VANO PAPUNIDZE

WATER-REGULATING AND SOIL-PROTECTIVE FUNCTION OF MOUNTAIN FORESTS OF AJARA AND THE TECHNOLOGY FOR CREATING OF INDUSTRIAL PLANTATIONS

2025

The book deals with the results of studies of the transformation of environmental factors by forest ecosystems, anthropogenic changes and forecasts taking into account the long-term economic development of the regions. It provides an assessment of the forest resources of the republic, describes their environment-forming and environment-determining functions and shows the possibility of using forest ecosystems for environmental optimization of the region.

Based on the stationary hydrological methods of the conducted research, on the example of the territory of the small catchment basins of the mostly widespread mountain forests of the wetland and temperate climatic zone of Ajara, quantitative and qualitative characteristics of protective functions (soil protection, water protection, water regulation) and others (erosions, snow avalanches, landslides, etc.), as well as percentages of forest cover and optimal norms of research objects are provided.

As a result of excessive, unsystematic industrial-selective cutting in the mountain forests of Ajara, as well as in the mountain forests of Georgia in the past, production and extraction of timber is very limited, and the existing forests cannot even minimally meet the country's systematically growing demand for wood. Therefore, in order to avoid the excessive cutting of timber above the permissible norm, to reduce the expected negative agricultural impact on mountain ecosystems, and to restore degraded forest areas and improve their protective functions, based on the study of multi-year stationary-experimental trials, in a special part of the book, the technological processes and effective practical recommendations for the creation of industrial plantations of high-yielding, fast-growing woody forest varieties in the weakly swampy area of the Colchis plain are discussed.

The book is intended for foresters, geographers, scientific and engineering workers of forestry and other specialists working in the field of studying natural resources and environmental protection, ecologists and university students.

EDITOR:
Chagelishvili Revaz - Doctor of Agricultural Sciences, Professor, Academician of the Georgian Agricultural Academy of Sciences

EDITOR OF ENGLISH TEXT:
Siradze Tamar - Doctor of Philology, Professor

REVIEWERS:
Gavardashvili Givi - Doctor of Technical Sciences, Professor, Academician of the Georgian National Academy of Sciences
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Lomtatidze Zaur - Doctor of Biological Sciences, Professor, President of the Abkhazian National Academy of Sciences, Academician, Professor of Sokhumi University

COMPUTER SOFTWARE:
Donadze Mikheil - Doctor of Computer Science, Associate Professor

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FOREWORD

In modern conditions, a person has the power to directly influence the course of natural processes, but it is also clear that this ability is dialectically related to the creation of a real threat to the conditions of human existence. Of course, it is also necessary to take into account that we live in a really different natural environment, which requires a new revision of the views on the nature and consequences of ecological threats formed over decades.

Recently, a lot has been written about some of the dark sides of the scientific and technological revolution, which can lead to an ecological crisis. Unfortunately, this crisis is not an unreasonable threat. It is clear to us that ecology and problems related to it are the most serious pain of modern times, and in many cases, seemingly painless mistakes, become the basis of irreparable and destructive disasters in the future. In order to avoid this great danger, it is necessary, as some think, not to stop the scientific and technical progress, which is just as impossible as the reverse development of humanity, or to transform the biosphere into a technosphere, but to manage the most complex processes in nature more and more perfectly - consciously and intelligently regulating the relationship between man and the biosphere.

Today, there is no doubt that as a result of technical progress and the ever-increasing active economic impact on the environment, forests, as the main component of the biosphere and an irreplaceable factor on a planetary scale, are given global importance. And this is not accidental - despite the chemical and most important technological researches, instead of decreasing, the demand for the main forest product - wood is increasing day by day. But today, wood is no longer the most important product of the forest, because other components of the multifaceted value of forest resources are gaining no less national importance under the conditions of urbanization, industrialization and the development of public production in general. In this regard, first of all, the role of forest impact in stabilization and improvement of environmental conditions is noteworthy. Among the functions that create the environment, the most important is the influence of the forest on air and soil temperature, wind and hydrological regime, atmosphere, sanitary-hygienic level, water and wind erosion processes and others.

In the past, as a result of over-intensive involuntary-selective or industrial-selective cutting in the forests of Georgia, as a result of excessive felling of useful wood, a number of massifs were destroyed and left the field of forestry exploitation for a long time, there was a change of varieties on a significant area; they have lost water storage and other protective functions, large areas have been covered by evergreen undergrowth of bay-cherry, rhododendron and other shrubs, as well as weedy grasses that hinder natural regeneration; subalpine forests were especially damaged. The subalpine forests located close to the summer pastures are being cut down for heating and are strongly affected by unsystematic grazing, the natural renewal has stopped, due to which the irreversible process of lowering the upper natural border of the forest has developed; the vital environment-creating functions of forests have decreased; In the period after the Second World War, and especially in the 1950s, the widespread spruce blight significantly damaged the mountain spruce trees of Georgia, lowering their productivity. The unwanted disturbance of the balance in the plant biodiversity caused a significant change in the natural plant communities; important plant species have been destroyed and are on the verge of complete extinction.

The special relevance of the consistent development of forestry in Georgia derives from the peculiarities of the forestry sector of the republic.

About 40% of the total area of Georgia, or 2.8 million hectares, is covered by forests, of which about 600,000 hectares are protected areas, 850,000 hectares are other types of protected forests (for example, with a slope of more than 35 degrees), and 1,350,000 hectares are the so called usable forests. 98% of the forests are classified as mountain forests and 80% of them are located on slopes steeper than 35 degrees. 97.4% of the total area of the forest fund, according to the functional, i.e. farming purpose, belongs to reserved forests and valuable forest massifs, green zone forests around industrial enterprises and cities, prohibited zones along rivers and buffer strips along highways, resort forests. Therefore, important functions of forests as an ecosystem include protection from erosion, landslides and avalanches. Mountain forests also have other important functions of regulating water and soil regimes. 2.4% of the forests belong to the forests of the Colchis lowland and the forests along the beds of the Alazani, the Mtkvari, the Iori and other rivers. The forests of this group have exploitation and climate protection importance.

The center of attention of the Government of Georgia is to take all necessary measures to ensure the strong rise of forestry in the Republic, the further development and strengthening of the material and technical base of forestry, forest protection, effective use of forest fund lands, radical measures and their practical implementation.

The social impact of forests in Georgia is also worth noting. According to the estimation of the National Forestry Agency of the Ministry of Environment and Natural Resources Protection, the volume of wood cut per year is 604,400 m^3, of which 80% is given to provide firewood for the population. It indicates the strong dependence of the local population on the timber resources of the forest. Also, it should be noted that in 2006-2012, special licenses for timber production were issued for approximately 10% of forests on individuals and legal entities, which has further complicated the sustainable management of forests in the conditions of the existing situation in the forestry sector and the limited financial or human resources required for supervision. The high-slope distribution of most forests determines the specific technical requirements for forestry infrastructure, logging, and timber transportation, further complicating sustainable logging. If human influence on nature is not carried out correctly and we do not approach the use of self-regulating reserves of nature, and if we do not lay a solid scientific foundation for the management of processes in the biosphere, the ecological systems established over several million years will be disrupted, which can lead to severe irreversible consequences for humanity. This circumstance puts us in front of the necessity to give a scientific assessment to the ecological processes in nature and to take practical steps to prevent ecological disasters expected in nature.

Considering the function of forests as a vital ecosystem for the population, it is necessary to implement sustainable forestry practices throughout the country. Considering this opinion, in 2012 the Government of Georgia made a decision to change the existing forest management practices and introduce sustainable forest management. To achieve this goal, the Ministry of Environment and Natural Resources Protection of Georgia started the forestry reform. In particular, the functions of development, management and supervision of forestry policy were separated from each other, relevant structural units were created and strengthened, the process of development and implementation of the national forestry program was started. The planned reform in the forestry sector envisages changing the existing approaches to forest management, namely the creation of forestry farms and the introduction of an effective model of sustainable forest management based on long-term benefits in the country.

Despite all the above, there are still unsolved problems in the reproduction of forest resources. In particular, until today we do not have the qualitative and quantitative indicators of knowledge of the internationally recognized protective and other ecological functions of the forests of the above-mentioned category; we do not have a purposeful, rationally thought-out, scientifically based systematic system for optimizing forest ecosystems, which is very necessary from the point of view of environmental impact assessment of mountain forests.

Considering all the above, the book includes works on the water protection, water regulation and soil protection role of mountain forests. In them, actual material and results of forest hydrological studies in mountain forests in the complex of vertical belts of the wetland region of Western Georgia are presented, the results and scientific conclusions of the study of the characteristics of protective functions in small water catchment basins of different forests on the example of the Ajara Autonomous Republic.

The problem of interaction between forest, moisture and soil is considered in connection with the solution of tasks relevant for forest, rural, water and other branches of the national economy. The works provide quantitative assessments of the water-protection and soil-protection functions of forests. They can be used to develop the scientific basis for establishing optimal forest cover, the width of restricted forest strips along rivers and other measures aimed at the rational use and protection of the environment.

In a special chapter of the book, it is also brought to the attention of the extremely limited production and extraction of timber in Georgia, the inexorable rise of the country's forestry, the main forest products, the sharp increase of timber and the maximum improvement of protective functions, general instructions and practical proposals for the development of agro-techniques and technology for the creation of high-yield industrial plantations of fast-growing woody species in the weakly swampy area of the Colchis lowland.

I consider it necessary to draw attention to the fact that the problem of protecting the biosphere and its components (air, vegetation, soils, water, etc.) is one of those global problems, the processing of which and the solution of the issues related to it are possible only with the long-term mutual cooperation of scientists and practitioners of various interstate governmental, non-governmental organizations, scientific and research institutions.

I emphasize this especially because these kinds of events, such closeness to science, provide the basis and means to really tie together a single circle of science and production, and this connection is without any dividing line!

The work was carried out at the Tbilisi Institute of Forestry named after academician Vasil Gulisashvili (where the author worked for 9 years) and at the Batumi Botanical Garden of the Georgian Academy of Sciences (where the author worked for 34 years).

The work, together with literary sources, compiles a wide range of scientific-experimental material, published scientific works, monographs, manuals and practical experience, collected and analyzed by me for many years.

The author considers it his pleasant duty, with a great sense of gratitude, to express his deepest gratitude to the real member of the Georgian Academy of Sciences, the laureate of the state prize, academician Vasil Gulisashvili, and Valentin Protopopov, forester-ecologist, Doctor of Agricultural Sciences, Professor, honored scientist of the RSFSR, chief researcher of the V. N. Sukachev Institute of Forest of the USSR Academy of Sciences for their assistance while working on the topic.

The author

INTRODUCTION

> **"In general, the biosphere is characterized by great resistance to external influences. It is reflected in the fact that the biosphere is capable of undergoing profound changes of its structure, in which the flow of basic processes remains undisturbed… This plasticity gives a person a serious trump card, as it allows him to transform the biosphere on a large scale and use some of its elements for own needs. However, the transformation is restricted by certain limits, depending on the method of intervention and the ecological type under consideration, beyond which it threatens to disrupt the dynamic balance of the biosphere. Over vast areas, these boundaries have already been left behind, which has led to damage a significant part of the biosphere, the depletion of soil fertility and fresh water reserves, and the disappearance of many species of plants and animals. Man and human society are an integral part of the biosphere and are entirely dependent on its resources. Protecting the biosphere is a vital task for humanity."**
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> ***Use and conservation of the biosphere*, UNESCO, p.1**

Against the background of the mentioned UNESCO provision, it becomes quite clear that environmental protection and human health are inter-related.

Among the natural resources of the Republic of Georgia, the forest is one of the main priority natural resources, both from the point of view of the economic and the vital, multifaceted functional role of the mountain forests in a stable state.

Unfortunately, since the second half of the last century, in the conditions of energy crisis and economic hardship, the facts of unsystematic and intensive cutting of mountain forests have become more frequent, which is equivalent to destroying the land and water of our small land and mountainous country. Concerned by this fact, the Catholicos-Patriarch of All Georgia, Ilia II, addressed our population on October 10, 2000 in this way: "I would like to point out with a heavy heart that the events taking place in our country recently, which are related to the cutting of timber and its export abroad, have turned into an evil against the population of Georgia. If this process is not banned, we will witness great ecological disasters... Deforestation must be stopped."

The forest is a complex biological community that has a great impact on the environment, and it is also the object of human economic activity. The analysis of the forest resources of Georgia proves that the forests of the Republic are an irreplaceable universal resource, which has a significant role in meeting the increased multifaceted needs of the society, in the ecological optimization of the country, and is used multi-functionally. It should also be noted that the environmental and social functions of the forests of this region provide an effect of great national importance and are almost equal to the economic effect of the production base of these forests. In some places used for resort and recreational purposes, it is significantly higher (Khidasheli, Papunidze, 1976; Papunidze, 1981).

The mentioned problem, in connection with the development of the following events, puts on the agenda a thorough, complex scientific study of the mountain forests of the Republic as a complex natural ecosystem - the development of a system of appropriate and effective measures for the restoration and renewal of degraded, undervalued forest groves, determined in the right direction, the implementation of the recommendations of which should contribute to the maximum improvement of the protective functions (soil protection, water protection, water regulation, etc.) of the mountain forest, prevention of natural disasters (avalanches, landslides, floods, droughts, etc.). Both theoretical and practical scientific treatment of the mentioned problems is of particular importance in the conditions of the Republic of Georgia, for which, with the characteristic smallness of land, it is extremely important to use every hectare of agricultural land with the maximum effect, development of the livestock industry for normal living conditions of the population.

In the quite numerous works of an ecological nature published in our country in the last period, which are dedicated to the problems of the protective functions of mountain forests, there is a great difference of opinion. In this regard, we would like to emphasize one circumstance: it is a mistake to think that a part of scientists or scientific institutions should work on purely theoretical problems of ecological or economic nature of forestry. And the second part should examine only practical issues. Such a view on the research of any issue of forestry means neglecting the relationship between theory and practice, which is convincingly condemned (Gulisashvili, 1935). The study of theoretical issues of ecological problems of mountain forests is unthinkable in isolation from practice.

Raising the theoretical level of ecological research in forestry means, first of all, the scientific treatment of this or that problem based on a detailed analysis of rich factual material, which reflects the situation in individual formations of forestry, taking into account zonal features.

Any ecological research has a theoretical and practical value when it is based on generally accepted world standard methodology, a thorough scientific approach to the study of ecological phenomena, program directives, guidelines. At the same time, it must always be remembered that the study of an ecological nature, including the study of the environmental functions of mountain forests, which relies only on mainly individual cases, cannot be considered to be somewhat complete. Here it is necessary, first of all and more than anywhere, to express the process as a whole, complexly, taking into account all tendencies and determining their equivalent or their sum, their results.

It must be said that this very important methodological provision in the ecological research of forest ecosystems is not so rarely observed, which is why sometimes the conclusions made as a result of the analysis of ecological events do not correspond to the reality.

Taking into account the above-mentioned methodological references and the requirements of modernity, the present paper discusses the issues related to the role of the ecological functions of the complex natural ecosystems of Georgia, mountain forests in the biosphere, on the example of the mountain forests of the Ajara Autonomous Republic. Before discussing these issues, let us briefly dwell on the individual indicators of the natural conditions of Ajara, which determine the diversity of forests and some features characteristic of the general condition.

Ajara is the richest part of Georgia in forests. Within the temperate zone of the earth, there is literally no area that covers an area equal to Ajara and is distinguished by such a diversity and richness of the plant world - 1837 species growing wild in Ajara are recorded, which are united in 159 families and 742 genera, woody species are represented by 177 species (9.6%), including 57 trees (3.1%), shrubs - 71 (3.86%), lianas - 11 (0, 59).

Ajara forests, the area of which is equal to 65% of the total territory of the autonomous republic, are located unevenly, completely on different slopes of 21 degrees and more, in hard-to-reach, deep valleys and have important social functions in the ecological optimization of the region. Despite the high forest cover, the general condition of the forests cannot fully respond to the protective functions imposed on it, which is mainly due to the clearing of existing forest groves. This was also facilitated by the fact that previously 42.8% of Ajara's forests were occupied by collective agricultural forests, which were mostly located near settlements. In them, as a result of unsystematic cutting of high intensity by the population, the frequency and stock per unit of area are low. For example, according to the data of the recent past, if on average 197.9 m^3 of wood was obtained per 1 ha of the forested area of the State Forest Fund, it did not exceed 60 m^3 in the forested area of the collective agricultural forests.

Due to the pronounced vertical zoning characteristic of Western Georgia, as well as the whole of Georgia, we are dealing with sharp changes in natural, ecological, economic conditions and plant biodiversity in a small area, which leads to a great difference between the agricultural parts of individual forestry (economic purpose of groves, level of intensity of agricultural production and functional purpose of forests) and agricultural sections (growth of forests, composition production and condition).

Among the functions created by the environment, the most important are: the influence of the forest on air and soil temperature; on wind and hydrological regime; on the atmosphere; at the sanitary-hygienic level; on water-borne and wind-borne erosion processes; Balneological, recreational, agroforestry and improvement, as well as the importance of the forest as a reserve of valuable gene pool. It regulates and improves the country's water and climate regime, promotes the development of multi-terrain agriculture, protects against negative natural events (erosion, floods, avalanches, etc.).

Based on all the mentioned, the ecological and social functions of Georgia, and in particular the Ajara mountain forests, should be taken as the basis for administering the country's forestry. Let us briefly touch on the situation in the individual formations of the Ajara mountain forests from the point of view of the overall assessment of natural renewal and its determining reasons, taking into account the trends of changes in forestry conditions in connection with the increase of anthropogenic loads on natural complexes:

There are various reasons for the undesirable imbalance in plant biodiversity. In Georgia, it is mainly caused by the non-rational use of natural vegetation, the limitation of land beds, excessive, unsystematic cutting of forests, the disproportion between forest restoration and forest consumption for decades, the failure of natural pastures, and disordered cattle grazing. In addition to this, the harsh weather conditions characteristic of Georgia is added. All of the above-mentioned factors significantly disturbed the ecological stability of the mountain forests of our country, the disruption of protective functions, which was mainly manifested in the replacement of high-productivity forest species with devalued, deforested phytocenosis-producing species, in lowering the frequency of forest groves, in the creation of low-productivity groves with a simple structure, in the loss of the self-recovery ability of the main forest-forming species. The optimal afforestation of catchment basins is disturbed in the complex of vertical zoning of the forest. There is a very negative process of lowering the climatic boundaries of the subalpine forest and their degradation.

In this regard, the situation is particularly alarming in the alpine and subalpine belt, where due to deterioration of soil porosity caused by cuts and continuous, long and unsystematic grazing of cattle, the surface water runoff reaches the coniferous forest belt, where the soil receives a large amount of water. This, together with the formation of erosive processes and snow avalanches, leads to the activation of landslide events, i.e. the collapse of forested slopes.

In the high mountain areas of Ajara, due to the sharp thinning of the spruce-fir forest, due to the long-term influence of the cold winds blowing from the Alps, the process of natural renewal of the spruce and fir is completely stopped. In some places, under the influence of these factors, 30-40-year-old spruce and fir are drying up massively.

We live in an era of powerful development of science and technology. The greatest loss for humanity is the energy obtained as a result of military action, which destroys natural vegetation and animal world along with human destruction. Misuse of natural wealth, destruction of its resources, which is done by the use of weapons of mass destruction during war, puts the life of mankind in great danger. In August 2008, during the Russia-Georgia war, up to 1,000 hectares of valuable forest area was destroyed, and the largest part of useful animals inhabiting the forest was also destroyed. Due to the military action, the natural ecological balance of not only local areas, but also the entire forest massifs of the country was disturbed (Gavardashvili, 2009, 2017).

Therefore, when talking about the complex use of forest resources, one cannot fail to mention the modern global-ecological problems of environmental pollution with toxic chemical compounds. The results of urbanization, development of industry and transport, production of chemicals for agriculture, military action and other activities return to man like a boomerang in the form of life-threatening toxic compounds.

The 19th and 20th centuries clearly show us that the higher the development of society, the worse the ecological condition of the planet, the pollution of the environment with chemical toxins, which shows a constant growth trend, in the 21st century hung over humanity like a sword of Damocles.

Thus, it becomes quite clear what role forests have in terms of cleaning the atmosphere from impurities. But it is necessary to take into account the fact that everything has its limit. For example, an excessive increase in the concentration of carbon dioxide in the atmosphere can lead to the death of the forest itself. Such facts have already appeared in America, near Los Angeles and Chicago, in certain areas of Germany, Poland, the Czech Republic, Slovakia and a number of other countries.

Once again, we would like to emphasize that when we talk about the functional purpose of Ajara, as well as other mountain forests of Georgia, at the modern stage, maintaining the stabilization of forest cover in the country should be considered as a strategic direction. The further decline, reduction in frequency and disruption of the balance in biodiversity can lead to the activation of even more undesirable negative ecological processes and other negative events.

Scientific study of ecological and social functions of Georgian forests, solving theoretical and practical problems of optimal construction, high frequency and productivity, improvement of the best soil protection, water regulation, climate regulation and other useful socio-ecological functions is a very complex process. It depends on many interconnected factors, because it concerns the zonal peculiarities of the very complex vegetation ecosystems of the forests of Georgia, and especially the forests of the Autonomous Republic of Ajara, landscapes represented by many, different, diverse forest types, where, under the influence of pronounced vertical zonation, there is a very wide variety of natural, ecological and economic conditions, even in a relatively small area. Suffice it to say that almost all types of climate and soil typical for most different areas of the world occur in the republic. It is impossible to solve the problems based on one's own strength, it is necessary to develop a scientifically based complex program by specialists in forestry and related fields (soil science, climatology, ecology, botany, etc.). This will give us the opportunity to make the scientific analysis of the ecological events of mountain forests more grounded and logical, and ways to further increase the role of a specific forest and the effectiveness of its impact on the environment.

It must be said that in the conditions of Georgia, special research dedicated to the complex study of the problem of ecological functions of mountain forests is rarely found. The published papers are mainly devoted to the current situation in the forestry of the Republic and to the separate issue of restoration and renewal in relation to other problems. In this regard, it is worth noting the joint works on some interesting and important problems in solving ecological issues in Georgia (Chagelishvili, 1979, 1984; Chagelishvili, Papunidze, Abesadze, 1981), and, and, on the individual issues of which the discussion of the reports made by the author at various scientific sessions, conferences and meetings (both in our republic and in the former Soviet Union and foreign countries) provided an opportunity to clarify the positions.

In relation to the issue under discussion, the conclusions reached by research before us were significantly complemented by the section of the Scientific Council of the Academy of Sciences of the USSR "Problems of Forestry", the annual extended sessions of the "Ecological Function of the Forest", which was headed by Valentin Venyaminovich Protopopov, forester-ecologist, Doctor of Agricultural Sciences, Professor, honored scientist of the RSFSR, chief researcher of the V. N. Sukachev Institute of Forest of the USSR Academy of Sciences.

One such extended visiting session was held on November 1-4, 1989 in Georgia, namely in Khulo municipality. At the mentioned session, the report made by the author of the present paper about Georgia and in particular the mountain forests of Ajara, as the most complex region and relevant problems in many ways, also, on the basis of materials discussed at the session, theoretical and practical issues carefully studied and researched by well-known scientists participating in the session on the mountain forest ecosystems of different regions of the Soviet Union, a Resolution and practical recommendations were made.

It was the conclusions obtained as a result of the above-mentioned studies and the decision of the session that became the basis for the cessation of industrial forest cutting in Georgia for a certain period of time. All this, of course, is an unmistakable confirmation of what is derived from the needs, the course, the main content of which is that the tasks facing the mountain forests of the country can be solved only based on science and through the scientists.

Based on all of the above, taking into account the individual shortcomings that occur in the development of forestry production in the Republic, at the same time, proceeding from the well-known statement that scientific research should help to identify shortcomings and to determine ways to eliminate them, we considered it necessary for Ajara, as well as for all of Georgia, to include the full text of the Resolution of the session as a programmatic document of special importance in this book:

On November 1-4, 1989, the section “Ecological functions of forests” of the Scientific Council “Problems of Forestry” held an extended session. The session took place in the municipality of Khulo of Ajara Autonomous Republic and at the Batumi

Botanical Garden of the Academy of Sciences of Georgia. The meeting was attended by about 50 representatives from 25 scientific and industrial organizations.

Being complex natural ecosystems, mountain forests, unlike lowland forests, are more sensitive to various forms of anthropogenic impact, pascal, recreational and other loads and stressful weather situations. Being in a stable state, mountain forests perform a vital multifunctional role. The latter is especially clearly manifested in the formation of the flow of numerous mountain rivers, the water quality and optimal hydrological regime of which are largely determined by the condition and normal functioning of mountain forests. The anti-erosion role and anti-avalanche-protective function of mountain forests are extremely important. The meeting notes that the trend of deterioration in the condition of mountain forests continues everywhere. The situation is especially unfavorable in the mountain forests of the Caucasus. The condition of these forests is of particular concern here, since their irrational use and any stressful natural situation (landslides, avalanches, etc.) can lead to the degradation of mountain forest ecosystems and the loss of their stabilizing effect in natural complexes.

