Efficiency of field-protective forest plantations in the first agro-climatic zone of the Stavropol territory of the Russian Federation

P V Klyushin¹, V N Khlystun¹, A V Loshakov², S V Savinova¹ and T A Ivanova¹

¹State University of Land Use Planning, 15, Kazakova str., Moscow, 105064, Russia
²Stavropol agrarian University, Stavropol, 12, Zootekhnicheskiy lane, 355017, Russia

E-mail: klyushinpv@gmail.ru

Abstract. This paper presents studies on the state of agricultural land in the first agro-climatic Stavropol territory, and on the basis of this forest reclamation measures for effective and rational use have been developed. The specialization of agriculture is sheep breeding and cultivation of winter wheat and winter and spring barley. For this agro-climatic zone, only one type of crop rotation is suitable – grain-steam. In the structure of acreage, pure steam reaches 40%, which has a very negative impact on the quality of arable land. Protective forest stands play an important role in protecting agricultural land from the negative effects of water and wind erosion. At present, the total area of protective plantations on the lands of the I agro-climatic zone is 22730 hectares or 1.81% of the area of agricultural land, at least 2.5% is necessary.

1. Introduction

Stavropol region is one of the largest agricultural regions of the country, producing more than 3% of gross output. It occupies the Central part of the Caucasus and its area is 6616 thousand hectares. The composition of the Stavropol territory includes 26 administrative districts and 10 cities of regional subordination. 92% belong to the territory of the Stavropol territory. The plowed land in some areas is more than 80% of their land fund. Long-term intensive use of land has led to the deterioration of the environmental situation in the region and the development of many degradation processes that significantly reduce the productivity of agricultural land [1–3].

The total land area of the I agro-climatic zone is 1806348 hectares and it includes five administrative districts of the Stavropol territory: Apanasenkovsky, Arzgir, Levokumsky, Neftekumsky and Turkmen. The main limiting factor of agricultural production is the availability of moisture. The soil cover is represented by light chestnut and chestnut soils, as well as a significant spread of saline and saline soils. These soils are very poorly provided with humus, but contain a large number of trace elements.

The main specialization of agriculture in this area is sheep breeding and production of winter wheat and barley. For this agro-climatic zone, only one type of crop rotation is suitable – steam grain. In the structure of acreage, pure steam reaches 40%, which has a very negative impact on the quality of arable land. There is a steady increase in the area of eroded and deflated agricultural land, as well as significant losses of humus on them. In rare cases, the crop rotation includes spring crops such as millet and barley.

This paper presents the study and analysis of agricultural land in the first agro-climatic zone, and on this basis – the material for the development of forest reclamation measures to protect and preserve land from degradation processes, primarily from deflation.
2. Materials and methods

Work on the identification of degraded lands of the Stavropol territory was carried out in 2000-2016, and the methodological basis for the surveys was “Guidelines for the identification of degraded and contaminated land, published in 1995”.

In our work, we calculated the ecological stability of agricultural lands in the Stavropol region according to the data from 2000 to 2016, because during the period of our research there have been significant changes in the areas of land types, and therefore in the stable and unstable elements of agricultural landscapes. Based on the coefficient of environmental stabilization, we see that it is necessary to develop a set of measures to improve their stability for agricultural landscapes of the Stavropol territory, as the area of unstable elements is much larger than the area of stable ones. Thus the cheapest, but very effective means for the protection of agricultural landscapes are forest reclamation activities, which is why this work is dedicated to this topic [2–4].

3. Study of agroforestry activities in the first agro-climatic zone

The territory of the I agro-climatic zone is more than 95% represented by agricultural lands and during the period of research the area of these lands increased by 27906 hectares. This increase was mainly due to reserve lands (table 1).

| Area            | Year 2000 | Year 2016 |
|-----------------|-----------|-----------|
|                 | ha        | %         | ha        | %         |
| Apanasenkovsky  | 341635    | 95.32     | 341675    | 95.33     |
| Arzgirsky       | 310433    | 91.75     | 313026    | 92.51     |
| Levokumsky      | 439655    | 93.80     | 453205    | 96.69     |
| Neftekumsk      | 349676    | 92.09     | 356997    | 94.02     |
| Turkmen         | 247486    | 94.75     | 251888    | 96.43     |
| Total for zone I| 1688885   | 93.49     | 1716791   | 95.04     |

During the analyzed period, there was an increase in the area of agricultural land in all administrative areas, but the greatest growth was observed in the Levokumsky district, where this category of land increased by more than 13 thousand hectares. As observations showed, there was involvement in agricultural land turnover, which initially was not in a very good quality condition (solontsy, slope land and already degraded to varying degrees). The same situation exists on the territory of the Neftekumsk district, where 7321 ha of land was involved for sixteen years in agricultural use. The smallest increase in the area of agricultural land is noted in Apanasenkovsky area, within which this category increased by 40 ha.

