Sustainable Land Use Planning and Planning of Rural Road Networks

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ABSTRACT

To provide for peoples needs in the future, further improvements of the road network are a necessity. Simultaneously, harmful effects of this network on both local inhabitants and the flora and fauna become more penetrating. So, sustainable land use planning creates a great challenge for rural road network planning. To serve interests of both accessibility and a sustainable environment, a new planning approach must be developed. This approach also should tackle the problem of traffic unsafety on minor rural roads. The spatial concept of the Traffic Calmed Rural Area (TCRA) is presented as a solution to the dilemma between improving accessibility and damaging the environment. The concept will result in a concentration of present diffuse flows at the minor rural roads at a few trunk roads. So, traffic volumes and speeds within the region will decrease. For two regions, several impacts of the TCRA concept (on volumes, accessibility and environment) are calculated. These examples emphasize the possibilities of the concept to enable a sustainable development.

Keywords : Minor rural roads, rural traffic, traffic calming, environmental impacts

INTRODUCTION

In many industrialized countries, traffic volumes showed a considerable growth during the last decades. The same is true for Eastern European countries, with an economy in transition. Here, car ownership is fast growing. So, it is not surprising that in many countries the existing road network more and more fails in absorbing traffic and transportation in a safe and efficient way. Where increasing volumes will worsen the problems, these failures call for extensions and improvements of the road network. However, in the meanwhile some harmful effects of the road network and their traffic flows appeared. Traffic unsafety is a problem from early days (Jaarsma, 1994). Unfortunately, there are more traffic disbenefits: emissions and noise affect local people, flora and fauna (Van Langevelde and Jaarsma, 1997). Since sustainability, as put forward by the well-known Brundtland Commission, has become a hot topic in society, there is a growing interest into these impacts. It is necessary to tackle these traffic disbenefits, which are inseparable from motorized traffic flows. This all means a further complication in the planning of the rural road network, traditionally based on economic and social considerations. Beside financial and technical aspects, the planner must investigate how to minimize undesirable impacts of the road and its traffic. This holds for both new road projects (OECD, 1986) and the planning system for existing networks (Jaarsma, 1997).

The objective of this paper is to illustrate a possible approach of rural traffic planning, within the frame of sustainable land use planning. The paper emphasizes the so-called minor rural roads (the networks of mainly local collector and access roads), in relation to the major road network (motorways and rural highways). The paper focuses on countries with dense and intensively used paved rural roads, with average densities from, say, 1 $km.km^{-2}$.

SUSTAINABLE LAND USE PLANNING AND PLANNING OF RURAL ROADS

"Land use planning deals with an active planning of land to be used in the (near) future by people to provide for their needs. These needs are diverse: from food products to places to live; from industrial production sites to places to relax and to enjoy beautiful landscapes; from human uses to places where natural plants and animals can live and survive; and many more" (Van Lier, 1994). The term *sustainable* land use planning embraces several aspects, as given in 1. The Figure illustrates the two dimensions of both land use planning (physical planning and improvement plans) and sustainability (environmental and socio/economic sustainability).

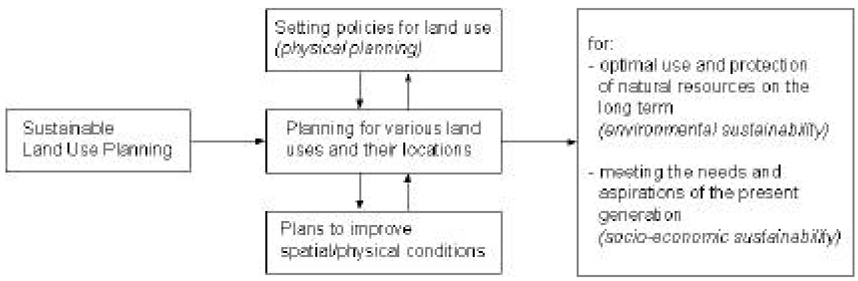

Figure 1. Sustainable land use planning and its embracing aspects (Van Lier, 1994)

It should be realized that a road is never a goal on itself. Roads are only constructed to serve traffic and transportation. Both, traffic and transportation, are derived functions from local land use (location and type of activities). Through this, the planning of the road network as a form of land use strongly depends on other land uses. These other land uses decide the desirable density of the network (mesh size) and the capacity of the road links in the network (pavement width). Simultaneously, all human land uses are strongly dependent on this network. Economic development, efficient use of land resources, and as a social aim, accessibility of rural areas need a well developed road network (Jaarsma, 1997).

