Dynamic choice of geographical area.
Method developed to select an analysis area from a bigger transport model.

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Content

Introduction

Extensive transport models give lengthy calculation times. In order to reduce calculation times, a tool to cut out the influence area from a complete strategic transport model is developed. A Part Area Model (PAM) has new geographical definitions compared to the original transport model, but should give the exact same results. The scope of this paper introduces a new method to deal with superfluously long calculation times in transport models.

Most of the more fundamental transport infrastructure decisions are supported by transport model analysis. Regional transport models have been established for five

regional areas in Norway. A joint demand model is estimated for the country, but during the calibration work minor regional adjustments were made to the parameters. Even if there were defined regional areas for the transport models to limit the calculation time, the most extensive model still holds about 6000 zones. This gives unsuitably long calculation times. Efforts have also been made to make the most of the dual-core technology, but the calculation times still need to be reduced further.

PAMs calculate the transport demand for fewer zones, the trip destinations and modal split for fewer origin-destination pairs, and contains a smaller transport network. This gives shorter calculation times, both in the network analysis phase and for each of the matrix calculations and adaptation.

Basis for PAMs – the regional transport model version 1.3

Organisations behind RTM
The Regional Transport Model version 1.3 has been developed from 2002 until December 2007. The working group, NTP Transport analysis, crosses the boarders of the public agencies, and was funded to establish and develop transport models in an international, national and regional level for personal transport and freight. The Public Roads Administration holds the regional administrators, and they take lead of the regional work.

Trip contributions
RTM consists of one major travel demand model; Tramod. Tramod calculate the demand for personal trips shorter than 100 kilometers on an average workday. In addition RTM import fixed personal trip matrices containing longer trips, from the national transport model. Freight traffic is eventually coming from a fright transport model. Meanwhile a fixed matrix is used. Traffic across the national boarders is eventually coming from an international model, but is omitted from the current version of RTM. School trips and trips to and from airports come from specially made models for those purposes.

The demand model Tramod has been estimated for five trip purposes:
- Trips to work
- Work related trips
- Service trips
- Visits and leisure trips
- Other

Five ways of traveling are part of the demand model:
- Car driver
- Car passenger
- Public transport
- Bicycle
- Walk

Geographic boundaries

The country is divided into five model areas. The limits follow the administrative boarders between the regional offices of the Public Roads Administration. Trips done in one region which are generated in the neighbor regions are added to the local trips as fixed matrices.

The National Transport Model has its own coarser network and bigger zones as a basis for the demand calculation. The demand matrices for trips over 100 kilometers are generally added to the shorter trips as fixed matrices. If the current measure affects the demand for long trips, one would have to use EMME/2 to calculate new Level of Service data from the coarser network and calculate new demand using NTM5b are one could use Level of service data calculated using CUBE and the coarser net as input to NTM5b. The Level of Service data varies, dependent of whether they are produced using EMME/2 or CUBE and thus the NTM5b can give different results dependent of which method has been used.

Implementation software

CUBE is software provided by Citilabs, and is used as a tool to systematize the different part of the transport model calculation. The system is divided into three main parts:
1. Transport net and Level of Service data
2. Demand model and trip matrices
3. Net distribution

The three parts are calculated sequentially. Output from earlier parts of the system, enter into later calculations. Each of these parts consists of several calculation routines organized hierarchical.

Calculation times

It is vital to reduce the number of zones in the model, since many of the calculations is done on each different cell. Table 1 shows number of zones and approximate calculation times in the regions.

Table 1: Approximate calculations times for the five regional models (not finished, numbers are unconfirmed yet)

Region	# Zones	Calculations times *without dual core*	Calculations times *with dual core*
East	5981	20 h	14 h
South	7195	24 h	18 h
West	3821	3 h	2,5 h
Mid	2948	2,5 h	2 h
North	2230	2 h	1 h

Additional tools in the RTM model system

Along with the transport model comes a tool to extract results from the transport model. It calculates user benefit; time-, distance- and monetary savings, from infrastructure scenarios calculated in RTM and the impacts for the Government and public transport companies. These results are later exported to EFFEKT; the Cost Benefit Analysis tool used by the Norwegian Public Road Administration.

