ABSTRACT
A new organization of an area forms a new arrangement of agricultural land, which is closely related to the agricultural production issue, which is handled by higher forms of management. This new arrangement is related to the creation of appropriate technological as well as ecological measures. A plan of public and common measures and facilities is an essential part of land consolidation, especially the communication, water management, anti-erosion and recultivation measures. Ecological precautions themselves mostly constitute landscape formations represented by types of land and permanent greenery. This leads to determination of the ecological land stability coefficient.

KEY WORDS
- land consolidation,
- land units,
- scope of management,
- technological measures,
- ecological measures,
- ecological stability coefficient.

INTRODUCTION
Land consolidation, from its definition, resolves not only the new organization and localization of pieces of land and their ownership, but also resolves optimal and economically profitable agricultural production, the arrangement of agricultural and forest management, and concerns about the ecological situation in the field of land consolidation (Act No. 330/91 Coll.). Besides resolving owners' relationships with land, the goal of land consolidation is to effectively support agricultural and ecological policies. Thus, land consolidation can provide a wide range of options for changing nature as well as the environment.

Land consolidation as a measure affecting agricultural land can:
- support technical measures within agricultural company management,
- resolve communal and neighbor relationships on the basis of land arrangement,
- improve the infrastructure of the environment,
- improve measures leading to environment protection.

Common and public measures and facilities, denoted as technical measures, are resolved by consequential project documentation, which should be a part of a complex solution to a consolidation project. Only a complex solution of a given problem can lead to optimal agricultural or forest production and the lowering of working costs. A solution to ecological problems will lead to a more distinctive and valuable environment for agricultural or forest land. The solution of technical and ecological measures and facilities in a land consolidation project depends mostly on the solution of elementary questions within the scope of the land consolidation (Geisse, E., 2001). These mostly include:
• resolution of the land ownership - through the register of the original state,
• establishing the ecological stability of the area,
• resolution of the land management (actual management of a piece of land, solution to leasing land, sale of the land, etc.),
• resolution of agricultural activity within the scope of land consolidation (management in the form of small farmers, farms, agricultural companies, whether incorporated or limited companies, agricultural cooperatives, etc.),
• resolution of conflicts of interest within the scope of land consolidation.

Thus we try to establish:
1) an economically profitable management of agricultural and forest land,
2) a healthy environment for agricultural and forest land,
3) an optimal infrastructure within the scope of land consolidation.

To establish an appropriate land structure, which will maintain the required land development as well as profitable land management within the scope of the land consolidation, it is necessary to resolve these issues:
1) agricultural or forest production,
2) projection of management areas,
3) resolution of efficient agricultural facilities,
4) establishing appropriate land units for economically profitable management.

On the basis of the resolution of the agricultural and forest resource management through determining the management areas, the resolution of technical measures will be approached through these points:
a) communication measures,
b) water management measures,
c) anti-erosion measures,
d) recultivation measures.

A detailed survey of a given piece of land should be used to establish an appropriate framework of the area from the point of view of the ecology through a project of
• positive landscape-forming element protection,
• establishing newly-planned landscape-forming elements with a positive impact,
• adaptation to the local area system of ecological land stability.

<table>
<thead>
<tr>
<th>Type of economic activity</th>
<th>Land units</th>
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<tbody>
<tr>
<td></td>
<td>Minimal area [ha]</td>
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<tr>
<td>Small farmers</td>
<td>1.0</td>
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<tr>
<td>Farms</td>
<td>10.0</td>
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<tr>
<td>Agricultural companies in flat or moderately hilly country</td>
<td>20.0</td>
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<tr>
<td>Agricultural companies in rolling or hilly country</td>
<td>3.0</td>
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</tbody>
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1. LAND CONSOLIDATION AND AGRICULTURAL PRODUCTION

Agricultural production can be characterized as:
• management in the form of small farmers,
• management in the form of farms,
• management in the form of agricultural companies.

Establishing management areas

One of the requirements of land consolidation is also the creation of efficient agricultural activities for particular production units. To achieve this, it is necessary to plan optimal management areas for particular production unit types. This must consider the fact that the units will not only work on their own land, but also on land that would be leased. To establish strong units from a long-term point of view, with profitable and efficient management, it is necessary to adjust leasehold agreements via legislative means. This should be based on at least 7-12 year leasing expectations to allow production units to invest their finances into land units (melioration, anti-erosion measures, etc.). Another condition is that owned land as well as leased land are resolved together to get areas of land units appropriate from economic as well as microclimatic points of view.

Establishing land units

If a production unit is to manage itself in a successful, profitable and economically beneficial way, it has to work under optimal conditions. Therefore, it is necessary, within the management scope of the production unit, to merge pieces of land with small areas into larger units or blocks, which we call land units.

A land unit is composed of one or several pieces of land designated for economic activity within one production unit. Usually it produces one crop (Geisse, E., 1995). Thus, in one production unit we can group pieces of land which are owned by a farmer together with leased pieces of land. To achieve the maximum possibility of the concentration and minimal fragmentation of the land or land units, determination of their area is dependent mostly on the size of the production unit itself.