Most regions in industrialized countries have, from a *quantitative* point of view, a sufficient rural road network (road density and mesh size). In practice, increasing volumes lead to damage to the verges and/or the road construction of minor roads, due to deficient road capacity. So, still a quantitative problem seems to appear. However, further research often shows that actual volumes are considerably above the level of region bound traffic. Often, especially where rat run traffic appears, the functional capacity (for region bound traffic) is sufficient. Therefore, the desired functional capacity of the links in the road network should be decided very carefully in the planning process. This will be elaborated further in a next Chapter.

However, from a *qualitative* viewpoint, growing volumes force growing traffic problems: discrepancies appear between the planned road function, the actual road use and traffic characteristics. In the Netherlands, the most important qualitative traffic problems on the network of minor rural roads are (CROW, 1989): (1) mixed composition by mode; (2) high speeds and large differences in speeds; and (3) rat run traffic (through traffic, using roads of a lower category, to avoid a longer travel time and/or distance on the functional route, along roads of a higher

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category). These problems result in a high level of unsafety (the number of personal injury accidents per vehicle kilometre on minor rural roads is the tenfold of the number on motorways!) and in high costs for the road management, to repair damage to the road and the verges. So, these problems conflict with socio-economic sustainability.

In western European countries, traffic unsafety significantly decreased the last decades, despite a considerable growth of traffic volumes. However, this decrease stagnates now. A substantial further decrease requires a complete new approach (Koornstra *et al.*, 1992). In countries in transition, the number of traffic victims is relatively high and even increasing. Here, the standard of the existing road network fails to cope with the present rapid growth of car ownership and the simultaneous technical upgrading of the car stock.

Beside traffic problems, environmental problems appear. Growing volumes also increase emissions, noise for people and habitat fragmentation for the fauna. These environmental impacts conflict with environmental sustainability.

Emission problems diminish by the introduction of catalysts, but growing volumes increase the problems of traffic noise. This is mainly an urban problem. Outside built-up areas, roads and traffic cause habitat fragmentation of the fauna. For minor roads, the two most important aspects are physical barriers by the presence of roads and barriers by traffic (Van Langevelde and Jaarsma, 1997). The presence of roads separates functional areas, such as living and reproduction areas or rest and food areas and increases resistance for movements. Traffic flows may create inability or unacceptability for crossing through disturbances and/or a high collision chance during crossing. Further, it can be concluded that both an increase of the overall stock of roads and growing traffic volumes intensify habitat fragmentation.

This leads to contrary conclusions (Jaarsma, 1997). "To provide for peoples needs in the (near) future, both physical planning and improvement plans for the rural road network are a necessity. Simultaneously, harmful effects of this network conflict with the principles of (environmental) sustainability. This contrast creates a great challenge for planners!". Beside a solution for the traffic problems explained before, such a planning of the road network should take in consideration next problems (Jaarsma, 1997): (1) increasing costs for road management; (2) unsafety (mixed modes, high speeds and rat run traffic); (3) declining liveability for residents (annoyance, emissions, unsafety); and (4) increasing habitat fragmentation for the fauna.

ON THE WAY TO A SUSTAINABLE PLANNING OF THE RURAL ROAD NETWORK

This Chapter deals with developments in the planning of the rural road network. In retrospect, the first Section summarises the traditional approach of planning for road links. To overcome its shortcomings, in succession new approaches are developed. This is illustrated in the Sections describing planning for a network and planning based on durable safety.

Traditional Planning: Planning for Road Links

Traditionally, existing unpaved roads were paved and existing paved roads were widened or even reconstructed to improve the accessibility of the rural area. Further, new paved roads were constructed. This planning approach "follows traffic". It is based on road links, not on the regional network. As a result, the hierarchy in this network often got lost. In practice, many minor roads got such a high technical standard, that they became competitive with major roads.

Most industrialised countries left this policy in the 1970s. Mainly by lack of finances, a kind of "stand still principle" for the network of minor roads appeared. The OECD (1986) found a policy, primarily designed to conserve the network of high quality major roads. This network represents only 10 to 20 per cent of the overall stock. The minor road network "has tended to be run down and today a sizable effort in terms of investment and energy is needed to bring them up to acceptable standards." Further, the OECD reports state: "design standards are not static but changing in the light of technological, economic and social developments." New criteria in geometric design, involving such considerations as energy expenditure and traffic disbenefits (noise, pollution, unsafety), are included. This marks a transition to a road planning in a wider perspective. It also marks a transition from planning for road links to planning for road networks (Jaarsma, 1997).