The method

Requirements to make a PAM from a transport model

1) Equal demand
A demand model which calculates the same demand for each zone pair, as long as the LoS data is the same, and independent of the demand between other zone pairs, is necessary for making PAMs.

Rekdal at the Trafikdage 2004:

> For å bedre ivareta behovet for samferdselsmyndighetenes daglige planlegging er programmeringen av modellene uavhengig av soneinndelingen. Dette gjør at en planlegger relativt lett kan definere og spesifisere mindre modellområder enn en region, for eksempel fylker eller grupper av kommuner, og kjøre modellene på disse. Dermed kan man unngå å kjøre modellen på en hel region med 5000-6000 soner hvis man skal studere et prosjekt eller en prosjektpakke med en klar geografisk avgrensning.

Different test calculations show that the demand calculated by Tramod in a full regional model and a PAM with similar LoS data is almost the same.

Even if the choice of influence area is dynamic, it is necessary that the calculations consist of entire municipals. This is a practical limitation with the demand model.

2) Affected links and zone pairs
It must also be relatively easy to pick the links that actually are affected by the specific infrastructure project, and from there the zone pair that get changes in their LoS data as a consequence of the infrastructure project. This might be harder if the model has a loop between net distribution and calculation of LoS data as input to the demand calculation. In RTM the input to the demand model is an unloaded network, with a fixed downward adjustment on the link speeds in order to take account of capacity restraints.

Prerequisites to a PAM

It is an overall goal that the method to select a smaller area for analysis, should give the same results, whether the calculation is done with a full size model or a Part Area Model. The method is adjusted according to this goal.

The cut-out PAM and the full model area are required to give:

- Equal Level Of Service (LoS) data (in the "do nothing" scenario
- The same number of trips on the border of the Part-area
- Equal trips matrices from the demand calculation
- Equal link loads
- Equal user benefit calculation results (time use, distance traveled, monetary costs)

New demand calculations are made only for OD-pairs with both ends within the PAM. The LOS data will become equal if the traffic has the same possibilities regarding route choice as in the full regional model. One has to regard the route choice possibilities when the border is drawn.

In order to fulfill the last of these requirements, it is necessary that the analysis of current interest must be of a kind that one can isolate to a distinct area. For instance might general changes in public transport fares, make it hard to isolate a smaller influence area from a full regional model. One of the challenges in making a PAM is that trips crossing the border of a PAM should not be affected by the coming analysis.

Separating dynamic and fixed demand zone pairs

The capital idea in the method to make PAMs, is to reduce the matrix sizes in order to reduce calculation times. *Why spend calculation time on zone pairs that are not affected by the project to be studied?* The unilateral focus on matrices is due to the fact that superfluous links (links outside the influence area) does not contribute a lot to the calculations times.

The dynamic demand is calculated by the demand model Tramod. The fixed demand is fetched from a previous calculation of the full regional model. Trips on the boarder of the PAM area are discussed in the next chapter.

Example: Figure 1 shows an area which could represent the full regional model. The red dotted line is the infra structure project that we want to analyze in our model. There are five zones which are affected by the project. They have dark blue houses. Light green houses represent zones which are not affected by the project. This means that the zone pairs with both the origin and the destination among the blue houses are affected – they get different LOS data because of the project (maybe not to all other zones, but to some zones) and as a result they get changes in the demand calculation.

