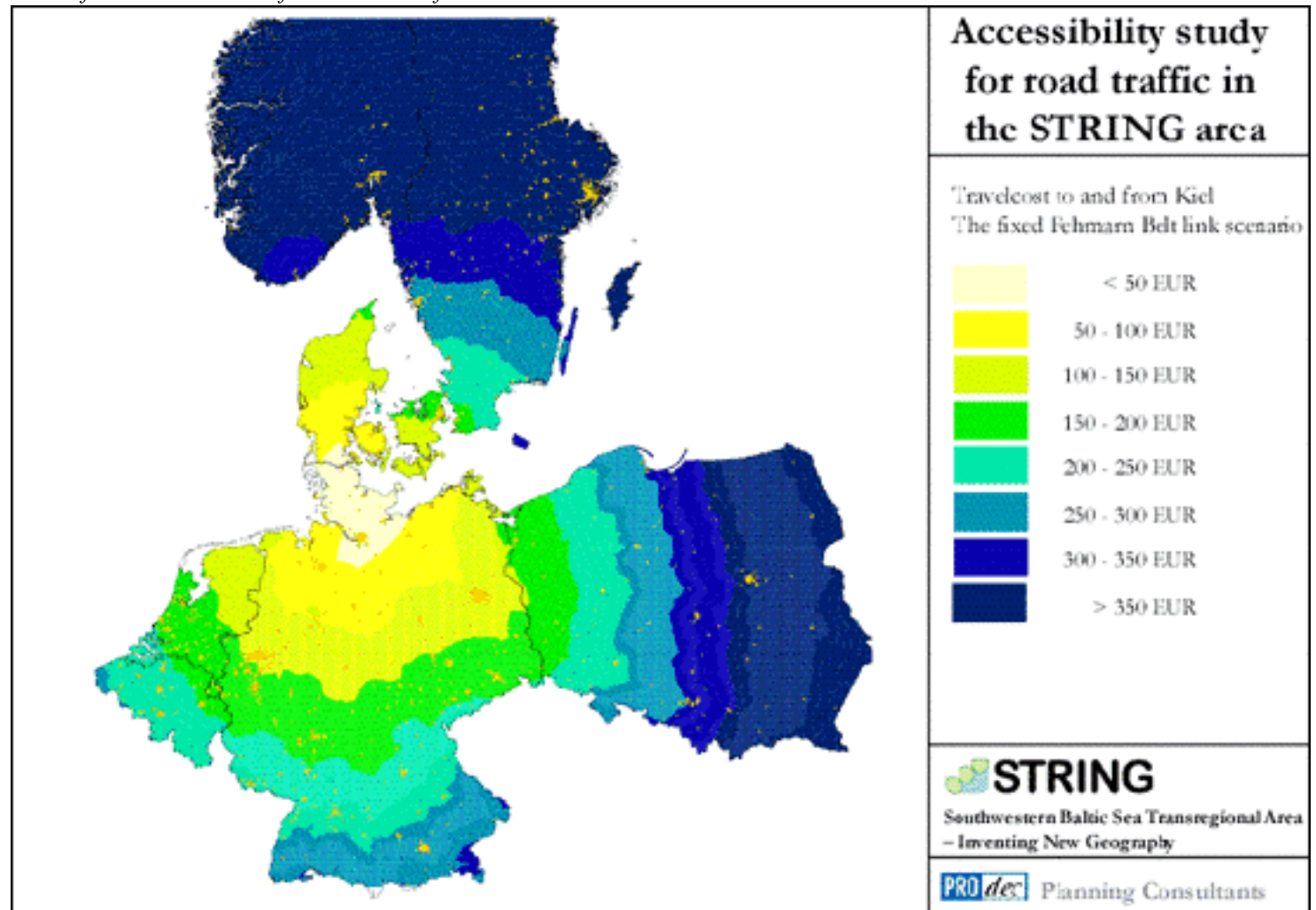
The first set of isocost shows the travelcost to and from Kiel before and after a construction of a fixed Fehmarn Belt link as well as the geographical distribution of the travelcost changes.

