LEAF LITTER AND TRAFFIC SAFETY

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Background and key problems

Leaves from trees, but also the inflorescence and seeds may be a nuisance for people or may give rise to unsafe of the road for traffic. Although there is not known so much about the quantitative contribution of leaf litter to the safety of the road and with that the number of accidents, it hardly needs an argument that a blanket of fallen leaves will decrease the "grip" for the tyres of vehicles.

Most tree species loose their leaves during autumn, usually during a short period of time, and many municipal cleansing departments or urban green departments are logistically prepared for the annual job of getting rid of the fallen leaves before they bring about an unacceptable mess. If, when and to what extent such a mess will develop will depend on local weather conditions and other specific local situations such as the towns green structure. During thunderstorms large amounts of leaves may come down during a rather short period. When wet, this may adhere to the road surface from which it is not easily removed with the usual blowing equipment, once it is flattened out by vehicles riding over it. A relative advantage is that usually on busy traffic road the leaves and also the smeared out leaves on the road surface will be blown aside whining a relative short time because of the traffic action itself. It also must be noted that in many cases trees along this type of roads are planted on a larger distance form the driveway so that proportionally less amount of leaves will fall directly on the road surface. However it is reported sometimes by road maintenance services that it may endanger the safety of the side strips when the slurry of leaves is pressed into the space between the stony particles of the asphalt pavement from where it is difficult to remove (there no cleaning action from the wheel of vehicles) and may serve as some kind of growing substrate for weeds that develop which on its turn will have an advere effect on the traffic safety of the side strips.

On smaller streets, where trees have hanging their branches also hanging above the driveway, this will be different also because the traffic generally is driving slower and there is less influence of its action itself. It has been suggested that especially on this locations accidents may occur in which a relative high number of bicycles, scooters and motorbikes are involved.

A case on its own are the railroads and tramways. Fallen leaves that adhere to the rail surface causes that wheels slip when the vehicle is braking or speeding up. This results in unevenness in the wheels rounding and extra (expensive) repair costs.
Besides that, some metro trains are equipped with an automatic speed control system that comes into action when the electric contact of the wheels with the metal rails is interrupted. As a consequence the speed of the train is limited to walking speed.
The latter occurs frequently during autumn and can be ascribed to tree leaves that are pressed to some kind of dry film of organic material and iron rust on top of the rail. The link up of these events at times may disturb daily passenger to a great extent.

Actions and results

Actions to be taken are mainly, if not exclusively tree based strategies. Which are selection of tree species and designing aspects of the urban green. The nature of litter, i.e. seeds and

inflorescence often can be controlled by a conscious choice of tree. If fruiting is a problem for traffic safety (e.g. the acorns of certain oaks -*Quercus spp* -) it is better to choose for trees that for example have catkins (e.g. White willow -*Salix alba* -, Poplar - *Populus spp*.-). If blossoming is desired, but fruits not, a (restricted) number of cultivars can be used that have sterile flowers, such as the cv. Baumannii of the Horse chestnut (*Aesculus hippocastanum*). For that mater litter from petioles will have generally not so much influence on traffic safety as, apart form a few exceptions, the abundant flowering trees usually are small or medium sized trees and with that the amount of litter is proportionally low and also its horizontal dispersion.

Falling of leaves (or needles) however is more difficult to manipulate as the presence and regular fall of leaves on trees is an established fact for all deciduous trees (and even for evergreens although the period of shedding of part of their foliage may not correspond with those of deciduous trees). The amount of leaf litter that "hits" the road can be controlled by taking into account the tree size including its total leaf mass when designing the road profile in its entirety and coherence.

Initially one may think of the distance to the road with respect to final tree height, from the point of view that the higher the tree will grow the more leaves will fall and the larger will be the dispersion area thereof. But it also my be considered to reduce the number of trees by enlarging planting distance or even planting trees as clusters so that the source of "pollution" is concentrated to a relatively small area and removing the litter will assumingly take less time.

Along circular roads or entrance roads that have sufficient space in the verges a planting structure may be established in which the higher trees are standing at the greatest distance from the road and the smaller trees inclusive the shrubs at shorter distance. This design has the additional advantage that much of the leaves are "caught" by the plantation itself and that relatively less will be blown elsewhere. Besides it also may stay within the planting to further contribute to the natural mineral recycle which brings down the need to clear it away.

If the width of the road profile allows a structure of hedges this may reduce the amount of leaves that are blown away from the trees over a large distance once they have fallen to the ground. It even may be possible to construct some kind of natural collection points by doing so, but there is not yet much practical experience with the application of hedges for this specific purpose to give any directives for the design.