A New Planning Approach: The Triangle Applied To A Road Network

Traffic problems on minor rural roads should be solved on a regional scale (Jaarsma, 1991). Moreover, the relationships between minor roads (local collector and access roads) and major roads (rural highways and motorways) in the regional network should be considered (OECD, 1986; Jaarsma, 1991).

To get a safe and efficient traffic system, first a functional classification of the network should be made. The assignment of functions to the regional road links should be based on an inventory of the present situation (function; traffic volumes and speeds; traffic accidents; acceptable road capacity; geometric features), regional transportation plans, (possible changes in) land uses and traffic volumes. A proper distinction between minor roads with (mainly) a residence (access) function and minor roads with (mainly) a traffic (flow) function should result from this functional classification.

Next step in the planning is a mutual harmony between (1) desired function, (2) technical layout and (3) traffic characteristics, for every road link in the regional network in question. This is schematized in the triangle in 2. In this second step, the actual technical layout of each road link in the network is compared with its desired layout, conformed to the road function assigned in the first step. Discrepancies, if any, should be removed by introducing the desired technical layout (Jaarsma, 1994). This may result in downgrading of a road. Rat run traffic on roads with a residence function should be forced to use roads with (mainly) a traffic function.

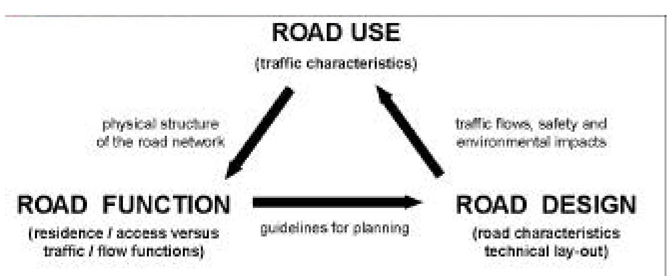

Figure 2. Relationship between road function, design (technical layout) and traffic use

In the third step, traffic characteristics on each road link, such as volumes and speeds of cars, are compared with the characteristics belonging to a road with the function assigned in the first step. For example, for a road with an access function only, volumes should be modest (less then, say, some hundreds). Further, in view of the residence function, speeds should be rather low (less then, say, 60 $km.h^{-1}$). Discrepancies, if any, should be removed by adjustment of traffic characteristics. CROW (1989) suggests measures for implementation of these adjustments.

The regional scale and the network approach form fundamental differences with the traditional way of planning. This also holds for the leading role of the road function, resulting in an adjustment of traffic characteristics instead of the road characteristics if discrepancies appear. However, the road users insufficiently adapt their behaviour (traffic characteristics, such as speed) to the road functions. Therefore, a clarification of the functional classification for minor rural roads for road users (especially car drivers) needs further research. The concept of a durable safe road network brings a strong impulsion into this discussion (Jaarsma, 1997).

A Durable Safe (DS) Road Network

To a large extent, the decrease of traffic unsafety during the last decades in most western European countries is attributable to a systematic improvement of the so-called black spots in the road network. In the long term, such a curative approach becomes less efficient. To tackle the recent increasing number of fatalities, a preventive approach is needed. With the concept of "Sustainable safe road traffic" Koornstra *et al.* (1992) introduced such an approach. This concept describes a "Durable Safe" (DS) traffic system. Instead of the car, the human being with all his constraints is the starting-point of DS. DS consists of three components: traffic participants, vehicles and infrastructure. For the infrastructure, DS suggests a classification of the complete road network in only three categories. This classification is based on three traffic functions: (1) a flow function, for a fast and comfortable service for through traffic on long distances; (2) a regional access function (opening-up of regions); and (3) a local access function (accessibility of destinations). Minor rural roads will have the third function: access on the local level.

