OPTIMIZATION OF WOOD TRANSPORTATION THROUGH TRUCKS FROM WOOD CUTTING AREAS TO CUSTOM CENTER USING GIS TECHNOLOGIES

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In recent years there has been a significant development of the agrarian sector in Bulgaria and a lasting tendency for the consolidation of agricultural arable lands. The establishment of large arable land masses is made in order to simplify the technological operations in the management of agricultural land. In much of Bulgaria, the agricultural territories completely surround the forest fund. The treatment of Polish roads and the lack of access to forest areas leads to the hindering of any activity in forests - harvesting, icing, keeping, guarding special uses, hunting, etc. After analyzing the freight transport process and optimizing the freight routes, a 25-30% reduction in transport distances has been achieved, with productivity gains. The highest percentage of the transport cycle is at the expense of the movement of the transport machine on agricultural roads.

Object of research

The subject of the study are the STEYR (forwarded trucks) high-throughput trucks, which are widely used in our country for transporting timber from forest areas to consumer centers (Fig. 1). The trucks are all-terrain and all-wheel drive. This allows to overcome significant irregularities in the terrain and allows it to move without difficulty under poor road conditions and in some cases without pavement. When traveling on the national road network, they are moving at a higher speed, which also achieves a high productivity of the transport process.

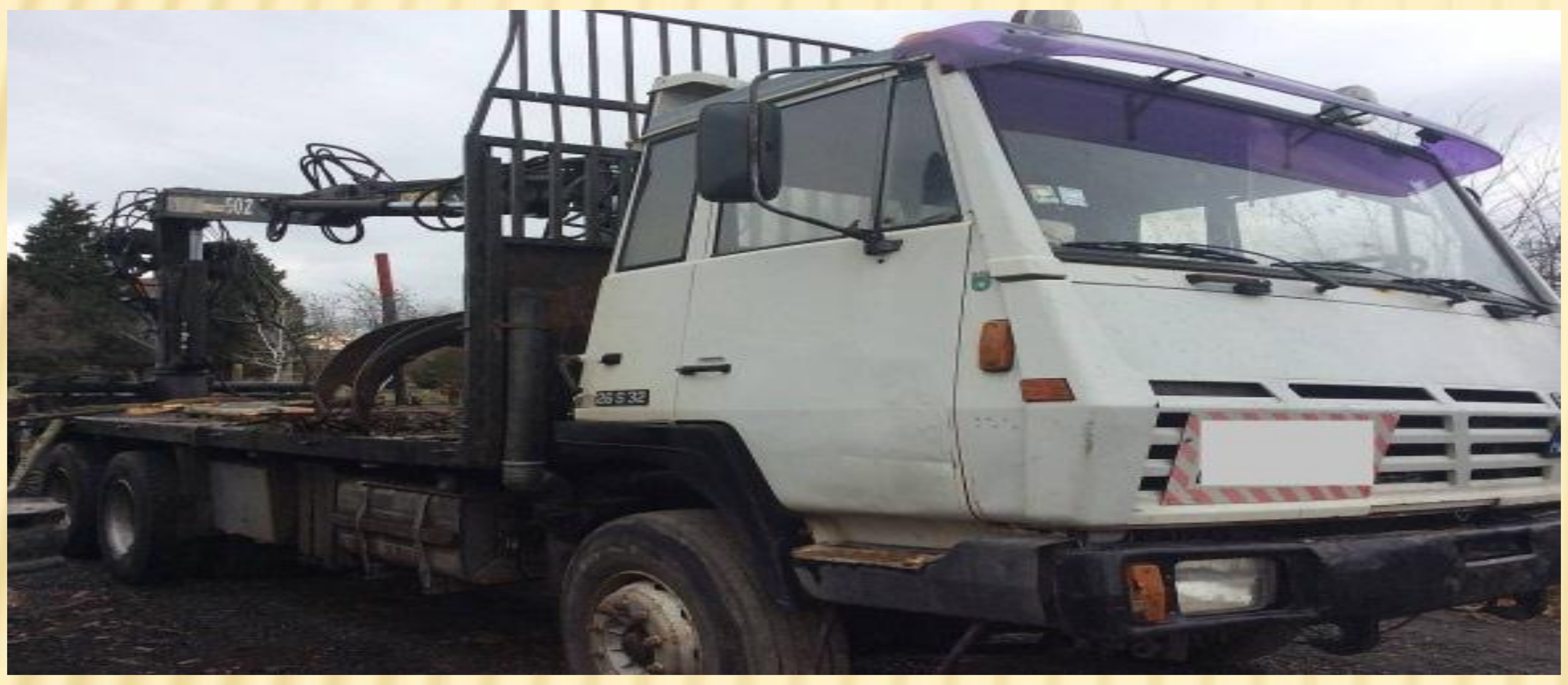

Fig. 1 High Passage Truck

Timber transport routes The transport of timber was emigrated to northeastern Bulgaria, where agriculture is best developed (Fig. 2). Large agricultural blocks require truck traffic to be made around the periphery, and in some cases due to lack of road, even directly on arable farmland

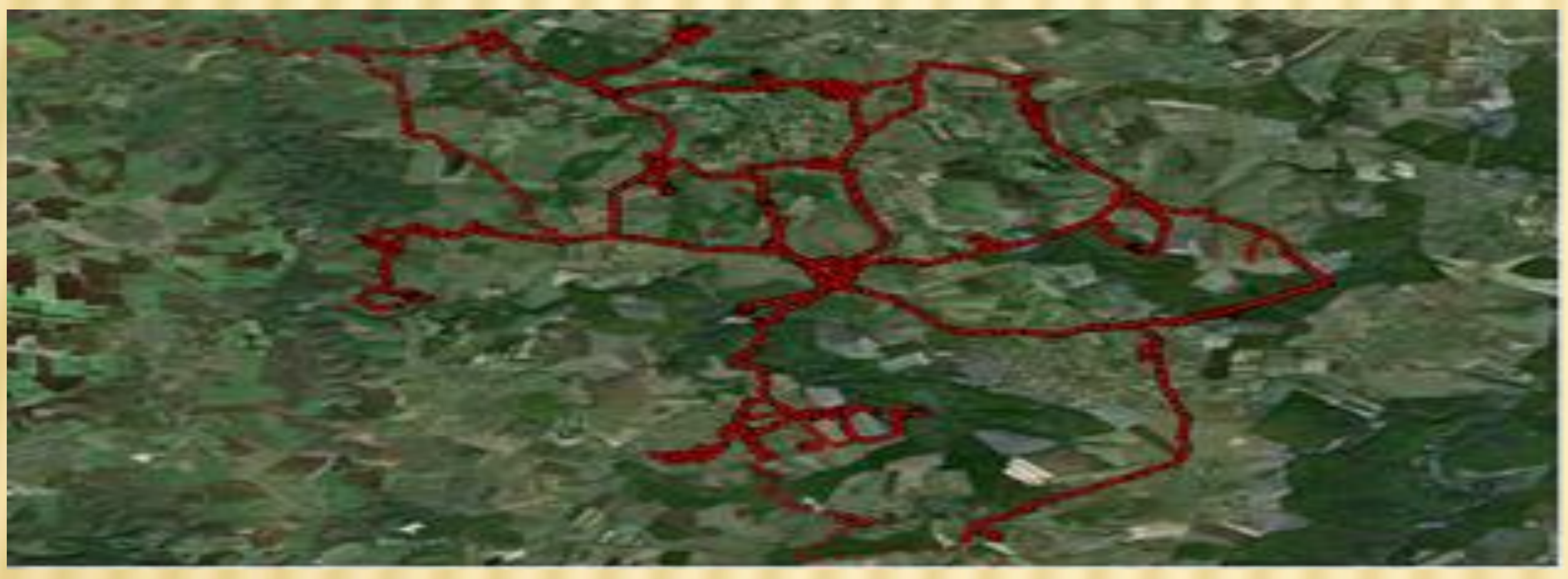

Fig. 2 Timber transport routes

Methodology

The transport process consists of a series of sequential and interconnected operations. For the transportation of timber, the completed cycle (from temporary storage to transfer) of the transport process consists of the following operations:

- Move empty trucks to temporary warehouses;
- Timber loading;
- Moving trucks from temporary warehouses to consumers;
- Timber unloading.