The meeting considers it reasonable to:

1. Concentrate efforts on studying anthropogenic changes in the ecological functions of mountain forests, developing assessment criteria and recommendations for the rational use of forests, taking into account their multifunctional role.
2. Pay attention to the rational use of forest ecosystems in resort and tourist areas, based on an ecological approach that provides for an optimal balance between forest, agricultural and resort complexes.
3. Recommend that the State Committee of the Republic of Georgia on Forestry and Nature Conservation prohibit final logging in the mountainous part of the Ajara Autonomous Republic for a period of 15-20 years. The State Committee of the Ajara Autonomous Republic for Forestry and Nature Conservation should strengthen control over compliance with the current rules of sanitary felling. Recommend tougher sanctions for loggers who violate current rules.
4. Consider it expedient to develop a long-term plan for the socio-economic development of the republic, taking into account the demographic situation until 2005.
5. In connection with natural disasters and the prohibition of final felling in the Ajara Autonomous Republic, ask the State Forestry Agency to allow, on a contractual basis, the supply of timber from densely forested areas of the country in the amount of 20 thousand m^3 per year.
6. Recommend that the State Committee of the Ajara Autonomous Republic for Forestry and Nature Conservation, together with specialists from the Institute of Mountain Forestry of the USSR State Forestry Committee and the Batumi

Botanical Garden of the Academy of Sciences of the GSSR, develop a system of reforestation measures for non-renewed felling, especially in the subalpine zone.

7. Taking into account the unique value of the gene pool of the flora and fauna of the republic, it is recommended that the State Committee of Georgia for Forestry and Nature Conservation designate specially protected areas in the basins of the Kintrishi, Korolistskali, Chakvistskali, Namtsvavistskali rivers and in the area of Mount Mtirala.
8. In order to mitigate the negative consequences of catastrophic disasters, recommend that district, village and town councils of workers' deputies strengthen control over the development and construction of a complex of engineering structures to protect national economic facilities (railways and highways) in particularly dangerous areas.
9. Consider it expedient for the State Committee of the Georgian SSR for Forestry and Nature Conservation, together with specialists from the republic's research centers, to make changes to the current rules for final felling, taking into account new data on the stabilizing role of the republic's natural complexes.
10. Considering the difficult ecological situation in the region, it is necessary to expand research on recreational forest management and the study of the protective functions of forests at the Institute of Mountain Forestry of the USSR State Forestry Committee and the Batumi Botanical Garden. Ask the State Committee for Forestry of the USSR and the Academy of Sciences of the GSSR to increase the staff and funding of the Institute of Mountain Forestry and the Batumi Botanical Garden to address this issue.
11. The Republican Society "Nature Conservation" and the Society "Knowledge" - strengthen the propaganda of environmental culture among the population.
12. In connection with the increasing recreational loads on the mountain forests of Crimea and the aggravation of the environmental situation in the region, it is considered appropriate to hold the next on-site meeting of the section in the city of Alushta on the basis of the Crimean GLOS in September-October 1990.
13. Consider it appropriate to publish the material and decisions of the section meeting. The publication of materials should be requested to be organized by the State Committee of the Ajara Autonomous Republic for Forestry and Nature Conservation jointly with the Batumi Botanical Garden of the Academy of Sciences of Georgia.
14. The meeting participants express gratitude to the Ajara Autonomous Republic, the State Committee of the Republic for Forestry and Nature Conservation and the Batumi Botanical Garden of the Academy of Sciences of Georgia for organizing and holding the meeting.

Taking into account the above circumstances, in this paper, on the basis of our own investigations, based on the latest methods of long-term stationary-trial-experimental research, characteristics of protective functions (soil protection, water regulation and water protection) in small catchment areas of mostly widespread mountain forests in Ajara are discussed, the comparative data of which served as the basis for the development of a scientifically based concept for improving the condition of the mountain forests of Ajara.

The important massifs of the forest of the Republic represent the main base of wood raw materials and the source of satisfying the population's demand for wood. In this regard, as we discussed above, from the reports of the deterioration of the state of the mountain forests of the Republic, it is clear that the production and extraction of timber is very limited, which put the necessity of planting artificial forest plantations for industrial purpose on the agenda.

Today, Georgia is directly involved in the multifaceted, economic and scientific relations between the West and the East. It is gradually becoming one of the most important places of tourism. If we also take into account that in summer, both the local population and the majority of tourists from different countries consider it necessary to rest and relax in the wooded mountain area, in the picturesque landscapes of the wide open space and forest, in excellent conditions arranged by the villagers as an individual resort, from this point of view, Ajara, with its unique location, will occupy a special place in strengthening these ties, it will be more visible and interesting for tourism.

In our opinion, a system of a number of measures of forest restoration, its protection and rational, reasonable use of forest resources discussed and developed, which ensures an economically and ecologically favorable combination of forest lands, taking into account their multifunctional role, will be of considerable use. The author plans to continue the further scientific research of the problem raised in this direction.

CHAPTER 1

Results of the Study of the Role of Water Protection and Soil Protection Mountain Forests of Ajara
Methods and Objects of Research

The research carried out by us belongs to the field of biogeocenology. Following V. N. Sukachev, forest types are understood as complex biogeocenological systems, many properties and qualities of which (composition, structure, productivity, etc.) are an external reflection of internal processes and interactions between the main components of forest biogeocenosis.

Methodical approaches to the implementation of the goals and objectives of the program for the protection of mountain forests, as the main vegetation of the planetary scale and the most important component of the biosphere, have been carried out by us for many years and were based on the ideas of V. Dokuchaev about the unity of natural complexes, the interconnection and interaction of all natural phenomena, which were further developed in the concepts of Verandsky and Morozov, covering the basic provisions of the forest.

We adhere to the views that when studying the multifunctional role of the forest, the vegetation of forest communities should be considered as complex dynamic self-regulating systems, the main functions and processes in which affect the state and dynamics of the biosphere (Gulisashvili, 1948; Gigauri, 1980; Melekhov, 1980; Protopopov, 1980, 1982, 1986).

Humans widely use various natural resources to satisfy their vital needs. Huge biological resources are concentrated in forest plant communities. It is obvious that in the future the use of wood and various forest products will be increasingly expanded.

At present, along with the biogeocenotic approach to the study of the biological productivity of forest plant communities, a new direction has been formed - resource science (Pozdnyakov et al., 1969; Papunidze et al., 2021). One of the tasks of this direction is to study the resources of wild useful plants in forest phytocenoses.

Water protection and soil protection functions of mountain forests of Ajara and their quantitative indicators were studied comprehensively on the basis of the study of the elements of the water balance (in the catchments) and the water-physical properties of soils, the main of which are the following: silvicultural and geobotanical studies and the study of anthropogenic impact on forest vegetation; ecological research on the study of some protective functions of the forest; research in the resource science aspect to study the biological resources of forest plant communities.

Forest typological, inventory and silvicultural studies and the study of the impact of anthropogenic loads on forest ecosystems were carried out according to generally accepted methods (Gulisashvili, 1956; Sukachev and Zonn, 1961; Pobedinsky, 1976; Makhatadze, 1966; Melekhov, 1980).

The main hydrological parameters in the catchment areas were studied by proven methods (Sokolovsky, 1958; Molchanov, 1962, 1968; Rakhmanov, 1962; Azmaiparashvili et al.; 1972; Fedorov, 1977).

Below is a detailed description of the objects of study.

In order to study the water-regulating and soil-protective functions of mountain forests and the hydrological regime of rivers depending on the percentage of forest cover of their basins, we organized experimental/stationary forest-hydrological studies at the level of small catchments. The research was carried out in three plant groups of Ajara, which differ greatly from each other in natural and climatic conditions:

In the Kobuleti forestry: a zone of excessive moisture, a belt of mixed broad-leaved forest, a region with slopes facing the sea and low watersheds - 4 catchments.

In the Keda forestry enterprise: a zone of moderate humid climate with cold winters and long cool summers; on the medium-altitude mountain of the Ajara-Guria range: a belt of chestnut, beech-chestnut and beech forests - 3 catchments.

In the Shuakhevi forestry: a zone of moderate humid climate with cold winters and short cool summers, typical for the alpine and subalpine belts of the highlands - 3 catchments (Fig. 1).

Fig. 1

A total of 10 catchment areas were selected.

In the region of excessive moisture, in the gorge of the Kintrishi River, four catchment areas of different forest cover were selected: 1 - 10%, 2 - 35%, 3 - 80%, 4 - 90%. Among the mountain belt in the gorge of the Latauri River, three drainage basins with different forest cover were selected: 5 – 20%, 6 – 60%, 7 – 90%. In the highland region, in the gorge of the Nagvarevi River, three drainage basins of different forest cover were also selected: 8 – 35%, 9 – 50%, 10 – 90%. In all ten points in the closing section of each catchment area of the mouths of the right-bank (Okhtomi stream and Chakhati stream) and left-bank (Kechieti stream and Tsiskvli stream) tributaries of the Kintrishi River, as well as the right-bank tributaries of the Lataurististskali and Nagvarevi Rivers, 10 Thompson-type measuring weirs were arranged at an angle of 90° with the installation of GR-38 liminigraphs, two water metering rivers on each of them and with the installation of “Valdai” water level recorders and other measuring devices on each of them (Fig. 2).

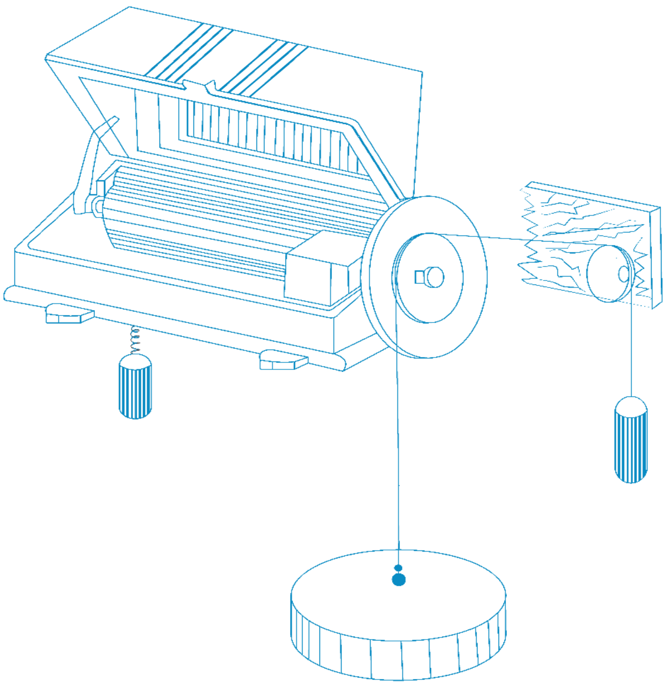

Fig. 2 (a)

The automatic self-recording device "Valdai" СУВ-М is intended for the recording of water level changes in the aqueducts and water reservoirs of small water catchment ponds of different forests on the form of the diagram. Technical data for recording water level changes of self-recorder СУВ-М - device description and principles of operation, special instructions for self-recorder installation and operation rules are attached to the "Valdai" СУВ-М device.

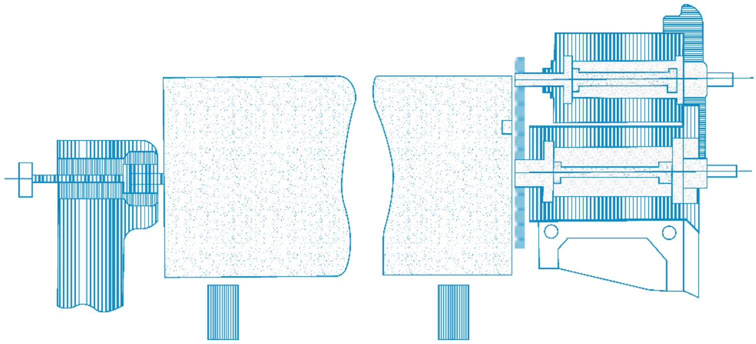

Fig. 2 b)

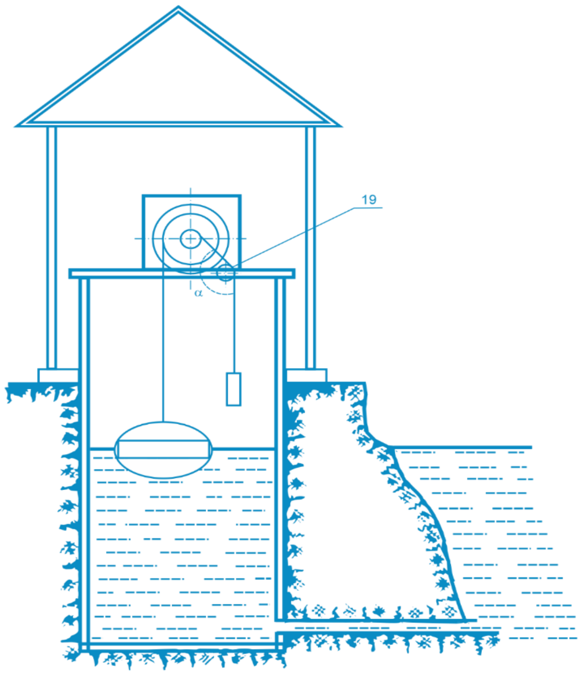

Fig. 2 c)

It should be noted that during the allocation of catchment basins and the construction of weirs, a comprehensive reconnaissance survey of objects was carried out in three regions in accordance with the consultations of Professor V. V. Protopopov (1975, 1980). At the catchments, work was organized to establish the geological structure of soils and their water permeability in order to identify the created flow conditions. Also, special attention was paid to determining the areas of individual weirs.

Comparison of catchment data with large-scale maps made it possible to accurately determine the area of individual catchments, after which runoff began to be monitored in the wet-wet region since 1977, and in the mid-mountain and high-mountain regions since 1987.

When organizing stations, catchments with a deeply cut channel and an underlying waterproof surface under the soil were selected, contributing to the complete drainage of catchments (Sokolovsky, 1958; Rakhmanov, 1962; Molchanov, 1966).

Observations of runoff elements were carried out according to the methodology developed by L. S. Azmaiparashvili, G. I. Kharaishvili, and R. G. Chagelishvili (Guidelines for Hydrological Stations and Posts and Methods for Studying the Water Protection Properties of Mountain Forests, 1972).

The greatest difficulty is the differentiation and accounting of solid runoff. The main regularities of the formation of this runoff, developed by G. V. Lopatin (1952) and S. I. Shamov (1959), are accepted by us as a basis for its study in small catchments. Moreover, in the weirs of small catchments, along with water runoff, it is possible to determine the intensity of soil washout by observing the runoff of solid and dissolved substances.

At the same time, one of the components of solid runoff – these sediments – can be determined after they settle in the useful volume of the weir; suspended sediments are based on the dependence of suspended sediment discharge on water discharge (Lvovich, 1963).

Accounting of incoming precipitation in the catchments was carried out by Tretyakov rain gauges, distributed evenly over the entire catchment area (10 units in each catchment). Catchments in individual regions are considered to have the same amount of rainfall on average, which was corrected based on the average of ground rain gauges and rain gauges installed in medium-sized windows.

The intensity of precipitation entering the catchments of individual regions was specified by pluviographs, the temperature of water and air on the weirs was measured by ordinary thermometers; relative humidity – by Asman psychometers; evaporation from the soil surface by evaporators of V. N. Popov (1963) with a significant improvement in the process of taking a soil monolith with an undisturbed structure.

The study of the main physical properties of soils in catchments and other objects was carried out by the Wigner method. The main attention was paid to the determination of total porosity, capillary duty cycle and water tightness.

Soils were taken in cylinders with a capacity of 1000 cm3, and on thin soils - with a capacity of 250 cm3. The total porosity was determined by the difference in the weight of the soil in full saturation with water and the absolutely dry weight of the same soil.

Capillary duty cycle - by subtracting the weight of the soil in an absolutely dry state from the weight of the soil saturated with water after two hours of soaking; non-capillary duty cycle – the difference in the weight of the samples at full saturation with water and after two hours of soaking.

The watertightness of the soil was studied by the method of I. Kopetsky (Gulisashvili, Stratanovich, 1935), both at natural humidity, directly at the objects of study, and after saturation of the monolith with water, and was determined by the time required for a 100 mm high column of water to seep into the soil.

The determination of water tightness after saturation of the soil with water was carried out in order to determine the time required for filtration under conditions of moisture capacity. Such soil conditions are observed during prolonged and intense precipitation, as well as during snowmelt, and are extremely important for preventing surface runoff and transferring it to infiltration.

In the course of the study, the main physical properties of soils in the upper (0 – 20 cm) and lower (20 – 40 cm) horizons were studied at the sites, since they are mainly the main recipients of rain and melt water.

All determinations were carried out with 8-12 times repeatability.

In addition, the following were determined: aggregation, mesan composition (according to Robinson), humus (according to Tyurin), nitrogen (according to Kjeldahl), PH (electrometric, glass electrode), volumetric weight (in the usual way), moisture (the difference in weight in natural occurrence and absolutely dry soil after drying).

Studies of the snow cover in the catchments: its thickness, density and amount of water reserves in the snow were carried out by the route method using the Lyuboslavsky weight snow meter (VS-43). The depth of soil freezing was determined before snow fell and under the snow cover by the presence of ice crystals of water in the soil pores.

The obtained numerical data on the water-physical properties of soils were processed by the method of variation statistics (Snedskov, 1962; Aptsiauri, 1972).

It is known that the method of Burger and Wigner for studying the physical properties of soils suffers from certain drawbacks (V. Z. Gulisashvili, A. I. Stratanovich, 1935), namely: at the moment of driving the cylinder into the soil with a wooden hammer or mallet, the cylinder deviates from the vertical position, as a result of which the structure of the monolith of the soil sample is disrupted.

We used the method of R. G. Chagelishvili (1965), which implies the use of cylinders with a closed metal nozzle with a diameter of 10.6 cm, a height of 40 mm, a thickness of 10 mm, a metal rod with a diameter of 90 mm, a height of 150 cm instead of a wooden beater and a nozzle used for a cylinder driven into the soil; as well as a metal bar weighing 10 kg with a hole in the center, which can move freely along the rod to the cylinder to be pushed into the soil, a head nozzle with a round hole in the center for screwing a metal rod is also adapted. A metal blank is put on the rod. The rod screwed to the nozzle ensures that the cylinder is driven in a strictly vertical direction in all terrain conditions. The place of contact between the nozzle and the beater is cone-shaped, so the blows made act in the same direction.

Thus, the taking of soil monoliths with an undisturbed structure is fully ensured, which is very important for obtaining reliable results and reducing labor-intensive field work.

In the study of the anti-avalanche protective functions of mountain forests, stationary and route methods were used (Chagelishvili, Dzebisashvili, 1982).

The study was carried out in almost all high-mountain areas in the forestry enterprises of the Autonomous Republic, subject to avalanche impact, taking into account the zoning of the forest fund of the republic (Gigauri, 1980), since on the basis of a wide change in anthropogenic and ecological factors in these conditions, the mutual influence of forests and avalanches is most clearly outlined.

At the level of stationary studies (Keda, Shuakhevi, Khulo), the features of avalanche initiation in the subalpine zone, the features of the origin and descent of avalanches in the zone of beech forests of medium density, the processes of intake, deviation, redistribution of snow precipitation, snow melting in forest and treeless biogeocenoses, the processes contributing to the origin of creeping avalanches, etc., were studied by means of direct empirical observations.

In the course of route and expedition studies, issues related to the structural elements of avalanche protective stands were solved according to the method developed by VNIIL (Chuenkov, Vlasov, 1977) and others.

The following were determined: 1) the places where snow avalanches were observed, 2) the nature of the avalanche-prone area: a) the steepness of the slope, b) the height of the a.s.l., c) the exposure, d) the state of the soil cover, e) the presence of forest on the slope, species composition, age, diameter, height, fullness of forest stands, etc., f) the length of the avalanche run above the upper boundary of the forest growth; 3) nature of the avalanche: a) size, area of avalanche collections, b) height of snow cover, c) traces of destruction; 4) frequency of avalanches (year, month, etc.).

In the course of route studies, the identification of individual anti-avalanche complexes was carried out. The latter were delimited on the basis of existing natural boundaries (Chuenkov and Vlasov, 1977).

In avalanche complexes, after the identification of anti-avalanche forest belts, relascopic and circular sample plots with a constant radius were taken using the selective-static method, where all inventory measurements were carried out in accordance with the recommendations of N. P. Anuchin (1982).

The following were determined: the sum of cross-sectional areas (using the prism of N. P. Anuchin), the number of trees; average height and diameter of forest stands; composition (in terms of the ratio of the sum of cross-sectional areas), age (with the use of the Pressler drill by taking model trees) and other taxation indicators.

The study of the growth and development of native tree species and forest cultures in the upper belt of tree vegetation growth was carried out by the method of N. N. Kobranov (1980). When studying growth by height, the length of the main shoot was measured with an accuracy of 1 mm, the increase in diameter was determined by a macrometer in the middle of the trunk segment between the whorls.

The study of the impact of forestry measures on the physical properties of soils, water-regulating and protective functions of forests was carried out in the forest stands of Kobuleti, Khelvachauri, Keda, Shuakhevi and Khulo forestry enterprises, in which various felling was carried out in the past.

The main physical properties of soils were determined according to the above-mentioned Wigner method. Effluent regulating and protective functions were studied permanently at runoff sites. In route studies, runoff was studied with a device for determining soil washability proposed by A. S. Voznesensky, M. S. Gagoshidze, and V. B. Gussak (1940).

In order to study liquid surface runoff at the objects of stationary studies, catchment areas (0-400-2500 m2 each) were allocated, bounded by boards up to 24 cm wide and 3 cm thick, planted in the soil up to half of their width in order to limit the tolerance of surface runoff from the outside of the site.

Surface runoff at runoff sites was measured in receiving catchment vessels with a capacity of 100 liters.

Runoff sites were laid in a diamond-shaped shape, since this shape achieves a uniform direction of runoff into water intake vessels and avoids the construction of ditches for the diversion of surface water flowing down from the upper part of the slope (Molchanov, 1962, Azmaiparashvili, Kharaishvili, Chagalishvili, 1972).

The study of the water-physical properties of the forest litter, as well as the change in these properties after the implementation of forestry activities in dynamics, was carried out by the Keda and Khulo forestry enterprises using the methods used in route studies. Particular attention was paid to the study of water capacity, water permeability and filtration capacity of forest litter, as well as the impermeability of soils covered and not covered with litter. The same methods were used to study changes in the water-physical properties of soils in dynamics, as a result of main felling and reforestation.

CHAPTER 2

Some Environmental Consequences of Anthropogenic Loads on Forest Vegetation of Ajara

Apart from logging, the forest vegetation of Ajara is significantly influenced by other forms of anthropogenic pressure, which, primarily in the conditions of Ajara, include agricultural activities, the use of forest ecosystems for recreation, the development of resorts, etc. In each specific case, the environmental consequences of various economic activities are determined by the natural features of the region, its socio-economic development (Gulisashvili, 1957; Eganov; 1963, Papunidze, 2012; Pobedinsky, 1976; Protopopov, 1970, Gavardashvili, 2010, 2011, 2017).

Without stopping to analyze the natural conditions of the region, we will consider the economic and social features of the republic.

2.1. Economic and social features of the republic

The area of the Autonomous Republic of Ajara is 2.9 sq. km and occupies 4.3% of the entire territory of Georgia. As of January 1, 2019, the population of Georgia was 3,723 thousand people, which decreased by 0.2% compared to last year. According to the National Statistical Center of Georgia, as of January 1, 2019, 58.7% of the total population of Georgia lives in urban areas. The number of residents of Ajara for this period was 349 thousand people, of which 151,400 (43.4%) were rural residents and 197,600 (56.6%) were urban residents.

The dynamics of the population, which is directly related to the human impact on natural complexes, is given in Table 1.

Due to the peculiarities of natural conditions and geographical location, the territory of Ajara is unevenly populated. In some areas there is a high concentration of settlements, in others there are few of them, although the number is large. The coastal part has the highest population density.

It should be noted that from 1917 to 1996 the population of all municipalities of Ajara grew. From 1996 to 2019, the population of Ajara decreased by 42,600 people. But the urban population has increased. The latter is associated with the resettlement of a significant part of the population from mountainous Ajara to coastal areas, which was associated with the rapid economic development of these areas. This process continues today (Komakhidze, 1971; Papunidze, 2012; Turmanidze, 2005).

Of the total territory of the Autonomous Republic of Ajara, the flat part makes up 1.7%, the foothills - 0.8%, and the remaining 97.5% - the mountainous region. Ajara is a land-poor republic: out of 290 thousand hectares of administrative territory, agricultural land accounts for 72,900 hectares, which is only 25.1% of the total territory of the republic.

In Ajara, about 59% of agricultural land is occupied by alpine and subalpine pastures and hayfields, the duration of which during the year is only 2.5-3 months. 41% of this land is arable land. According to official data, Ajara is the most land-poor among all the republics of the post-Soviet space (except Armenia). There is an average of about 0.2 hectares of farmland and 0.02 hectares of arable land per capita. In terms of land availability, Ajara is three times behind the Georgian indices on average.