When it is known which zones are affected, it is possible to draw a line surrounding the influence area (see Figure 2). The desire lines represent the zone pairs with dynamic demand in the PAM.
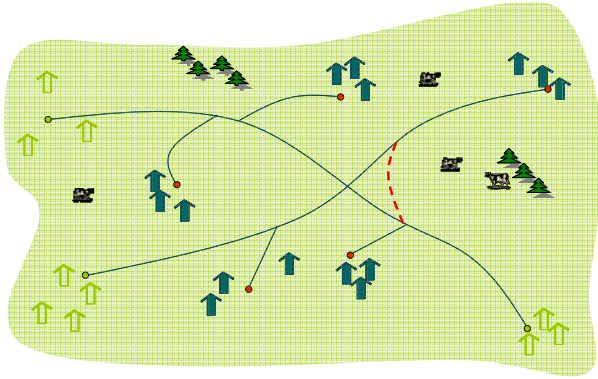
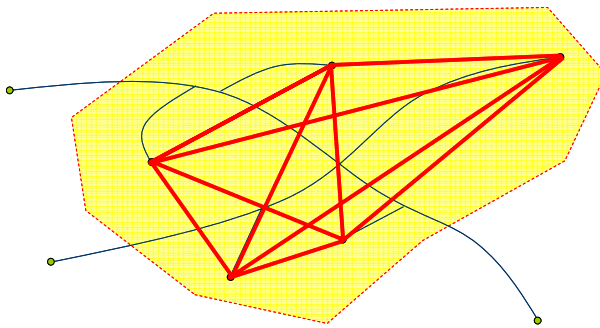*Figure 1: Analysis area (representing a full regional model area)*

Figure 2: Desire lines between zone pairs with changes in the LOS-data and dynamic demand in a PAM

Establishing external matrices (cross boarder trips)

Equal user benefit calculation results, means that the road-links (for car traffic) should have the same speed after the net distribution calculation has reached equilibrium. This means that all the links in the PAM area need to be loaded with both the internal trips (trips between OD-pairs in PAM area) and trips in to, out of or through the PAM area. These are denoted external trips.

If some of the trips are missing from the net distribution, link loads in the boundary area of the PAM give less time use on the links, and this might lead to different impacts from studied infrastructure projects.

To embrace all the traffic, we extract all trips crossing the boarder using "Selected link" analysis. We start by defining gateways for the external traffic (see Figure 3). "Selected link" analysis gives the origin and destination of all trips traversing a specific link.
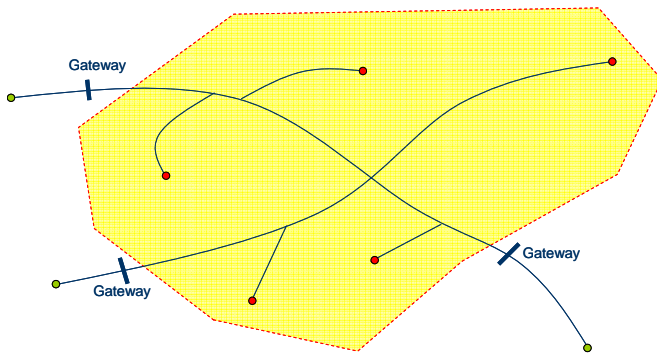
Figure 3: Gateways

Trips on the gateway are both trips with one end point in an internal zone and one in an external zone, or it might be trips between two external zones, which have their route through the area (see Figure 4 and Figure 5).
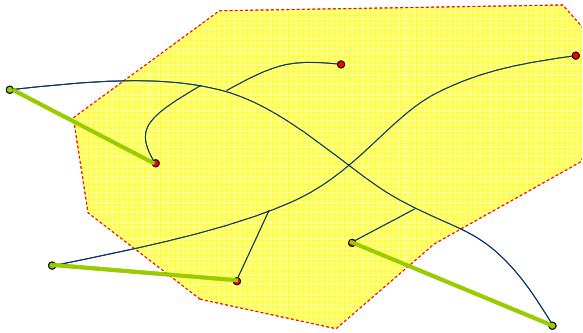

