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INVESTIGATION OF DEFORMATION PROCESSES IN CHANNELS OF REGULATED STREAMS

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Abstract. The paper analyses deformation processes occurring in channels of regulated streams and discusses the reasons of their occurrence. As the study results have shown, the most frequent deformations of regulated streams include the erosion of slopes, accumulation of sediment in the channel, and the overgrowth of the channel with grass, bushes and woody vegetation. Deformations occurring due to the effect of different natural phenomena determined the changes of stream channels in cross-sectional and longitudinal profiles. Most streams under investigation have not been controlled, i e they are overgrown with thick and high grass vegetation. The paper presents analysis of current situation and discusses different possibilities of the naturalization of regulated streams.

Keywords: regulated streams, deformations, channels, meanders, sediment, vegetation.

1. Introduction

During the fulfillment of large-scale land reclamation works, the greatest part (82,6 %) of rivers and streams of Lithuania has been regulated. During the regulation process of the channels of rivers and streams their natural bends were eliminated, and the cross-sectional profile of channels was formed artificially. Rivers regulated in such a way became comparatively straight channels arranged in the valley of a former meandering stream. It was calculated that currently the amount of regulated channels of rivers and streams reaches 82,6 %, while natural channels cover only 17,4 % of total river network [1].

Recently there has been a lack of funds for the reconstruction, repair and maintenance works of land reclamation systems in Lithuania, therefore, even regulated streams have become derelict. The Government does not allocate sufficient amount of funds for the mentioned works, and the owners of land plots, where the mentioned constructions are arranged, are unable to carry out all necessary maintenance works of water flows at their own expenses. As there is no possibility for proper maintenance of regulated streams, their technical state is constantly becoming worse. Slopes of non-maintained regulated streams tend to overgrow with thick grass, bushes or even trees. The stability of such stream slopes is disordered, different kinds of deformations occur in channels of the streams. Ground slipping from the stream slopes accumulates on the foot of slopes making the streambed narrower. A certain amount of ground accumulated in the stream channel creates obstacles for water flow and thus distorts the flow of the stream. During the deformation processes of a stream channel and slopes, the bed of regulated streams becomes meandered (i e natural stream bends appear). Stream slopes overgrown with grass and woody vegetation, a stream channel formed by deformation processes and stream bends formed by the stream flow create favorable conditions for the formation of naturalization processes of regulated stream channels.

Currently, the objective is to achieve the self-naturalization of regulated streams with as little expenses as possible. However, the streams are also to carry out their main function, i e they must be able to let the excess water from drainage systems. As the study results have shown, a certain part of regulated streams may be at least partially naturalized, and in such a way their natural balance would be restored. Some of researchers have noticed that the maintenance of naturalized streams is much easier, and under favorable conditions no maintenance works are needed at all. Naturalization is particularly needed for the improvement of ecological conditions and landscape [2].

The objective of the study was to evaluate the deformations occurring in regulated stream channels of the Jiesia catchment, and to determine the reasons of their occurrence.

2. Study object and methodology

Regulated streams contained in the river Jiesia catchment were chosen as study objects. The river Jiesia is one of the smallest tributaries of the river Nemunas. The catchment area of the river Jiesia covers 473,7 km². 63 % of the total catchment area is covered with heavytextured soils with bad filtration qualities; in the upper reaches (and particularly in the middle reaches) of the river non-sloping flat loam plains are prevailing. Wood density of the catchment is 20 %. The catchment of the river Jiesia is narrow and rather symmetrical. Only 4 tributaries of the river Jiesia (the Šventupė, the Girmuonis, the Šlapakšna and the Vyčius) are longer than 10 km. There are only two lakes in the catchment area (both lakes are located in the catchment area of the tributary Šventupė). There are also some ponds (the largest ponds are those of Išlaužas fishery farm). The hydrographic network of the river catchment contains 358,7 km of river channels from which 259,5 km (72,4 %) are regulated [1]. In Lithuania regulated river channels make up 82,6 % of the total length of river network. In the Jiesia catchment the channels of rivers and streams were less affected by the land reclamation works and other kind of human activity.

Certain sections of regulated streams of the Jiesia catchment were selected for study in respect of their designed bed slope and the type of soil prevailing. On the basis of these criteria, the technical state of regulated streams in randomly selected 58 places was analysed. During the studies the following points were determined:

1) cross-sectional and longitudinal deformations of regulated streams;
2) overgrowth of slopes and bed with grass and woody vegetation;
3) peculiarities of deformations and naturalization of channels.