When regarding the total leaf mass account, it may be interesting for the urban green planner to know that there are substantial differences between tree species of the same crown volume. Commonly the amount of foliage is expressed as Leaf Area Index (LAI) which is the total ratio between total leaf area and the crown projection of the tree As a rule of thumb, an "average' solitary, non columnar or fastigiate tree will have a LAI of about 4 to 5 and a fresh weight of the leaves of about 150 to 200 g/m2 leaf surface. For a tree with a crown projection of 100 m2, the total weight of the freshly fallen foliage will be somewhere between 60 and 100 kg per tree.
But taking the differences between trees into account, there are both substantial differences in both the LAI and (sometimes) also weight of leaf mass. For instance, an adult Common maple (*Acer pseudoplatanus*) and Norway maple (*Acer platanoides*) at the age of about 70 years both have a comparable crown volume (ca. 1200 - 1400 m3), but a total leaf surface of respectively 400 and 1100 m2. Corrected for leaf weigth of resp. 160 and 150 g/m2 (this is

not so much different in this case), this results in total leaf weights of respectively 64 and 165 kg per single tree. These are “attractive’ differences to be considered when setting up planting designs in locations where presence of abundant leaf litter is less desired or someway has to be limited.

As far as railway traffic is concerned, besides tree based strategies there are also some technical solutions to prevent or overcome nuisance. Often most of the trouble occurs after nights when the first trains ride out. During the day most of the freshly fallen leaves usually are blown away from by the passing trains and the rails will stay rather clean. In this case the first trains sometimes are preceded by a heavy locomotive that crushes and pushes away any leaf debris including films of iron rust that has formed overnight from the top of the rails. When this method has too little effect, special wagons can be put in operation with broom like devices in front of the wheels sometime in combination with a device that sprays a roughening agent (e.g. Sandite) on top of the rails. So, from a technical point of view the problem can be controlled to some extent, and its impact on traffic safety can be brought down to an acceptable level although it needs no further elucidation that also extra maintenance costs are involved, although it must be emphasized that also without the presence of leaf litter rails may become slippery because of rust formation and therefor have to be maintained anyhow.

Preventing of weed development on side strips of motroways, promoted by leaf litter, is still a subject to be studied further as the possibilities for using chemicals (apart form deicing salt, of which summer application may be effective) are restricted nowadays in many European countries.

Influence of some biotic and abiotic factors on leaf fall

Mostly leaf fall is regarded, and also accepted as a common and natural phenomenon, provide that it will be restricted to the autumn period, as cleansing departments take this into account in their organization of usual annual activities.
It may happen however that substantial leaf fall already occurs during (early) summer and thus may give rise to unsafe traffic situation at unusual (and unexpected) times.
The reasons for premature leaf fall can be a prolonged period of drought, but also attacks by some pests and diseases. Examples are: Leaf blotch of Plane tree (Platanus x acerifolia) caused by the fungus *Apiognomonia errabunda*; Leaf blotch of Horse chestnut (*Aesculus hippocastanum),* caused by the fungus *Guignardia aesculi*; Rust or Leaf spickle disease of Poplar (*Populus spp*.), caused by respectively the fungi *Melampsora spp*. and *Marssonina spp.*, but also insects like the Horse chestnut leaf miner (*Cameraria ohridella*). This may be a reason tot take also the sensitiveness of the tree to these type of ‘persistent’ diseases into account when defining and choosing tree species on locations where premature leaf fall might be a problem or a nuisance.

Apart from premature leaf fall some pests can give rise to nuisance by for instance excretion of honey dew by leaf aphids. This is a sticky substance that under specific conditions also may adversely affect the roughness of the road surface. Although this only might happen in extreme occasions it may be a type of nuisance that could be taken into account when selecting the right tree for the right place. In this way for example, most Lime species (*Tilia spp*.) are not to be preferred to use as a shade tree on parking lots because of their annual infestation by the leaf aphid *Eucallipterus tiliae*. But fortunately there are enough other tree species with comparable characteristics and markedly less honeydew that can be used instead.

Conclusion

Unsafe traffic situations because of leaf litter will be mainly restricted to locations where masses of fallen leaves can concentrate (e.g. by wind turbulence) or where fallen leaves are converted to a kind of slippery porridge before it is cleared away by road maintenance services. If and to what extent these situations will occur will depend on the duration of leaf fall: when all leaves come down within a very short period of time the nuisance will be more, but the duration of the time that traffic unsafe situations might occur will be shorter.

Of coarse the way the road cleansing department is accustomed and equipped to handle these situations will play an important role. By taking the above mentioned aspects into account when planning the spatial structure of the urban green, a number of potential problems with leaf litter may be prevented or overcome.

Table 1: Indicative fresh weight of total foliage of some urban trees at crown volumes of 1000 m3. (Source: Vreštiak, 1991)

Tree species	**Total fresh weight (kg)**
A campestre	45
A. negundo	65
A. platanoides	150
A. pseudoplatanus	90
A. saccharinum	115
Aesculus hippocastanum	325
Ailanthus altissima	65
Betula verrucosa	140
Carpinus betulus	50
Celtis occidentalis	60
Fagus sylvatica	55
Fagus s. 'Atropurpurea'	70
Fraxinus excelsior	90
Gleditsia triacanthos	85
Juglans nigra	125
Pauwlownis tomentosa	200
Platanus x acerifolia	115
Populus nigra	60
Populus simonii	80
Quercus robur	80
Quercus rubra	120
Robinia pseudoacacia	90
Salix alba 'Tristis'	75
Sophora japonica	100
Tilia platanoides	75
Ulmus glabra	80