*Isocost for travelcost to and from Kiel in the basic scenario.*

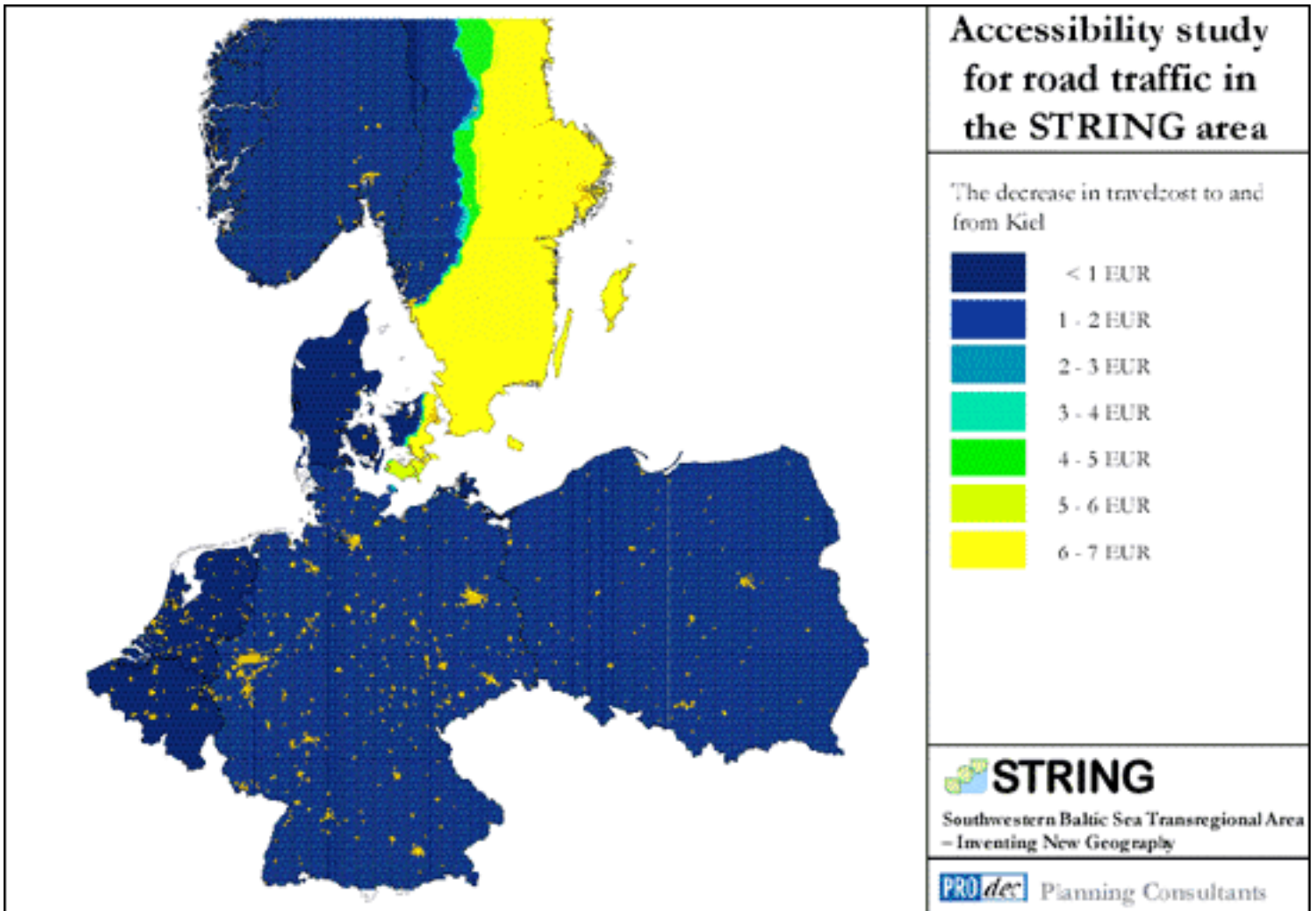


It is interesting to see how the toll on the Great Belt link and the Øresund Fixed Link influence the cost of travelling to and from parts of the Scandinavian area.

*Isocost for travelcost to and from Kiel in the fixed Fehmarn Belt link scenario.*



*The decrease in travelcost to and from Kiel as a consequence of a fixed Fehmarn Belt link.*