The information about the present technical state of the study objects was summarized into special logbooks preliminary made for the evaluation of the condition of streams. The following observation criteria were presented in the logbooks:

1) purpose of land around the study objects, agricultural land use (arable land, grassland – pasture, derelict land plots);
2) flora growing on channel slopes (thickness of grass, species prevailing, density of shrubs);
3) cross-sectional and longitudinal deformations of channels;
4) present configuration of a channel (width, depth, meandering parameters);
5) state of channel bed (sediment layer, level of vegetation cover on the bed).

In the selected segments of regulated streams the cross-section of channel beds (for the evaluation of cross-sectional deformations) and longitudinal channel profiles (for the determination of channel bed slope) were measured. The study data were collected within the period of 2004–2005. The data collected were compared with the design material of stream regulation as well as with the data of repair and reconstruction works of streams. The latter repair and reconstruction projects were fulfilled in 1997–1998. Deformations on the studied streams occurred within the period of the last 9–10 years. Thus the extent of the deformations of regulated stream channels calculated in such a way has developed during a certain period of time.

On the basis of calculated study results, a graph of the distribution of average standard deformations within a cross-sectional profile of stream channels is created. Along with the graph, the schematic cross-section of the channel is presented with 3 distinguished spheres where characteristic deformations mostly occur. The paper presents the scheme of channel deformations and bend formation. The scheme indicates how different deformations affect changes in stream channels that form natural meanders of streambeds.

Relationship between the width and depth of studied streams was calculated and graphically presented in the paper. The ratio of depth and width (h/b) of the studied regulated streams was determined and compared to the results obtained by other researchers. Distribution of the ratio between the width and depth of stream channels was estimated on the basis of the designed width of a streambed. A graph of data distribution was made up. A graph of the dependence of sediment layer depth on the grain-size composition of soil was calculated and created, showing how much the soil prevailing determines the formation process of sediments.

The information contained in logbooks is systemized, the data are processed with mathematical statistics methods. The paper presents the mathematical-statistical analysis of different data collected and the results calculated during the study period.

3. Study results and discussion

Cross-sectional deformations of channels of the studied objects were evaluated having compared the measurement results with the material of design, repair and reconstruction works [3, 4]. Summarized study data of deformations are presented in the graphical chart (Fig 1).

Fig 1 presents the chart of the distribution of average standardized deformations within a channel profile. The chart shows average digital values within a 0–5-m interval across the stream channel.

Fig 2 presents a schematic profile of a channel with 3 relative areas (1 – area of water flow, 2 – middle part of slope, 3 – upper part of slope) where deformations typical of these areas occur.

As it is seen from the summarized data presented in the chart, landslides occur mostly on the upper part of the slopes (0,09–0,17 m deformations on the average). Landslides of the upper part of slopes occur in 72,8 % of all the studied cases. In the middle part of slopes (2,0–6,5 m from the channel axis) deformations are insignificant (0,02–0,12 m, sometimes 0,23 m). The most significant deformations were observed in the area affected by water flow, i e where water flow effect is most intensive. In this area (2,0 m from the channel axis) in 63,4 % of all the studied cases a large amount of sediment and slid soil accumulates (0,25–0,30 m). In all the rest cases (36,6 %) under the conditions of higher gradients of the streambed the stream flow tends to form a channel with the bed below the designed level. Such conditions enhance the cessation of sediment accumulation, however, the channel experiences constant scour and deformation. Soil