The technical layout of the roads in the DS concept depends on the function assigned, by which an optimal safety is guaranteed. Key is the systematic and consequent application of three safety principles: (1) to prevent for unintended use; (2) to guard against large differences in speeds, direction and mass for situations with modest or high speeds; and (3) to promote the predictability of road path and traffic behaviour (Wegman, 1997). For minor rural roads, these safety principles lead to: (1) prevention for through traffic and rat run traffic; (2) enforcement of low speeds, of, say, 40 $km.h^{-1}$ at maximum; and (3) standardization of layout, as much as possible. Low speeds on minor rural roads are necessary in the DS concept, due to the presence of slow vehicles, traffic in two directions and a mix of light and heavy vehicles. For cars, a halving of the present legal limit is pursued!

The acceptability of low speed levels, both from the viewpoint of driver psychology and regional accessibility, strongly depends on its duration. Koornstra *et al.* (1992) propose a maximum trip duration of three minutes on roads with a low speed limit. By this, realization of the DS principles depends on the mesh sizes of the regional and local access roads. The larger the area to open-up with local access roads, the larger the travel time. This argues for small regions opened-up by local access roads. On the other hand, such a small region needs a high density of roads with a regional access function. This is an expensive solution, which needs much space. Therefore, we expect large regions with only access roads on the local level. This forces another problem. The larger the region with local access roads only, the larger the volumes. However, larger volumes need wider roads. For that reason, pavement width of present minor roads varies considerably: between 2.5 and 5.5 metres (Jaarsma, 1991). This conflicts with the DS aim of standardization. In other words: the technical layout of minor rural roads cannot be similar. A modest type of minor rural roads seems realistic for small volumes only. Where higher volumes with region bound traffic occur, pavement width cannot be too modest. For the moment, it is not clear how the required low speed levels can be enforced.

We conclude, that the implementation of the DS concept on minor rural roads needs further investigation for the functional classification within the network and the technical layout belonging to it. This also holds for the acceptable travel time with a low speed limit. Further, it should be concluded that the DS concept only considers traffic unsafety, and not the other traffic disbenefits. Nevertheless, the approach of the durable safe road network has given new impulses to the principles of network planning, as presented in the previous Section. Principles of both the network and the DS approach are included within the concept of the Traffic Calmed Rural Area (Jaarsma and Van Langevelde, 1996; Jaarsma, 1997). The TCRA concept also considers the mitigation of other traffic disbenefits. It is elaborated in the next Chapter.

THE SPATIAL CONCEPT OF THE TRAFFIC CALMED RURAL AREA (TCRA)

So far, the assignment of road functions is implicitly or explicitly based on appearing or planned traffic flows. Starting point is a less or more stressed traffic function for each link. In built-up areas, this idea was left with the introduction of residential areas. There, the approach of traffic calming started, with speed reduction. Traffic calming became a wider idea, with the Dutch concept 'woonerf' in the 1970s, followed by the German 'Verkehrsberuhigung' in the 1980s (Macpherson, 1993). The basic principle is an integration of traffic in residential areas, but based on priority to the needs of *people*, not the needs of *traffic*. In the residential space, traffic is unavoidable, but it should be subsidiary to other spatial functions. Traffic flows are concentrated onto distributor roads, able to cope with it.

The concept of a Traffic Calmed Rural Area (TCRA) transfers these wider ideas on traffic calming from built-up areas to the rural area. Starting-point should be the *desired spatial function* of the rural area, not the *appearing traffic flows*. Besides the needs of people, the needs of nature are considered. Usually, the *residence functions* (for inhabitants and recreationists, but also for local fauna) will be stressed, not the *flow function* for through traffic. So, within the region roads will mainly have an access function, with a belonging (modest) technical layout. The region is surrounded and accessible by rural highways, with a flow function.

The underlying idea of the TCRA is a clear separation of space for living and staying and space for traffic flows (Jaarsma and Van Langevelde, 1996; Jaarsma, 1997). Although this underlying idea is the same in rural and built-up areas, large differences occur in desired traffic characteristics and in measures to realise these. In the TCRA, traffic speeds should be modest, say, 40 to 60 $km.h^{-1}$. However, it is not desirable for a rural bound driver to drive too long on these roads. Therefore a second type, with somewhat higher technical standards and speeds of, say, 60 to 80 $km.h^{-1}$ is planned. Only this second type of minor rural road is connected with the major road network.

The concept of the TCRA results in a reorganisation of traffic flows. Diffuse volumes at the minor rural roads will be concentrated at a few trunk roads. Remaining traffic flows at minor rural roads are rural bound (origin and/or destination along a minor road). Further, volumes and speeds within the region will decrease. It is expected, that such a reorganisation will counter both traffic unsafety and habitat fragmentation within the region (Jaarsma and Van Langevelde, 1996).

