POSSIBILITIES OF WATER RETENTION SOLUTIONS IN SUBURBANIZED AND AGRICULTURAL LANDSCAPE

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Abstract
The most effective adaptation measure is a suitably designed complex land consolidation (CLC) and the realization of the plan of joint facilities (PJF). However, the only problem is the local effect and duration of the whole process. On average, 151 CLC processes are completed per year, which therefore represents the affected area de facto 151 cadastral areas. The total number of cadastral areas in the Czech Republic (CR) is 13072. However, the CLC process does not mean that designed adaptation measures has been realized. According to the Superme audit office's data (SAO), only 8.7% of the proposed adaptation measures were realized until 2015. It is therefore necessary to look for a faster strategy for adapting to current climate change. This paper addresses the possibilities of placing low-cost retention elements in the landscape, which can be quickly implemented in various variants in small and medium-sized areas on land owned by municipalities. A frequent case of these plots are plowed field roads within large blocks of land. These measures must therefore be adapted in size to the available area within these plots. The network of elements created in this way brings, in addition to increasing the retention, evapotranspiration and erosion protection of the area, also other benefits within the framework of territorial system of ecological stability, landscape character, making the landscape accessible through roads and line water retention elements that also provide cultural intangible services in the sense of increasing the recreational potential of the locality.

Key words: land consolidation, retention, landscape accessibility, recreational potential

Introduction

Land consolidation programme in the CR is the most important instrument for landscape management. The sense of land consolidation can be divided into two parts: 1) organization of individual plots ensuring their accessibility and settling property rights, 2) designing of measures for improvement of environmental conditions, soil protection, water management and ecological stability in the frame of so called Plan of joint facilities (PJF) (Podhrázská et al., 2015; Vitikainen, 2004). Undoubtedly, the most effective adaptation measures against erosion and drought is a properly performed complex land consolidation process (CLC) and the realization of PJF. However, the only problem is the local effect and the duration of the whole process. According to SAO inspection of 2015 on average 151 CLC is completed annually. The total number of cadastral areas in the CR is 13,072. However, the finished CLC does not mean that their realization has been completed. According to SAO data, only 8.7% of the proposed PJF were completed until 2015. However, if we consider only hydrological and erosion control measures and measures to protect the environment, only 5.6% of the proposed measures have been realized. According to another SAO inspection of 2020, 68% of the proposed flood control measures approved under the Plans for Flood Risk Management in the Danube, Elbe and Odra River Basins for the period 2015-2021 will not even start realization until 2022. In the period 2010-2018, 87% of all realized flood control measures were a technical. Thus, these data show that naturally close flood protection measures are not being taken in to account and realized, although they can represent a cost-effective reduction of flood risk and at the same time increase the retention and evapotranspiration of the landscape and reduce the risk of extreme drought. From the mentioned statistical data and the current development, it can be assumed that the CLC and realization of the proposed measures will take place for several more decades. It is therefore necessary to look for a faster strategy for adapting to current climate change. The presented contribution proposes a solution in the form of an retention elements in the landscape to support evapotranspiration and a small hydrological cycle with fast realization potential and minimization of property disputes.

Based on the analysis of cadastral maps and archival aerial photographs, we identified a promising possibility of using areas owned by municipalities. The first phase of the solution therefore consists in the application of the adaptation measures in the area of municipal land in the land blocks, which

minimizes property disputes and significantly speeds up the realization of adaptation measures and its positive effects. Emphasis is placed on efficiency, speed of realization and low cost. Part of these measures is also suitable accompanying vegetation, which, thanks to increased retention, will also increase the evapotranspiration of the area and thus also support a small hydrological cycle in the landscape and also other intangible benefits, including the improvement of the recreational potential of the place with the proposed protective, retention and adaptation landscape elements.

Materials and methods

An analysis of the effectiveness of completed CLCs was performed on the basis of documents from the State Land Office (SLO). All completed CLCs in the years 1991 to 2021 were analyzed. It was a total of 2806 CLCs. The analysis focused on several attributes and their development over time - duration, total number of CLCs during the period, ownership fragmentation and number of ownership plots before and after CLC, ownership structure of land used for PJFs, structure of proposed measures and realization percentage of proposed measures.