Table 1

Population Dynamics of the Ajara Republic

Years	Population (thousand people)	Including		Percentage of total	
		Urban Population	Rural Population	Urban Population	Rural Population
1897	80,0	28,5	51,5	35,6	64,4
1917	76,7	20,0	56,7	26,1	73,9
1921	122,0	58,0	64,0	47,5	52,5
1940	204,4	79,2	125,2	38,7	61,3
1950	203,9	74,4	129,5	36,5	63,5
1960	251,3	113,1	138,2	45,0	55,0
1970	309,8	136,8	173,0	44,2	55,8
1975	337,1	151,8	185,3	45,0	55,0
1980	358,3	162,0	196,3	45,2	54,8
1985	372,0	169,4	209,6	44,7	55,3
1987	385,0	177,2	207,8	46,0	54,0
1994	423,0	189,1	233,9	44,7	55,3
1996	391,6	177,3	214,3	45,3	54,7
1997	374,0	169,8	204,2	45,1	54,9
2001	347,4	167,4	180,0	48,2	51,8
2002	342,1	166,9	174,4	49,0	51,0
2005	338,6	165,9	172,7	49,0	51,0
2014	333,2	184,2	149,0	55,3	44,7
2017	343,0	192,6	150,4	56,3	43,7
2018	346,3	195,2	151,1	56,4	43,6
2019	349,0	197,6	151,4	56,6	43,4

To illustrate the population density of Ajara, here is another comparison: according to the 2019 population census, 120 people live per square kilometer in Ajara, 83 people live in Imereti, which ranks second in terms of this indicator, and the overall figure for Georgia is 53.4 per square kilometer.

In the coastal regions of Ajara (Khelvachauri, Kobuleti) the number of rural settlements is smaller than in the inland regions (Keda, Shuakhevi, Khulo), but the size of these villages in terms of the number of inhabitants is twice as large as in inland Ajara. The formation of larger villages in coastal Ajara was facilitated by less dissected relief, a favorable geographical location and the development of intensive agricultural production.

Thus, the territory of the Ajara Republic is populated very unevenly. In some areas we encounter a concentration of settlements, in others there are few of them, but the number of inhabitants is large. Naturally, due to population growth, demands for land allocated for personal plots for both public and private use are increasing.

Based on the scarcity of land throughout Georgia and, in particular, Ajara, we consider it necessary to dwell on one more feature of this region: Ajara has a high animal density, for example, the number of cattle per 100 hectares of farmland is three times higher than in the rest of Georgia. In some areas, in areas suitable for pastures, 10-15 times more animals are grazed than required by the norm. On 60% of the territory of the Ajara forest fund, livestock grazing is not properly organized and significantly exceeds the norm.

Among the functions organizing the environment, the most important are: the influence of the forest on the wind and hydrological regime, soil protection, processes of water and wind erosion, etc. The forests of Ajara, which occupy 65% of the total territory of the republic, are located unevenly, on different exposures with a slope of 21 degrees or more, in inaccessible deep gorges, however, they perform a significant social function. The average density of a significant part of the forest area has today reached a critical point, as a result of which the forests have significantly reduced or stopped their ability to self-regenerate, and their ability to perform a protective function has also decreased.

Along with population growth, housing construction is expanding, the network of paved and unpaved roads is increasing, water consumption for domestic and agricultural needs is increasing, and forest exploitation, secondary and recreational use is increasing.

Excessive anthropogenic load on the natural complexes of Ajara, the oversaturation of some natural complexes with heavy engineering structures and agricultural use are the main reasons for the activation of landslides, mudflows and other negative processes in the republic.

In all these processes, large amounts of precipitation play a significant role. This is evidenced by the fact that in the winter of 1988-1989, due to particularly heavy snowfall and intense snow melting in the spring, 6 thousand families with a total of 20 thousand people found themselves in an avalanche zone in Ajara and were resettled in other regions of Georgia.

In 1976-1987, about 2,000 cases of snow avalanches, landslides and mudflows were recorded in Ajara. By the beginning of 1988, more than 700 families in the republic were in the zone of active natural processes, there were more than 300 active landslides, and 175 places where mudflows were expected to occur. Over the past 20 years, as a result of erosion processes, more than 1,600 hectares of arable land have become unusable (8).

An extremely important role in solving this problem belongs to the planned resettlement of residents from land-poor mountain villages to Aspindza, Adigeni, Tsiteltskaro and other areas where there is a significant reserve of unused land and a labor shortage.

The very low proportion of farmland, pastures and hayfields, the high population density determine that the economic and everyday interests of the absolute majority of the population of Ajara are closely connected with the forest.

Thus, the forest ecosystems of Ajara are affected by a full range of anthropogenic factors, which manifest themselves in various forms.

Without pursuing the goal of considering the consequences of all the various forms of anthropogenic influence, we will focus, firstly, on studies of the environmental consequences of cutting down the Colchis forest, the creation of eucalyptus crops, and the recreational use of forests in the coastal part of Ajara. Secondly, we investigated the consequences of livestock grazing in the subalpine forest belt. This is important because these forms of anthropogenic loads have development prospects in Ajara.

At the same time, the main attention in research is concentrated on studying the water-physical properties of forest soils. It is these parameters that are associated with the stability of forest ecosystems and the qualitative and quantitative manifestation of their protective functions.

To study the effects of recreation on forest ecosystems, we used research objects in the Batumi Botanical Garden, whose forest plant formations are representative of the coastal part of Ajara. The consequences of subsoil loads were studied in the subalpine forests of the Khulo forestry enterprise, which is a typical livestock-raising area of the republic.

2.2 Changes in the water-physical properties of soils under conditions of anthropogenic impacts on the vegetation cover of the coastal part and subalpine zone of Ajara

On the Black Sea coast of Ajara, in specific natural conditions, the large-scale introduction of technical and valuable subtropical plants (tea, citrus fruits, tung, bamboo, cryptomeria, eucalyptus, etc.) led to a radical change in the vegetation of the Black Sea coast. Essentially, a cultural landscape, anthropogenic in nature, has formed here.

The characteristic Colchis forests with their inherent numerous species composition have been preserved only in fragments and, in most cases, they are represented by highly thinned and degraded plantings (7, 9).

Under the conditions of the anthropogenic impacts that we have noted, which accompany the change in forest vegetation cover, at the same time there is a significant change in both ecological and, especially, edaphic environmental conditions. In this case, first of all, changes occur in the water-physical properties of the soil, which control the growth and development of woody plants.

The processes of formation of red soils in the mountainous and hilly part of Ajara are clearly expressed up to 400-500 m above sea level (2.16).

The most valuable materials concerning changes in the physical properties of red soils in connection with the reconstruction of the Colchis forests of the Black Sea coast of Ajara by tea and citrus plantations are found in the studies of Sh. D. Palavandishvili (7).

Among the works of an earlier period, the studies of M.K. Daraselia (3) and others should be noted. However, the question of what changes occur in red soils in the conditions of replacement of natural forests on the Black Sea coast of Ajara by introduced species, as well as during the recreational use of parklands, still remains unexplored.

In order to study the water-physical properties and temperature regime of red earth soils under the influence of the anthropogenic loads noted above, the following four sites were studied on the territory of the Batumi Botanical Garden of Georgia.

1. A plot of untouched Colchis Forest. Mixed beech-hornbeam planting with an undergrowth of Pontic rhododendron, cherry laurel, Colchis holly, etc. The density is 0.8-0.9, there is no herbaceous layer. Height above sea level - 90 m, slope of north-western exposure, steepness - 22^{o}.

2. A plot of cleared forest on a slope of western exposure, slope - 16^{o}, height 150 m above sea level. Vegetation consists only of grass cover.

3. A section of eucalyptus plantation on a slope with southwestern exposure, steepness 15-20^o, height 70 m above sea level. In the undergrowth there is acacia and a powerfully developed grass cover.

4. Walking areas of the “Lower Park”. Slope of western exposure, steepness 17^o, height 60 m above sea level. Mixed planting with a density of 0.6 from introduced conifers. (Japanese cryptomeria, fir, spruce, maritime pine).

The soils in all studied areas belong to the category of common deluvial red soils, belonging to the same genetic group. Below is a morphological description of the sections in the studied areas.

Section I - Natural Colchis Forest

A 0-3 cm - On the soil surface there is litter from half-decomposed leaves of chestnut, rhododendron, etc.

A 3-21cm - Fresh dark brown with dark veins of humus, loose composition, uniform color, medium-lumpy structure, heavy loamy, in the upper part it is abundantly penetrated by roots, manganese is found, the transition to horizon B is noticeable in color and composition.

B 21-68 cm - Fresh, brown, lighter than the previous one, the color is heterogeneous, in the lower part it is more uniform, there are small inclusions of manganese, there are many roots in the upper part, and fewer in the lower part, the structure is medium-nutty, the mechanical composition is heavier, there are dead roots, gradual transition to horizon C

C 68-190 cm - Wet, ocher color, heterogeneous color, compacted composition, small inclusions of manganese and a small amount of lithomargin are found, the structure is not expressed, there are few roots, the mechanical composition is heavy, a small amount of iron, ocher-ferruginous ones are found in the lower part of the horizon nodules, more quartz sand grains, gradual transition to the next horizon.

D below 190 cm - The weathering crust of andesite-basalts is represented by variegated material of undefined structure.

Section II – Forestless

A 0-22 cm - Dark brown, loose structure, uniform color, fine-lumpy structure, heavy loamy, there are many roots of herbaceous plants, on the surface there is litter of dilapidated grass, in the lower part there are dead roots, the transition to horizon B is noticeable by color and addition

B 22-53 cm - Fresh, light brown color, uneven color, a large amount of humus streaks on the surface of structural aggregates, amorphous ocher-colored iron concretions, small inclusions of manganese appear, the composition is more dense, the mechanical composition is heavy, the structure is medium-nutty, in the upper part there are many roots, and below there are dead, semi-decomposed roots, the transition to the C horizon is gradual.

C 53-158 cm - Wet color is ocher, the color is heterogeneous, the build is dense, and there are large inclusions of manganese, lithomarge, and amorphous iron. In the lower part there is a large number of quartz sand grains, there are few roots, the structure is not expressed, the mechanical composition is heavy loam, and the transition to the next horizon is gradual.

D below 158 cm - Weathering crust lithomarge (red), conglomerate.

Section III - Eucalyptus planting

A 0-18 cm - Fresh, brown, with dark veins of humus, loose composition, uniform color, fine to medium lumpy, heavy loamy, in the upper part abundantly penetrated by the roots of herbaceous plants. On the soil surface there is litter from half-decomposed eucalyptus leaves and the remains of grass and branches; in the lower part there are large ferruginous nodules, the transition to the B horizon is noticeable in color and composition.

B 18-40 cm - Fresh, the color is lighter than the previous one, brownish-brown, the color is heterogeneous, in the upper part there is a large amount of humus streaks, in the lower part the color is lighter: more uniform with individual spots of amorphous accumulations of iron, there are single small inclusions of manganese, the structure is fine- and medium-nutty, the composition is more dense, the mechanical composition is heavier, there are fewer living roots, semi-decomposed roots are found, the transition to the C horizon is noticeable by color.

C 40-120 cm - Moist, ocher-brown color, uneven color, compacted build. a large number of large inclusions of manganese and lithomarge, amorphous ferruginous nodules, the structure is not expressed, there are few roots, the mechanical composition is heavy loamy, a large number of quartz sand grains, the transition to the rock is darkened in texture.

D below 120 cm - The weathering crust is represented by variegated colluvium material of andesite-basalts.

Section IV - Lower part of the park (walking)

A 0-23 cm - Fresh, low-humus, brown, uniform color. In the upper part it is abundantly penetrated by plant roots, the structure is medium-clumpy, loamy, the transition to horizon B is noticeable in color and composition.

B 23-56 cm - The color is lighter than the previous one, brownish-brown, the color is uneven, and in the lower part it is lighter. There are single small inclusions of iron and small amounts of manganese. There are more roots in the upper part than in the lower part. The structure is medium nutty. The transition to the C horizon is gradual.

C 56-183 cm - Damp. The color is ocher-brown, the color is heterogeneous. There are a small number of small inclusions of manganese and iron. The structure is not expressed. The mechanical composition is heavy. The transition to the next horizon is gradual.

D below 183 cm - Weathering crust. Lithomarge red, conglomerate.

Structural analysis of the studied soils (Table 2) showed that the highest coefficient of structure (6.30) is characterized by the untouched Colchis Forest, followed by the soil under eucalyptus plantations (4.81). The treeless area has the lowest structure (K = 2.97), which accounts for the maximum share of the particle size fraction of 0.25 mm (12.7% for dry sifting of soil) and is characterized by a minimum value for the sum of water-resistant aggregates of 0.25 mm - 62.8%, whereas for the surface layers of soil under Colchis protected forest and eucalyptus plantations, it is 73.5% and 72.2%, respectively.

Table 2

Fractional composition of soils (layers 0-10 cm deep)

Objects of research	Fractional composition of soils (%) by sample weight															
	When dry sifting, fraction size (mm)								Coefficient structure	For wet sifting, fraction size (mm)						Sum of water collection aggregates <0.25
	10	10-7	7-5	5-3	3-1	1-0,5	0,5-0,25	0,25		5	5-3	3-1	1-0,5	0,5-0,25	0,25	
Plot of virgin Colchis forest (control)	5,8	6,9	7,9	17,8	34,7	7,8	11,2	7,9	6,30	16,9	12,7	24,7	8,8	10,4	26,5	73,5
Plot of 70-year-old eucalyptus plantation (introduced species)	12,1	7,8	11,8	19,2	25,1	6,2	12,6	5,1	4,81	32,5	14,6	17,0	4,3	3,8	27,8	72,2
A treeless area of un-renewed 100-year-old deforestation of the Colchis forest	12,5	11,4	11,0	17,5	24,2	3,8	6,9	12,7	2,97	15,3	17,1	18,5	4,8	6,9	37,2	62,8
Walking section of the lower park of BBG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

A study of the basic physical properties of the surface soil layer (Table 3) shows that the soil under the natural Colchis Forest has the highest non-capillary porosity (16.2% ± 0.27). It decreases to a minimum in cultures of established eucalyptus plantations

(11.7% ± 0.45). The non-capillary porosity of the soil drops significantly when forests are destroyed in long-standing, non-renewed felling (9.3% ± 0.58). The non-capillary porosity of the surface layer of soil in walking areas in parklands decreased especially strongly (4.2% ± 0.28). In the same sequence, the indicator of total soil porosity changes, which in the protected Colchis Forest is 66.3% ± 2.1; in a treeless area 48.8% ± 0.95; 51.3% ± 1.16 in eucalyptus plantations and 40.3% ± 2.00 for the walking area soil. The undisturbed surface layer of soil in the Colchis Reserve Forest has the lowest bulk density (0.521 g/cm3 ± 0.01). It increases greatly with high recreational loads in the walking area of the park (0.071 g/cm3 ± 0.01). The soils under eucalyptus plantations and in areas of non-renewed old clearings occupy an intermediate position. However, in the first case, the volumetric weight of the soil is significantly lower (0.603 g/cm3 ± 0.03) than in the second (0.746 ± 0.05).

Indicators of soil structure, its volumetric weight, especially non-capillary porosity, determine the infiltration capacity of the soil in the studied objects. It takes 0.61 minutes for a 100 mm column of water to pass through the surface layer of soil under the protected Colchis Forest. (±0.31), under eucalyptus plantations 1.69 min. (± 0.94), in the area of non-renewed old felling it increases significantly (15.25 min. ± 2.16) and reaches up to 40.15 min. (± 6.82) in the walking area of the park under introduced coniferous trees.

Table 3

Changes in the physical properties of red soils depending on the nature of anthropogenic impacts

Objects of research	Sample depth, cm	Duty factor, %			Volumetric weight of soil, g/cm3 M±m	Water permeability min. (filtration) M±m
		Non-capillary M±m	Capillary M±m	Total M±m		
Reserved Colchis forest (control)	0-10	16,2±0,27	50,1±0,62	66,3±2,1	0,521±0,01	0,61±0,31
Treeless area (non-renewed old clearings)	0-10	9,3±0,58	39,5±0,93	48,8±0,95	0,746±0,05	15,25±2,16
Ripe eucalyptus plantations (introduced)	0-10	11,7±0,45	39,6±0,98	51,3±1,16	0,603±0,03	1,69±0,94
Walking section of the lower park BBG (coniferous introduced species)	0-10	4,2±0,28	36,1±2,00	40,3±2,00	1,071±0,01	40,15±6,82

A more objective assessment of the existence of differences in the basic physical properties of red soils under various anthropogenic loads is confirmed by the data in Table 4.

Thus, from our research it follows that in the subtropical zone (coastal Ajara), red soils under undisturbed natural vegetation (Colchis Forest) are characterized by the highest water-physical properties. This is of great importance in preventing the development of soil erosion and maintaining the ecological stability of the mountainous and hilly part of the coastal zone of Ajara, where the amount of precipitation reaches 4000 mm per year.

Relatively slight deterioration in the water-physical properties of red soils is observed in areas under eucalyptus plantations. As a result of logging of the Colchis Forest, in areas where reforestation is taking place, the most severe negative change in the water-physical parameters of the soil occurs. Significant degradation of the surface layers of red soils is facilitated by high recreational load in areas under park introduced plantings.

Table 4

Reliability of the difference between individual indicators of water-physical properties soil depending on the nature of anthropogenic impact (Depth of 0-10 cm)

Comparable objects	Non-capillary duty cycle			Capillary duty cycle			Total porosity		
	M_{cp} %	T	W %	M_{cp} %	T	W %	M_{cp} %	T	W %
1	2	3	4	5	6	7	8	9	10
Colchis forest Felling	16,2 9,3	10,77 10,78	99,9	50,1 39,5	9,48	99,9	66,3 48,8	7,59	99,9
Colchis forest Eucalyptus planting	16,2 11,7	8,57	99,9	50,1 39,6	9,05	99,9	66,3 51,3	6,25	99,9
Colchis forest Walking area	16,2 4,2	30,85	99,9	50,1 36,1	3,19	98,5	66,3 40,3	8,97	99,9
Eucalyptus planting Felling	11,7 9,3	3,27	98,9	39,6 39,5	0,07	50,0	51,3 48,8	1,67	50,0
Eucalyptus planting Walking area	11,7 4,2	14,15	99,9	39,6 36,1	1,57	80,5	51,3 40,3	4,76	99,8
Felling Walking area	9,3 4,2	7,92	99,9	39,5 36,1	1,54	80,5	48,8 40,3	3,84	99,5

1) M_{cp} – average value of the indicator; 2) T – the significance of the difference between the average values of the indicator; 3) W – chance of probability

Table 5

Dynamics of herbaceous plant species depending on the degree of recreational digression in Colchis type forests (density 0.3-0.5)

Latin Name of plants	Stages		
Latin Name	**I**	**II**	**III**
Polinia nuda Trin.	Cop.	Sp.	Sp.
Paspalum digitaria Poir.	Sp.	Sol.	Sol
Agrostis alba L.	Sp	Sp	Sol
Calamagrosisarudinacea (L.) hort.	Sp	Sp	Sp
Poa annue L.	Sol	Sp	Sp
Festuca-montana M.B.	Sp	Sp	Sol
Brachypodium silvaticum (Ands) R.B.	Sp	Sp	Sol
Hordeum Curopacum (L.) All.	Sol	Sol	Un
Plantago maior L.	Sol	Sp	Sp
Galanthus Woronowii A.Los-Los.	Sol	Sol	Un
Paris incomplete Bieb.	Sol	Sol	-
Tamus communis L.	Sol	Sol	-
Aristolochia pontica Lam	Sol	Sol	-
Helleborum caucasicus A.Br.	Sol	Sol	Sol
Corydalis caucasica DC.	Sp	Sp	Sol
Dentarya quinquefolia MB.	Sp	Sol	-
Hellaria medica L.	Sp	Sol	-
Fragaria viridis Duch.	Sol	Sol	Sol
Malva silvestris L.	Sol	Sol	Sol
Hypericum perforatum L.	Sol	Sol	Sol
Viola scotophylla jord.	Sol	Sp	Un
Circea lutetiana L.	Sp	Sol	-
Sanicula europaea L.	Sol	Sol	Un
Aegopodium padarraria L.	Sp	Sol	Un
Primula sibthorpii	Sol	Sol	-
Cyclamen ibericum Stev.	Sol	Sol	-
Trachystemon orientale	Sol	-	-
Aiuga reptans L.	Sol	Sol	-
Salvia glutinosa	Sol	Sol	Un
Brunella vulgaris L.	Sol	Sp	Sp
Glechoma hederacea L.	Sol	Sol	-
Lamium album L.	Sol	Sol	Un
Scropularia nodosa L.	Sol	Sol	-
Campanula-ranunculoides L.	Sol	Sol	Un
Lampsana communis L.	Sol	Sol	-
Solidago virgaurea L.	Sol	Sol	-
Doronicum orientale Hoffm.	Sp	Sol	-
Trifolium pratense L.	Sol	Sp	Sp
Geum urbanum L.	Sol	Sol	Un

Notes: 1) Name of plants according to A.A. Dmitrieva (3)
2) Stages of digression according to Drude [(citation: V.Z Gulisashvili (1)]

At the same time, with a change in the water-physical properties of the soil, a transformation of its thermal regime is observed in the studied objects. Compared to the untouched Colchis Forest, in areas subjected to various anthropogenic loads, there is an increase in average air temperatures at various depths, and the amplitudes of their fluctuations increase. The most contrasting changes in the soil temperature regime noted above manifest themselves in non-renewed deforestation, as a result of the destruction of the Colchis Forest.

Taking into account the prospect of increasing recreational loads on Colchis-type forests and the poor knowledge of the issue, we conducted research on the influence of this type of anthropogenic impact on the transformation of herbaceous plants. The mechanical impact of recreants on herbaceous vegetation growing under the canopy of plantations and changes in environmental parameters in the soil cover determine its species dynamics and condition (Table 5).

With increasing recreational loads on forest ecosystems, which are reflected in the stages of plant digression, the total number of species in the grass cover is reduced, and the indicators of their projective cover change, primarily due to typical forest grasses. Particularly vulnerable in this regard were tuberous and rhizomatous forest grasses, the rudiments of which are located in the soil no deeper than 15 cm (cyclamen, snowdrop, corydalis, etc.).

Broad-leaved forests (trachistemon, doronicum, warthog, golden rod, urban gravilate) also showed instability. Bluebells, dead nettles, ferruginous sage, etc., as well as small herb species: chickweed, and violet, are being replaced. Among cereals, European barley is being replaced first. The most resilient were annual bluegrass and reed grass. As the recreational load increases, an increase in the number of individuals and an increase in the projective cover of plantain, which tolerates wounds caused by recreational overload of the area, becomes apparent (Polyakov, 1971; Protopopov, 1970; 1975).

Depending on the recreational load, the ratio of various ecological groups in the cover also changes greatly (Table 6).

The averaged data given in Table 2.5 indicate that with increasing recreational load, the relationship between different ecological groups of herbaceous plants changes sharply. In particular, the number of typical forest grasses changes greatly, the number of meadow and especially weed grasses increases, which tolerate both soil trampling and changes in light and temperature conditions in recreational plantings.

Colchis broad-leaved forests are characterized by an abundance of vines (sarsaparilla, ivy, periploca, etc.). In recreational plantings, the crowns of trees are densely entwined with sarsaparilla, in which case these trees become inaccessible to recreationists, they are well preserved from recreational damage.

Table 6

Participation of environmental groups in the formation of living ground cover in recreational plantings

Stages of digression	Total average amount of herbs per 1 m^2	Including, in %		
		forest	meadow	weedy
I	297,1	95,6	3,4	1,0
II	186,4	53,5	29,3	17,2
III	148,7	23,4	20,3	51,3

In contrast to the dry and moderately humid areas of Georgia, in the humid subtropical zone of the Batumi coast, not only the lush development of grass cover is observed, but also its excessive humidity. Therefore, in plantings of the second stage of digression, there is a strong decrease in the number of herbaceous individuals, especially forest ones, which differ in "tenderness" from meadow and, especially, pastoral grasses.

Waterlogging of the soil cover is one of the factors contributing to the destruction of soil aggregates. Because of this, recreation is primarily focused on plantings on steep slopes, rather than on flat ones, where water often stagnates.

Similar studies were carried out in the belt of subalpine forests of the republic, which are subject to partial deforestation and are intensively used during the growing season for grazing and recreation. The main attention in these studies was paid to the study of the water-physical properties of mountain-forest-meadow soils, which, along with mountain-meadow soils, are common in the subalpine forest belt of Ajara, located within 2100-2400 m above sea level (Dmitrieva, 1990; Papunidze, 1990; Khidasheli, Papunidze, 1976).

Research was carried out at the following three sites:

Fenced forest (since 1977), before isolation there was free grazing of livestock.

An area of completely cleared forest, with intensive grazing throughout the growing season.

An area of unfenced forest, partially cut down, with intensive trampling of livestock during the movement of livestock to pasture and back, and a recreational load on average of 15-20 people per day per 1 hectare during the growing season.