APPLICATIONS OF THE TRCA: TWO REGIONS IN BRIEF

In this Chapter, the results of two applications of the TCRA concept will be discussed. First, the Ooststellingwerf region, a rural area with safety problems by rat run traffic, will be indicated (Jaarsma *et al.*, 1995). The second example is from the coastal region of the western part of Zealand-Flanders. There, conflicts arise between outdoor recreation, nature and agriculture (Jaarsma and Baltjes, 1995; Jaarsma and Van Langevelde, 1997).

To apply the concept of the TCRA, next five steps are completed.

(1) Define the study area, taking into account the national and regional major road networks and both natural and administrative boundaries.

(2) Define the road network and its function for both the present situation and the so-called autonomous development (AD). In this way, independent developments such as road reconstructions outside the study area, new residential areas etc., are included. The AD is the reference for the impacts, to be calculated in step (5).

(3) Calculate the traffic flows on the network in the AD and determine the road links with discrepancies between road function, design and use (Figure 2) and/or other problems, such as traffic unsafety (black spots) or conflicts with the ecological network.

(4) Determine an alternative road network, with adapted speeds and technical design, aiming at concentration of present diffuse flows on minor rural roads on a few trunk roads. Next, calculate traffic volumes and travel times per road link for this network.

(5) Based on the new traffic volumes, calculate the impacts of the alternative network on accessibility, traffic performance, safety and liveable surroundings for people and fauna. These impacts are compared to the AD.

Both steps four and five may be repeated for other variants of the network, when one wants to compare more alternatives and/or when the calculated flows or their impacts insufficiently solve the problems determined in step 3.

Finally, road authorities must decide to implement the technical measures belonging to the final variant. It is advised to monitor the changing traffic flows in the region during, say, five years, in order to check the concentration of diffuse flows at trunk roads aimed at.

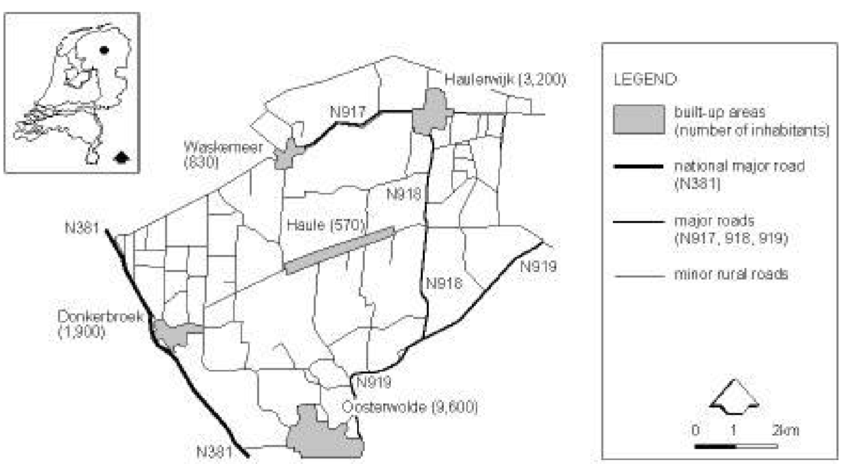

Figure 3. Road network and built-up areas in the Ooststellingwerf region (Jaarsma *et al.*, 1995)

The study area in Ooststellingwerf (2) is about 80 km^2. It is situated between small towns and villages and a small, long stretched village in the centre of the study area. The rural area is mainly grassland, with some small, forested zones. However, the area is important as a corridor zone, both wet and dry, in the National Ecological Network. The N381, a rural highway west of Oosterwolde and Donkerbroek, connects the study area with the national network of motorways. The southern boundary is the N919, a smaller highway connecting Oosterwolde with the eastern part of the Netherlands. Further major roads in the study area are between Oosterwolde and Haulerwijk (N918) and the connection between Haulerwijk and the N381, via Waskemeer (N917) and the Leidijk. However, the actual categorisation of the road network is not so clear. The technical standard of the major roads is remarkable low, where several minor roads have a high technical standard. The latest is the result of a policy for decades, of frequently adapting the actual road layout to the needs of appearing traffic. As a result, traffic flows in the study area are very diffuse. Residents complain of high speeds and rat run traffic; safety figures are unfavourable (Jaarsma *et al.*, 1995).