In order to be able to map potentially suitable areas of municipal land for the realization of the proposed adaptation measures, it was necessary to perform an extensive analysis of digital cadastral maps of the CR. As part of this very time-consuming analysis, polygons of all cadastral territories of the CR were manually downloaded and subsequently land ownership certificates (LOC) were analyzed. After downloading all the data and identifying the ownership certificates of the municipalities in most cadastres, the LOCs were assigned to individual plots using a script. In this way, it was possible to identify municipal land in 12,278 (out of a total of 13,076) cadastral territories of the CR.

Results and discussion

In the first step, an analysis of the effectiveness of CLCs was performed on the basis of data from the SLO. The graph on Fig. 1 shows the trend in the duration of CLCs courses from all evaluated cases, which clearly decreases below 5 years. The average duration for the whole period is 5.74 years with a standard deviation of 5.02 years. According to the graph on Fig. 1, the course of the CLC duration for individual periods is around this average and there is a gradual reduction in the duration to 4 years and also a significant reduction in the standard deviation (SD). It can therefore be expected that in the next period the duration of the CLCs will stabilize and standardize to 4 years for all cadastres.

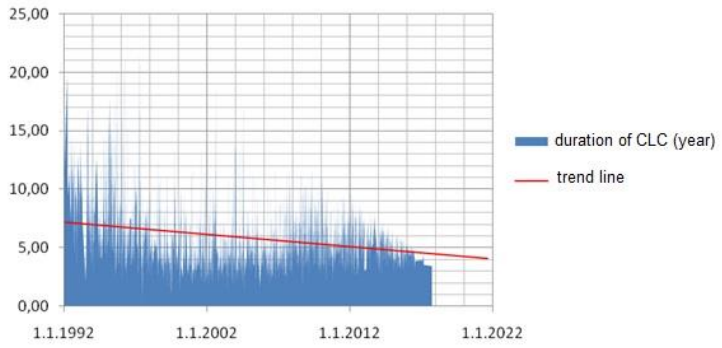

Fig. 1: Average duration of CLCs.

The graph in Fig. 2 shows the culmination in the period 2011 to 2015, when 825 CLCs were started, and the subsequent decline for the period 2016 to 2020, when 110 CLCs less were started.

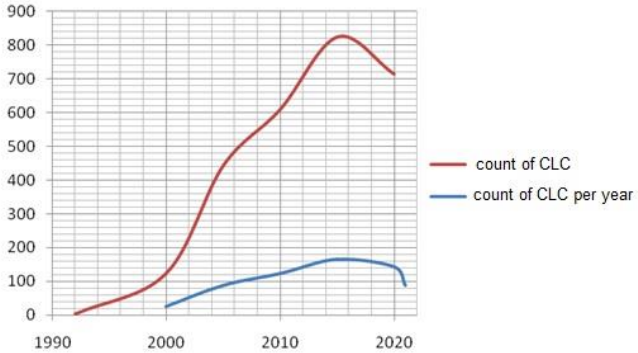

Fig. 2: Number of started CLCs in the monitored 5-year periods.

The analysis of land ownership fragmentation is shown in the graph in Fig. 3. The number of ownership plots before the start of the CLC fluctuates around the average of 1008.56 with a SD of 972.22 during the whole period. In many cases, the number of plots before the CLC can be around two thousand. After the CLC, ownership fragmentation is reduced to an average of 51.75%. The number of ownership plots will therefore be halved. The number of participants in the proceedings averages around 200 with a standard deviation of 220. The ownership structure of the land measured for the PJF is shown in Figure 4.

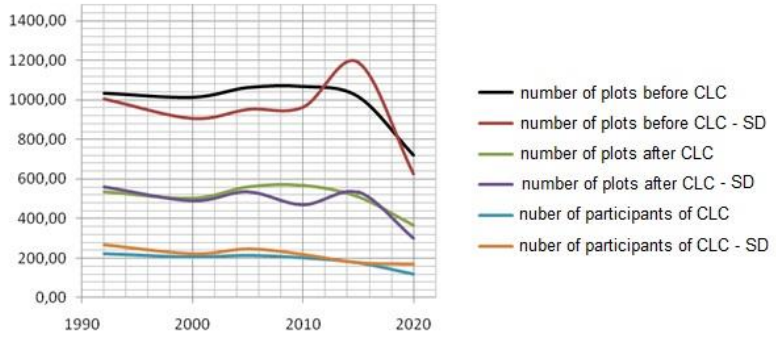

Fig. 3: Analysis of ownership fragmentation before and after CLC.