The soil of the experimental plots is typical mountain-forest-meadow, of medium and heavy mechanical composition, with sandy loam products of weathering of the main rocks. The profiles of all soil sections are represented by a system of horizons A-B-C-D, with a total thickness of up to 1 m; their morphological features are identical, so we provide only one description of a typical section:

A 0-10 cm - Dark gray, humified, well structured, fine-lumpy structure, loose, medium loamy. There are large quantities of roots of herbaceous plants. The transition to the next profile horizon is noticeable.

B 10-24 cm - Heterogeneous in color, interspersed with humus, crushed rock fragments with a diameter of 10-15 cm, and the remains of dead roots. There are fewer living roots compared to horizon A, it is compacted, and the mechanical composition is heavier. There are no signs of illumination. The structure is medium (large) lumpy, inclusions and admixtures of manganese, the transition to the next horizon is gradual.

C 24-65 cm - Lightened, uneven in color, structureless, light loamy, roots are practically absent.

D below 65 cm – Light loamy to sandy loam, lighter and more uniform.

The results of the structural analysis of the surface (0-10 cm) layer and soil at the sites (Table 7) showed that for the studied soils the predominant aggregate size is from 1 to 3 cm (dry sieving).

The content of this fraction from 21.9% to 42.8% of the total number of aggregates prevails in the composition of the fractions, regardless of the area where the samples were taken. This is apparently a genetic characteristic of the structure of these soils, because similar results can be found in some classification studies related to the structure of mountain-forest-meadow soils in Ajara. For example, according to the structural analysis of the surface layer of 2-12 cm of a typical mountain-forest-meadow soil, the maximum proportion of aggregates (during dry sieving) falls precisely on the 3-1 mm fraction (3-2 mm = 14.90%, 2-1 mm = 31.11%). However, the content of the fraction is different for each site. Thus, the maximum number of fractions (based on the results of dry sifting) was noted on the soils of a treeless area with intensive grazing. In areas of unfenced, partially cut down forest and fenced areas of plantings, the amount of this fraction is reduced by almost 2 times.

However, in the soils of these last two areas the content of large fractions increases: 3-5 mm, 5-7 mm, 7-10 mm and more than 10 mm, while in the treeless area the destruction of large structural particles occurs and their content here is much lower. This is due to highly intensive, constant grazing of livestock, which explains the increase in the structure coefficient, although this phenomenon requires more in-depth scientific research. Fencing the site, as the results show, led to the restoration of the structure of large fractions - this is evidenced by the highest proportion of fractions: 10, 10-7, 5-3 mm. The content of fine fractions of 0.5-1 mm, 0.15-0.5 mm and less than 0.25 mm in the soil of a treeless area significantly exceeds the total proportion of soils in other areas.

Table 7

Structural analysis of soil (layer 0-12 cm)

Place where samples were taken for analysis	Fractional composition of soils (% of sample weight)															Sum of permeable aggregates 0.25
	For dry sifting, fraction size, mm								Coefficient	For wet sifting, fraction size, mm						
	10	0-7	7-5	5-3	3-1	1-0,5	0,5	0,5-0,25		1-5	5-3	3-1	1-0,5	5-0,25	0,25	
Treeless area with intensive grazing	3,1	5,3	5,8	15,3	42,8	4,0	10,6	13,1	5,17	8,3	16,3	35,5	8,7	7,6	23,6	76,4
Unfenced partially felled forest (recreational load and periodic short-term grazing of livestock)	14,6	15,9	15,0	18,4	25,2	3,6	5,0	2,9	4,71	35,4	12,8	7,3	3,3	2,6	28,6	71,4
Fenced area of forest (for 13 years)	17,7	16,0	14,3	20,5	21,9	2,6	4,1	2,9	3,85	40,1	18,5	13,3	3,3	3,7	17,8	82,2

Thus, the analysis data show the presence of a destructive effect of clear cuttings and intensive grazing on the structural and aggregate composition of soils. They indicate a decrease in the proportion of large fractions and an increase in the number of small aggregates compared to the fenced forest area. When fencing, the aggregative state of the soil is restored.

Wet sifting of soil samples showed that the 1-3 mm fraction of aggregates that predominates in the soil of a treeless area is little susceptible to the destructive effects of water, while larger fractions turn out to be insufficiently water-resistant, they are destroyed in water and the amount of these fractions here is significantly lower than in the soil under a fenced area and an unfenced, partially cleared area of forest. A fenced area of forest is characterized by a maximum content of water-resistant aggregates greater than 5 mm. The destruction of the soil structure of a treeless area is maximum: the fraction of fractions up to 1 mm and less here is almost 40%; in the soil under a fenced forest area and in an area with partial deforestation, the content of aggregates less than 1 mm is equal to 25 and 35%, respectively. Partial destruction of aggregates in a treeless area and in an unfenced, slightly deforested area of forest leads to an increase in the proportion of fractions less than 0.25 mm and, consequently, an increase in the sums of fractions of 0.25 mm, i.e. sums of water-resistant aggregates, which is the maximum share for a fenced forest area (82.8%). In a treeless forest area with intensive livestock grazing and in an unfenced area of sparse forest, which is trampled by livestock during the period of moving herds to pasture and back, and the recreational load is 76.4 and 71.4%, respectively, the sum of water-resistant aggregates.

Thus, the fencing of forest ecosystems in the conditions of the subalpine belt of Ajara contributes to the restoration of the structure of the surface layers of mountain-forest-meadow soils, which is also reflected in the results obtained from the study of the basic water-physical properties of areas of different nature and degree of anthropogenic impact (Table 8).

Table 8

Basic water-physical properties of soils in the subalpine zone under conditions of various anthropogenic influences

Objects of research	Sample depth cm	Duty factor in %			Volumetric weight of soil, M ± m	Water permeability, min. (filtration) M ± m
		Non-capillary, M ± m	Capillary, M ± m	Total M ± м		
Fenced area of forest (for 13 years)	0-10	10,2±0,18	7,5±0,30	59,7±0,32	0,681±0,03	42,0±2,3
Unfenced partially felled forest (recreational load and periodic short-term grazing of livestock)	0-10	8,4±0,15	47,8±0,58	56,2±0,49	0,735±0,19	118,0±1.5
Treeless area with intensive grazing	0-10	7,9±0,18	45,8±0,19	53,7±0,27	0,913±0,0,25	174±2,0

As follows from the table, the fenced area of the forest is characterized by the highest value of the non-capillary porosity index (10.2% ± 0.18), followed by the soil in the unfenced area with partially cleared forest, experiencing recreational pressure and periodic short-term grazing (8.4% ± 0.15) and a treeless area with intensive grazing (6.9% ± 0.18). The overall porosity indicators change in the same sequence - 59.7% ± 0.32, 56.2% ± 0.49 and 53.7% ± 0.27, respectively. The surface layer of soil has the lightest volume and weight in the fenced forest area (0.681 ± 0.03). The heaviest - in a treeless area with intensive grazing (0.913% ± 0.25); in an unfenced area of partially cleared forest, the volumetric weight of the surface soil layer is 0.735 ± 0.13. The indicated values of non-capillary porosity and volumetric weight of the soil determine the water permeability of its surface layer in the study areas. The infiltration capacity of the surface layer of soil in a treeless area experiencing intensive livestock grazing and in an unfenced area of partially cleared forest with recreational load and periodic short-term trampling by livestock is greatly reduced. To pass a column of water 100 mm high in the above options, it takes 174 minutes ± 2.0 and 118 minutes ± 1.5, respectively, whereas when fencing the area, it is 42.0 minutes ± 2.3.

The significant difference in the results we obtained on the basic water-physical properties of the surface layers of soils in various types of impacts is confirmed by mathematical processing of the experimental material (Table 9).

Table 9

Reliability of the difference between individual indicators of water-physical properties of soils (depth 0-10 cm) depending on the nature of anthropogenic impacts in the subalpine forest belt of Ajara

Comparable objects	Non-capillary duty cycle			Capillary duty cycle			Total porosity		
	M_{cp} %	T	W %	M_{cp} %	T	W%	M_{cp}%	T	W%
1. Fenced area of forest (for 13 years)	10,2	7,60	99,9	47,5	0,46	50,0	59,7	5,98	99,9
2. Unfenced area of partially cleared forest (recreational load and periodic short-term grazing of livestock)	8,4			47,8			56,2		
1. Fenced area of forest (for 13 years)	10,2	9,00	99,9	47,5	4,71	99,8	59,7	14,33	99,9
2. Treeless area (intensive grazing)	7,9			45,8			53,7		
1. Unfenced area of partially cleared forest (recreational load and periodic short-term grazing of livestock)	8,4	2,13	90,5	47,8	3,28	98,5	56,2	4,47	99,8
2. Treeless area (intensive grazing)	7,9			45,8			53,7		

Thus, as a result of unregulated livestock grazing and recreational loads, the water-physical properties of mountain-forest-meadow soils and, to a large extent, the structure of the surface layers of soils are greatly deteriorated, porosity indicators and, especially, non-capillary porosity of the soil are reduced. As a result of these changes, the infiltration capacity drops significantly, which is decisive in ensuring the water protection functions of the highlands of Ajara.

The above-mentioned anthropogenic and liberating loads are the main cause of snow avalanches, erosion and landslide phenomena and a decrease in the upper limit of the subalpine forest (Fig. 3, 4).

The fencing of degraded areas in the belt of subalpine forests of Ajara, the cessation of all kinds of negative anthropogenic impacts in them for 13 years contributed to the suspension, and according to some signs, even a noticeable improvement in the structure and basic water-physical properties of the surface layers of the soil.

In conclusion, the following should be noted. Under the influence of anthropogenic loads in the coastal part of coastal Ajara, a large area of the land fund is occupied by a cultural landscape, anthropogenic in nature, represented by artificial subtropical plants (tea, citrus fruits, tung, bamboo, cryptomeria, eucalyptus, etc.).

Fig. 3

A decrease in the non-capillary porosity of the soil as a result of unsystematic logging and grazing of livestock, a deterioration in the water permeability of deep soils, leading to the development of water erosion and landslide phenomena (Shuakhevi forestry enterprise, altitude 1900 m above sea level)

Fig. 4

Intensive logging and open forests on steep slopes do not retain snow cover, therefore, snow avalanches have become more frequent, which causes damage to forests, people's economy and local population.

The Colchis-type forests characteristic of this part of the republic are represented in fragments. They are greatly sparse and are at various stages of digression. Under the influence of increasing recreation, a change in environmental conditions occurs here, which entails a change in the species composition in the living ground cover and a loss of stability of plantings.

First of all, plantings on steep slopes are subject to strong recreational influence, but not on plains that are heavily waterlogged. Therefore, forestry activities aimed at maintaining the stability of forest ecosystems (including "forest at rest") should be carried out mainly on slopes.

Similar activities, but coordinated with the natural features of the sub-alps, should be carried out in the subalpine forests of Adjara. In the future, the problem of raising the upper limit of the forest to the climatic limit of its distribution must be solved. Both for forests of the Colchis type and for subalpine ones, more reliable scientific justification for the norms of recreational and pascal loads is required (Papunidze, 1990; Khidasheli, Papunidze, 1976, 1981).

CHAPTER 3

Brief Characteristics of Forest Hydrological Objects

For the sake of brevity, below is a description of only stationary objects of study of small catchment areas selected and organized by three regions of Ajara that are very different from each other in natural and climatic conditions and vegetation groups: in the Kobuleti forestry enterprise in the zone of excessive moisture (excess precipitation 2200 mm per year, of which 2030 mm in rain, 140 mm in solid), in the Keda forestry enterprise in the zone of moderate humid climate of the middle mountain region (average annual precipitation 1300 mm, of which 1420 mm of rain, 330 mm of heavy rain) and the Shuakhevi forestry in the zone of humid climate with relatively cold winters and long cool summers of the highland region (average annual precipitation is 1700 mm, of which rain is 1200 mm, 500 mm is solid). The characteristics of the objects of route research, as well as the elemental catchment areas are given in the text.

In the region of excessive moisture in the gorge of the Kintrishi River (Kobuleti forestry, state reserve), the surface of the area of stationary studies is strongly indented by deep gorges, the relief of the foothills and mountains of the subtropical zone.

The average elevation of the catchment area is 400 m (200-300 m), the average steepness of the slopes is 30-35°. The climate is humid and subtropical, precipitation, mainly rainfall, falls almost evenly throughout the year. Stable snow cover is formed extremely rarely, in the middle upper part of the catchments.

The geological structure of the area is dominated by andesites and basalts. The main types of soils are: red soils, yellow-brown and brown forest soils.

Forests are mixed, of different ages of subtropical nature, represented mainly with the predominance of chestnut, alder, etc., with an admixture of species of the Tertiary period.

When farming in these forests (bringing the completeness to 0.5-0.5), evergreen understory species such as Rhododendron Ponticum, laurel, etc., are strongly developed. At the same time, the presence of evergreen understory species contributes to the maintenance of favorable water-physical properties of soils.

The forests of this region have been greatly modified under the influence of subtropical agriculture. Everywhere, on steep slopes (20-30°) up to 600 m above sea level, tea and citrus plantations are planted and grown.

Below (Table 10) are the characteristic data of the elements of the watercourses of the Kintrishi River

Tab. 10

Characteristics of watercourses in the Kintrishi River (Region of excessive moisture)

Catchment Basin	Gorges with weirs	Forestation, %	Exposure against gorges	Basin height above sea level			Watercourse Length, km^2	Perimeter length, km^2
				highest	lowest	area km^2		
1	Okhtomis-Gele	10	NE	490	220	0,717	1,105	3,280
2	Chakhatis-Gele	35	NE	600	300	0,625	1,010	3,110
3	Kechietis-Gele	80	NW	610	280	0,594	0,950	2,805
4	Tsiskvilis-Gele	90	NW	650	260	0,518	1,130	0,900

The data given in Tab. 10 indicate the comparative homogeneity of catchments according to these characteristics. Their main difference is the forest cover of the catchments - the ratio of areas open to forested and not covered by them.

Site 1. Catchment area of the Okhtomis-Gele River. The catchment area is 71.7 hectares, the forest cover is -10% (the area not covered with forest). Measuring weir - 4, installed at the mouth of the Okhtomis-Gele River. The basin includes deforested areas of farmland. The area of the drainage basin by land category is distributed as follows:

Forested area:

Plot A - Alder-chestnut forest stand with a density of 0.1-0.2 with cherry laurel - 7.1 ha (10%).

Un-forested area:

Plot B - haymaking-pastures 40, 1 ha

Plot C - Tea plantation 19.5 ha 64.6 ha (90%)

Plot D - farmland (arable land) 5.0 hectares

In general, the catchment area of the Okhtomis-Gele River is a relief cut by drains with a deeply incised channel; slope 30-35^0; the soil in the lower part of the catchment area is yellow-brown, in the upper part it is brown forest. In terms of mechanical composition, these soils are heavily loamy and clayey; water resistance of units - high; the soil surface is covered with a rapidly developed subtropical high grass.

Below are the indicators of the water-physical properties of the soils of the catchment area (Table 11).

The data indicate that the soil (horizon 0-20 cm) of the Ochtomis-Gele catchment, some of its sections with alder-chestnut forest stands (0.1-0.2 density), are characterized by low, but at the same time comparatively homogeneous indicators of total porosity (50.3-56.2%), non-capillary density (7.9-3.3%), water permeability (18-29.0 min.), etc.

Table 11

Indicators of the main physical properties of soils (layer 0-20 cm) covered and not covered with forest at the back of the catchment area of the Okhtomis-Gele River (Site 1)

Plot A - Alder-chestnut stand With density -0.1-0.2				Plot B - hayfield pasture				Plot C – Tea plantation			
total porosity %	non-capillary density, %	water permeability in min.	vol. weight g/cm³	total porosity %	non-capillary ensity, %	water permeability in min.	vol. weight g/cm³	total porosity %	non-capillary density, %	water permeability in min.	vol. weight g/cm³
55,1	9,8	25,0	1,095	52,0	6,8	42,0	1,380	51,6	8,2	28,0	1,201
58,0	6,4	15,0	1,125	50,4	6,4	36,0	1,200	56,0	8,6	29,0	1,120
54,2	9,4	14,0	1,120	49,2	8,8	29,0	1,221	54,2	6,8	32,0	1,213
55,1	7,4	18,0	1,200	48,8	8,2	39,0	1,306	55,8	6,6	26,0	1,117
54,3	8,2	17,8	1,133	50,5	7,4	47,0	1,118	55,0	9,2	29,0	1,243
56,3	8,0	20,0	1,135	50,8	7,8	42,0	1,178	54,0	9,6	30,0	1,260
57,1	9,4	19,0	1,084	49,8	8,0	38,0	1,210	54,8	8,8	28,0	1,210
59,4	11,8	14,0	1,257	50,9	9,6	37,0	1,197	52,2	6,2	30,0	1,293
Aver. 56,2	8,8	18,0	1,135	50,3	7,9	38,0	1,220	54,2	8,0	29,0	1,199

Low indicators of soil water permeability, with comparatively high values of non-capillary density, indicate the presence of constant natural soil moisture in this region.

Site 2. Drainage basin of the Chakhatis-Gele River. The catchment area is 62.5 hectares, the forest cover is -35%.

Measuring weir -5, installed at the confluence of the Chakhatis-Gele River, covers deforested areas, tea and citrus plantations with its basin.

The area of the drainage basin by land category is distributed as follows:

Forested area:

Plot A - Alder-beech forest with a density of -0.4-21.8 hectares (35%).

Deforested area:

Plot B - tea plantation 12.8 hectares

Plot C - citrus plantation 10.0 ha 40.7 ha (35%)

Plot D - pasture 17.9 hectares

The Chakhatis-Gele catchment area (catchment area 2) is identical to the previous catchment 1. "The parent rock in all catchments is represented mainly by andesites and basalts. The catchments are distinguished by forest cover. In the Chakhatis-Gele catchment area, 35% of the catchment area is covered with forest. The distribution of forest stands is mainly strip. The main mass is located in the upper part of the basin along the watershed across the slope, the smaller part - along the drains. The forests of this drainage basin are represented by mixed-age, mixed stands with a density of 0.4.

The most characteristic group of forest types in this catchment area is chestnut forests with evergreen undergrowth (*Castanetun-Laurocerasum*, *Castanetun - Rhododendrosum*.).

Water-physical properties of soils in individual sections of the Chakhatis-Gele catchment basin: non-capillary density, water permeability, volumetric weight, etc., from individual sections of the catchment area of 35%, forest cover, which differ from each other (Table 12). The above primarily applies to areas covered with alder-beech trees with a density of 0.4, tea and citrus plantations of pasture (section D), characterized by relatively low values of these indicators.

Table 12

Indicators of the main physical properties of soils (layer 0-20 cm) covered and not covered with forest in the catchment basin of the Chakhatis-Gele River (Site 2)

Plot A - Alder-chestnut stand With density -0.4				Plot B - Tea plantation				Plot C – Citrus plantation				Plot D - Pasture			
total porosity %	non-capillary density, %	water permeability, min.	vol. weight g/cm^3	total porosity %	non-capillary density, %	Water permeability, min.	vol. weight g/cm^3	total porosity %	non-capillary density, %	Water permeability, min.	vol. weight g/cm^3	total porosity %	non-capillary density, %	Water permeability, min.	vol. weight g/cm^3
54,1	8,0	20,0	1,205	61,6	7,5	29,0	1,195	54,0	8,0	27,1	1,254	61,0	7,0	31,1	1,200
56,2	9,1	16,0	1,216	55,4	7,8	35,0	1,225	55,8	8,2	28,0	1,116	61,8	7,6	30,2	1,293
58,0	9,4	16,0	1,011	49,9	6,6	37,0	1,311	53,2	6,4	29,0	1,202	48,6	5,6	36,1	1,270
58,8	0,9	13,0	1,116	54,0	8,6	26,1	1,108	56,1	8,9	25,0	1,104	49,1	5,8	36,0	1,262
56,6	8,5	14,0	1,006	52,4	7,6	32,2	1,200	52,2	6,0	31,1	1,320	55,0	8,0	32,0	1,204
57,3	8,7	16,0	1,008	51,8	7,0	30,0	1,109	53,0	6,5	31,3					
57,0	8,8	19,0	1,054	52,2	7,2	30,2	1,234	54,4	7,6	26,0	1,200	49,9	6,2	40,1	1,300
58,8	0,2	14,0	1,184	55,1	7,7	36,5	1,293	59,7	10,8	26,5	1,124	54,2	8,9	35,5	1,234
Aver. 57,1	9,2	16,0	1,100	52,8	7,5	32,0	1,210	54,8	7,8	28,0	1,200	50,9	6,8	36,0	1,260

Site 3. Catchment basin of the Kechietis-Gele River. The catchment area is 59.4 hectares; forest cover is 30%.

Measuring weir-6 was installed at the confluence of the Kechietis-Gele River with the Kintrishi River. The catchment basin covers forest areas and non-forest areas - farmland. The catchment area by land category is distributed as follows:

Plot A - hornbeam-beech-chestnut forest stand - 47.5 hectares (80%).

Deforested area:

Plot B - tea plantation 8.4 hectares

Plot C - 3.5 ha tunga plantation, 11.9 ha (20%)

The main distinguishing feature of this catchment from the previous ones, in addition to those indicated in Tab. 1 should be considered the predominance of the percentage of the forested area equal to 47.5 hectares.

Forested area (plot A) - composition: 6 chestnut 2 beech, age - 90 (30-120) years; completeness 0.5; DSR = 42 cm; HCP = 20; the most common group of forest types, is chestnut forests with evergreen undergrowth (*Castanetura Lauro-cerasosun; Rhododendrosum*).

Table 13

Indicators of the main physical properties of the upper soil horizons (0-20 cm layer) of forested and non-forested areas of the Kechietis-Gele River catchment basin (Site 3)

Plot A – Hornbeam-beech-chestnut stand With density -0.5				Plot B - Tea plantation				Plot C – Tung plantation			
total porosity %	non-capillary density, %	water permeability, min.	vol. weight g/cm³	total porosity %	non-capillary density, %	Water permeability, min.	vol. weight g/cm³	total porosity %	non-capillary density, %	Water permeability, min.	vol. weight g/cm³
62,8	10,0	10,1	1,110	53,6	7,8	56,4	1,398	52,9	8,0	47,2	1,518
59,6	10,1	11,2	1,109	53,0	7,6	54,0	1,620	55,0	9,8	38,0	1,574
60,9	10,5	12,0	1,038	55,1	7,9	48,0	1,628	52,6	6,8	40,0	1,530
66,8	12,0	13,0	1,076	54,2	8,2	55,0	1,500	57,3	9,6	30,2	1,580
60,0	9,8	12,2	1,220	55,0	8,9	46,0	1,548	56,9	9,7	36,2	1,500
58,0	7,0	16,1	1,200	54,6	8,3	49,0	1,596	53,8	7,0	39,3	1,498
62,0	7,8	16,0	1,140	53,0	7,5	57,4	1,611	54,5	8,4	45,0	1,468
64,3	11,2	13,4	1,009	56,7	8,6	53,2	1,733	56,2	5,5	50,3	1,593
Aver. 61,8	9,8	13,0	1,119	54,4	8,1	52,0	1,580	54,9	8,1	42,0	1,536

Vegetation, which is the main factor influencing the complex processes of transformation of environmental factors in this catchment area, is represented by subtropical mixed forests of the Colchis type, consisting of edible chestnut, beech, alder, oak, persimmon, fig, boxwood, linden, etc. The data characterizing the water-physical properties of the upper horizons of the soils of forest and non-forest areas are given in Table 13.

Indicators of water-physical properties of soils, from the catchment area 80% of the forest cover (Table 4), indicate that individual areas of this catchment are characterized by heterogeneous values. For example, the site covered with alder-beech stands (average density 0.5) is characterized by relatively high indicators of water-physical properties of soils. The above is equivalent to the indicators of total porosity, capillary density, volume weight, etc. In particular, the volume weight of the soil on the site occupied by the tung is 1.536 g/cm^3, which indicates a strong compaction of the upper soil horizons.

Site 4. Ciskvilis-Gelė river catchment area. The catchment area is 51.3 hectares, the forest cover is 30.3.

The catchment area of the Tsiskvilis-Gele River, which covers forest areas of the same name with its basin, borders the previous catchment area (30% of the forest cover) and differs from it in higher forest cover and the density of forest stands equal to 0.7. Measuring weir 7 is installed at the confluence of the Tsiskvilis-Gele River with the Kintrishi River.

The distribution of forested and non-forested areas by land category is as follows.

Forested area:

Plot A - a mixed alder-beech-chestnut forest stand covered with 46.62 hectares or 90% of the total catchment area, a characteristic group of core forest types is the same as in the previous catchment.

Non-forested area:

Plot B - citrus plantation 2.44 5.18 ha (10%)

Plot C - haymaking-pasture 2.74 ha

The forested area is characterized by the following description:

Plot A - NW exposure; slope 30-35°; altitude of 500 m. Alder-beech-chestnut stand.