The TCRA is applied for the rural area between the major roads mentioned before. The proposed speed for the major roads is 80 $km.h^{-1}$ (the legal limit). A 60 $km.h^{-1}$ speed is the starting-point for the minor rural roads.

Accessibility is quantified as the part of the road network, fit to be travelled within several minutes from a built-up area. Jaarsma *et al.* (1995) conclude that the concept of TCRA hardly diminishes the accessibility of the area. It should be considered, however, that distances within this TCRA are modest, about ten kilometres in a beeline at maximum. Therefore, travel times are also modest. Of course, the scale of the TCRA should not be too large.

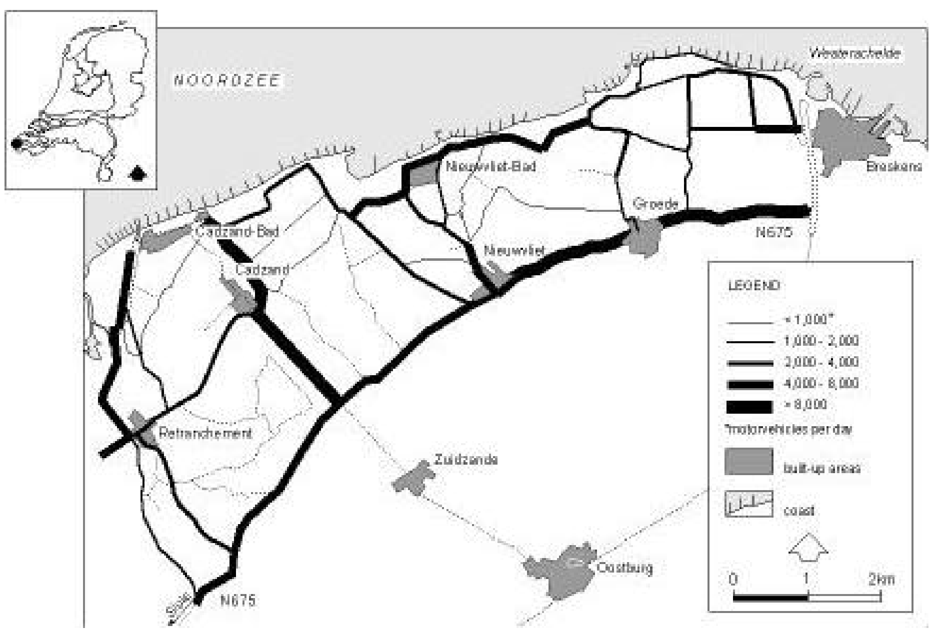

Figure 4. Traffic volumes, as calculated for the autonomous development in coastal Zealand Flanders (Jaarsma and Baltjes, 1995)

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Regarding traffic flows, the differences between the autonomous and the planned situation are quite clear. In the autonomous development, diffuse flows will continue and grow some ten per cent. In the TCRA, the N919 serves most heavy flows, now crossing the area (from Donkerbroek via Haule eastward v.v., but also from Waskemeer via Haule eastward v.v.). The number of daily vehicle kilometres in the TCRA is about 15 per cent lower than in the autonomous development. The kilometrage on minor roads in the TCRA is only 43 per cent, whereas the major roads have an increase of 20 per cent (Jaarsma *et al.*, 1995).

The impacts on unsafety are calculated by a combination of vehicle kilometrage and accident rates per type of road. The yearly number of injuries will rise from 51 now to 54 in the autonomous development; in the TCRA the number will decline with 20 per cent to 43. A comparable decline, on a much lower absolute level (2 to 3), is calculated for the number of traffic kills (Jaarsma *et al.*, 1995).

The concept of the TCRA is also in favour for decreasing the barriers by the presence of roads and its traffic (Van Langevelde and Jaarsma, 1997). For three roads indicated as bottlenecks in the Ooststellingwerf corridor zones they found a considerable volume decrease. So, a smaller pavement width will satisfy. As a result, traversability for the roe deer will improve with 40 to 95 per cents in relation to the autonomous development. For the major rural highway, the N381, differences are modest.