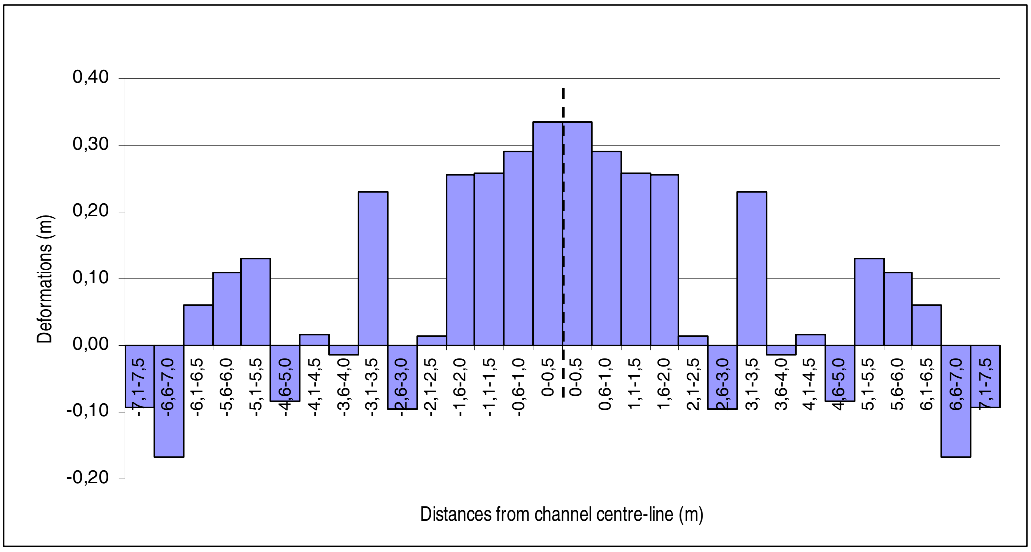

Fig 1. Distribution of cross-sectional deformations in regulated streams

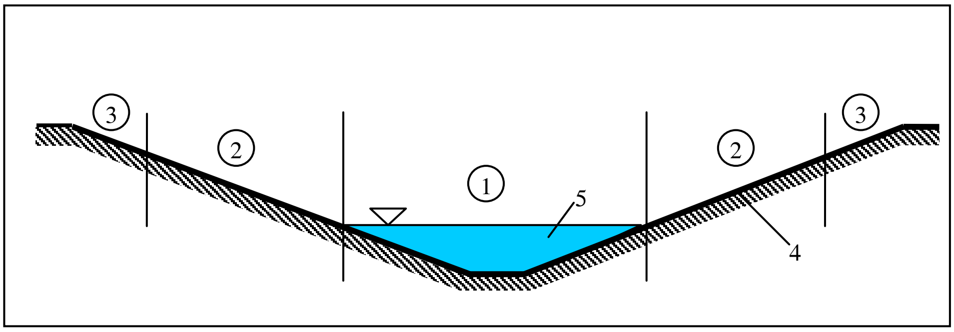

Fig 2. Scheme of distribution of regulated stream channel profile into deformation areas: 1 – area of water flow effect; 2 – middle part of slope; 3 – upper part of slope; 4 – channel slope; 5 – water flow

washed from the slopes and channel bed is transported downstream and deposits within a stretch of lower gradient where water flow velocity decreases. This results in the accumulation of sediment, which enhance the changes in design parameters of the channel. The cross-sectional profile of a channel rarely remains stable: a smaller channel with a narrower bed is formed on the designed stream channel. Such cases made up 6,8 % of all the studied variants.

Considering the available data and information, it can be stated that the deformations presented in the chart occurred within the period of the last 9–10 years, i e since the repair or reconstruction works performed in the studied streams. Thus average deformations occurring every year may also be calculated in the following way. However, it must be considered that deformations may have occurred during a comparatively short period of time and may have stabilized later. In such a case it is rather difficult to say if particular deformations have been forming regularly or if they are random and momentary.

In order to determine the most frequent size of deformations in cross-sections of channels, the chart (histogram) of the most frequent deformation values has been made (Fig 3).

As it is seen from the chart, the most frequent deformations include 0,2–0,4-m high accumulation of sediment and soil deposits. In the negative part of deformations also 0,2–0,4-m high deformations, including scours of channel bed and slides of slopes. Asymmetric coefficient of the chart is 0,77. This implies that the distribution is not symmetric with the declination to the side of positive-frequency values. This is explained by the fact that in the studied objects the tendencies of sediment formation and accumulation of soil slid from channel slopes into channel beds are dominant.

Having made the mathematical-statistical analysis of deformation measuring results it was determined that the weighted average value of deformations was 0,2 m. This implies that the formation of sediment and soil layer is the most frequent type of deformations. Negative deformations are less frequent. The latter deformations mostly occur as the leaching and deposition on the middle and upper parts of slopes. The variation scope of values is 2,1 m (from 1,2 to 0,9 m). Standard deviation of data set $\sigma = 0{,}42$ m. The dependence of deformations extent on their position in the channel profile is expressed by a correlation coefficient $R = 0{,}639$ (determination coefficient $R^2 = 0{,}409$). This shows a strong relationship