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The complete cycle of the transport process, including: unladen movement (tнт), loading (tтов), loaded moving (tт) and unloading (tразт) is called a course. The time (Tk) for which a course is taken is determined by the formula:

$$T_k = t_{\text{нт}} + t_{\text{т}} + t_{\text{разт}} + t_{\text{тов}}$$

The movement time with and without load must be created and diverted to the carriage and the speed of movement:

$$t_{\text{нт}} = \frac{l_{\text{нт}}}{V_{\text{нт}}} \text{ and } t_{\text{т}} = \frac{l_{\text{т}}}{V_{\text{т}}}$$

Where $l_{\text{нт}}$ и $l_{\text{т}}$ – are respectively the distance traveled without load and with load;

$V_{\text{нт}}$ and $V_{\text{т}}$ – respectively, are the average speeds when unloaded and loaded.

From which it follows that the transport distance significantly affects the duration of the transport process.

The average transport distance also affects the productivity of the transport unit. Also the distance of the truck affects the performance of the trucks. This is also evident from the shift performance formula. As timber truck transport routes involve traffic on different road conditions, we can develop the Shift Performance ($\Pi_{\text{см}}$ m^3.km/см) formula as follows:

$$\Pi_{\text{см}} = \frac{\varphi_{\text{т}}.\varphi_0.\gamma_{\text{дин}}.(T - t_{\text{пз}}).V_{Q\text{ном}}.(l_1 + l_2 + l_3 + l_n)}{l_1 \cdot \frac{v_{\text{т}1} + v_{\text{нт}1}}{v_{\text{т}1}.v_{\text{нт}1}} + l_2 \cdot \frac{v_{\text{т}2} + v_{\text{нт}2}}{v_{\text{т}2}.v_{\text{нт}2}} + l_3 \cdot \frac{v_{\text{т}3} + v_{\text{нт}3}}{v_{\text{т}3}.v_{\text{нт}3}} + l_n \cdot \frac{v_{\text{т}n} + v_{\text{нт}n}}{v_{\text{т}n}.v_{\text{нт}n}} + t_{\text{тов}} + t_{\text{разтв}} + t_{\text{изч}}},$$

When selecting optimization solutions for the choice of transport routes, it is necessary to use the coefficient of difficulty ($K_{\text{т}}$) . It reflects the actual operating conditions of a road, taking into account the greater or lesser difficulties encountered in a given transport route. The purpose of choosing an alternative transport route is to keep $K_{\text{т}}$ with minimum values.

$$K_{\text{т}} = \frac{L_B}{L_{\Pi\Pi}}$$

Where $L_{\Pi\Pi}$ – is the actual length of the road;

L_B- virtual road length

$$L_B = L + \left(\sum \frac{i_k}{W}.l_k\right) - \left(\sum \frac{i_c}{W}.l_c\right) + \left(\sum \varphi.l_{\text{н}}\right) + \left(\sum \varphi.l_{\text{кр}}\right) + \sum l_{\text{др}}$$

Where L is the entire length of the road in question (the actual length of the road);

i_k and i_c– respectively the longitudinal slope of embarkation and descent;

l_k and l_c - respectively the length of the slope of embarkation and descent;

W - 4% - 0,04 - the movement resistance, including the air resistance for ordinary crushed stone in good condition;

φ –- coefficient of resistance of the movement for the pavement in depending on the condition (0,15 - 0,60);

$l_{\text{н}}$ — the length of the road in the appropriate state of the pavement in medium, poor and very poor.

$l_{\text{кр}}$ — length of the curve.