In Zealand Flanders traffic problems are quite different from those in the Ooststellingwerf region. Here, diffuse flows of motorized recreational traffic on minor roads alongside the coastal dunes frustrate both recreational and nature developments in the coastal zone (2). As a solution to this problem, a lobate structure is suggested. The opening-up is coordinated with this principle by means of a so-called "slagen" structure, *i.e.*, connections between the provincial major road (N675) and the beaches. These "slagen" are ending in a blind alley at the coast. Jaarsma and Baltjes (1995) investigate two to five alternative locations for the "slagen," connecting the four villages (Breskens/Groede, Nieuwvliet, Cadzand and Retranchement) with the coast. They calculate traffic volumes and their impacts for these alternative network solutions (Table 1). In comparison with the so-called autonomous development in 2, most of the alternatives produce more motor vehicle kilometres. However, by the concentration of traffic on the restricted number of "slagen," remaining minor rural roads will have only modest volumes. This favours the opportunities for alternative modes, for example recreational biking.

With a "slagen" structure, traffic performance within the lobates decreases. Traffic flows on the major road (N675) increase. Differences between the alternatives are considerable. An overall reduction of traffic performance of six per cent is possible. However, several alternatives include an increase of performance, up to 60%! Travel times along minor rural roads increase, because of lower speeds and the closure of the direct connection along the coast.

The impacts on habitat fragmentation are not defined directly in the study. Both, traffic noise and traversability are calculated for residential built-up areas only. Alternatives with low traffic volumes on minor rural roads near areas reserved for nature and/or nature development are considered to be favourable. Especially for the Nieuwvliet and Retranchement beaches, large differences between the alternatives appear for this aspect.

Table 1. Effects for alternative locations (A...E) for the "slagen" connecting the four villages with the coast (Jaarsma and Van Langevelde, 1997)[§]

"Slagen" to / Effects on	Autonomous development	A	B	C	D	E
		Alternative				
Breskens/Groede						
Performance[1)]	100	119	134	162	154	
Safety[2)]	0.40	0.10	0.11	0.13	0.12	
Accessibility[3)4)]		4	3	1	2	
Road capacity[5)]	14.5	0.8	0.8	2.9	3.1	
Traffic noise[6)]				no differences		
Nature development[3)]		2	2	2	2	
Nieuwvliet						
Performance[1)]	100	95	78	80	82	84
Safety[2)]	0.42	0.09	0.08	0.08	0.08	0.09
Accessibility[3)4)]		1	3	5	2	4
Road capacity[5)]	13.5	4.6	1.5	0.9	3.0	0.9
Traffic noise[6)]		-3	+3	+2	-3	-3
Nature development[3)]		1	5	3	5	3
Cadzand						
Performance[1)]	100	103	103			
Safety[2)]	0.34	0.12	0.07			
Accessibility[3)4)]		2	4			
Road capacity[5)]	9.3	5.0	1.4			
Traffic noise[6)]		-1	+1			
Nature development[3)]		4	4			
Retranchement						
Performance[1)]	100	100	100	137	142	
Safety[2)]	0.35	0.09	0.09	0.10	0.10	
Accessibility[3)4)]		4	2	4	2	
Road capacity[5)]	10.8	5.3	6.1	3.1	3.1	
Traffic noise[6)]		-3	+2	-6	+3	
Nature development[3)]		1	2	3	4	

1) In percentages; autonomous development = 100
2) Number of traffic kills (based on accident rates per type of road)
3) Relative, 1 = worst and 4 (or 5) = best solution
4) Travel time to the beaches and to the major camping sites
5) Road length (kilometres) where calculated traffic volumes exceed road capacity
6) Difference in noise level (dB(A)) for selected road links

§ Data elaborated from Jaarsma and Baltjes (1995)

CONCLUSIONS AND FINAL REMARK

A rural road network is a walking contradiction. The presence of a well-developed road network in a region is a *conditio sine qua non* for economic development and an efficient use of land resources. Accessibility of rural areas is also a social aim. But at once the presence of the road network and its traffic flows have harmful effects. Emissions and noise affect local people, flora and fauna. Last, but not least, there is the problem of traffic unsafety (Jaarsma, 1997).