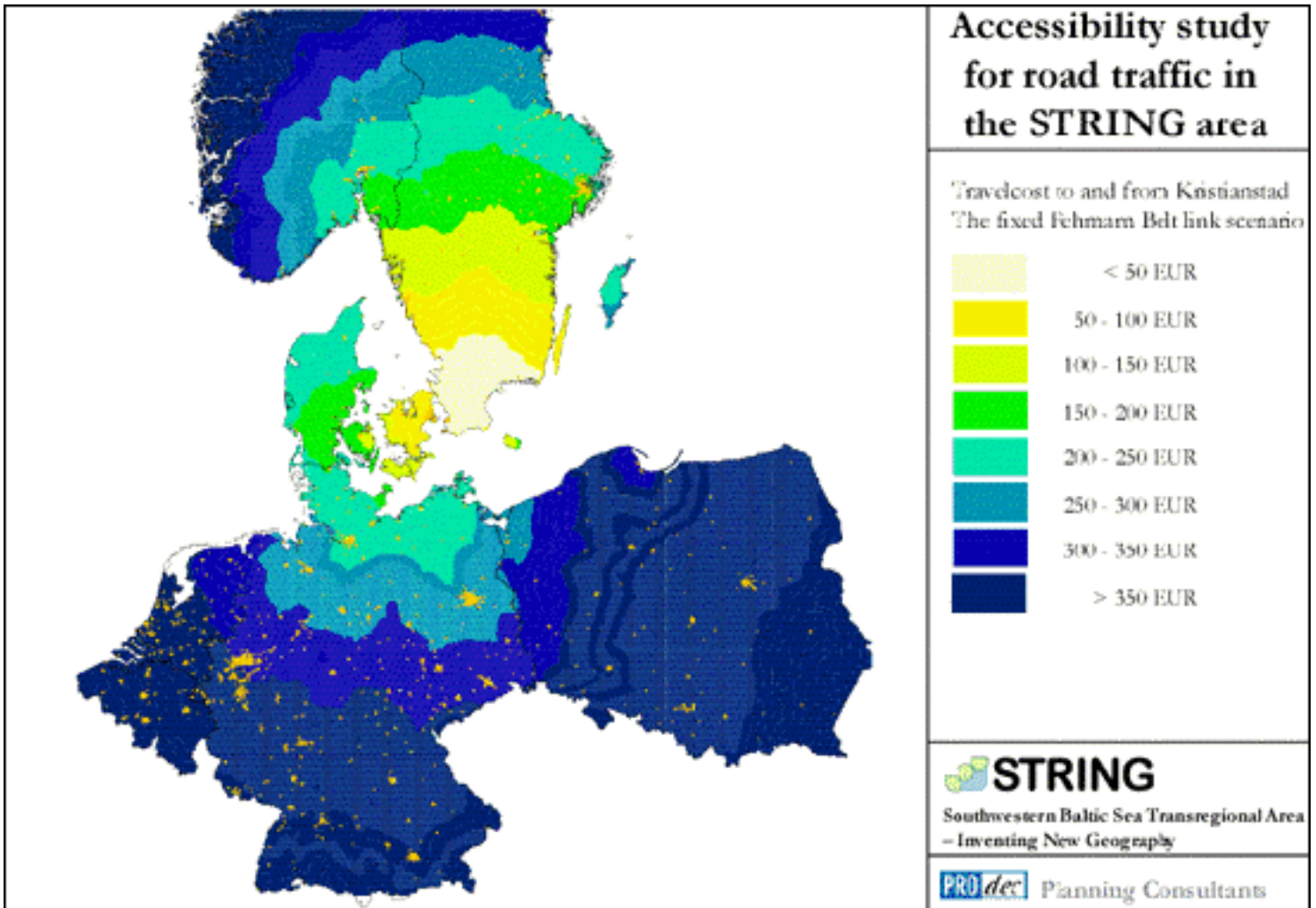
The decrease in travelcost to and from Kiel is in Sweden mainly limited by the possibility of using the free motorway system in Jutland and the ferry connection Frederikshavn – Göteborg between Denmark and Sweden.

The second set of isocost shows the travelcost to and from Kristianstad before and after a construction of a fixed Fehmarn Belt link as well as the geographical distribution of the travelcost changes.