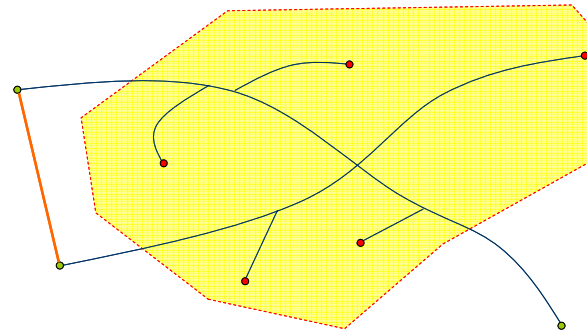*Figure 4: Trips in to or out of the PAM*   *Figure 5: Trips through the PAM*

The trips that are results of the selected link routine are shown in Figure 6. These trips form the basis of new matrices containing external traffic to the part area model. The external trips matrices are fixed. They can only change their route choice, the demand is fixed. Trips longer than 100 kilometers are fetched from the national transport model (NTM) as a fixed matrix.

The selected link routines are made for each crossing of the border of the part-area, identifying trips going either into, or out of the area, and identify trips with two crossings of the border (look at the figure next page). Trips with more than two crossings of the boarder are partly included, but not in a 100 % correct way. If a lot of trips cross the boarders more than twice, it is necessary to reconsider the placement of the boarder.
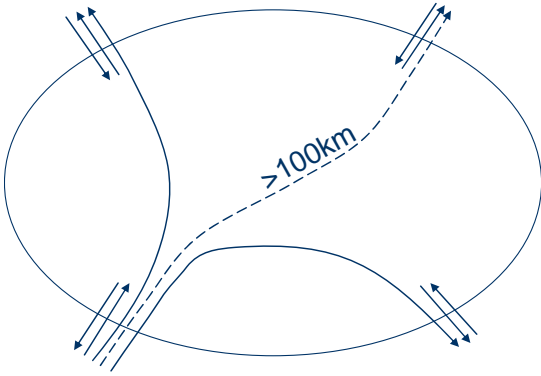
Figure 6: Traffic in and out of the part area model

Trips in, or out of, the area constitute the green cells in the matrix below, provided the PAM consists of zones S2-S6. Trips through the area are part of the content in the white cells, dependent on whether the route choices imply that they cross the border. The yellow cells are trips within the PAM, for which new demand is calculated to measure effects.

	S1	S2	S3	S4	S5	S6	S7	S8
S1								
S2								
S3								
S4								
S5								
S6								
S7								
S8								

Figure 7: Matrix with yellow cell color on OD-pairs within the Part Area and green on OD-pairs with one trip end in the Part Area

Transport net

The amount of links is not contributing a lot to the calculation times. In this method we connect border links to external zones, and the rest of the net can remain if the user doesn't want to cut away links for other reasons.

The practical implementation

Preliminary work

Using our method, require some preparation:
1. Calculation of a base (do nothing) scenario with the complete transport model to get a basis for the fixed matrixes, including external trips. One for each scenario year.
2. Calculation of a scenario including the project or project at interest to limit the PAM area (for instance chose the most extreme alternative or a combination of several alternatives to be analyzed)
3. Create scenario structure in Cube (Figure 8)
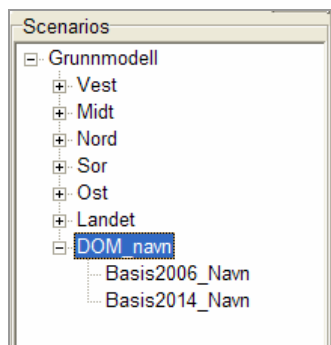4. Create scenario structure in Explorer (Figure 9)
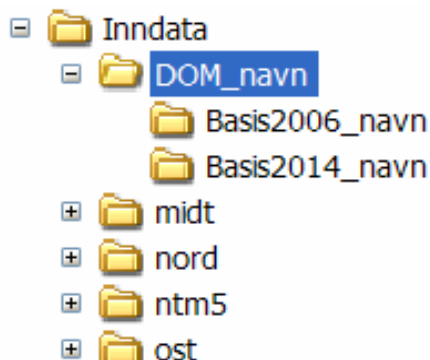

Figure 8: Scenario setup in Cube (PAM=DOM)

Figure 9: Scenario setup in Explorer (PAM=DOM)