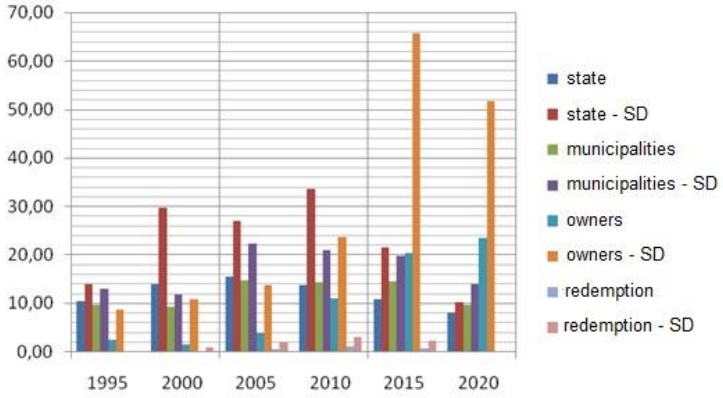

Fig. 4: Analysis of land ownership structure measured for PJF.

Furthermore, the structure of the proposed measures within the PJF (Fig. 5) was analyzed. However, the key problem is the percentage of realizations of the proposed erosion control, ecological and water management measures. This analysis on the graph on Fig. 5 shows that in terms of area, only 16.05% of erosion control measures (ECM), 10.1% of environmental measures (EM) and 40.11% of water management measures (WMM) were realized. It is also important to draw attention to the trend of increasing proposed areas for individual categories of measures and the constantly declining percentage of realizations, with the exception of WMM, where the percentage of realizations for proposals submitted in 2011-2015 increased significantly. In the period 1991 - 2005, an average of 5.87 ha of ECM, 13.66 ha of EM and 2.27 ha of WMM were proposed for each CLC, of which only 18.53% ECM, 11.9% EM and 30.98% WMM was realized. In the period 2006 - 2020, an average of 11.18 ha of ECM, 17.29 ha of EM and 2.29 ha of WMM were proposed for each CLC, of which on average only 6.06% ECM, 3.54% EM and 24.74% WMM were realized. The percentage of realizations of individual types of proposed measures and their development since 1991 is shown on the graph in Fig. 6. Since 2010, the data are incomplete or missing. According to this analysis, it is clear that the CLC cannot respond effectively to ongoing climate change.

It is therefore necessary to look for a faster strategy for adapting to current climate change. The presented contribution proposes a solution in the form of low-cost retention elements in the landscape to support evapotranspiration and a small hydrological cycle with fast realization potential and minimization of property disputes due to the promising use of land owned by municipalities.

The first phase of the solution therefore consists in the application of the adaptation measures in the area of municipal land in the land blocks, which minimizes property disputes and significantly speeds up the realizations and its positive effects. Emphasis is placed on efficiency, speed of realization and low cost. Part of these measures is also suitable accompanying vegetation, which, thanks to increased

retention, will also increase the evapotranspiration of the area and thus also support a small hydrological cycle in the landscape.

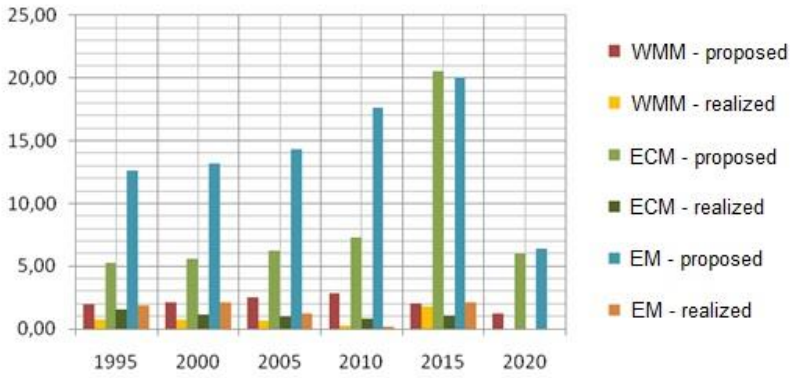

Fig. 5: Comparison of proposed and realized measures (ha).