In composition of agricultural lands, the majority of the area is agricultural land. Currently, 93.2% of agricultural lands of the I agro-climatic zone are involved and intensively used for agricultural production. The share of arable land in agricultural land shows the degree of anthropogenic load on agricultural landscapes. The maximum percentage of ploughing of the territory is noted in the Turkmen region (71.47%), but during the period of research it decreased by 0.67%. This increases the area of pastures in both physical and percentage terms. The area of perennial plantations has decreased slightly, such lands as hayfields and deposits are absent within the boundaries of the Turkmen district.

There are only two types of land on the territory of the Arzgir district – arable land, which occupies 62.12% of the agricultural land area, and pastures, which occupy 33%. During the 16-year period, the area of arable land increased by 128 hectares, but in relative terms its share decreased; respectively, the share of pastures increased from 32.54% to 33%.

Farmlands of the Apanasenkovsky district is represented by four types of land, the maximum percentage of which is arable land (55.62%) and pastures (of 35.94%). Hayfields and perennial plantations occupy a total of 0.9% of the land. The dynamics of areas for all types of land remains stable...
for the entire period of research.

The least ploughed area is observed in Neftekumsk (27.1%) and Levokumsky (38.82%) areas, and for the analyzed period, this percentage has not significantly decreased. This increases the area of grassland, especially pastures (+ 8969 hectares in the Levokumsky and + 4007 hectares in Neftekumsk district). Also in these areas, the largest areas of perennial plantations, which are represented by vineyards during the research period, a tendency to reduce their area is revealed. For a more detailed description of the use of agricultural land, we conducted surveys of forest plantations outside the state forest fund, presented mainly by protective forest plantations (table 2).

**Table 2. Dynamics of the area of forest plantations not included in the state forest fund by areas**

| Area           | Year 2000 | year 2006 | Year 2012 | Year 2016 |
|----------------|-----------|-----------|-----------|-----------|
|                | ha        | %         | ha        | %         | ha        | %         | ha        | %         |
| Apanasenkovsky | 4732      | 1.38      | 4744      | 1.39      | 4744      | 1.39      | 4744      | 1.39      |
| Arzgirsky      | 3923      | 1.26      | 4104      | 1.31      | 4104      | 1.31      | 4104      | 1.31      |
| Levokumsky     | 4365      | 0.99      | 4536      | 1.02      | 4536      | 1.01      | 4536      | 1.01      |
| Neftekumsk     | 4561      | 3.52      | 4639      | 3.46      | 4638      | 3.45      | 4638      | 3.46      |
| Turkmen        | 4708      | 1.90      | 4708      | 1.88      | 4708      | 1.88      | 4708      | 1.88      |
| Total for zone I | 22289   | 1.81      | 22731     | 1.81      | 22730     | 1.81      | 22730     | 1.81      |

The presence in the composition of agricultural land protective forest plantations and their condition plays an important role in protecting the land from the negative effects of water and wind. The total area of protective plantations on the lands of the I agro-climatic zone increased by 441 hectares in 16 years and in 2016 it was 22730 hectares or 1.81% of the agricultural land area. The highest percentage of land occupied by forest plantations is noted in the Neftekumsky district (3.46%) and the smallest within the boundaries of the Levokumsky district (1%). During the period of research in all administrative areas of the zone there is an increase in the area of protective forest plantations [5–7].

**Table 3. Quantitative characteristics of field-protective forest stands of the I agro-climatic zone**

| Area           | Area of agricultural land, thousands of hectares | The percentage of afforestation | Area of protected forest plantations, ha | Number of protective forest strips, pieces |
|----------------|-----------------------------------------------|-------------------------------|----------------------------------------|-----------------------------------------|
| Apanasenkovsky | 315.9                                         | 1.2                           | 3965                                   | 1706                                    |
| Arzgirsky      | 297.7                                         | 1.0                           | 2944                                   | 1405                                    |
| Levokumsky     | 416.5                                         | 0.4                           | 1653                                   | 872                                     |
| Neftekumsk     | 326.9                                         | 1.0                           | 2550                                   | 1474                                    |
| Turkmen        | 239.2                                         | 1.7                           | 4061                                   | 2220                                    |
| Total for zone I | 1596.2                                       | 1.1                           | 15173                                  | 7677                                    |

Protected forest areas play an important environmental role, being part of the ecological framework of the agricultural landscape, including agricultural land, contribute to reducing soil erosion, improve the overall microclimate and hydrological regime of the territory, perform a number of useful functions. Thus, in the Stavropol region, the area of forest plantations outside the forest fund is 143.7 thousand hectares, of which 22730 hectares (15.8%) fall on the land of the I agro-climatic zone. This area differs in its importance from the materials of the inventory of trees and shrubs, which was held in the Stavropol territory in 2004. According to the materials of the "Inventory of wood and shrub vegetation of protective value and roads on agricultural land" the area of protective forest strips in the zone was 15173 hectares. The table below shows the area of protective forest plantations in areas of the I agro-climatic zone of the Stavropol territory (table 3).
The percentage of afforestation of agricultural land throughout the agro-climatic zone is critically low, especially in the Levokumsky district, where it is 0.4%. The number of forest shelter belts and the area is more than two times less than that in other zones, while the Levokumsky district is the largest in the Stavropol region [8–10].