To find the right balance between maximizing accessibility and opening-up on one hand and minimizing traffic unsafety, noise and pollution as well as habitat fragmentation for the fauna, the concept of Traffic Calmed Rural Areas is developed. This concept provides a spatial organisation principle. It will result in a reorganisation of traffic flows: concentration of present diffuse flows on minor rural roads at a few rural highways and a decrease of volumes and speeds within the region. In the Ooststellingwerf region, the kilometrage on minor roads in the TCRA is only 43 per cent of the kilometrage in autonomous development, whereas the major roads have an increase with 20 per cent. As a result, the number of traffic injuries will decline with 20 per cent. On minor roads, traversability for the roe deer will improve with 40 to 95 per cents. Given the acreage of the study area, the "price" for these improvements is modest. Only a slight decline of accessibility appears: travel times for trips crossing all the area (covering about ten kilometres) increase with about one minute.

The approach of a Traffic Calmed Rural Area holds a fundamental change in rural transportation planning: from *following* actual traffic flows to *regulation* of it. Its application creates bridges between contrary demands to rural road networks within a sustainable land use planning.

REFERENCES

[1] CROW. 1989. *Verkeersmaatregelen in het buitengebied (Traffic measures in rural areas.)* Mededeling 21, Ede, Netherlands. (In Dutch).

[2] Jaarsma, C.F. 1991. *Categories of rural roads in The Netherlands: functions, traffic characteristics and impacts. Some problems and solutions.* In Proc. XIXth World Road Congress, PIARC-publication 19.52E: 101-103. Marrakech, Morocco, 22-28 September.

[3] Jaarsma, C.F. 1994. *Rural low-traffic roads (LTRs): the challenge for improvement of traffic safety for all road users.* In Proc. 27th ISATA, dedicated Conference on Road and Vehicle Safety, 177-183. Aachen, Germany, 31 October 31 - 4 November.

[4] Jaarsma, C.F. 1997. *Approaches for the planning of rural road networks according to sustainable land use planning.* Landscape and Urban Planning 39 (1):47-54.

[5] Jaarsma, C.F. and C.R. Baltjes. 1995. *Herinrichting Kust West Zeeuwsch-Vlaanderen: ontsluiting onder de loep. Eindrapport: varianten voor een ontsluitingsstructuur met verkeersprognose en effectbepaling. (Reconstruction of the coastal region West Zealand Flanders: accessibility scrutinized).* Nota vakgroep Ruimtelijke Planvorming 59, Wageningen, Netherlands. (in Dutch).

[6] Jaarsma, C.F. and F. van Langevelde. 1996. *The motor vehicle and the environment: balancing between accessibility and habitat fragmentation.* In Proc. 29th ISATA, dedicated Conference on the Motor Vehicle and the Environment, 299-306. Florence, Italy, 3-6 June.

[7] Jaarsma, C.F. and F. van Langevelde. 1997. *Right-of-way Management and habitat fragmentation: an integral approach with the spatial concept of the Traffic Calmed Rural Area.* In Proc. 6th International Symposium Environmental Concerns in Rights-of-way

Management, 383-392. New Orleans (LA), 24-26 February.
[8] Jaarsma, C.F., J.O.K. Luimstra and T.J. de Wit. 1995. *De kortste weg naar een verkeersleef-baar platteland. Onderzoek ruraal verblijfsgebied Ooststellingwerf. (The shortest path to a liveable rural area. A traffic and transportation plan for a residential rural area in Ooststellingwerf.)* Nota vakgroep Ruimtelijke Planvorming 58, Wageningen, Netherlands. (In Dutch).
[9] Koornstra, M.J., M.P.M. Mathijsse and J.A.G. Mulder. 1992. *Naar een duurzaam veilig wegverkeer: nationale verkeersveiligheid voor de jaren 1990 - 2010. (Towards a sustainable safe road traffic: national traffic safety for the period 1990-2010).* SWOV, Leidschendam, Netherlands. (In Dutch).
[10] Macpherson, G. 1993. *Highway and transportation engineering and planning.* Harlow, UK: Longman.
[11] OECD. 1986. *Economic design of low-traffic roads.* Paris, France.
[12] Van Langevelde, F. and C.F. Jaarsma. 1997. *Habitat fragmentation, the role of minor rural roads and their traversability.* In Proc. international conference Habitat Fragmentation, infrastructure and the role of ecological engineering, 171-182. Maastricht/The Hague, Netherlands, 17-21 September 1995.
[13] Van Lier, H.N. 1994. *Land use planning in perspective of sustainability: an introduction.* In Proc. International Workshop, 1-11. Wageningen, Netherlands, 1992, 2-4 September.
[14] Wegman, F. 1997. *The concept of a sustainably safe road traffic system.* SWOV report D-97-2, Leidschendam, Netherlands.