Tab. 1 Size of land units
Determination of optimal land unit shapes
According to our experience so far, it is necessary to produce (due to agricultural mechanization, especially from the point of view of efficient use of agricultural technologies) land units in the shape of parallelograms and similar shapes (rectangles, rhomboids, squares, and others). Thus, the determining element of a land unit's area is its length and width.

A very important criterion is the operation of vehicles on arable land where the economic driving distance is 150-300 m; these data concern mostly flat and moderately hilly country. In rolling or hilly country, driving on arable land is dependent on the hydrographic network.

The width of land units in flat country depends on an optimal ratio of length to width. This should not be less than 20 m. In mountainous land, where mostly areal water erosion occurs, the width of the land units is dependent on the tolerable length of the mountain side (Wischmayer-Smith, Alena, et al.). Determination of a land unit's length is dependent mostly on a terrain's morphology and the working distance of the agricultural mechanisms used. The optimal length of a land unit is 1600 m, in extreme cases up to 2000 m.

2. TECHNICAL MEASURES

Communication measures
From the point of view of agricultural transport, it is possible to use transportation on national roads of the II. class with exemptions, the III. and IV. class, local roads and other purpose roads (Geisse, E., 2001). Together with projected roads, it should form an optimal road network.

A road network is projected in the shape of:
• a chessboard (parallel) suitable for flat or moderately hilly land,
• a radial, suitable for valleys or mountains,
• a circle, suitable for rolling land or fairly long slopes,
• a combination of the above.

The accessibility of land has to be resolved in such a way that:
• pieces of land or land units up to 20 ha on plains and 5 ha in hilly terrain would be accessible from one side,
• land units of more than 75 ha have to be projected to provide access from three sides,
• accessibility of permanent grassy area land units has to be projected through unsurfaced driving roads,
• when projecting access roads, their density has to allow access to a field of 300 m with access from one side, a maximum of 500 m on low density soils, 600 m with access from both sides, and a maximum of 1000 m on low density soils,
• the network on a terrain should be resolved in such a way that prevents land units for farms and agricultural companies to be smaller than 3 ha,
• when combining a road with accompanying greenery, it is appropriate to place the road in a shady area.

According to the spatial arrangement and projected elements, the access roads can be classified into two groups:
• access roads with light traffic for small farmers with an expectation of smaller and lighter agricultural vehicles,
• access roads with medium traffic for farms and agricultural companies.

Based on such classifications, we propose these categories for access roads:
• main access roads
• secondary access roads
• accessory roads for light traffic.

Water management measures
The water management aspect of land consolidation resolves the water system within the scope of land consolidation, such as elimination of water erosion from the bottom and retaining and retardation of precipitation outflow where required by morphological and pedological conditions and where melioration measures are projected. Failing to respect the natural properties of a water flow, non-professional intervention in a new land arrangement from the water management point of view may negatively impact the ecological stability of the land and thus result in damages for future owners or users of the land. Concerning the long-term process of nature's adaptation to any new interference, negative impacts will arise later, and its removal may require high financial costs.

The issue of water management in land consolidation concerns these three basic topics:

a) respecting the existing state of water management measures on land where the land consolidation project is being implemented
• determining the boundaries of pieces of land belonging to water streams, boundaries of water-management work areas, and border adjustments; exchanging land units according to the requirements of the water stream administrator (manipulation of areas, access roads, etc.),
• considering hydro melioration facilities to prevent their becoming damaged and giving rise to conditions affecting their proper use after the consolidation,

b) considering projected water-management works which are directly related to agriculture or forest production
• mostly the meaning and urgency of construction which is for the public benefit (consider the requirements for taking up and leaving reserves for land exchanges),
• integration of the land from the water-management point of view into a complex land system of ecological stability (ÚSES),

c) directly linking hydro melioration facilities with the new land arrangement within the scope of land consolidation, including:
• draining and irrigation of the land,
• the location of artificial water pools and ponds,
• consolidation of small water streams,
• forest-technological melioration,
• damming streams and forest units,
• building up protective dikes.

Anti-erosion measures

An important element of organizing land resources is the protection of land against erosion. Land can be threatened by water, wind or ground erosion (landslides). Anti-erosion measures are constructed on land threatened by erosion. In the Slovak Republic, these kinds of water erosion mostly consist of:
• areal water erosion,
• groove erosion,
• stream erosion.

Large areas are also impacted by wind erosion, and to a lesser extent, ground erosion occurs. On pieces of land threatened by erosion, where the average wearing away of soil has been determined and where it is higher than tolerable, anti-erosion measures are conducted. Vegetation coverage lowers erosion activity. The largest amount of wearing away occurs on land with no vegetation. With root crops and maize, erosion drops by one half; cereal crops decrease it by 1/4 - 1/10; and even perennial crops decrease it by 1/200 when compared with arable soil with no vegetation.