Composition: 45k 4K 1201 100 (30-120) years old, mixed with oak, Imeretian oak, persimmon, ash, linden, boxwood, figs, etc. The density of trees is 510-620 pieces per 1 ha; Der=40 cm; N.sr=20 m. Undergrowth of beech and linden, in gaps, satisfactory. In the sparse underbrush there is laurel, rhododendron, staphylea, holly, etc. The cover is mostly dead.

A_0 06 cm. Continuous fall of leaves and branches of chestnut, beech, alder, laurel, etc. at different stages of decomposition.

A_1 6-18 cm. Color is dark, dirty-brown. Grainy-powdery, fresh with fine gravel. Compacted, densely penetrated by roots, medium loam, very moist. The transition is clear.

B_1 18-30cm. Brownish-yellowish, nutty structure, medium loam, more compacted: inclusions of roots and fragments of the material rock (andesite), moist. The transition is clear.

C_1 30-35 cm. Brownish-yellow, yellow tone intensifies with depth. Lumpy-nutty, moist, dense loam, fewer roots with a very large number of small fragments of rocks.

The values of the indicators of water-visual properties of soils, individual sections of this catchment area, are given in Table 14.

Table 14

Indicators of the main physical properties of soils (layer 0-20 cm) covered and non-forested fertility of the Tsiskvilis-Gele river catchment area (Site 4)

Plot A – Hornbeam-beech-chestnut stand, with density -0.5				Plot B - Citrus plantation				Plot C – Pasture			
total porosity %	non-capillary density, %	water permeability, min.	vol. weight g/cm^3	total porosity %	non-capillary density, %	Water permeability, min.	vol. weight g/cm^3	total porosity %	non-capillary density,	Water permeability, min.	vol. weight g/cm^3
61,6	10,0	10,0	1,210	56,0	8,2	15,0	1,231	57,1	6,8	53,0	1,440
62,0	12,0	9,0	1,157	55,6	6,6	23,0	1,337	55,9	5,9	49,0	1,425
60,3	9,8	16,0	1,200	53,2	7,1	25,0	1,245	54,2	6,2	45,0	1,305
59,8	9,9	10,0	1,177	58,8	7,2	18,4	1,416	58,0	9,5	38,2	1,338
62,9	10,8	13,0	1,082	57,1	6,9	26,0	1,327	53,9	6,0	42,0	1,495
66,5	12,7	8,2	1,009	56,9	8,4	20,2	1,309	56,7	9,9	34,2	1,554
67,0	13,5	8,0	1,012	56,9	10,0	22,4	1,275	55,4	6,6	44,4	1,429
63,7	8,5	15,0	0,953	56,0	8,0	26,0	1,500	52,8	5,1	62,2	1,455
Aver. 63,6	10,9	12,0	1,100	56,2	7,8	22,0	1,330	55,5	7,0	46,0	1,442

Thus, in terms of geomorphological structure, forest growing conditions, as well as in terms of water-physical properties of soils, the objects of study (catchment basins 1, 2, 3, 4) of the excessively moist region of Western Georgia with different forest cover are generally characterized by similar indicators. First of all, this applies to the morphology of the soil profile.

On the other hand, within the boundaries of individual catchments, depending on the height above sea level and the nature of the presence of vegetation, there are differences. For example, for tea and tunga crops (Table 15); and also in the lower parts of the catchments, soils with a heavy clay mechanical composition prevail, in other parts of the catchments and in some areas there are loamy varieties of these soils.

Table 15

Mechanical Composition of Soils of the Studied Catchment Areas in the Excessively Wet Region of Georgia

Location of the Site	Horizon and depth, cm	Particle size, mm; fraction content, %						
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	< 0,001	< 0,01
1	2	3	4	5	6	7	8	9
Site 4: height above sea level 500 m Alder-beech-chestnut stand Density 0,7	A_1 6-18 B_1 18-30 C_1 30-75	20,6 20,7 24,8	33,7 36,9 39,5	22,3 17,7 15,5	4,9 5,2 1,5	9,9 10,9 8,7	8,6 8,6 10,0	23,4 24,7 20,2
Site 3: height above sea level 500 m Hornbeam-beech-chestnut stand Density 0,5	A_1 2-10 B_1 10-30 B_2 30-70	10,0 16,1 11,6	32,6 31,5 11,9	19,7 18,9 41,2	10,0 6,5 20,3	12,3 12,9 10,0	15,4 14,1	37,7 33,5
Ibid, height above sea level 450 m, vil. Chakhati vicinities, Tung plantation	A_1 3-28 B_1 28-48 C_1 48-70	8,0 2,0 4,2	16,1 6,1 8,8	13,2 22,1 20,0	14,0 10,4 10,1	19,5 20,4 20,9	29,2 39,0 36,0	62,7 69,8 67,0
Site 2: height above sea level 450 m. vil. Chakhati vicinities, Citrus plantation	A_1 0-10 A_1B_1 10-30 B_1C 30-70 C_2 70-100	17,9 17,5 20,2 29,0	38,0 30,8 39,7 36,7	21,1 24,5 17,9 3,6	8,8 11,3 11,3 19,1	13,6 13,7 3,4 6,6	7,8 2,9 7,5 5,0	30,2 27,9 22,2 30,7
Site 1: height above sea level 450 m vil. Chakhati vicinities, Tea plantation	A_1 0-6 A/B 6-31 B/C 31-74	0,8 0,9 0,7	19,2 15,4 13,6	19,2 13,9 19,6	7,6 13,0 15,2	27,0 28,2 19,9	26,2 28,6 31,0	60,8 69,0 66,1
Ibid, height above sea level 400 m, Hayfield, pasture	A_1 3-27 B_1 27-50 C_2 50-100	0,3 31,2 33,7	25,7 23,9 31,9	31,4 11,1 7,6	12,8 0,2 2,2	12,8 19,9 13,1	17,0 13,7 11,5	42,6 33,8 26,8

In terms of water resistance of aggregates (Table 16), increased stability associated with rapidly developed phytomass, subtropical forest and grass vegetation is almost universally noted.

As for the main indicators of the water-bearing properties of these soils, there is a more or less relative homogeneity of these values.

A significant increase in the indicators of general breed and non-capillary density in excessively humid conditions is noted only in areas covered with forest, primarily high-density (see Table 14).

In general, in areas with a predominance of forested covered area, the total porosity of soils is on average -53.6%, non-capillary density -10.9%, water permeability is determined by -12.0 minutes. In areas covered with forest, the water permeability of soils, even after 3-5 days of cessation of precipitation, is extremely difficult, and in areas not covered with forest, the soil becomes almost permeable.

Table 16

Aggregate Analysis and Some Chemical Indicators of Soils of the Studied Catchments in the Excessively Wet Region of Georgia

Location of the Site	Horizon and depth, cm	Humus %	Nitrogen %	pH (H_2O)	Particle size, mm; fraction content, %				
					3	3-1			
1	2	3	4	5	6	7	8	9	10
Site 4: height above sea level 500 m, Alder-beech-chestnut stand Density 0,7	A_1 6-18 B_1 18-30 C_1 30-75	12,4 7,2 1,6	0,62 0,36 0.08	5,5 5,4 5,3	61,08 52,04 46,32	23,64 22,72 26,40	9,12 11,08 15,28	98.84 85,84 88,00	6,16 14,16 12,00
Site 3: height above sea level 500 m, Hornbeam-beech-chestnut stand, Density 0,5	A_1 2-10 B_1 10-30 B_2 30-70	10,3 5,1 1,1	0,51 0,25 0,05	5,4 5,3 5,2	25,6 28,72 37,48	47,16 39,88 25,12	12,04 12,08 4,84	84,80 80,68 67,44	15,20 19,32 32,56
Ibid, height above sea level 450 m, vil. Chakhati vicinities, Tung plantation	A_1 3-28 B_1 28-48 C_1 48-70	7,8 1,6 0,3	0,39 0,08 0,01	5,1 5,1 5,0	72,72 60,8 53,4	14,84 23,56 29,04	1,48 5,24 4,24	89,04 89,64 86,68	10,96 10,36 13,32
Site 2: height above sea level 450 m. vil. Chakhati vicinities, Citrus plantation	A_1 0-10 A_1B_1 10-30 B_1C 30-70 C_2 70-100	10,0 2,6 0,8 0,2	0,50 0,13 0,04 0,01	5,3 5,3 5,1 5,0	18,32 33,32 38,12 35,76	49,36 40,88 37,44 43,04	20,28 14,36 18,12 13,0	88,36 88,56 91,68 91,80	11,64 11,44 8,32 8,20
Site 1: height above sea level 450 mvil. Chakhati vicinities, Tea plantation	A_1 0-6 A/B 6-31 B/C 31-74	8,6 8,2 0,67	0,43 0,41 0,03	5,2 5,1 5,0	56,08 57,52 28,36	28,48 20,24 48,88	2,56 2,52 9,68	87,12 80,28 86,92	12,88 19,72 13,08
Ibid, height above sea level 400 m, Hayfield, pasture	A_1 3-27 B_1 27-50 C_2 50-100	7,2 2,3 0,26	0,36 0,11 0,03	5,2 5,0 5,0	35,68 17,24 40,12	44,72 37,44 29,4	10,16 20,48 15,12	89,56 75,16 84,64	10,44 24,84 13,36

The volumetric weight of the forest canopy and, consequently, on the areas covered by them varies within the range of 1.100-1.135, i.e. this indicator under the forest canopy is always less in comparison with the areas covered by them (61.3.0-1.442).

If we compare the data on the water-physical properties of the soils of the catchment areas of the insufficiently moistened and waterlogged regions, the relative heterogeneity of these indicators will become apparent.

According to the morphological description of the soil sections of the study sites in the region of insufficient moisture in terms of mechanical composition, it is medium loamy, belongs to the type of forest brown soils. Under the canopy of forest stands, they are characterized by the presence of a thicker forest litter, loose composition of the upper soil horizons and a nutty-lumpy structure.

Areas not covered with forests are characterized by a dense grass cover that forms a turf horizon, and the soil is characterized by a poorly expressed structure and dense composition.

In the region of excessive moisture, despite more or less significant indicators of non-capillary density, as well as their comparative identity in values, on almost all areas covered with forests and not covered by them, there is a significant deterioration in water permeability and volumetric weight. In this region, there are significant values of non-capillary density and total porosity, but the latter has almost no effect on water permeability.

This unusual phenomenon has already been noted in Gulisashvili V. Z. and Stratanovich A. I. (1935), Azmaiparashvili L.S. (1961), Azmaiparashvili L.S., Dvalishvili O.I. (1974), Chagelishvili R.G. (1975, 1977) in the study of water-physical properties of soils on monoliths of non-artificial composition artificially saturated with water.

The above is explained by the partial filling of non-capillary pores of the soil with water, which in arid and moderately humid conditions of the habitat are filled with air and contribute to intensive seepage of water inside the soil. In excessively moist conditions, these pores are filled with water and the reception, as well as the distribution of systematically incoming precipitation within the soil, is very difficult, and sometimes becomes almost impossible.

These and other features accompanying the climate of different types (arid, excessively moist) cannot but affect the formation and distribution of precipitation and runoff in catchments with different forest cover in different conditions (Chagelishvili, 1975, 1979, 1931).

In the region of moderately humid climate of the medium-altitude mountain of the Ajara-Guria ridge in the area of the Latauristskali river (Keda forestry), the forestry, where the sites of our study are located, covers the north-eastern part of the Keda administrative district of the Ajara AR.

The surface of the forestry is mountainous, very sparse by deep rivers and ravines cutting through the territory in all directions. The average altitude above sea level is 1300 m; the average steepness of the slope is 30-35°.

The climate of the station belongs to a subtropical climate similar to the Mediterranean type with moderately cold winters and hot long summers, which, in altitude, turns into a moderately dampish climate, with cold summers on the mid-mountain mountains of the Ajara-Guria, Shavsheti and Arsiani ranges.

The amount of atmospheric precipitation can be taken as an average of 1500 mm. Stable snow cover is formed from December. Rocks of two formations take part in the geological structure of the area: volcanogenic and mountainous rocks.

The main body of soils are brown forest soils. Below in Table 17 are given characteristic data of the elements of the Lataurististkali River watercourses.

The data given in table 8 indicate a comparison of the surface homogeneity of the catchments. The main distinguishing factor is the forest cover of the catchments.

In order to study the flow conditions in the catchments in the most in-depth way, it is necessary to characterize in more detail the phytogeographical features of the growing conditions, for each catchment separately.

Site 5. Jargvala-Gele river catchment area. The catchment area is 22.2 hectares, the forest cover is -20%.

The catchment area of the Jargvala-Gele River is a mountainous, forested rugged relief, 20 percent of the territory of which is covered with stands of different ages with a predominance of oriental beech and edible chestnut.

In the lower part of the catchment area of 840 to 1100 m above sea level, chestnut stands with an admixture of Caucasian hornbeam and eastern beech prevail. In the upper part of the catchment area, starting from 1100 m above sea level, beech stands with an admixture of Caucasian hornbeam predominate, evenly distributed over the entire area.

Table 17

Characteristics from watercourses in the area of the Latauristskali River (Region of moderately humid climate of a medium-altitude mountain, Keda forestry)

Catchment Basin	Gorges with weirs	Forestation, %	Exposure against gorges	Basin height above sea level		Catchment area	Watercourse Length, km^2	Perimeter length, km^2
				highest	lowest			
5	Jargvala-Gele	20	South	1450	840	0,222	0,502	2,050
6	Usufa-Gele	60	South	1650	840	0,597	0,951	3,850
7	Khambogis-Gele	90	South	1335	882	0,508	0,611	3,998

The most characteristic group of forest types in this catchment area are: oatmeal beech (*Pegetun-festucosum*), chestnut with undergrowth of laurel and Rhododendron Ponticum (*Castanetun Lauroceraso-Rhododendrosum*), beech forest with undergrowth of laurel (*Pagetum Laurocerasosum*), beech forest with undergrowth of Rhododendron Ponticum (*Fagetun - Rhododendrosus*).

Treeless areas with single trees of alder, chestnut, as well as farmland (haymaking, pastures), occupy the lower parts of the reservoir. In general, individual areas of this catchment area are characterized by the following data by category A of land, forest element, as well as water-physical properties of the following data:

Forested area:

Plot A - beech stand 3 ha

Plot B - chestnut stand 2 ha

Non-forested area:

Plot C - treeless slopes with single chestnut trees 17 ha, 80% beech, aspen, pastures

Individual areas of the catchment are characterized by the following descriptions:

Plot A - Exposure - south-east, slope 30-35°, height -1300 m above sea level,

Beech stand: Ingredients: 6 Bc 2 gr. age 200 (80-300) years, obesity 0.04. Undergrowth and renewal from the same species is unsatisfactory with uneven distribution. In the undergrowth, Ponticum rhododendron, medicinal laurel, blackberry, Caucasian blueberry, Colchis ivy. Due to the intensive development of the undergrowth, living ground cover is excluded. *Festuca drymeja* is found in dry places.

The soil is typical brown forest, characterized by the following morphological characteristic:

A_0 - 0-5 cm undecomposed leaves of beech, hornbeam and evergreen species, well decomposed in the lower part. The transition is spaced.

A_1 - 5-20 cm. Dark-brown, moist-grained-nutty structure, medium loam, a lot of tree roots and gravel. The transition is gradual.

A_1 B 20-45. Brown, dense, moist, heavy loamy, lumpy-nutty; inclusions of tree roots, roots and fragments of parent species. The transition is gradual.

Bc 45-65 cm. Light brown, heavy loamy, dry, unstructured. A lot of fragments of species.

Section B Southeast, terrain slope 30-35; 950 m above sea level, chestnut stand with an admixture of hornbeam and beech (2 ha). Composition: 7 to 2 Bc IG: 80 (40-120) l, der=18cm; Hcp=15 m; completeness 0.4. Due to the strong development of the undergrowth of the main forest species, it is unsatisfactory.

Cherry laurel, rhododendron, blueberry, ivy, blackberry, etc. are strongly developed in the undergrowth. Living cover is excluded. Dead cover is present in places.

The soil is typical brown-forest.

A" -0-2 cm. Dead cover, in the upper part there are undecomposed leaves of chestnut, beech, hornbeam and other species. The lower part in the process of humification.

A_1 2-6 cm. Dark brown, moist, nutty structure, medium loam, inclusions - roots, rootlets, small fragments of the parent species. The transition is gradual.

B - 6 - 26 cm brown, moist, granular-nutty structure, loamy, inclusions of roots, rootlets, single large fragments of the parent species. The transition is gradual.

BC - 26 - 65 cm. Light brown, medium-moist, fine-grained, heavily loamy, inclusions of fragments of parent species significant, single large tree roots.

Plot B - treeless, with single chestnut specimens on slopes with very thin skeletal soils. Trampled from the grazing of cattle. In a significant part of the area, the soil is completely washed away and the parent rock protrudes on the surface.

Site 6. Catchment basin of the Usufa-Gele River. The catchment area is 59.7 hectares, the forest cover is 60%.

The catchment basin of the Usufa Gele River, which covers the basin forest areas of the Usufas-wood tract, borders on the above-described watercourse and in terms of natural and climatic conditions, in addition to forest cover, does not differ from the previous one. The measuring weir in this catchment area is installed near the mouth of the Usufa-Gele River.

The most characteristic groups of forest types in this catchment area are dry beech forests (*Fagetun-Festucosun*), beech forest with undergrowth of laurel and rhododendron Ponticum (*Fagetun-Lauroceraso-Rhododondrosa*), chestnut forest with undergrowth of laurel and rhododendron Ponticum (*Castanetun-Lauroceraso-Rhododendrosa*), taking into account vertically substituting forest types.

The catchment area of the Usufa-Gele River is distributed by land categories as follows:

Forested area:

Plot A - beech stand with an admixture of hornbeam 24 hectares

Plot B - chestnut stand with an admixture of hornbeam and beech 10 ha 41% ha 60%

Plot C - beech-chestnut stand with an admixture of hornbeam 6.7 ha

Non-forested area:

Plot D - treeless plot - pastures 19 ha 40%

These areas are characterized by the following description:

Plot A - south-eastern exposure; slope 30-35°; height above sea level I370 m; beech stand with an admixture of hornbeam.

Composition: 7 Bc 3 G 200 (100-250) l., fullness 0.4; No. p=60 cm; Hcp = 26 cm; bonitet P-Sh, undergrowth from these species is rare. Undergrowth: black currant, blueberry, wayfarer, blackberry. The cover is mainly grass from mountain fescue, mantle, yarrow, shield hip, sour, etc., the soil is brown forest, characterized by the following description:

A_0 - 0-3 cm. Continuous fall, leaves and branches, loose.

A_1 - 3-20 cm. Dark-brown humus layer, fine-grained structure, loosely composed loam, moist, permeated with roots and roots of plants. The transition is gradual.

A_1 B - 20-40 cm. Light brown, with a weakly expressed nutty-granular structure, medium loam; inclusions of roots and rootlets, single fragments of the parent rock. The transition is gradual.

BC 40-30 cm. Light forest, weakly expressed lumpy structure, loam, many fragments of parent species. The transition is clear.

C 65-110 cm. beige; structure is not expressed; inclusions, debris, small and large parent species.

Plot B - south-eastern exposure; slope 30-35°; height is 930 m, chestnut forest stand with an admixture of hornbeam and beech. The trees are mainly overgrown on ontogenetic over-mature stumps.

Composition: 7 km 2 G Bc, 90 (30–120) L, thickness 0.4; Der=20 cm; Nor=16 m, undergrowth of chestnut, beech, hornbeam - weak, in the undergrowth - *laurel officinalis, rhododendron Ponticus,* common bilberry, Colchis holly, butcher's broom, oriental viburnum, blackberry is poorly developed; representatives of the living ground cover - strawberry, fescue (Sp), *ferruginous sage* (Sp), fern (Sp), *Pontic milkweed* (Sp), *Pontic euphorbia* (Sp), etc.

Dead cover occupies 40% of the area. The soil is brown, foresty, characterized by the following description:

A_0 1.5 cm. dead cover of leaves and branches of chestnut, hornbeam, beech, upper part not decomposed, coarse, lower part of the process of humification.

A_1 1.5-4 cm. Blackish-brown, fresh, nutty structure, loam, inclusions of roots and rootlets, small fragments of the parent species. The transition is clear.

B - 4-30 cm. Light brown, fresh, nuts of a grainy structure, loam; inclusions - roots and rootlets, single large fragments of parent breed. The transition is gradual.

BC 30-70 cm. Lightwood, fresh, fine-grained, heavily loamy. There are many fragments of the parent breed, large single tree roots.

At the bottom, you can see the large sizes of incesites and basalts of the parent species.

Plot B - south-eastern exposure; slope 25-300; height 1110 m above sea level, beech/chestnut forest stand with an admixture of hornbeam (6.7 ha). 6 Bc km, 100 (30-160) years; fullness 0.5, Der=10 cm; Ner=20m; bonitet Sh; mixed hornbeam. Undergrowth of beech is unsatisfactory; in the undergrowth of laurel, rhododendron, blackberry, the cover is mostly dead; living cover of mountain fescue, sorrel, etc.-rare; the soil is brown, forest, and medium loam in mechanical composition.

Plot C - southern exposure; slope 30-35°; altitude 1000 m above sea level. Treeless area - low pastures, skeletal, light brown, light loamy, washed away in places.

Due to unsystematic overcutting, the soil is heavily compacted.

Site 7. Catchment basin of the Hambagilas-Gele River. The area of the water intake is 50.3 hectares, the forest cover is -3.2%.

The catchment basin of the Hambagilas-Gele River, which encompasses forest areas of the same name with its basin, borders with the previous catchment area (30% forest cover) and differs from it in higher forest cover and the density of forest stands equal to 0.7. The measuring weir is installed at the confluence of the Hambagilas-Gele River with the Lapaura River.

The distribution of areas covered and uncovered by forest by categories of land is as follows:

Forested area:

Plot A - mixed beech-hornbeam-chestnut forest stand occupies 47.33 hectares or 93.2% of the total catchment area. The characteristic group of indigenous forest types is the same as in the previous catchment.

Non-forested area:

Plot B - pasture 3.46 ha (5.36%). The forested area is characterized by the following description:

Plot A - exposure J3; the slope is 30-35°, the height above sea level is 1290 m. Beech-hornbeam-chestnut stand. Composition: 6 Bc 3 Gr I km, 200 (30-300) years, mixed elm, maple, faces, fullness 0.7. The density of trees is 450-550 pieces, per 1 ha: Der=30 cm. per =25 m; bonitet Sh. Undergrowth of beech and hornbeam, unsatisfactory in the gaps. There is no consumption. In the undergrowth, laurels, rhododendrons Ponticum, blueberries and others are dense, evenly distributed. The cover is mostly dead. The soil is brown, forested, characterized by the following morphological features:

A_0 - 0-2 cm. Continuous litter of leaves and branches of beech, hornbeam, chestnut, laurel, etc. at different decomposition stations.

A_1 - 2-15 cm. Color is dark, brown forest. Granular-nutty, medium loamy; inclusions roots and rootlets, moist. The transition is gradual.

AB 15-30 cm. light forest, granular-nutty structure, medium loam; inclusions are single roots and fragments of the parent rock (andesite), wet. The transition is gradual, the BC is 30-30 cm. Brownish-yellow, fine-grained, moist dense loam, there are fewer roots with a large number of fragments of parent rocks.

D 80 cm weathering crust: parent rock. In terms of mechanical composition (Table 18), medium-mountain forest soils are loamy or heavy loam.

0.01mm fraction ranges from 26-47% within. Based on mechanical analyses, the fraction is 0.25-0.01 mm in large quantities.

1-0.25 mm fraction contains in a minimum amount and is evenly distributed in a vertical profile. The exception is pastures, where this fraction is characterized by uneven distribution.

The data of chemical analysis (Table 19) show that these soils are characterized by a high content of organic substances. The amount of humus and nitrogen is directly dependent on the density of the forest. It is larger in the upper layer of the soil, and gradually decreases along its depth.

The soil reaction is acidic (pH = 4.8-5.0). In the vertical profile, the amount of soil acidity is stable.

In the region of moderately humid climate of the high-mountain Ajara-Guria ridge in the gorge of the Nagvarevi river (Shuakhevi forestry), the surface of the stationary research area is strongly indented by deep gorges, the relief of the zone is spruce-fir and subalpine.

The average height of the catchment area is 1500 m (1400-1600), the average steepness of the slope is 35-40°.