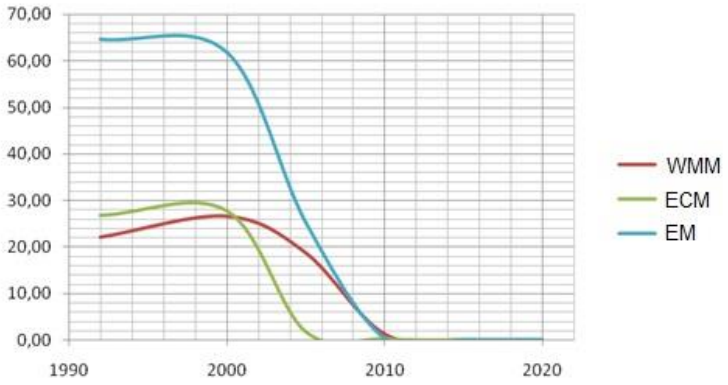

Fig. 6: Development of realizations of the proposed measures (%).

In order to be able to map potentially suitable areas of municipal land for the realization of the proposed adaptation measures, it was necessary to perform an extensive analysis of digital cadastral maps of the entire CR. A total 12,278 (out of the total number of 13,076) cadastral territories of the CR were analyzed. The current area of these municipal lands represents a total of 722,900 ha, which is 11.5 times larger than all erosion control, ecological and water management measures proposed in the CR since 1991. Potentially suitable areas of municipal land for the realization of the proposed adaptation measures are shown in map on Fig. 7. As can be seen from the map, it remains to analyze especially the area of the Šluknov promontory Krnov, Opava, Potštát, Bruntál, Přerov, etc. As part of ongoing research, further differentiation and categorization of these potentially suitable areas for the adapted adaptation measures will take place.

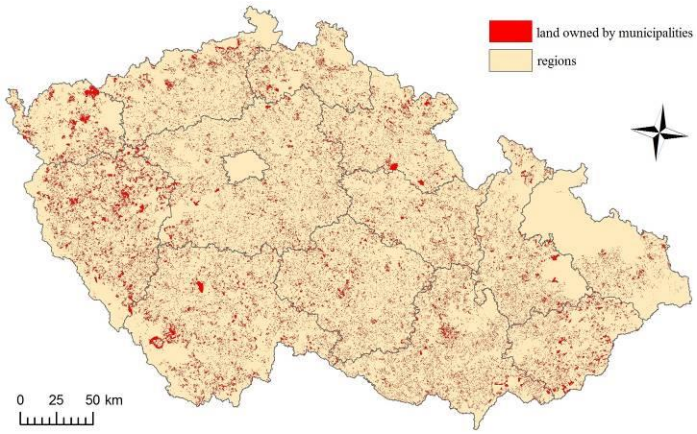

Fig. 7: Potentially suitable areas of municipal land for realization of adaptation measures.

Conclusion

A detailed analysis of the efficiency of land adjustments has been carried out. Based on the analysis of cadastral maps and archival aerial photographs was identified a promising possibility of using areas owned by municipalities for placement of adaptation measures which minimizes property disputes and significantly speeds up the realization of adaptation measures and its positive effects like increased retention and evapotranspiration of the area, support a small hydrological cycle in the landscape and other intangible benefits including the improvement of the recreational potential of the place with the proposed protective, retention and adaptation landscape elements. Base on detail analysis of digital cadastral map of CR were identified suitable plots for placement of adaptation measures of overall area of 722,900 ha, which is 11.5 times larger than all erosion control, ecological and water management measures proposed in the CR since 1991.

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Souhrn

Byla provedena podrobná analýza efektivnosti pozemkových úprav. Na základě analýzy katastrálních map a archivních leteckých snímků byla identifikována perspektivní možnost využití ploch ve vlastnictví obcí pro umístění adaptačních opatření, což minimalizuje majetkové spory a výrazně urychlí realizaci adaptačních opatření a nástup jejich pozitivních dopadů jako jsou zvýšení retence a evapotranspirace území, podpora malého hydrologického cyklu v krajině a dalších nehmotných užitků včetně zlepšení rekreačního potenciálu místa s navrženými ochrannými, retenčními a adaptačními krajinnými prvky. Na základě podrobné analýzy digitální katastrální mapy celé ČR byly identifikovány vhodné pozemky pro umístění těchto opatření o celkové výměře 722 900 ha, což je 11,5 krát větší plocha než všechna protierozní, ekologická a vodohospodářská opatření navrhovaná v ČR od roku 1991.

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