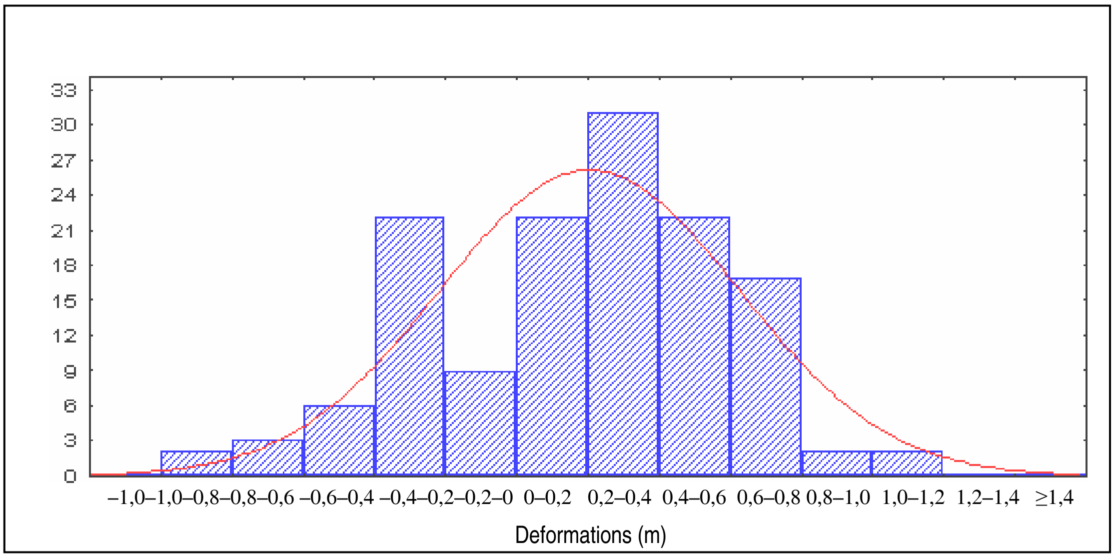

Fig 3. Distribution of deformations in stream channels according to their frequency

between the distribution of deformations within the channel profile. Correlation coefficient reliability is determined according to Student criterion t_{actual} = 6,49. The calculated value exceeds the theoretical value several times (t_{theor}=1,304) [5]. This shows a reliable estimation of cohesion of relationship between the distribution of deformations within the channel profile.

As the study results show, landslides of the upper part of a slope often depend on soil depressions and different types of human activity (often farming activity) resulting in the landslide of soil from the upper part of a slope towards its foot. In the middle part of a slope deformations are rare, however, here the tendency of increased accumulation of soil slid from its upper part is observed. The most significant deformations are observed in the area of water flow where it is constantly affecting the channel and changing its configuration. Flowing water scours the foot of slopes and thus creates conditions for the sediment accumulation on the channel bed. After the accumulation of sediment in the water flow area vegetation starts developing. Higher roughness of the channel bed results in lower water flow velocities, which in its turn creates favorable conditions for additional sediment accumulation. At the onset of the sediment accumulation process the gradient of channel bed decreases, which enhances the accumulation of sediment not only in the initial place of deformation formation, but in the whole affluent zone as well. The influence of surface water, hydro-dynamic pressure of soil and grain-size composition of soil also contribute to the formation of slope deformations (landslides of slopes). All the facts mentioned enhance the erosion processes of slopes and accumulation of soil slid from the slopes on the foot of the slope.

Accumulated sediment and distorted slopes form in such a way a new profile of the channel bed. As a result, the gradient of the stream and its flow velocity change, which ensures favorable conditions for further formation of cross-sectional and longitudinal deformations of channels of regulated streams.

Cross-sectional channel deformations highly influence the position of regulated stream channels in the plan. When cross-sectional deformations occur, the signs of meandering of channel beds instead of straight channels are observed. Soil slid from slopes on the foot of slopes creates obstacles for water flow, which results in the occurrence of cross-sectional circulation in the channel. Strong water flow starts scouring channel slopes. Due to the flow circulation scoured particles of slope soil are transported into the opposite side of the flow where they form shallows in the course of time. This enhances the processes of side accumulation and side erosion [6]. Having deviated from the designed position, the channel bed creates meanders similar to those of natural streams. The scheme below illustrates the formation of deformations in the channel bed and their effect on the formation of the streambed (Fig 4).

Meandering streambed was observed in 67 % of all the studied stream channels. This is mostly found in the stretches of channels where sandy-loam soils are prevailing (69,7 %), where sediment is accumulating (42,6 %) or where slope deformations are observed (72,8 %). Usually in such stretches of channels no maintenance or repair works are carried out.

More intensive meandering of channel induces lower water flow velocities. Leaching and transport of sediment discontinues, sediment accumulation begins, and the conditions become favorable for the development of aquatic vegetation on the channel slope. Increased water roughness in the channel results in an even more intensive reduction of flow velocity.