Table 18

Mechanical composition of soils in the studied catchment areas of moderately humid climate of a medium-altitude mountain

Location of the Site	Horizon and depth, cm	Particle size, mm; fraction content, %						
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	< 0,001	< 0,01
1	2	3	4	5	6	7	8	9
Site 5: height above sea level 1350 m Beech stand. Density 0,4	A_1 5-20 A_1 B 20-45 BC 45-60	7,4 11,6 11,6	23,8 26,8 23,0	31,0 29,1 26,2	10,5 10,3 14,5	20,8 16,4 19,3	6,3 5,9 5,4	37,6 32,6 39,1
Ibid. height above sea level 950 m. Chestnut stand. Density 0,4	A_1 2-6 B 6-26 BC 26-65	12,8 7,6 4,2	24,0 18,0 16,0	28,3 35,0 32,2	12,6 25,2 10,7	17,0 3,2 7,8	5,2 10,8 19,2	34,9 39,8 47,6
Ibid, height above sea level 900 m. Pasture	AB 0-14 BC 14-35	1,6 14,7	38,3 30,7	25,0 26,0	16,1 11,0	15,7 13,8	3,3 4,4	35,2 29,2
Site 6: height above sea level 1370 m. Beech stand with an admixture of hornbeam Density 0,4	A_1 3-20 A_1B 20-40 BC 40-65 C 65-110	10,7 7,7 6,3 17,8	22,3 39,8 36,4 44,9	28,7 25,9 26,7 21,2	23,4 10,4 9,9 8,2	4,2 10,4 15,1 6,1	10,7 5,9 5,7 4,8	38,3 26,6 30,6 19,1
Site 7: height above sea level 1290 m. Beech-hornbeam-chestnut stand. Density 0,7	A 2-15 AB 15-30 BC 30-80	10,5 2,6 1,6	32,7 24,6 39,5	17,2 27,8 22,7	11,8 13,6 10,5	19,4 16,4 13,8	8,3 15,1 12,0	39,6 45,1 36,2

The climate - moderately humid with cold winters, long and short cool summers in altitude is typical for the medium-altitude mountains of the Ajara-Guria, Shavsheti and Arsiani ranges of the alpine and subalpine belts of the highlands.

The amount of precipitation can be taken as an average of 1200 m. Precipitation here often falls in the form of showers, which greatly contributes to the surface washout of soils, the formation of mudflows and floods. In solid form, precipitation falls in the cold season, but hail falls are not uncommon in summer. With an increase in altitude, both the thickness of the snow cover and its stability increase. Snow avalanches are very common here, delaying traffic and causing great damage.

Table 19

Some chemical indicators of soils of the studied catchment areas of moderately humid climate of a medium-altitude mountain

Location of the Site	Horizon and depth, cm	Hygroscopic humidity	Humus %	Nitrogen %	pH (H_2O)
Site 5: height above sea level 1350 m. Beech stand Density 0,4	A_1 5-20 A_1 B 20-45 BC 45-60	1,07 1,21 1,07	5,3 2,9 1,9	0,44 0,14 0,08	4,9 5,0 5,0
Ibid.: height above sea level 950 m, Chestnut stand. Density 0,5	A_1 2-6 B 6-26 BC 26-65	1,08 1,06 1,11	--- 7,7 4,0	--- 0,41 0,14	5,0 5,0 5,0
Ibid, height above sea level 900 m, Pastures	AB 0-14 BC 14-35	1,04 1,10	3,2 1,3	0,28 0,07	5,0 5,4
Site 6: height above sea level 1370 m. Beech stand with an admixture of hornbeam Density 0,4	A_1 3-20 A_1B 20-40 BC 40-65 C 65-110	1,25 1,12 1,17 1,01	7,8 5,9 3,4 ----	0,42 0,28 0,12 ---	5,0 4,8 4,4 4,4
Site 7: height above sea level 1290 m. Beech-hornbeam-chestnut stand. Density 0,7	A 2-15 AB 15-30 BC 30-80	1,16 1,22 1,20	9,3 5,3 2,2	0,84 0,41 0,18	4,8 4,8 4,9

The geological structure of the area is dominated by andesites and basalts. The main types of soils are brown forest.

The forests are purely spruce-fir, of different ages. In view of unsystematic excessive logging and grazing, in these forests the fullness is increased to 0.3-0.4 and rarely to 0.5-0.6, which is due to a decrease in the total productivity of the forest.

In the thinned forests, thickets of tall grass and low-value evergreen understory phytocenoses of laurel, rhododendron and other species have spread strongly, which caused a weakening of the natural regeneration of the forest.

At the same time, the presence of evergreen understory species contributes to the maintenance of favorable water-physical properties of soils, but the thinned forests and the slopes occupied by evergreen underbrush are not able to retain snow, in the form of which they belong to the zone of systematic avalanches.

The object of research is a typical place of such territories widespread in Ajara.

Below (Table 20) are the characteristic data of the elements of the watercourses of the Nagvarevi River.

Table 20

Characteristics of watercourses in the gorge of the Nagvarevi River (Region of moderately humid climate of the highlands, Shuakhevi forestry)

Catchment Basin	Gorges with weirs	Forestation, %	Exposure against gorges	Basin height above sea level		Catchment area	Watercourse Length, km^2	Perimeter length, km^2
				highest	lowest			
1	2	3	4	5	6	7	8	9
8	Kilditakhevistskali	35	SW	2110	1080	1,835	2,275	7,730
9	Sagobiestskali	50	SW	2100	1360	1,470	3,250	5,250
10	Zeda Vakistskali	80	SW	1800	1430	0,363	1,000	2,500

The data given in Table. 11 indicate the comparative homogeneity of catchments according to these characteristics. Their main difference is the forest cover of the catchments, the ratio of areas covered with forests and areas not covered by them.

Object 8, Kilditakhevistskali River drainage basin. The catchment area is 183.5 hectares, the forest cover is -35%.

The measuring weir is installed near the mouth of the Kilditakhevistskali River. The basin includes: forested area, non-forested area, hayfield, scree.

The most characteristic group of forest types in the specified catchment area is the spruce-fir indigenous forests: *Piccetun-Abieto-Rhododendrosun, liceetum-Abieto-Oxalidosum, liceetun-Abieto-Struthiopteriosun, Ficee tum-Abieto-Laurocerasosum*. The area of the drainage basin by categories of land is distributed as follows:

Forested area:

Plot A - spruce-fir forests with a density of 0.4-34.2 (35%)

Unforested area:

Plot B - treeless hayfield area 56.1 ha (30%)

Plot C - ravines and steep slopes 33.7 ha (20%)

Plot D - sands and stone placers 27.5 ha (15%)

These areas are characterized by the following description:

Section A - south-west exposure; slope 30-35^0; elevation above sea level 1450 m; spruce-fir forest. Composition 7 1 x 33., 130 (80-130) years, fullness 0.5; Der=60 cm; Ner=30m; bonitet P-Sh, undergrowth from these species is rare; undergrowth in places - hazel, blueberry, blackberry, Pontic rhododendron, laurel officinalis. The cover is mainly grassy from sorrel (Sp), fragrant aspenberry (Sp), fern (Sp), sorrel (Sp). strawberry (Sp), blackcap (Sol), small-flowered bellflower (Sp), etc.

The soil is brown, forest, characterized by the following description:

A_0 0-3 cm. Medium-decomposed needles, branches, cones, spruce and fir, leaves of underbrush and other species.

A_1 3-20 cm. Dark-brown, moist, granular-nutty structure, medium loam, many tree roots and herbaceous vegetation. The transition is gradual.

A_1 B 20-40 cm. Lightened, moist, nutty-granular structure, light loam, inclusions - roots and roots. The transition is gradual.

BC 40-60 cm. Light brown, moist, granular structure, light loam, few roots, roots and fragments of the mother offspring.

CD 60-0 cm. Light, moist, structureless, a lot of rock fragments.

Section B - southern exposure: slope 30-35^0, elevation above sea level 1200 m; haying.

Forbs of the following species: creeping clover (Cop^3), grass snake (Sor^3), lanceolate plantain (Sp), sorrel (Sp), strawberry (Sp), common blackhead (Sp), woodfew (Sp), warthog (Sp), mantle (Sp), meadow grass (Sp), plantain (Sp). Field (Sp), angelica (Sp), pale stonecrop (SP), small-flowered bellflower (Sp), cow-weed (Sp), oregano (Sp), etc.

The soils are brown, forested, characterized by the following description:

A_0 0-2 cm. Derm. A lot of roots and rootlets.

A_1 2-20 cm. Dark-brown, granular structure, moist, loam. few roots and rootlets. The transition is gradual.

A_1 B 20-50 cm. Light brown, granular structure, moisture, loam, few inclusions.

BC 50 Light, granular, moist, loamy, many fragments of parent rocks (andesite).

A significant area (36.7 hectares) of the Kilditakhevistskali River catchment area is represented by unused ravines and steep slopes.

Along the river gorge on both sides (70 m x 70 m) there are permanent avalanches. This territory (27.5 hectares) is represented mainly by hazelnut areas, very sparse in some places, represented only by single trees or hazel, alder, buckthorn and blackberry thickets.

Due to the characteristic features of the catchment area, floods and washouts occur in the gorge during heavy rains and spring snowfalls. Along the entire length of the river bed, there are a lot of crushed stone sediments of all sizes.

Object 9. Catchment basin of the Sagobios-Gele River. The catchment area is 147 hectares, the forest cover is 50%.

The drainage basin of the Sagobios-Gele River encompasses the forested and treeless areas of the Sagobios-Gele River. The forests here are represented by purely spruce-fir stands.

A characteristic group of forest types does not differ from the previous forest types. In some high-density areas, spruce-fir forests with dead cover (*Piceetin-Abietin-Nudum*) are found.

The area of the drainage basin of the Sagobios-Gele River is divided into land categories as follows:

Forested area:

Plot A - spruce-fir forest stand 74 ha 50%

Unforested area:

Plot B - reds, 0.2 hectares with a density of 52 hectares 73 hectares 50%

B - rocks, screes of 21 hectares

These areas are characterized by the following description:

Plot A - southern exposure; slope 30-35^0; elevation a. s. l. 1500 m; Spruce-fir stand.

Composition: ZE 2 Px,150 (50-250) years: fullness 0.5; DSR = 50 cm;

Nor=23 m; bonitet P-Sh; undergrowth from the same species is weak, in the undergrowth there is rhododendron pontica, hazel, bilberry, blackberry, etc., the living cover of places free from shrubs is represented by the following species: Pontic euphorbia (Soc), milkweed-light bellflower (Sor), valerian officinalis (Sp), thistle (Sp), large-flowered downy (Sp), blackcap (S), fern (SP), gentian (Sp), understory (Sp), forest short-legged (Sp), victorious sedum (Sp), sticky sage (Sp), etc.

The soil is brown, forest in mechanical composition.

Plot B - exposure - south-east, slope 35^0, height above sea level 1450 m; spruce-fir stand: Composition: 5 E 5 Page 130 (30-160) years, fullness 0.2-0.3; Der=40 cm; Ner=13 m; bonitet IV.

Undergrowth and renewal from the same species are unsatisfactory with uneven distribution. In the underbrush there are rhododendron pontica, hazel, laurel, blackberry, etc., which create an impenetrable thicket. The cover is mostly dead. The ground cover, occupied by free spaces, is represented mainly by Pontic molokan, milky bellflower, sorrel, sage, etc.

The soil is brown, forest, characterized by the following morphological features:

A_0 0-3 cm. Dark brown, moist, loam. Granular structure; inclusions - roots, rootlets of a large number.

A_1 B 6-2.5 cm. Transition is gradual, brown, loam is moist. Granular structure; inclusions of roots and rootlets of woody vegetation, fragments of the parent rock. The transition is gradual.

BC 25-100 cm. Lighter, brown, loamy; granular, low-structural; inclusions - few, roots and fragments of parent rocks. A significant part (21 ra) of the drainage basin is occupied by rocks and screes, i.e. unused areas.

Object 10, drainage basin of the Zeda-Vakitskali river. The catchment area is 36.3 hectares, the forest cover is 30%.

The drainage basin of the Zeda-vakistskali River, which covers the forest areas of the same name with its basin, borders the previous catchment area (50% forest cover) and differs from it in a higher forest cover and the density of forest stands equal to 0.7, the measuring weir is installed at the confluence of the Zeda-vakistskali River with the Nagvarevi River.

The distribution of forest-covered and unforested areas by land categories is as follows:

Forested area:

Plot A is a mixed spruce-fir stand: it occupies 23.04 hectares or 30% of the total catchment area. The characteristic group of indigenous forest types is the same as in the previous catchment.

Unforested area:

Plot B - treeless slopes with single trees of spruce and fir, pine 20%, pastures - 7.26 hectares

The forested area is characterized by the following description: SE exposition; The slope is 15-20°, the altitude is 1500 m.

Plot A - spruce-fir stand. Composition: 6 E 4 II I60 (120-300) years. Fullness 0.7, Der=76 cm; Ner=32m; bonitet P. Undergrowth of fir and spruce - rare, satisfactory in the gaps. In the sparse underbrush there are laurel, rhododendron pontica, viburnum. The cover is mostly dead.

Table 21

Mechanical Composition of Soils of the Studied Catchment Areas moderately humid climate of the highlands

Location of the Site	Horizon and depth, cm	Particle size, mm; fraction content, %						
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	< 0,001	< 0,01
1	2	3	4	5	6	7	8	9
Site 8: height above sea level 1450 m. Spruce-fir stand with density 0,5	A_1 3-20 A_1B 20-40 BC 40-60 CD 60-80	8,9 2,8 4,6 6,4	42,5 42,0 41,8 37,3	26,8 28,1 22,7 23,0	10,6 9,3 9,4 18,4	7,7 16,1 12,4 3,9	3,9 3,7 9,0 10,9	23,2 29,2 30,8 30,8
Ibid. height above sea level 1290 m. Hayfield	A_1 2-20 A_1B 20-50 BC 50	1,8 6,9 8,5	33,3 33,8 41,2	30,6 27,6 13,3	6,7 8,7 18,2	19,8 16,5 13,5	7,8 5,1 5,3	34,8 29,2 37,0
Site 8: height above sea level 1450 m. Spruce-fir stand with density 0,2-0,3	A_1 0-6 B 6-25 BC 25-100	1,4 --- 32,9	60,0 --- 28,0	29,3 --- 25,5	2,2 --- 5,3	3,5 --- 7,9	4,0 --- 5,4	9,6 --- 18,6
Site 10: height above sea level 1500 m. Spruce-fir stand with density 0,7	A_1 5-23 A_1B 28-56 B 56-110	8,7 5,4 13,5	20,2 28,8 30,3	36,7 25,8 32,4	10,7 18,2 8,7	14,5 15,8 11,9	9,2 10,8 3,2	34,5 39,9 23,8
Ibid. height above sea level 1470 m. Pastures	A_1 0-5 A_1B 5-30 C 30-65	18,1 --- 7,1	30,1 --- 21,6	27,1 --- 27,4	6,1 --- 6,8	14,3 --- 15,2	4,3 --- 21,9	24,7 --- 43,9

Dark-brown soil, of high thickness, is characterized by the following morphological features:

A_0 - 0-5 cm. Continuous fall of leaves, cones and branches of spruce, fir, laurel, etc. at different stages of decomposition.

A_1 5-28 cm. Dark, wet, nutty structure; inclusions, roots, fragments of the parent rock. The transition is gradual.

A_1 B 28-56 cm. Lightwood, wet, granular structure, loam; single roots and fragments of the parent rock. The transition is gradual.

B - 56-110 cm. Lighter, wet fine-grained structure, single roots and fragments. The transition is gradual.

BC 110-140 cm. Straw-yellow, wet, structureless; inclusions single roots, rootlets, and large fragments of parent rock.

Plot B - treeless, with single spruce and fir specimens on the slopes, very thin skeletal soils. In a significant part of the area, the soil is completely saturated and the parent rock protrudes on the ancient surface.

A_1 0-5 cm. Humus layer: light brown, nutty structure, slightly loamy, wet; inclusions of roots and roots from herbaceous plants. The transition is gradual.

A1 B 5-30 cm. light brown, nutty-granular structure, many roots, rootlets and small fragments of the mother rock. The transition is gradual.

C 30-65 cm. Straw-yellow, raw, poorly defined structural single roots, large rootlets with fragments of the parent rock.

The soil of the high-mountain spruce-fir forest is medium clayey, loamy, and in some cases of light mechanical composition (Table 21).

Table 22

Some chemical indicators of soils of the studied catchments of temperate humid climate basins of highlands

Location of the Site	Horizon and depth, cm	Hygroscopic humidity	Humus %	Nitrogen %	pH (H_2O)
Site 8: height above sea level 1450 m. Spruce-fir stand with density 0,5	A_1 8-20 A_1 B 20-40 BC 40-60 CD 60-80	1-21 1,21 1,21 1,19	4,3 3,8 1,6 -	0,28 0,14 0,07 -	5,8 5,5 5,7 6,0
Ibid.: height above sea level 1290 m. Hayfield	A_1 2-20 A_1B 20-50 BC 50	1,05 1,06 1,06	11,5 6,3 -	0,78 0,28 -	5,8 5,9 6,0
Site 9: height above sea level 1450 m. Spruce-fir stand with density 0,2-0,3	A_1 0-6 B 6-25 BC 25-100	1,07 - 1,03	4,2 - 1,6	0,14 - 0,08	6,0 - 6,0
Site 10: height above sea level 1500 m. Spruce-fir stand with density 0,5	A_1 5-28 A_1B 28-56 B 56-110	1,14 1,10 1,13	8,3 4,5 -	0,42 0,28 -	5,0 5,4 5,2
Ibid.: height above sea level 1470 m. Pastures	A_1 0-5 A_1B 5-30 C 30-65	1,06 - 1,05	- - 0,8	- - 0,02	5,8 - 5,7

The amount of physical clay (<0.01) in horizon A averages 9.0-34.5%, and the sediment fraction (< 0.001) does not exceed 3.9-3.2%. Mechanical weight is clearly expressed in the lower part of the profile.

Table 23

Average indicators of water-physical properties of soils in different types of forests, catchment areas of the region of moderately humid climate, medium-high (Keda forestry) and highlands (Shuakhevi forestry) of Ajara

N	Sites under study	Depth of soil cut, cm	Porosity %			Water permeability, min	vol. weight g/cm3	surface runoff with precipitation amount of 80mm intensity 1,5 mm/min		Coefficient of runoff (K)
			General	Capillary	Non-capillary			Liquid l/m^2	Solid l/m^2	
1	2	3	4	5	6	7	8	9	10	11
1.	Keda forestry Yusufas-Gele. oat beech forest (*Fagetum-Festucosum)*, fullness 0.4-0.5, slope 30-35^0, exposure NE, height a.s.l. 1370 m	0-15 20-35	55,0 51,0	49,0 46,0	6,0 4,0	31,0 59,0	1,199 1,230	10,0 -	0,71 -	0,33 -
2.	Ibid., Latvris-Gele, rhododendron-beech (*Fagetum-Rhododendrosum florum*) forest, fullness 0.4-0.5, slope 30-35^0, exposure SE, height a. s. l. 1235 m	0-15 20-35	61,8 61,1	51,6 49,1	9,7 5,0	8,3 39,3	0,975 1,178	3,2 -	- -	0,10 -
3.	Ibid., Tskhmorisi forestry, chestnut undergrowth laurel cherry (*Castanetum Laurocerasosum*) forest, fullness 0.3-0.4, slope 30-35^0, exposure E, height a. s. l. 910 m	0-15 20-35	54,0 50,0	46,7 43,3	8,3 3,7	23,0 61,3	1,138 1,237	5,7 -	0,31 -	0,27 -
4.	Nearby chestnut undergrowth laurel cherry (*Castanetum Laurocerasosum*) forest, fullness 0.4-0.5, slope 30-35^0, exposure E, height a. s. l. 930 m	0-15 20-35	51,2 45,0	45,2 40,8	6,0 4,2	34,0 67,3	1,199 1,235	9,9 -	0,72 -	0,33 -
5.	Shuakhevi forestry Nagvarevi (Zeda Vakistskali), dead cover spruce forest (*Piceetum nudum*), fullness 0.8-0.9, slope 30-35^0, exposure NW, height a. s. l. 1500 m	0-15 20-35	64,3 59,6	51,3 53,3	13,0 6,3	3,2 28,5	0,830 1,123	1,6 -	- -	0,05 -
6.	Ibid., dead cover fir (*Abietum nudum*) forest, fullness 0.8-0.9, slope 30-35^0, exposure NW, height a. s. l. 1580 m	0-15	64,7	51,5	13,2	2,8	0,837	1,3	-	0,04
7.	Ibid., derivative mixed-grass spruce-fir forest (*Piceeto-Abietum Prasinosum*), fullness 0.3-0.4, height a. s. l. 14500 m	0-15 20-35	56,7 52,0	50,4 47,9	6,3 4,1	28,0 56,0	1,191 1,225	8,8 -	8,8 -	0,43 -

8.	Ibid., dead cover spruce-fir forest (*Piceeto-Abietum nudum)* fullness 0.8-0.9, slope 30-35^0, exposure SW, height a. s. l. 1450 m	0-15 20-35	65,8 61,3	52,2 53,8	13,6 7,8	2,3 20,4	0,809 1,095	1,0 -	1,0 -	- -
9.	Ibid., spruce-fir fern forest (*Piceeto-Abietum Sillocosum)* fullness 0.4-0.5, slope 30-35^0, exposure SW, height a. s. l. 1380 m	0-15 20-35	57,3 52,1	50,1 49,3	7,2 3,8	24,0 46,0	1,164 1,231	8,6 -	8,6 -	0,45 -
10.	Strip damaged by grazing	0-15 20-35	49,0 44,0	45,4 41,2	4,6 2,8	86,6 93,0	1,241 1,323	27,6 -	27,6 -	53,0 -

These soils in horizon A contain humus in the amount of 4.3-11.5% (Table 22). In depth, it decreases, due to which it creates a rare differentiation of the profile. In accordance with the humus content, the amount of total nitrogen in the profile gradually decreases. These soils have a slightly acidic fraction (pH = 15.2-2.60).

The soils of the studied objects/sites are distinguished by high physical indicators (Table 23), which is determined by the good structure and high humus content of their upper layer. The volume weight of these soils is low (0.309-1.241 g/cm3), and therefore their water permeability is high. In the profile, along the depth of the soil, their volumetric weight and water permeability increase.

Soils of both mid-mountain and high-mountain forests are characterized by high porosity, especially in their upper layer. The total porosity is on average in the range of 65.8-19.0. Most of the total porosity is made up of capillary pores, and the number of non-capillary pores decreases accordingly.

The physical properties of the soil are rarely influenced by the strength of anthropogenic factors. Depending on the longitude of the forest, the physical properties of the soil change.

Where there are thinned forests on soils overloaded due to intensified, excessive grazing, non-capillary porosity is significantly low, which reduces the water permeability of the soil, which is accompanied by an increase in surface washouts and the activity of erosion processes.

In general, the high physical characteristics of these soils contribute to high forest productivity and reduce erosion processes.

Chapter 4

Water Protection and Protective Functions of Mountain Forests Analysis Of Experimental Data

The steadily increasing involvement of natural resources (including mountain forests) in the economic turnover, the further industrialization of production and the urbanization of life have a negative impact on the environment. In this ecological situation, the forest, as the main type of vegetation on a planetary scale, as the most important component of the biosphere, an irreplaceable environment-forming factor, acquires global significance.

Nevertheless, there are still many unresolved problems in the field of nature protection, rational use and reproduction of forest resources. In particular, there is still no comprehensive quantitative and qualitative ecological and economic assessment of the social and protective functions of mountain forests, there is no general optimization of landscapes based on the results of comprehensive research, etc.

In the republics of the former Soviet Union, mountain forests occupied about 450 million hectares, which is 38% of the total area covered with forests of the country. They grow in almost all regions, but are extremely unevenly distributed in this area. The main part of mountain forests is concentrated in the Asian part of the country, in the European part mountain forests occupy only 5%.

In Georgia, almost all forest liabilities (98%) grow on mountain slopes. The forests of Ajara grow almost entirely on mountain slopes of varying steepness and play an important ecological and social role. They have a great water protection and soil protection value, regulate the water and climatic regime of the country, and contribute to the protection of diversified agriculture from negative natural phenomena (erosion, floods, snow avalanches, etc.). In economic terms, the water protection and protective functions of these forests should be estimated much higher than the benefits derived directly from the use of wood. Therefore, the ecological and social functions performed by the mountain forests of Georgia in general and Ajara in particular should be fundamental in forest management in these conditions.

The forests of Ajara occupy about 65% of the area and are classified as forests of the 1st group. They are mainly distributed in hard-to-reach places: ravines, gorges and steep slopes, which is why they are overexploited in more easily accessible places. As noted above, the disproportion between reforestation and forest management, which has existed for decades, has significantly disrupted the ecological balance of the forests of the region. Thinning of stands as a result of unsystematic logging led to the lightening of forests, the development of subthreshold vegetation. In large areas, the regeneration of the main forest-forming species: beech, chestnut, hornbeam, spruce, fir, etc., has practically stopped. In some regions of the republic, especially in the subalps and pastures, there are very high loads, 5-10 times higher than the permissible standards. As a result, the soil cover is disturbed, natural regeneration, in the subalpine belt the upper border of the forest has significantly decreased. Where it still remains at the same level, the forest is so sparse that it is not able to perform protective functions. As a result, erosion processes have intensified, snow avalanches and landslides have become more frequent, the hydrological regime of mountain rivers has been disrupted, etc.

On April 19, 1989, an unprecedented catastrophe occurred in the Tsablana gorge of the Republic of Ajara.