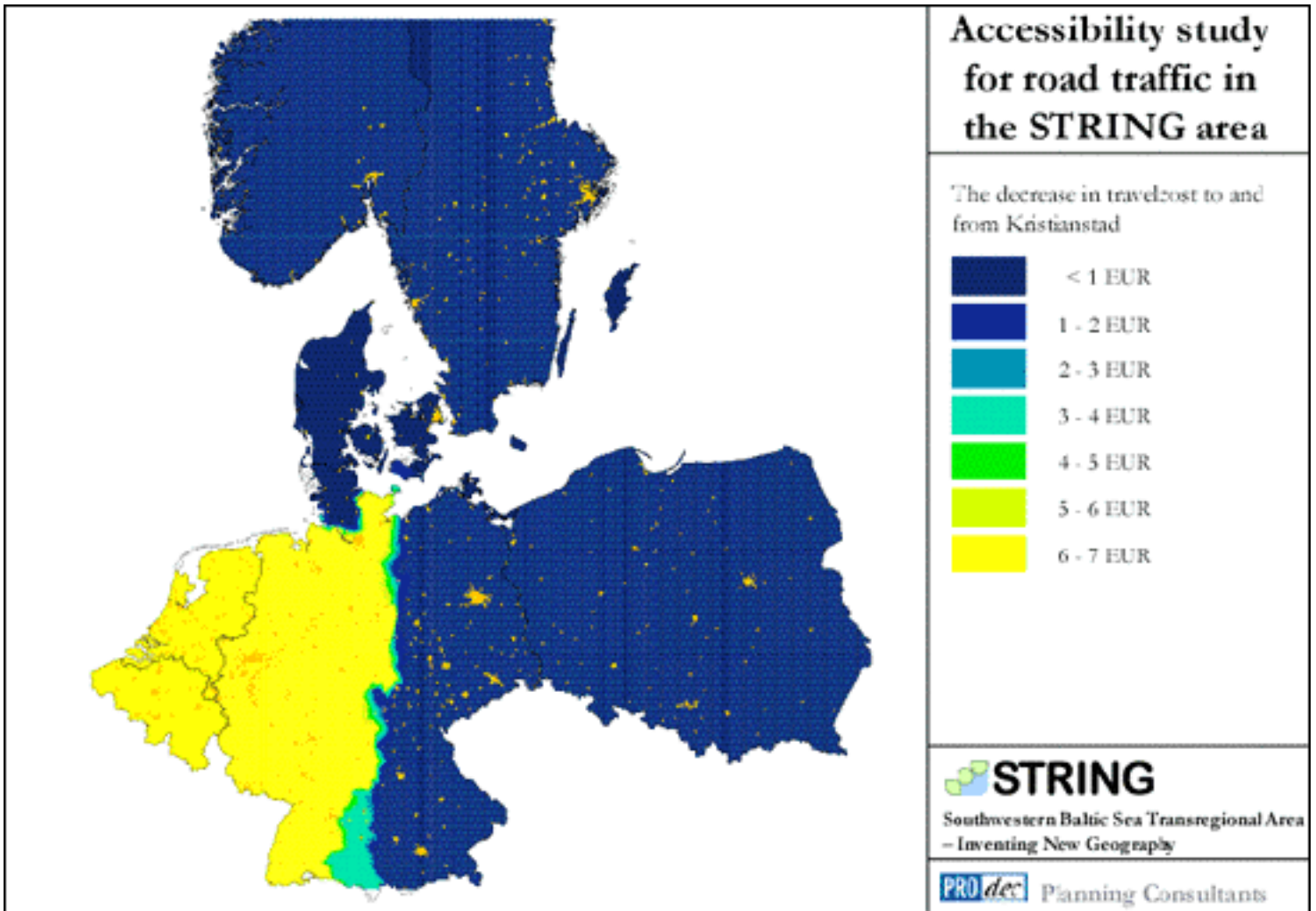
*Isocost for travelcost to and from Kristianstad in the basic scenario.*



*Isocost for travelcost to and from Kristianstad in the fixed Fehmarn Belt link scenario.*



*The decrease in travelcost to and from Kristianstad as a consequence of a fixed Fehmarn Belt link.*



The decrease in travelcost to and from Kristianstad as a consequence of a fixed Fehmarn Belt link is concentrated in the western part of Germany, mainly due to the Trelleborg - Sassnitz ferry.

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## 3. Analysis background

This section gives a short description of the analysis background and the used models.

The analyses presented in this report are all calculated and visualised by implementing the isocrone and isocost models in the geographical information system ARC/INFO. The calculation of both the Isocrones and the isocost have been based on a common digital network.

For each of the isocrones and isocosts 3 maps have been calculated: Two maps showing the situation before and after a construction of a fixed Fehmarn Belt link respectively and one map that illustrates the difference between the two scenarios.

### 3.1 The transport system

The transport system used in this analysis has kindly been made accessible by the Øresund Consortium. It is basically the same network as PRODEC used for the analysis of the strategic impacts of the Øresund fixed [footnote: An short English description of the this analysis can be found at [www.prodec.dk](http://www.prodec.dk). The full report are only available in Danish at the moment, but an English version will be online at the end of January 2000.] link but the network has been extended with roads for Norway, Poland, Holland and Belgium.

*The traffic network used in the analysis.*





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## Appendix, Timesavings

The isocrones in the STRING model has been calculated for a "Basic" scenario as well as for a scenario including a fixed Fehmarn Belt link. The fixed Fehmarn Belt link includes the following changes in the road network:

- The construction of a fixed Fehmarn Belt link
- An upgrade of the E47 to motorway standard between Ønslev and Saksøbing
- An upgrade of the E47 to motorway standard between Puttgarden and Oldenburg

The timesavings are composed by the following components:

	Basic (Ferry) scenario	Fixed link scenario	Time saving
Crossing	75,0	10,1	64,9
Motorway upgrade DK	6,1	4,5	1,6
Motorway upgrade DK	6,1	4,5	1,6
Motorway upgrade DE	9,4	5,8	3,6
Motorway upgrade DE	17,2	10,6	6,6
Total time saving			78,3

The crossing time in the Basic scenario has 3 components:

	Time
Crossing time	45
Meeting time before departure as demanded by Scanlines	15
Terminal time	15

Definition of "terminal time": Normally travellers do not know the exact travel time to the ferry (traffic situation etc), so they add some extra time to be on the safe side. This "hidden" waiting time is terminal time. With a fixed link, you can of course start your journey whenever you like.

All time are in minutes.