The photos provided depict the state of streams, showing the meandering of the streambed and their overgrowth with grass vegetation (Fig 5).

Fig 5a shows the intensity of grass vegetation cover in the channel of the regulated stream Viemuonia. After the accumulation of sediment on the streambed, high moisture-tolerant plants started growing (calamus, cattails). When there are plants in the channel, water flow velocity and hydraulic conductivity of the channel decrease,

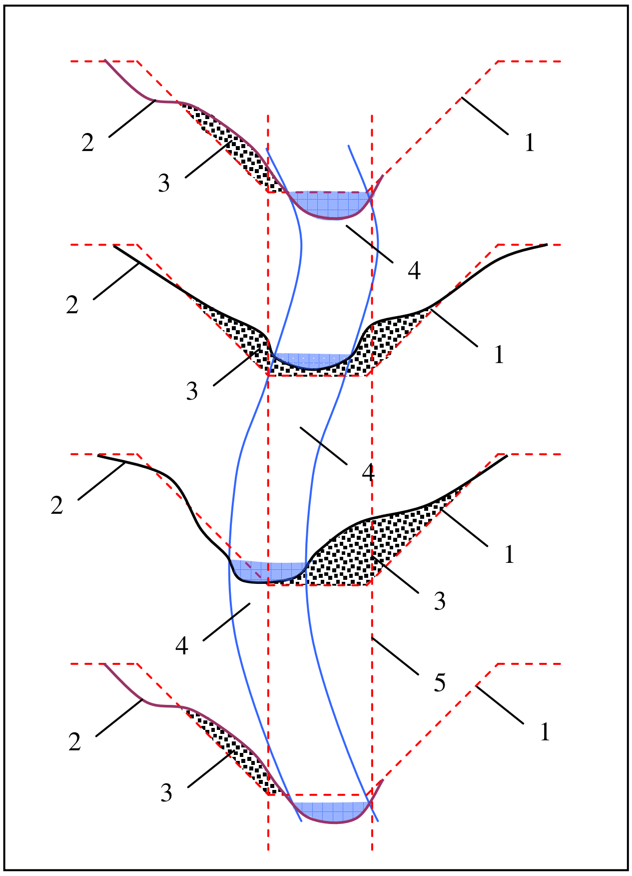

Fig 4. Effect of regulated stream channel deformations on the formation of channel bed: 1 – designed stream channel profile, 2 – present channel profile, 3 – accumulated sediment and soil particles, 4 – present flow of channel, 5 – designed channel bed

which creates perfect conditions for channel silting. In this particular case the channel bed is overgrown with thick aquatic vegetation and thus stable water is retained in the channel. This stretch of the channel does not perform its initial role as a water discharge pipe of a drainage system. Fig 5b shows the peculiarities of meander formation in the channel bed of the regulated stream Šventupė. Considering the data collected from Agricultural Department of the Municipality of Kaunas district, during the last 5–8 years no maintenance and repair works were performed in the catchment are of the stream Jiesia. In non-maintained (not mown) slopes perfect conditions occur for rapid development of high grass vegetation (nettles, thistles) that spread over the entire stream slopes and choke other plants [7]. The examples discussed clearly show that deformations developed in non-maintained streams enhance the designed changes of channels of regulated streams.

The width and depth of channels of the studied regulated streams were also measured during the study period. A chart of distribution of the results between the present width and depth of stream channels was made (Fig 6). Linear interrelation of these parameters was determined. Resilience level of the relation is expressed by the correlation coefficient R=0,7812.

a)

b)

Fig 5. Intensity of grass vegetation cover and meanders formation in the channels of the regulated Viemuonia and Sventupe streams: a) regulated Viemuonia stream, b) regulated Šventupė stream

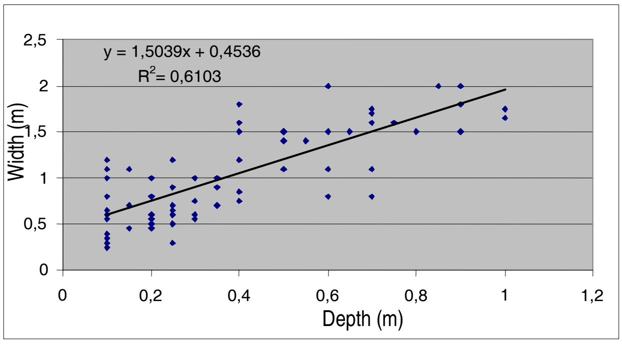

Fig 6. Distribution of results between present width and depth of stream channels

A chart of interrelation between the width and depth of channels was also created. The chart specifies the areas of width of the present channel beds in respect of designed width of channel beds. The mentioned areas show the distribution of the present width and depth values under the conditions of the following designed widths of channel beds: 0,6 m, 0,8 m, 1,0 m (Fig 7).