Scientists and specialists have repeatedly warned that mountain ecosystems, especially humid growing conditions with a marine climate, are very sensitive to negative natural phenomena, are vulnerable and quickly collapsing systems. We have long reached the limit of anthropogenic impact on mountain ecosystems when we should have stopped, and if we do not do this now, if we do not reduce the load on ecosystems, then in the future we will not avoid progressive destructive processes in other regions of the republic.

It should be noted that the systematic inflow of prolonged and intense precipitation is far from uncommon for Ajara, so the disasters should not be explained only by extreme weather conditions. It should be assumed that in these processes an important role belongs to the anthropogenic factor, i.e. thinning of forests on the slopes of mountains to the state of reduction, lowering the boundaries of subalpine forests, the creation of unsystematic settlements and the heavy equipment used in this process that is unsuitable in mountainous conditions. We believe that the intensification of destructive processes in the mountain ecosystems of Ajara is the result of the influence of a complex of factors, among which geological processes play an important role.

This assumption is confirmed by the fact that in mountainous Ajara, in the settlements of Tbeti, Tsablana, Ghurta, and in the villages of the Shuakhevi district, landslide phenomena intensified after the well-known earthquake (Armenia, 1988).

Of all the variety of socio-ecological functions performed by the mountain forests of Ajara, the most important, from our point of view, are: soil protection, water regulation, water protection, avalanche control, as well as recreational, balneology, etc.

4.1. Soil-protective function of mountain forests

The problem of soil protection from water erosion is especially important in the mountainous regions of Ajara, which are characterized by steep slopes, strongly dissected relief, intense and prolonged precipitation.

The essence of the soil-protective function performed by the mountain forests of Ajara is to protect soils from water and wind erosion, as well as to systematically increase their fertility. On the example of small catchments organized in different natural and climatic conditions of Ajara (excessively humid foothills, the belt of subtropical forests of the village of Chakhati, moderately humid middle mountains, the belt of broad-leaved forests, the village of Tsoniarisi and the upper mountains, the belt of dark coniferous forests, the village of Nagvarevi), the features of the formation of solid runoff in connection with the forest cover of catchments and human economic activity are most evident.

The positive influence of forests, as the main factor in soil conservation on mountain slopes, is indicated by the works of both domestic and foreign researchers.

In Georgia, the study of L. K. Parjanidze (1938) deserves attention, who, on the basis of two-year observations, came to the conclusion that the solid runoff in treeless areas is 1496.9 kg/ha, in areas with grassy cover - 155.5 kg/ha, and there was no solid runoff at all in the forest area.

Studies by N. M. Gorshenin (1974) revealed that in the North Caucasus there is no solid runoff in a normally closed forest. With a decrease in the afforestation of the basin from 40% to 10%, soil erosion increases by 3.5-4.0 times, according to I. P. Koval (1986), the main felling in the mountain forests of the North Caucasus with the help of ground tractor technology inevitably leads to a violation of the water-regulating and soil-protective functions of mountain forests. On clear cuttings during tractor skidding, 300-500 m^3 of soil are demolished from 1 hectare of felling.

According to I. S. Safarov (1986), in the eastern part of the Caucasus, due to the reduction of the forest area, the regime of mountain rivers is also strongly disturbed. For example, solid runoff with a forest cover of 25% of the basin was 5.69 t/km^2, and with a forest cover of the basin of 5.6 it reached 30.7 t/km^2.

Long-term stationary studies by R. G. Chagelishvili (1985) in Eastern Georgia (insufficiently moistened region) have established that in a catchment area with a forest cover of 70%, solid runoff is formed exclusively due to suspended sediments in a basin with a forest cover of 50%, these sediments make up an average of 24% of the total value of sediments, and with a forest cover of 30-37%, i.e. with a decrease in the forest cover of the basin, an increase in sediments, including data, is observed. At the same time, large flash floods sometimes provide 85-90% of the total annual solid runoff.

Studies conducted by us in Western Georgia (an excessively humid region) have shown that the same pattern is observed in the formation of solid runoff here as in Eastern Georgia.

The higher the percentage of forest cover, the lower the runoff (Table 24). However, if in the region of insufficient moisture suspended sediments and these sediments take part in the formation of runoff only with low forest cover, then in the region of excessive moisture even in catchments with high forest cover, these sediments are formed in significant quantities. For example, from a catchment area with a forest cover of 10%, these sediments amount to 50.4 t/ha, from a catchment area with a forest cover of 35% - 34.7 g/ha, from a catchment area of 80% - 13.7 t/ha, and from a catchment area of 90% - 5.0 t/ha.

The corresponding data from the region of moderate moisture (mid-mountain zone, belt of broad-leaved forests (Table 25)) are characterized by significantly reduced values of these sediments (catchment area with forest cover of 20% - 20.6 t/ha; catchment area with forest cover of 30% - 16.5 t/ha; catchment area with forest cover of 90% - 4.9 t/ha).

Still higher above sea level, in the upper mountain forest zone bordered by dark coniferous forests, the data of stationary studies (Table 26) indicate that these sediments in this zone, taking into account the percentage of forest cover of catchments, vary within a wide range. In particular, from a catchment area with a forest cover of 35%, these sediments are 39.0 t/y, from a catchment area with a forest cover of 50% - 20.5 t/ha, from a catchment area of 80% - 5.05 t/ha. Comparison of these data, taking into account the zonality and forest cover of the catchments, makes it possible to visually trace the increase in this component of solid runoff in the region of excessive moisture, in the belt of broad-leaved forests, in moderately humid conditions, this indicator decreases comparatively, and in dark coniferous forests it rises again, not exceeding the corresponding indicators of the excessively moistened region.

Table 24

Solid runoff from small catchment areas of different forest cover, t/ha
(Over-moistened region; foothills; Chakhati village; Kobuleti forestry enterprise)

Year of observation	Catchment with forest cover			Catchment with forest cover			Catchment with forest cover			Catchment with forest cover		
	10%			35%			80%			90%		
	suspended sediment	sediment data	total	suspended sediment	sediment data	total	suspended sediment	sediment data	total	suspended sediment	sediment data	total
1978	148,6	55,6	204,2	129,4	41,8	171,3	57,6	16,9	74,5	11,4	6,5	17,9
1979	104,2	50,7	154,9	112,2	34,2	146,3	50,1	15,2	65,3	9,5	5,4	14,9
1980	98,5	44,8	143,3	96,9	28,2	125,2	39,8	9,1	48,9	8,8	3,2	12,0
Total:	351,3	151,1	502,4	338,5	104,2	442,8	147,5	41,2	188,7	29,7	15,1	44,9
Average	117,1	50,4	167,5	112,8	34,7	147,6	49,1	13,7	62,9	9,9	5,0	14,9

In general, with the same other parameters, the total solid runoff reaches its highest levels in the foothills. In the middle mountain zone, these indicators decrease significantly, again rising further in the upper mountain forest belt.

Table 25

Solid runoff from small catchment areas of different forest cover, t/ha
(Moderately humid region; mid-altitude mountains; Tsoniarisi village; Keda forestry enterprise)

Year of observation	Catchment with forest cover			Catchment with forest cover			Catchment with forest cover		
	20%			60%			90%		
	suspended sediment	sediment data	total	suspended sediment	sediment data	total	suspended sediment	sediment data	total
1988	67,0	29,0	96,0	54,5	16,0	70,5	8,8	6,0	14,8
1089	66,3	22,2	88,5	49,0	17,0	66,0	4,8	3,8	8,6
Total:	133,3	51,2	184,8	103,5	33,0	136,6	13,6	9,8	23,4
Average:	66,6	25,6	92,2	51,7	16,5	68,2	6,8	4,9	11,7

Table 26

Solid runoff from small catchment areas of different forest cover, t/ha
(Moderately humid region; highlands; Nagvarevi village; Shuakhevi forestry enterprise)

Year of observation	Catchment with forest cover			Catchment with forest cover			Catchment with forest cover		
	35%			50%			80%		
	suspended sediment	sediment data	total	suspended sediment	sediment data	total	suspended sediment	sediment data	total
1988	104,0	34,0	138,0	66,0	22	88	27,5	7,5	35,0
1989	71,0	44,0	115,0	50,0	19,0	69,0	6,4	2,6	9,0
Total:	175,0	78,)	253,0	116,0	41,0	157,0	33,9	10,1	44,0
Average:	87,5	39,0	126,5	58,0	20,5	78,5	16,9	5,05	22,0

4.2 Water-regulating function of mountain forests of Ajara

The essence of this function is the intensive redistribution of precipitation and runoff over time by increasing the infiltration and decreasing the surface component of the water balance.

A good example of the effect of this function is the preservation of a stable regime and an increase in the low water supply of rivers due to the leveling of the amplitudes of fluctuations in discharge during spring floods and summer low water.

G. M. Tarasashvili (1955), on the basis of five-year stationary observations in the Lagodekhi Reserve (Eastern Georgia), determined that on slopes with a steepness of 20-23^0, the surface runoff in felling areas is ten times greater than in beech stands with a density of 0.6-0.7, and 1.2 times more than in stands with a density of 0.2-0.3.

Three-year stationary observations by G. I. Kharaishvili (1971) showed that, other things being equal, on slopes with a steepness of 18°, in comparison with bare slopes, oak-hornbeam forest with a density of 0.8 reduces liquid surface runoff by 9-17 times, pine forest by 4-8 times, and spruce-deciduous forest by 7-12 times. In comparison with the closed association of herbaceous vegetation, oak-hornbeam forests with a density of 0.8 reduce surface runoff by 3.5-6.0 times, pine forests by 2.1-4.1 times, and spruce-deciduous forests by 3.1-5.7 times.

On the basis of thirteen years of observations in the region of insufficient moisture in Eastern Georgia, R. G. Chagelishvili (1985) determined that drainage basins with a forest cover of 70% are characterized by stable runoff, insignificant fluctuations in water discharge during rainstorms and snow melting. Drainage basins with a forest cover of 30% are characterized by very high and relatively short floods, quickly turning into low water. Flooding here does not begin immediately after intense precipitation and turns into low water two to three hours after their cessation.

Drainage basins with a forest cover of 50% are distinguished by high amplitudes of water discharge during heavy rains and snowmelt. Runoff hydrographs are more similar in nature to runoff from less forested basins (30% forest cover) than from catchments with 70% forest cover.

Thus, the high water-regulating effect of forested watersheds in the region of Eastern Georgia is beyond doubt.

Other regularities in the formation of flood runoff from catchments of different forest cover have been established by us in the excessively moist region of the Republic of Ajara (Western Georgia). When analyzing the layer height, coefficients and maximum runoff modules (Table 27), only trends of decrease in these parameters with an increase in the forest cover of catchments are traced, but there is no pronounced increase in the regulating effect as in the basins in the region of insufficient moisture.

The highest indicators of the runoff modulus in this region by periods of the year are associated with the maximum precipitation values.

Average characteristics of flood runoff from catchments of different forest cover in the region of excessive moisture (Chakhati village, Kobuleti forestry enterprise).

The average values of these values for catchments with different forest cover are uniform with a tendency to decrease due to an increase in the forest cover of catchments.

For example, in September 1979, with the arrival of maximum daily precipitation (189 mm), the runoff layer from the catchment area with a forest cover of 10% was 112.3 mm, with a catchment area of 35% forest cover - 110.8 mm, with a catchment area of 80% forest cover - 113 mm, and with a catchment area of 90% forest cover - 11.89 mm. 12.99 l/s-ha, respectively; 12.83 l/s; 13.08 l/s-ha; 11.89 l/s-ha).

Table 27

Characteristics of flood runoff from watersheds of different forest cover in the region of excess moisture (village Chakhati, Kobuleti forestry enterprise)

Flood date	Total precipitation, mm	Drain layer, mm				Runoff coefficient, m				Maximum flow module l/s-ha			
		Forest cover, %				Forest cover, %				Forest cover, %			
		10	35	80	90	10	35	80	90	10	35	80	90
25.09.1978	81,0	82,1	82,2	61,6	62,3	0,90	0,90	0,68	0,68	9,51	9,52	7,13	7,22
05.06.1979	160,0	105,9	99,2	99,0	95,7	0,66	0,64	0,62	0,59	12,25	12,03	11,48	11,08
01.09.1979	189,9	112,3	110,8	113,0	102,7	0,59	0,58	0,58	0,54	12,99	12,83	13,88	11,89
29.01.1980	61,0	31,3	30,8	27,6	23,6	0,51	0,50	0,45	0,39	3,62	3,56	3,19	2,74
13.09.1980	83,6	57,4	53,9	34,1	35,3	0,68	0,64	0,40	0,42	6,65	6,24	3,95	4,09
04.10.1980	78,6	66,7	63,4	61,6	54,8	0,84	0,80	0,78	0,69	7,34	7,34	7,13	6,25
28.10.1980	58,7	45,0	39,5	36,0	27,6	0,76	0,67	0,61	0,47	5,21	4,57	4,17	3,66

The studies carried out by us in the belt of broad-leaved (Tsoniarisi village, mid-mountain belt) and dark coniferous forests (Nagvarevi village, upper mountain belt) in the zone of moderate moisture (Tables 28 and 29) indicate that the indicators of the layer, coefficients and maximum runoff modules at this stage of the study differ little from those in the region of excessive moisture. Runoff indicators decrease here with an increase in forest cover. However, it should be noted that the difference between these indicators in connection with the forest cover of the catchments is characterized by a tendency to comparative homogeneity.

Table 28

Characteristics of flood runoff from watersheds of different forest cover moderately humid region, medium-altitude mountains
(Village of Tsoniarisi, Keda forestry enterprise)

Flood date	Total precipitation, mm	Drain layer, mm			Runoff coefficient, m			Maximum flow module l/s-ha		
		Forest cover, %			Forest cover, %			Forest cover, %		
		20	60	90	20	60	90	20	60	90
18.01.1988	78,0	60,0	52,0	46,2	0,77	0,66	0,59	3,5	1,32	1,53
10.10.1988	108,0	68,0	60,0	57,0	0,63	0,55	0,53	3,09	1,00	1,10
15.10.1988	64,0	38,0	33,0	30,0	0,59	0,51	0,46	2,78	1,07	1,25
05.12.1989	58,8	34,0	33,0	28,0	0,58	0,55	0,47	2,64	1,00	1,11
21.12.1989	120,0	86,0	80,0	76,0	0,71	0,67	0,63	5,40	2,01	2,36

Table 29

Characteristics of flood runoff from watersheds of different forest cover moderately humid region, highlands (Nagvarevi village, Shuakhevi forestry enterprise)

Flood date	Total precipitation, mm	Drain layer, mm			Runoff coefficient, m			Maximum flow module l/s-ha		
		Forest cover, %			Forest cover, %			Forest cover, %		
		30	50	80	35	50	80	35	50	80
08.10.1986	50,0	38,0	37,0	36,0	0,76	0,74	0,72	3,30	2,10	1,50
16.12.1988	64,0	44,0	40,0	36,0	0,68	0,62	0,59	4,04	3,16	1,60
17.10.1989	48,0	38,0	32,0	28,0	0,75	0,66	0,58	3,80	2,00	1,20
02.12.1989	88,0	52,0	51,0	46,0	0,59	0,57	0,52	6,08	5,20	3,16
21.12.1989	43,0	18,0	20,0	17,0	0,41	0,46	0,39	2,20	2,00	1,84

Thus, our comprehensive studies have proved that in the Ajarian regions of excessive and moderate moisture against the background of systematically falling intense precipitation, the water-regulating functions of forest ecosystems as a whole are significantly reduced. At the same time, in the belt of dark coniferous and broad-leaved forests in the zone of moderate moisture, these data are less clear.

One of the main ecological functions of the mountain forests of Ajara is the water protection function.

The complexity and versatility of this function is evidenced by the fact that there is still no consensus among researchers of this issue regarding the essence of this function.

Some of the researchers believe that the essence of the water protection function lies in the ability of forests to maintain the hydrological regime of the territory within optimal limits and that the essence of this function follows from the water-regulating function.

According to other researchers of a more hydrological profile, the water protection function of the forest should consist in the most efficient use of moisture in the area occupied by the forest, and in obtaining the maximum runoff per unit area.

Most researchers of this issue in the republics of the former Soviet Union believe that the flow of rivers from forested catchments increases with the increase in forest cover (Rakhmanov, 1951, 1981; Bochkov, 1954; Sokolovsky, 1958; Izon, 1963; Fedorov, 1877; Lebedev, 1964, 1982, etc.).

Another, less numerous group of researchers believes that the annual flow of rivers increases with a decrease in the forest cover of the territory (Vysotsky, 1937; Lvovich, 1963; Shpak, 1968; Burger, 1954 and others).

In mountainous countries, this important issue for the national economy has not been sufficiently studied. In Ajara, in the region of moderate moisture, it has been studied for the first time.

It is known that the mechanism of forest influence on river flow is determined by a large number of factors, including water-physical properties of soils (total, capillary and non-capillary density, water permeability, volume weight, water strength of aggregates). They change depending on the degree of afforestation and the nature of management in the catchments, with a tendency to improve these properties with an increase in the forest cover of the basins.

Studies by R. G. Chagelishvili (1985) carried out in the arid conditions of Eastern Georgia showed that the average long-term values of the runoff layer for a 13-year period of observations from the catchment area with 70% forest cover amounted to 307 mm, from the catchment area with forest cover of 10% - 269 mm, from the basin with forest cover of 30% - 249 mm.

It has been revealed that the average annual runoff from a catchment area with a forest cover of 70% is greater the drier the year. In wet years, with regular precipitation, runoff from catchments of smaller forest cover increases.

Stationary studies carried out by us together with R. G. Chagelishvili and T. K. Abesadze (Chagelishvili, Papunitze, Abesadze, 1982) in the zone of humid subtropics of the Republic of Ajara, where the average annual precipitation exceeds 2700 mm, have established other features of the influence of forestation of catchments on runoff (Table 30). The average long-term value of the runoff layer from catchments with forest cover of 10, 35, 80 and 90 % was 2009, 1910, 1898, 1828 mm, respectively.

Table 30

Average indicators of the runoff layer from watersheds of different forest cover in a region of excess moisture

(Village Chakhati, Kobuleti forestry enterprise)

Year of observation	Total precipitation, mm	Drain layer, mm			
		Forest cover, %			
		10	35	80	90
1977	2628	1801	1646	1549	-
1978	2973	2110	2036	2006	1922
1979	2982	2220	2129	2148	2038
1980	2339	1696	1564	1541	1523
Всего	10922	7827	7375	7244	5483
Average					
1977/1980	2731	1957	1844	1811	1828
Average					
1978/1980	2765	2009	1910	1898	1828

These data indicate a slight, but regular decrease in the indicators of the runoff layer with an increase in the forest cover of catchments.

At other identical sites organized by us in the region of moderate moisture in the growth zones of broad-leaved and dark coniferous forests of Ajara, we obtained the following indicators (Tables 31, 32).

Table 31

Average indicators of the runoff layer from watersheds of different forest cover
(Moderately humid region, mid-altitude mountains, vil. Tsoniarisi, Keda forestry enterprise)

Year of observation	Total precipitation, mm	Drain layer, mm		
		Forest cover, %		
		20	60	90
1988	1680	890	840	801
1989	1730	953	970	997
Total:	3410	1843	1810	1798
Average:	1705	921	905	699

Table 32

Average indicators of the runoff layer from watersheds of different forest cover
(Moderately humid region, highlands, vil. Nagvarevi, Shuakhevi forestry enterprise)

year of observation	precipitation, mm	Drain layer, mm		
		forest cover, %		
		35	50	80
1988	1880	1270	1190	1300
1989	1789	1150	1200	1180
Total:	3669	2420	2390	2480
Average:	1834	1210	1195	1240

In the middle mountain forest belt (broad-leaved forests, Tsoniarisi village), the average indicators of the runoff layer with precipitation of 1705 mm with a catchment area of 20% forest cover were 921 mm, with a catchment area of 60% forest cover - 906 mm, with a catchment area of 90% forest cover - 900 mm. Thus, with a catchment area of 35% forest cover, the runoff layer was 1210 mm, with a catchment area of 50% forest cover - 1195 mm, and with a catchment area of 80% forest cover - 1240 mm.

Thus, in the waterlogged region of the subtropical stench, the increase in the runoff layer due to the decrease in the forest cover of the catchment is beyond doubt. In the region of moderate moisture, but in the inland Ajara, there are no pronounced differences in connection with the forest cover of the catchments.

The results of the studies allow us to state that in the excessively humid conditions of Ajara, along with the regions of moderate moisture, water protection and protective functions are manifested primarily in the reduction of suspended and bottom sediments from the catchments of high forest cover. The water-regulating effect of these forests, i.e. a decrease in the amplitude of flood flow fluctuations, is insignificant, and the water protection function is manifested in the preservation of water quality from high-forest catchments. The main protective function of the forests of the foothills of the subtropical zone and the middle mountains (broad-leaved forests) of inland Ajara should be considered to be soil-protective, and for the upper belt (dark coniferous forests) the anti-avalanche function is on a par with the soil-protective.

The essence of the anti-avalanche function of forests, according to the definition of R. G. Chagelishvili (1982), is to prevent the generation and weaken the processes of avalanches due to the anti-avalanche resistance of protective stands.

We believe that the forest is a powerful factor preventing the generation of avalanches. However, it should be pointed out that not every forest will be able to prevent the origin of avalanches and even more so to neutralize the process of their descent, therefore, in the studies carried out by us in the forests of Ajara, considerable attention was paid to the establishment of the optimal structure of avalanche forests.

Studies have proven that high avalanche resistance is distinguished by: in composition - mixed forest stands; by age - of different ages (with a predominance of trees at the age of 50-100 years), by structure - complex, by height - twice the maximum thickness of the snow cover. In terms of density, there are spaces in the "belt of struggle", gradually turning into high-trunk and high-density stands.

Based on the results of the research, it can be stated that the water protection and protective functions of the forests of Ajara are manifested mainly in the decrease in the runoff of suspended and bottom sediments from catchment basins with high forest cover. The water-regulating effect of these forests is not as significant as in insufficiently moistened eastern Georgia.

We consider the main protective function of the forests of the subtropical zone and middle mountains to be soil-protective, in the upper belt of dark coniferous forests soil-protective and anti-avalanche.

The results of our research confirm the opinion of many scientists that the geography of the forest, which G. F. Morozov spoke about, is also manifested in the protective functions they perform (Chagelishvili, 1984) and that the ecological functions of forests are a geographical phenomenon (Protopopov, 1990).

The results of our experimental studies, which are still ongoing, give reason to talk about the high water protection role of the mountain forests of Ajara, which is manifested in the reproduction of clean fresh water in forested catchments.

Taking into account the urgency of the problem of combating avalanche phenomena, we have carried out an inventory and compiled a characteristic based on the studies of avalanche-prone areas of Ajara, which primarily need environmental protection using forest ecosystems (Table 33).