Defining the area in GIS

We have used ArcView to select the influence area and produce shape files containing nodes and links.
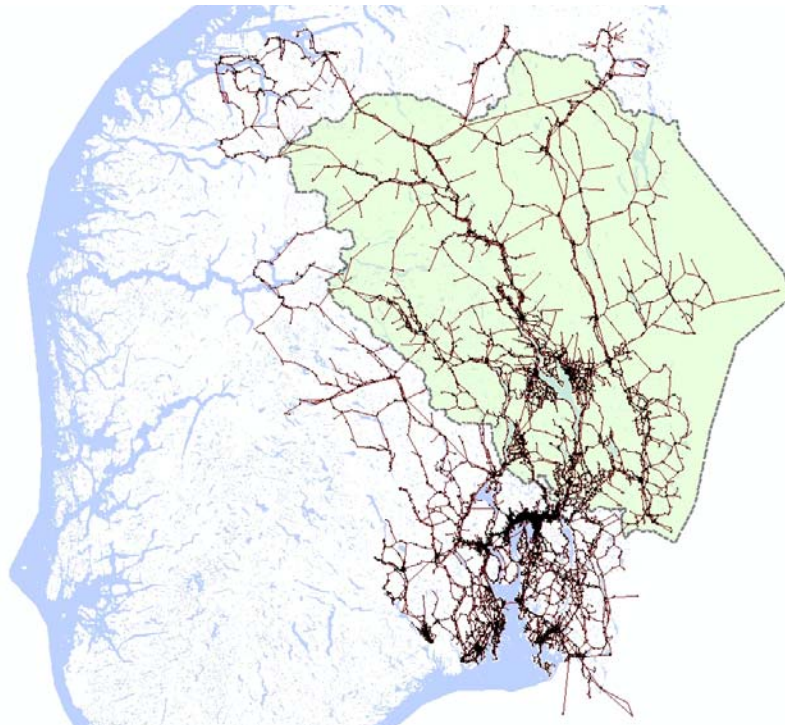
Figure 10: RTM Region east, area, net and selected polygon

In ArcView we attach new attributes to the outer links in the area. These are the gateways to the PAM. DOM_A and DOM_B are new attributes given manually by the user and define the gateway link, as shown in Figure 11.
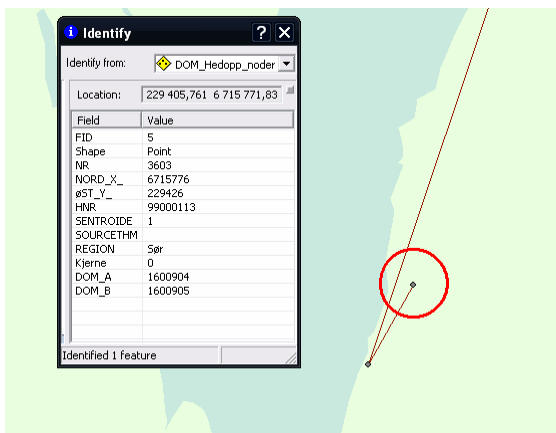

Figure 11: Attributes for gateway

Selected link routines

Shape files from ArcView now have defined which links should be included in the selected link analysis. The resulting matrices are prepared, named and saved in the correct place.

If all the previous routines have been carried out successfully, the PAM is all set and ready to be used in analysis.

Results and experiences so far

The method is now implemented as a tool for the transport model users, as an addition to the regional transport models. The method is tested on several areas, one was made for two Norwegian counties, Oppland and Hedmark, and one on the border between two of the regional transport models. The results are promising, with only minor difference between the PAMs and the complete regional transport model.

Calculation times to find the external fixed traffic is time consuming, but is done only once for each scenario year.

References

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Tørset, Trude, Olav Kåre Malmin, Snorre Ness, Ina Abrahamsen og Oskar Kleven (2008): *Regionale modeller for persontransport. Modellbeskrivelse.* SINTEF-report STF A3973. Trondheim.