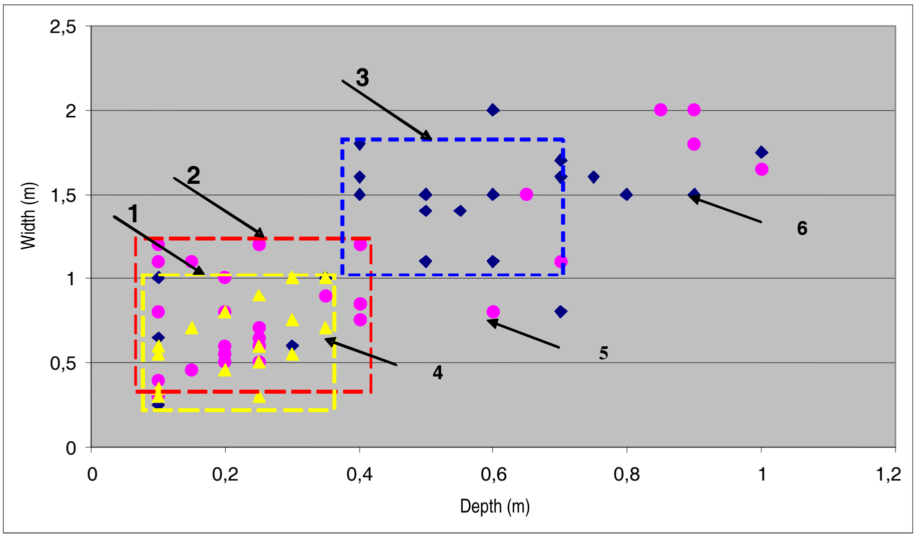

Fig 7. Distribution of results between present width and depth of stream channels according to designed width of streams 1, 2, 3 – designed bed width areas of regulated streams (accordingly: 1 – 0,6 m; 2 – 0,8 m; 3 – 1,0 m); 4, 5, 6 – present width and depth values

As it is seen from the chart (Fig 7), when the designed width of the channel bed is 0,6 m, the present average width remains similar – 0,66 m (designed channel width – 0,6 m) in all the studied cases. An average square deviation σ = 0,23 m. When the designed channel width is 0,8 m, the present average value of widths of these channels is 0,98 m, having eliminated the most distant values (77,4 % of all the studied cases). An average square deviation was σ = 0,45 m. Meanwhile, when the designed channel width is 1,0 m, the channel bed widened on the average to 1,37 m (50 % of all the studied cases), although the channel width values of this group were distributed in a wide range, and an average square deviation was σ = 0,43 m. This may be explained by the fact that under the conditions of a wider channel the washed power of water flow is respectively higher. This, however, enhances more intensive leaching of the channel.

The chart of relationship between the width and depth is also described by Fisher coefficient F_{actual} = 117,44. Having compared the theoretical (F_{theor} = 6,63) and actual values of coefficients, it is seen that the actual value of Fisher coefficient is much higher than the theoretical one. Student coefficient T_{actual} =0,6868 is calculated in the same way. Having calculated the theoretical value of this coefficient (T_{theor} = 0,6765), it was determined that $T_{actual}(0,6868)>T_{theor}(0,6765)$ [5]. As the values of both coefficients satisfy the necessary conditions, it may be stated that the cohesion of the relationship between the width and depth was estimated reliably.

B/h ratio for the investigated streams was observed. By operated natural data it was estimated that B/h ratio was from 3,0 to 3,6 for the analysed streams. V. Altunin has been analysing data of channel parameters B, h, and B/h ratio for steady rivers. According to his calculation, B/h ratio for small streams with meanders is 4–5 [8, 9]. These differences show that the investigated streams are not natural and steady, but after some time they can reach that ratio. After that regulated streams channel profiles become steady and their configuration will become near parabola. According to V. Altunin, all steady river channels have a parabola form [8, 9].

The thickness of sediment layers accumulated in regulated streams was also measured during the study. Connection between the depth of a sediment layer and the type of soil prevailing in the territory was determined. The study data are presented in Fig 8.