Recultivation measures

The main condition for efficient agricultural production is the conservation of highly fertile soil. On soils with good properties this can be achieved by appropriately chosen agro technical measures. Soils with low fertility, for which the measures listed are insufficient, require the application of technical measures, especially water management and anti-erosion recultivating and fertilizing techniques. The goal of recultivating and fertilizing measures is to protect and increase the fertility of agricultural land in a consolidated area so that the full intensification of agricultural production at all levels of management can be achieved. Recultivation is planned for land where the arable conditions comply with the basic criteria for the delimitation of particular categories of arable land, special cultures, permanent grass or forest.

From an economic point of view, recultivation is a very profitable single intervention, which does not require repetition or maintenance if the land is properly cultivated. The aim of a land consolidation project is to classify and mark areas, pieces of land, and land units, which require recultivation measures.

3. ECOLOGICAL MEASURES

Ecological measures within the ambit of a land consolidation project can (Geisse, R., 2001, Oberholzer, 1987):

a) assure the local land system of ecological stability (M-ÚSES), if this has been worked out for the area of land consolidation concerned,
b) through advance planning, improve the local land system's ecological stability if it is specially required by an environmental department after agreement with the land department and departments of agriculture and forestry,
c) develop a land system of ecological stability in a simple way within a project of land consolidation.

Developing the M-ÚSES in a simple way is based on the Regional System of Ecological Stability (R-ÚSES), so that the project of land consolidation aims to respect the proposed landscape elements. Respecting the existing and projected landscape-forming elements (the so-called unregistered permanent greenery) on the land will also create a new situation for the land concerned. After dealing with particular pieces of land and recording the landscape-forming elements, the scope of the land consolidation can be, from the point of view of the ecology, resolved graphically based on an evaluation of the:
• biocenters (areas up to 0.5 ha),
• biocorridors (line elements wider than 10 m),
• interaction elements (line elements 3-10 m wide),
• protective zones (areas preventing soil contamination).

Amenity planting based on cadastre maps

Amenity planting on the land is the first step in determining the impact of landscape-forming elements and determining depressed areas. After a functional survey of the area, the position of unregistered permanent greenery is determined via GPS technologies, and the result is a layer of amenity planting on the land. See Figure 1.

Optimization of the impact of a landscape-forming element

After having calculated the ecological stability coefficients, the impact of landscape-forming elements is determined such that the circumference of each element is aligned at a distance corresponding to the impact.
For every biotechnical element, the value of the biological stability coefficient of the element is determined (KBSP) (Rybářsky, Švehla, Geisse, 1992). The biological stability coefficients of the elements are listed in Table 2.

The positive impact of landscape-forming elements can be determined (Geisse, R., 2003):

For registered permanent greenery by the equation:

\[ D = \frac{100 \ln P}{10 - KBSP} \]

where 
- \( P \) – area of the landscape-forming element [ha],
- \( KBSP \) – biological stability coefficient of the element according to Table 2,
- \( D \) – impact distance of the landscape-forming element [m].

For unregistered permanent greenery by the equation:

\[ D = \left( \frac{10}{PBSP} \right)^{\frac{1}{5}} P \]

where 
- \( P \) – area of the landscape-forming element [sqm],
- \( KBSP \) – biological stability coefficient of the element according to Table 2,
- \( D \) – impact distance of the landscape-forming element [m].

Since the differences among areas of unregistered permanent greenery are small and in some cases concern hedges, the areas of particular elements were determined as follows: length of 100 m, and at widths up to 10 m, the length of 50 m was considered. These values gave rise to the values of the landscape-forming element impact distances in Table 3.

Aligning the values of the landscape-forming element impacts produces the impact areas of landscape-forming elements. See Figure 2.

### Determination of areas with negative impacts

After determining the impact distance of the landscape-forming elements, areas with negative impacts that are not positively influenced by any landscape-forming element or that are unstable are determined. These areas with a negative effect serve to determine the ecological stability coefficient based on the impact distance of the landscape-forming elements. Figure 3 shows areas with a negative effect based on cadastre maps.
Calculation of $KES_6$ ecological stability coefficient

To calculate the $KES_6$ ecological stability coefficient, we use the following formula (Geisse, R., 2003):

$$KES_6 = \frac{P_{NP}}{P_{ZU}} \times 100$$

where $P_{NP}$ – extent of areas with a negative impact [ha],
$P_{ZU}$ – area of land concerned [ha].

Through calculations we obtain the ecological stability levels of the area, see Table 4.

CONCLUSION

Through the complex resolution of land consolidation, we can achieve a new organization of land resources within the scope of land consolidation. Using the land consolidation described here, we can approach the land consolidation methods used in countries of the European Union. Thus, the new land organization will resolve the ownership of particular pieces of land, provide conditions for the optimal operation of agricultural and forest resources, improve living conditions and enhance the esthetic properties of the consolidated land.

REFERENCES

- **GEISSE, E.**: Land Consolidation. ES STU, Bratislava 1995
- **Team of authors**: Plan of public and common measures and facilities in Land Consolidation. (German) BElUF Munich 1987
- **OBERHOLZER, G.**: Another development of a cultural landscape. (German) UdB Munich 2000
- **RYBÁRSKY, I., ŠVEHLA, F., AND GEISSE, E.**: Land Consolidation. (Slovak) ALFA Bratislava 1992