4. Conclusion
According to the results of the inventory, it can be concluded that 5,524 hectares (26%) of forest belts are in good condition, 6,561 hectares require logging and maintenance, 1526 hectares need to be supplemented with planting, 885 hectares – reforestation, 677 hectares need to be decommissioned. The proposed activities for the administrative areas of the I agro-climatic zone are presented in table 4.

Table 4. Forest belts and proposed activities in administrative areas of the I agro-climatic zone

| Area           | Number of protective forest strips, pieces | Area, hectares | The area of the proposed activities acre | landing | care cabins | reforestation | stubbing |
|----------------|-------------------------------------------|----------------|------------------------------------------|---------|-------------|---------------|----------|
| Apanasenkovsky | 1706                                      | 3965           | 199                                      | 2192    | 23          | 199           |
| Arzgirsky      | 1405                                      | 2944           | 219                                      | 535     | –           | 104           |
| Levokumsky     | 872                                       | 1653           | 542                                      | 176     | 27          | 75            |
| Neftekumsk     | 1474                                      | 2550           | 548                                      | 551     | 30          | 188           |
| Turkmen        | 2220                                      | 4061           | 18                                       | 3107    | 805         | 111           |
| Total for zone I | 7677                                      | 15173          | 1526                                     | 6561    | 885         | 677           |

As can be seen from table 4 protective forest strips require a large amount of various works aimed at improving their quality. Small afforestation of agricultural land and especially arable land, non-compliant with the rules of rational land use and disregarding the specifics of the terrain, as well as a large area of clean vapors, contribute to the development of various degradation processes, especially water erosion and deflation. And natural factors determine the presence of saline, flooded and saline lands.

The maximum area to complement existing forest identified in Neftekumsk (548 ha) and Levokumsky (542 ha) areas, and the lowest in Turkmenistan (18 ha). Logging work is required in a large volume of Turkmen (3107 ha) and Apanasenkovsky (2192 ha) areas. The Turkmen district will need to make reforestation on the area of 805 hectares, the largest area of forest belts that require stubbing detected in Apanasenkovsky (199 ha) and Neftekumsk (188 ha) areas. At the same time, the quantitative composition and condition of forest belts cannot but cause concern among agricultural specialists. Afforestation of arable land by forest belts is extremely low – 2.5%.

5. Acknowledgments
The research was carried out according to the program "About the Federal target program "the South of Russia (2014-2020)" adopted by the Order of the Government of the Russian Federation on December 26, 2013 N 1297 in Moscow.

References
[1] Ryabov E I 1996 Wind erosion (deflation) and measures to prevent it (Stavropol: Kniga)
[2] Poluektov E V 2003 Erosion and deflation of agricultural landscapes of the North Caucasus (Novocherkassk: NGMA)
[3] Zhuchenko A A, Trukhachev V I, Penchukov V M et al 2011 Systems of agriculture of the Stavropol region (Stavropol: AGRUS)
[4] Hasai N Yu 2009 Improving the efficiency of environmental management on the basis of ecologically safe use of land resources for agricultural production, abstract of candidate thesis (Stavropol)
[5] Loshakov A V, Klyushin P V, Shirokova V A, Khutorova A O and Savinova S V 2019 Environmental problems of treatment of saline lands for agricultural needs in the first agro-climatic zone of the Stavropol territory South of Russia: ecology, development [in Russian – Yug Rossii: Ekologija, razvitie] 14(1) 105-116

[6] Gostishchev D P and Khutorova O A 2011 Agriculture the effect of the introduction of shelterbelts Environmental engineering 5 36-41

[7] Shapovalov D A, Klyushin P V, Shirokova V A, Khutorova A O and Savinova S V 2018 Problems and efficiency of land use in the North Caucasian federal district 18th Int. Multidisciplinary Scientific GeoConf. SGEM 2018 18(5.1) 667-674

[8] Zelepugin A 2010 Scientific basis of land monitoring classification Agricultural journal 1 50-51

[9] Larina G E 2010 Ecological control of agroecosystems state Actual problems of humanities and natural sciences [in Russian – Aktualnye problemy gumanitarnyh i estestvennyh nauk] 10 39-41

[10] Yurtaev A A 2011 Agrolandscape researches: theory and practice Scientific sheets of BelSU. Series Natural Sciences [in Russian – Nauchnye vedomosti of Belgorod State University. Serija Estestvennye nauki] 15 217-221