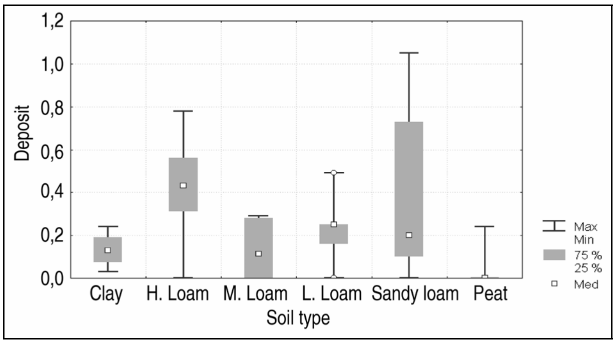

Fig 8. Dependence of deposit layer on soil type

Fig 8 presents summarized study data and depicts the cases of sediment accumulation and deformation occurrence under the conditions of different types of soils. The results presented in the chart show their spread, i e showing minimum, maximum values and densest areas of values (50 %). As it is seen from Fig 3, when sandy-loam soils are prevailing, the thickness of the layer of slid soil and accumulated sediment is changing within a wide range (0–1,05 m), and mostly (50 %) the layer mentioned varies from 0,1 to 0,73 m. When heavy loam soils are prevailing, the range of an accumulated sediment layer formation is 0–0,8 m, however, mostly (50 %) the formed layer is 0,3–0,55-m thick. Thus it can be stated that sandy loam soils are less stable, therefore, here the most significant deformations occur.

Relationship between the thickness of a sediment layer and the designed gradient of the channel bed was also analysed during the study. It was determined that the largest amount of sediment accumulated under the conditions of low gradients (0,4–0,6 %) forming a 0,1–0,65 m thick sediment layer. When gradients are higher (1–2,5 %), a sediment layer is only 0,2–0,3 m thick. Formation of a sediment layer depends mostly on different obstacles occurring in channels. The obstacles form an affluent and thus create favorable conditions for the accumulation of sediment in a stream channel.

In 17,2 % of all studied cases the slopes of streams were overgrown with bushes and trees. This occurred mostly in streams located in outer woods or forests. Obviously, these streams were not properly maintained for several years. During the last years the slopes and channel of these streams overgrew with a thick high grass, thin bushes and separate trees.

4. Generalization of study results

Having summarized the study results it was determined that the deformations of slopes and the channel bed are the most frequent deformations occurring in regulated streams. The main deformations observed in the study objects include:

1) landslide of slopes, soil slid from slopes, soil scour (in the middle and upper parts of slopes);
2) channel bed silting and leaching, scour of foot of slope, accumulation of slid soil on foot of slopes, overgrowth of the channel bed with grass vegetation (in the area of water flow).

One of the most frequent channel deformations – landslide of slopes – usually depends on soil grain-size composition, stratification of soil layers, improper human activity and other factors. Bank erosion is a complex phenomenon in which many factors play a role, but in general it is flow, sediment transport, and bank properties that determine rates of bank retreat [10].

The main factors causing channel deformations of regulated streams include:

1) surface water, human activity, vegetation grown on channel slopes (in the zone of slopes);
2) water flow in the channel, stability of slopes (in the zone of water flow).

Bank properties include: material weight and texture; shear and tensile strengths; groundwater level; permeability; stratigraphy; geometry; and vegetation [11]. With such a wide range of contributing factors, it is useful to consider bank erosion in terms of broad process categories. Lawler identified three bank-erosion process domains: subaerial preparation; fluvial entrainment of bank sediment; and mass failure mechanisms [12, 13].

However, it should be noted that in respect of certain conditions the same factor may enhance different channel deformations and the same deformation may be a result of several factors [14].

All the mentioned and other related factors inducing channel deformations occur due to the non-maintenance of regulated streams. Currently, due to the lack of funds allocated for the maintenance of land reclamation systems, it is impossible to maintain properly all regulated streams and ensure their designed operation properties. As a result, proper functioning not only of regulated streams as water recipients but of all drainage systems may be disturbed. Affluent of outlet may result in flooding and loss of nearby land areas.

To maintain the initial state of regulated streams is a complicated and expensive task. This is not an economically optimal exploitation way of water recipients even if the allocation of funds was sufficient. The dynamic balance between the effect of flow and state of the channel is unstable, which means that deformation processes are inevitable in channels. As the study of naturalization processes have shown, there is a possibility to create nature-based dynamic balance in regulated streams as well, i e the exploitation ways are to be changed and improved [15].

Only separate stretches of streams should be renaturalized; nearby them there should be no land plots valuable from the agricultural point of view. Therefore, when renaturalizing regulated streams it is necessary to consider natural condition in each separate case. Considering the practice of foreign countries, within the area of renaturalization thin vegetation and bushes are to be eliminated in short stretches on one of another bank of a stream in succession.

In Lithuania the main means of naturalization is natural overgrowth of channels with bushes, trees and grass vegetation. Natural meandering of channels and formation of shallows is a significantly slower process. Therefore, natural naturalization is acceptable from technological as well as ecological points of view [2].

In west European countries these processes are enhanced artificially. In such a case the meanders of stream channels are re-established faster, adapting them to local landscape conditions. Unfortunately, this requires large expenses and work input. Channel meanders may be created having excavated them in certain places or having arranged small dikes. Then the channel flow would be distorted and conditions for intensive bed processes would be created. Artificial meandering of channels stabilizes water levels increased during the flood. More favorable conditions for the self-purification of flow from certain pollutants and nutrients are created in the meandering flow [15]. During the artificial naturalization of streams the re-establishment and maintenance of channel meanders are particularly important, the highest channel flow velocities are to be reduced, a stable channel is to be formed, flow transport capacity is to be induced [16]. Applying "mild" maintenance means of canalized streams used in western European countries, it is possible to coordinate sufficient hydraulic conductivity of streams and gradually improve their hydro-dynamic balance and natural diversity. To achieve this, meandering of a straightened stream bed is recommended [9].

As the results of study carried out by the researchers of Water Management Institute show, the naturalization processes of regulated streams and channels as well as the activity of their water recipients may be successfully coordinated. In such a way their environmental protection effects on nature will be improved. Moreover, the maintenance of water recipients will become less complicated and much cheaper. During the naturalization process of regulated streams balance between flow impact and channel stability is gradually restored, and the need for maintenance works decreases [17].

5. Conclusions

1. The most frequent deformations occurring in regulated streams include the deformations of their slopes.

2. The most significant deformations occur in the zone of channel flow. In 63,4 % of all studied cases large amounts of sediment and soil particles accumulate here forming a 0,2–0,40-m thick layer.

3. Sediment accumulation and distorted slopes result in changes of the designed stream channel, which creates favorable conditions for further development of cross-sectional and longitudinal deformations.

4. During the formation of deformations on channel slopes, meandering of the channel bed is observed. Meandering of the stream bed occurred in 67 % of all the studied cases.

5. In a channel with accumulated sediment favorable conditions for the development of aquatic vegetation are observed. Vegetation impedes water flow in channels and thus enhances further formation of deformations.

6. Changes in the profile of regulated streams and non-maintenance of the streams induce the development of naturalization processes in regulated streams.

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DEFORMACINIŲ PROCESŲ SUREGULIUOTŲ UPELIŲ VAGOSE TYRIMAI

R. Baublys

S a n t r a u k a

Straipsnyje analizuojami sureguliuotų upelių vagose vykstantys deformaciniai procesai ir aptariamos jų priežastys. Tyrimais nustatyta, kad dažniausios tokių upelių vagų deformacijos yra šlaitų erozija, sąnašų susikaupimas vagoje ir vagos užaugimas žolėmis, krūmais bei miško augalija. Deformacijos, pasireiškusios dėl įvairių gamtinių veiksnių, lėmė upelių vagų skersinių ir išilginių profilių pokyčius. Dauguma tirtųjų upelių buvo neprižiūrimi – apaugę tankia ir aukšta žoline augalija. Analizuojama esama situacija. Aptariamos galimybės natūralizuoti sureguliuotus upelius.

Prasminiai žodžiai: sureguliuoti upeliai, deformacijos, vagos, vingiai, sąnašos, augalija.

ИССЛЕДОВАНИЕ ДЕФОРМАЦИОННЫХ ПРОЦЕССОВ В РУСЛАХ ОТРЕГУЛИРОВАННЫХ РЕК

Р. Баублис

Р е з ю м е

Проанализированы деформационные процессы, происходящие в руслах отрегулированных рек, причины их возникновения. Исследованиями установлено, что чаще всего это эрозия откосов, скопление наносов в русле и зарастание русла травой, кустами и лесной растительностью. Деформации, образовавшиеся вследствие различных природных факторов, обусловили изменения поперечных и продольных профилей русел рек. Большинство исследованных рек были неухоженными – заросли густой и высокой трявянистой растительностью. Проанализирована создавшаяся ситуация, обсуждены возможности натурализировать отрегулированные реки.

Ключевые слова: отрегулированные реки, деформации, русла, повороты, наносы, растительность.

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