Table 33

#	Name of avalanche-prone area	Avalanche danger zone	Avalanche date	Steepness of avalanche-prone slope	Exposure of avalanche-prone slope	Maximum height of avalanche-prone slope. a.s.l.	Avalanche path length, m	Surface condition of avalanches	Presence of forest in the avalanche area	Traces of destruction
	1	2	3	4	5	6	7	8	9	10
1	The right slope of the river Acharistskali, near the village of Tsoniarisi	Sporadic avalanche zone	half XII I half March	30-50	S	1200-1400	400-600	Washed away	Single chestnut, alder, hornbeam	No damage
2	Ibid., near the village of Satskhoria	_"_	_"_	30-45	SE	1400	200	Thinned chestnut plantations 0.2-0.3 density	Group 8B I chest. I Grkl + Elm pol. 0.3 – 0.4; 100 (80-140) years.	Uprooted and broken trees (beech, chestnut, hornbeam)
3	Ibid., near the village of Sasadilokeli	_"_	_"_	40-45	N	1400-1500	200-300	Pastures with an admixture of beech	Single chestnut, alder, hornbeam	No damage
4	The left slope of the river Acharistskali, near the village of Ghurta	Sporadic avalanche zone	II half XII I half IV	30-50	NE	1200-1300	200	Pasture hayfields	Partially forested	Destroys houses, there are casualties
5	The sources of the Acharistskali River, the western slope of the Arsiani Range, the Goderdzi Pass area	Systematic avalanche zone	II half XII I half III	40-50	W	2400	1500	The pasture is turfed, washed away in places	Group, on the cornice in the transit part	Traces of erosion on the cornices
6	Ibid., southwestern slope of the Arsiani Range	_"_	_"_	_"_	SW	_"_	1600	_"_	_"_	Traces of erosion on the cornices block the road
7	Ibid., northern slope of the Arsiani Range	_"_	_"_	40-50	N	2600-2700	2200	_"_	_"_	Traces of erosion
8	The right slope of the river Acharistskali, gully of "Sabaduri", Mount Peranga	Systematic avalanche zone	II half XII, II half III	35-50	SW	2800	2500	Pasture	Alpine carpets, rhododendron, in the cone of forest cover	Uprooted trees in the emission cone
9	The right slope of the river Acharistskali, near the village of Agara	Sporadic avalanche zone	III	40-45	SW	2200	200-300	hayfields	Group 6BZE1D. 0.4; 100 (90-140) years.	Traces of erosion
10	The left slope of the river Acharistskali, near the village of Tsoniarisi	Sporadic avalanche zone	III	40-45	NE	2300	1100	Pasture hayfields	Single beech, spruce	_"_

11	The left slope of the river Skhaltistskali, near the village of Tsablana	Sporadic avalanche zone	II half XII II half III	40-45	E	2200	800-900	Pasture hayfields	Alpine meadows, rhododendron cone forest cover	Destroys houses, first half of February, 1989. 47 people killed
12	Ibid., near the village of Skhalta	_"_	_"_	40-50	NW	1200	400	Erupted 6B2Gr2E (0.2-0.3)	Single spruce, beech, hornbeam	No damage
13	The right slope near the village of Gudzauri	_"_	_"_	35-45	SW	2200	1000	Strong eruption (0.1-0.2) spruce-beech (6E4B) stands of 100 (80-140) years	Alpine meadows, rhododendron, cone forest cover	_"_
14	Ibid., the left slope	_"_	_"_	_"_	NE	_"_	700-800	_"_	_"_	_"_
15	Ibid., the left slope near the village of Dzmagulashi	_"_	_"_	40	SW	1800	500-600	_"_	Single beech	_"_
16	Ibid., the left slope near the village of Kinchauri	_"_	_"_	40-45	SW	2000	500	_"_	_"_	_"_
17	Ibid., the right slope	_"_	_"_	_"_	NW	_"_	_"_	_"_	Single beech, spruce, fir	_"_
18	Ibid., the right slope near the village of Cheri	_"_	_"_	35-40	SW	_"_	600-700	Igneous (0.2-0.3) spruce-beech B + Fir stands 100 (90-130)	Single spruce, beech	_"_
19	Ibid., near the village of Pachkha	_"_	_"_	35-45	NE	_"_	_"_	_"_	_"_	_"_
20	The left slope of the river Chvanistskali near the river Nagvarevi	Systematic avalanche zone	III	40-50	NE	2500	1600	hayfields	Alpine carpets, rhododendron in a cone subalpine sparse forest of beech and spruce east.	Uprooted trees
21	Nearby	Systematic avalanche zone	III	45-50	SW	2500-2600	1400	Pastures, washed away in places	Fragments on the avalanche collection cornices	Uprooted trees (beech, spruce, aspen) block the road
22	Ibid.	_"_	III	40-45	W	2600	1000	Washed away	Rhododendron fragments	Traces of erosion on the cornices block the road
23	Ibid.	_"_	II half XII I half III several times	35-40	S	2000	800-900	turfed, washed away in places	Very thinned forests 4BCHEIGrGP 80 (60-100) years	No damage

24	The right slope of the river Chvansitskali near the village of Khabelashvilebi	Sporadic avalanche zone	III	40-45	SW	2000	1800	Pasture	Alpine carpets, in a cone forest cover. 6БЗЕIП 0.3; 100 (80-120) years	Uprooted trees (beech, spruce, fir) destroy residential buildings, there are casualties.
25	Ibid., the gully of "Khevagele"	_"_	_"_	_"_	_"_	_"_	1000	hayfields	_"_	Uprooted trees (beech, spruce, fir)
26	Ibid., the gully of "Tskavnari"	_"_	_"_	_"_	_"_	_"_	1300	_"_	Rhododendron	No damage
27	Ibid., the gully of "Tskhemlisgele"	_"_	_"_	35-40	SE	2200	1000	_"_	_"_	_"_
	Ibid., "Nakokhvari"	_"_	_"_	_"_	SW	_"_	900	_"_	Subalpine woodlands, 6BZEIP 0.3; 100 (80-140) years.	No damage
28	The left slope of the river Chvansitskali near the village of Khabelashvilebi, gully of "Brolisgele"	_"_	_"_	_"_	N	2000	500-600	_"_	_"_	_"_
29	Ibid., gully of "Chankhistavi"	Systematic avalanche zone	_"_	40-45	NE	1800	5000	_"_	Very thinned /01 - 02 /; spruce-beech (6E4B + fir) forest stand 100 (80 – 120) years	Houses are destroyed, there are casualties
30	The left slope of the river Merisistskali, near the village of Satevzia	Sporadic avalanche zone	II half XII I half March	30-45	NE	1200-1300	1500	Washed away	Very sparse beech-hornbeam forest stand. Single beech, hornbeam, glen, dense undergrowth of rhododendron, cherry laurel, blueberry	No damage
31	Ibid.	_"_	_"_	40-45	NW	1500	1000	Pasture	Group Rhododendron	_"_
32	Ibid., near the village of Namonastrevi	_"_	_"_	40-45	NE	1200	100-150	Pasture	The slope is covered with dense I-I, 3 m high undergrowth of rhododendron, cherry laurel and blueberry	No damage Block the road

33	Ibid.	_"_	_"_	35-40	S	_"_	_"_	Washed away	Heavily thinned beech stand 100 (80 – 120) years old	No damage
34	Ibid.	_"_	III	_"_	_"_	_"_	100	Forested slope	10-year-old plantings of common ash.	_"_
35	The left slope of the river Chirukhistskali, near the village of Kidzinidzeebi	Sporadic avalanche zone	II half XIII П half III	40-45	NE	2200	500-700	Washed away	Group 6BZEIGr + Cl 03 – 04; (80 - 120) years.	Uprooted trees
36	Ibid., near the village of Oladauri	_"_	_"_	_"_	_"_	_"_	1000	hayfields	Single, beech, spruce	No damage
37	The sources of the river Kintrishi, Mount Khino	Sporadic avalanche zone	II half II II half	40-45	NE	2400	1000	Pasture	Group 7B2GrIKl 0.5; 100 (90 – 140) years	Uprooted trees
38	Ibid., gully of "Sarmikeli"	_"_	_"_	35-45	_"_	_"_	800	_"_	_"_	_"_
39	Ibid., gully of "Narakhali"	_"_	_"_	_"_	S	_"_	800-900	_"_	Group 6B2GRIDI0 fir	_"_
40	Ibid. gully of "Sarbiela"	_"_	_"_	40-45	SW	_"_	_"_	_"_	_"_	_"_

Chapter 5

Creation of Highly Productive Plantations of Fast-Growing Woody Species on the Wetland Territory of Colchis Lowland Using New Technologies

Introduction

Despite significant chemical and technological research, the demand for forest products such as timber is systematically increasing, and the possibility of using the mountain forests of Georgia for their further exploitation is very small. The demand for wood material was met mainly by importing it from the regions of the RSFSR, which, in turn, was associated with great costs and difficulties. In the past, in particular, in the 1930s and 1950s, as a result of continuous, unsystematic industrial use of timber, involuntary selective farming, only timber trees of a certain diameter were cut. There were firewood, small-sized, stunted, overgrown, fout, dead, broken-stemmed trees left on the ground. This led to the deterioration of the general condition of our mountain forests, natural renewal and, most importantly, the protective functions - water protection, water storage, soil protection, sanitary-hygienic, balneological, due to the massive lowering of density. If we take into account the state policy of the last century, especially after the 40s-50s, from the point of view of protection of forest ecosystems and the use of forests, we will see that the existing state policy of managing and promoting forestry in the country did not allow the revival of the sector, the reproduction of forest resources, its protection and restoration to the desired result of the update. For decades, the massive cutting of the forest continued mercilessly, which practically excluded any possibility of continuous use of the product of the forest - timber. Therefore, it was no coincidence that for many years, many Georgian scientists and practicing foresters have dedicated themselves to the importance of forests in Georgia, the mistakes made in forest exploitation and the need to improve the state of the field. Academician Vasil Gulisashvili, the founder of mountain forestry as a science and the Georgian school of forestry, was at its head.

Unfortunately, in the recent past, with the creation of a very difficult political situation to transition to a new relationship, due to the energy crisis and the deterioration of the socio-economic situation in the country, the facts of irrational use of forests, unsystematic and intensive felling have become even more frequent, which greatly harmed the sustainability of mountain forest ecosystems.

Prof. Ioseb Bachiashvili's assessment gives us a clear idea of the current state of forests and forest resources in Georgia. Here is an excerpt from the author's book - "Nation and Time", 2014, p. 159: “Effective utilization of the timber stock in the entire territory of Georgia is limited due to many factors... These limitations are caused by the fact that typical mountain forests in Georgia, 73% of which grow above 1500 m above sea level, and 66% of the stock (>25o slopes)) is in the inaccessible area of conventional logging systems. At the same time, the density of 55% of groves is less than 0.6, which excludes the possibility of extensive cutting. The age classification of forests also gives us an unfavorable picture, according to which, where mature and overgrown groves occupy 45% of the stock and 30% of the area, therefore, the indicators of the area of middle-aged and young forests are small."

It is known that one of the ways to increase the level of forest intensification is the introduction of new varieties. Often, introduced woody plants, compared to native plant species, are characterized by rapid growth, shorter period, per unit area, accumulation of much more wood, greater resistance to pests and diseases, frost resistance, drought resistance, etc. (Kozmin, 1954; Prilipko, 1961; Savin, 1962; Ushakov, 1979; Gonchar, 1982). Thus, one of the main ways to reduce the exploitation of our mountain forests, increase the productivity and improve the protective functions, is the cultivation of artificial forests of fast-growing woody species (especially introduced species). Foreign researchers-experts offer unmistakable and accurate conclusions made on the basis of important theoretical and practical experience. For example, UN experts are convinced that the growth of timber production is impossible without the creation of large plantations. As evidenced by the achievements of New Zealand, Brazil and other countries, the productivity of forest plantations under artificial conditions is 5-7 times higher than that of natural forests. Plantations are cost-effective and, most importantly, they can be harvested 3-5 times earlier than natural forests. A notable example of this is the data of Kobuleti forestry, 60-year-old incense pine, and Japanese cryptomeria and tita tree plantations in Tikeri forestry: The height of the incense tree of the mentioned age reaches 30 meters, the diameter is 60-64 cm and gives 1200 cubic meters of wood per ha, cryptomeria - 25-28 m and 800 cubic meters, tulip tree - 25-30 m and 1000 cubic meters wood stock per hectare. It should be noted that in the 1970s the annual allowable amount of wood production in the forests of Georgia (reported forest capacity) was 432 thousand cubic meters, more than half of which was used by the Enguri pulp and paper plant. Taking into account the annual increase in the demand for wood, it can be assumed that Engur pulp paper plant could not be supplied with enough wood for a long time. This was the reason for the import of wood material from outside the country.

Based on all of the above, the task was set before the Tbilisi Forestry Scientific Research Institute: In order to create a wood resource base of Enguri cellulose-paper plant, to conduct scientific-production trials of agrotechnics and technology for the creation of industrial plantations of fast-growing, highly productive woody species on the weakly swampy soil of the Colchis lowland. Our experimental works and observations were carried out in 1971-1987.

Fig. 5. Artificial planting of 50-year-old incense pine and Japanese cryptomeria (Kobuleti Forest Farming, Tikeri Forestry)

5.1. Colchis plain forests as an important site of nature protection

For more than 20 years, large-scale works were carried out in order to cultivate the Colchis lowland with agricultural crops. Colossal scientific-practical works sacrificed and felled thousands of hectares of natural forest, millions of roubles were spent from the state budget. Nevertheless, it has not produced any results, on the contrary, it has resulted in an absolutely pointless expenditure of funds, deterioration of flora, fauna and soil cover. It is important to note the fact that in accordance with the Decree No. 686 of November 11, 1975 of the Central Committee and the Council of Ministers of Georgia - "On the improvement of the use of Colchis wetlands", under the pretext of creating a solid base for livestock breeding and cultivating technical and citrus crops, 38,263 hectares of Colchis Forestry Fund lands were transferred to collective farms and Soviet farms. Our fifteen-year research allowed us to make some conclusions: the groves of the natural forest (mainly alder) of the Colchis lowland, which is one of the best means of protection against frequent and strong wind erosion and phytomelioration for this region, play a decisive role in increasing the yield of agricultural crops and preserving nature in terms of avoiding other negative events. Unfortunately, neglecting these conditions in the past has caused significant damage to families newly settled in Colchis, as well as to its nature. Many examples can be cited to illustrate this. We will stop at only one issue: Residents of relatively early times remember well that the large massifs of the forest along the Poti-Senaki main road, 6-7 decades ago, in order to plant agricultural crops, were completely cleared and thousands of hectares of deciduous forest were uprooted. Previously, these lands were recognized as one of the best forest areas in Colchis, from the point of view of forest use. Several collective farms were formed on the areas freed from the mentioned forest, on the basis of which hundreds of families from the densely populated areas of the mountain were settled in well-equipped houses built by the state. Over time, these areas became swampy again, the waters became polluted, which caused massive human disease. As a result of the secondary swamps of the areas, the land beds intended for the cultivation of agricultural crops were out of order; the collective farms established on areas unsuitable for growing agricultural crops became unprofitable; the majority of the population returned to the mountain; hundreds of houses were destroyed and empty; for 4-5 decades, the forest massifs here could bring 8-10 million roubles of profit to the state; Existing forest massifs, as a means with powerful phytoremediation (evaporative) properties, could save thousands of hectares of soil from secondary swamping; massive deforestation led to the almost complete destruction of the world-famous Colchian pheasant. This unique, endemic bird of Colchis is of such great interest that it has been bred in many foreign countries. Roe deer, hare, wild boar and many other birds and wild inhabitants of the forest also became extinct; powerful, destructive storms have become more frequent in the forestless area, which has led to the activation of wind erosion of the soil and the destruction of the yield of agricultural crops. In the winter of 1969, a strong wind caused great damage to the population, agriculture and the public economy. A similar incident took place in 1974 and in the following years as well.

All of the above gives us the basis for making the conclusion that in order to use the agricultural land in Colchis lowland, massive deforestation and uprooting should be done on the basis of deep scientific analysis. Deforestation and destruction are irreparable, researches and practical experience have proven in many ways that the forests of Colchis, which are one of the important conditions for multifaceted and multifunctional ecological, economic and social progress, should be taken as the basis for managing forestry in this region, and when developing complex measures for the production of a separate field of agriculture, the useful, vital importance of these forests must be taken into account. Deforestation of the forest area should be done only if there is a full guarantee of utilization of the land with highly productive agricultural and useful crops. In addition, in order to maintain ecological stabilization and avoid negative events of nature, during cultivation by other crops, it is necessary to take into account that the area should be cleared from the forest in strips, the width of the strip should not exceed 100-150 meters. The need to create industrial plantations of fast-growing woody species should be taken into account when utilizing the weakly swampy area of the Colchis lowland.

5.2. A Brief Description of Natural-Climatic Conditions of Colchis Lowland

Among the plains of Georgia, the Colchis lowland has the lowest location and is characterized by an absolutely straight terrain. Its climate belongs to humid subtropical. It is characterized by warm winters and mild summers, a large amount of atmospheric precipitation caused by the warm, deep Black Sea and high mountains that surround the Colchis lowland from three sides. The mountains, on the one hand, protect from the cold winds of the north, as well as from the influence of the Armenian mountains and the air masses of Asia Minor, on the other hand, they are a barrier to the winds blowing from the sea. The combined influence of the mountains and the sea affects not only the temperature conditions of Colchis, but also ensures the absence of precipitation, high relative humidity of the air and, under the influence of the sea, significantly softens the temperature variation in Colchis, thus gradually warming up during the summer and cooling down in the winter. Breezes alternate almost continuously, blowing from the sea to the land during the day, and from the mountains to the sea at night, and significantly regulate the daily air temperature in the summer. The annual variation of temperature is almost identical throughout Colchis. The coldest month is January. Relatively warm - July and August. The average daytime temperature in the coastal part of Colchis rarely falls below 14.4^{0}C, but there are cases when arctic air masses invade in winter, frosts can reach 12^{0}C-15^{0}C in Colchis.

Colchis is characterized by high precipitation, especially a large amount of precipitation falls in the coastal zone, and the most in the southern part, where it is 2300 mm on average. The average amount of precipitation in the central part of the Colchis lowland reaches 1800 mm, and in the northeastern part it reaches 1200-1400 mm. The maximum duration of rainfall is observed in Poti, where we have planted trial plantations of fast-growing woody species. Here, during 1 hour and 30 minutes, during one torrential rain, the maximum amount of precipitation was recorded and amounted to 70 mm. It is estimated that the total number of rainy days in Kobuleti is 180, Poti - 153, Sokhumi - 146, Zugdidi - 147, Senaki - 166, and Samtredia - 125.

According to the available data, the average annual amount of evaporation in the natural forest of alder, poplar and plane plantations is 1300-1500 mm. The comparative data of the annual amount of atmospheric precipitations and the water evaporated by trees and plants give us a clear idea of the extremely great phytoremediation value of Colchis forests. This is especially evident where forests are cleared to grow agricultural crops.

A slight general declension from east to west is characteristic of the Colchis lowland. Inter-river watersheds follow a general declension towards the sea and are characterized by different slopes. For example, the Chaladidi massif has a slope of 0.004°, the Tsivi-Tekhuri massif - 0.0014°, the Tekhuri-Abasha massif - 0.0023°, the Enguri-Jumati section of the Khobi-Enguri massif - 0.005°, the Churia river valley of the same massif - 0.0001°, the Enguri-Khumushkuri section of the Enguri-Gali massif - 0.0044°, in the northern part of the same massif near the Okumi river flow - 0.0028°.The data given to characterize the said declension show that the massifs between the rivers are characterized by a very small declension, which is not enough to ensure the surface flow of water. This complicates the hydrological regime of the lowland and, therefore, reclamation works. Rainwater that flows to the soil surface and is spent only on transpiration and physical evaporation is not enough to reduce wetlands.

There is a supposition that the Kolkheti plain experiences a certain depression, under the influence of which the sea moves towards the land and approaches the surface of the groundwater, therefore the soil of the Colchis lowland is a rather difficult reclamation site, which is why we should not expect significant success from the melioration/reclamation network here. The lowest location of the Colchis lowland, the abundance of atmospheric precipitation, the slight declension and the active depression are the main factors that cause these lands to become swampy to varying degrees.

Despite the great difficulty of utilizing the lands of the Colchis lowland with agricultural crops, the bio-ecological potential of this region represents favorable conditions for the cultivation of artificial forest plantations of fast-growing woody species on the slightly swampy soils of the Colchis lowland.

5.3. A general review of the results of scientific research and practical experience of growing industrial forest crops in our country and abroad

We agree with the view of scientists that in the multi-functional study of forest vegetation, forest communities must be considered as complex dynamic self-regulating systems whose main functions and processes affect the state and dynamics of the biosphere (Gulisashvili, 1948; Gigauri, 1980; Khidasheli, Papunidze, 1976: Melekhov, 1980; Protopopov, 1980).

The forest is a complex biological community that has a great impact on the environment, and it is also the object of human economic activity. The analysis of the forest resources of Georgia proves that the forests of the Republic are an irreplaceable universal resource, which has a significant role in meeting the increased multifaceted needs of the society, in the ecological optimization of the country, and is used multi-functionally. It should also be noted that the environmental and social functions of the forests of this region provide an effect of great national importance and are almost equal to the economic effect of the production base of these forests. In some places used for resort and recreational purposes, it is significantly higher (Khidasheli, Papunidze, 1976; Papunidze, 1980).

Due to the pronounced vertical zoning characteristic of Western Georgia, as well as the whole of Georgia, we are dealing with sharp changes in natural, ecological, economic conditions and plant biodiversity in a small area, which leads to a great difference between the agricultural parts of individual forestry (economic purpose of groves, level of intensity of agricultural production and functional purpose of forests) and agricultural sections (growth of forests, composition production and condition).

Among the functions created by the environment, the most important are: the influence of the forest on air and soil temperature; on wind and hydrological regime; on the atmosphere; at the sanitary-hygienic level; on water-borne and wind-borne erosion processes; Balneological, recreational, agroforestry and improvement, as well as the importance of the forest as a reserve of valuable gene pool. It regulates and improves the country's water and climate regime, promotes the development of multi-terrain agriculture, protects against negative natural events (erosion, floods, avalanches, etc.).

There are various reasons for the undesirable imbalance in plant biodiversity. In Georgia, it is mainly caused by the non-rational use of natural vegetation, the limitation of land beds, excessive, unsystematic cutting of forests, the disproportion between forest restoration and forest consumption for decades, the failure of natural pastures, and disordered cattle grazing. In addition to this, the harsh weather conditions characteristic of Georgia are added. All of the above-mentioned factors significantly disturbed the ecological stability of the mountain forests of our country, the disruption of protective functions, which was mainly manifested in the replacement of high-productivity forest species with devalued, deforested phytocenosis-producing species, in lowering the frequency of forest groves, in the creation of low-productivity groves with a simple structure, in the loss of the self-recovery ability of the main forest-forming species. The optimal afforestation of catchment basins is disturbed in the complex of vertical zoning of the forest. There is a very negative process of lowering the climatic boundaries of the subalpine forest and their degradation.

Due to the urgency of the problem, in order to meet the balance wood of the Enguri pulp-paper plant, the issue of conducting scientific-research works in the direction of planting plantations of fast-growing, valuable wood species for industrial purposes in the weakly swampy area of the Colchis lowland was raised as early as in the 1950s. Despite the extremely great state importance of the problem, no work was carried out in this direction. Due to the failure of more than 20 years of efforts to utilize the lands of Colchis with agricultural crops, in the 1970s, it was decided at the government level to meet the ever-increasing demand for the Enguri pulp and paper plant and for timber in general, to conduct a scientific-experimental project in the weakly swampy area of the Colchis lowland related to planting a plantation of valuable, fast-growing woody species.

But the main and most important problem lies in the fact that it would contribute to the restoration of the self-renewal ability of the strategic national wealth of the country - forests, which have been destroyed by excessive, unsystematic cutting for decades, changing devalued, forestless phytocenoses with high-yielding main forest-creating varieties, improving complex, multi-functional protective properties, etc. There is significant theoretical and practical experience of this in a number of foreign countries.

In many countries of Europe, Asia and America, we have rich theoretical and practical experience in the selection of fast-growing woody species (poplar, willow, etc.), variety testing, propagation and introduction of distinctive forms. Polish scientists have achieved great success in this field. For example, R. Damansky (1969), who studied the dependence of poplar growth in the nursery on temperature and atmospheric precipitation, came to the conclusion that climatic factors (drought, frost, humidity, etc.) had the least effect on such poplar species as: *Populus simonii, Populus Zobusta, Populus Genezosa*. The author attaches great importance to this feature of poplars for its propagation and implementation in practice. J. Milewski (1968), studying the productivity of oak, aspen and alder forests in river valleys, came to the conclusion that the productivity of forests on rich alluvial soil along river valleys can be increased by planting fast-growing poplars and willows. B. Volsky (1966), who conducted trials of varieties of poplars in Legeston (Poprad river valley), showed the best growth results in height and diameter of *Populus Hybrida* - 275. Therefore, the author considers *Populus Hybrida*-275 to be the most promising variety for Poprad valley. Bulgarian scientists: V. Bogdanov, Al. and Sl. Iliev (1968); Al. Iliev, V. Bogdanov, N. Kotev and Sl. Iliev (1968); D. Stepanov, B. Zashev, P. Tsainov (1961), achieved great success in scientific research and practical activities of testing poplar species and varieties. Tests were conducted on many types of poplars, including Euro-American poplars. According to the results of tests conducted on the rich non-swampy alluvial soil near the Danube, poplars have achieved unparalleled growth and development: A three-year-old poplar plantation planted in a 3.0 x 3.0 m plot showed the following parameters: *Populus Canadensis* height (h) 9.99 m, diameter (d) - 11.33 cm, *Populus trichocarpa* , respectively-(h) 9.02 m, (d)-10.89 cm, of *Populus vernirubens*,-(h) 10.90 m, (d)-12.03 cm, and *Populus J 214*

(h) 10.99 m, (d) - 12.17 cm. These poplars were recommended for growing on deep and rich, non-swampy alluvial soils, while the above-mentioned scientists indicate that in order to avoid dangerous pest diseases of poplars, it is necessary to observe the average frequency of groves and the agrotechnical and technological processes of timely transplanting and maintenance of standard planting material or cuttings. Czech scientists: L. Krebes and J. Orgoni (1964) analyze the methods of poplar cultivation, indicating that for poplar cultivation, it is necessary to pre-treat the soil in compliance with high agrotechnical rules, and after planting, as necessary, the use of multiple cultivation of the land. They also consider it permissible to grow agricultural crops between the rows of poplar plantations, which at the same time ensures timely care of poplars. R. Leontov and V. Zhemerski (1964) devoted their research to the study of poplar rot as a result of cutting branches, and came to the conclusion - hard-to-restore cut areas are the center of the spread of rot. A Hungarian scientist, Strodfridt Istavan (1962), determined that the best arrangement for growing a large poplar plant is 4.0 X 4.0 m. More frequent plantings, such as 2.0 x 2.0 m spacing, require high intensity (50%) pruning after 5-8 years. Adorion Jorsef (1966), due to the increased demand for high-quality timber, began to test Euro-American poplar hybrids in different soil water regimes in the alder forest. The author determined that under conditions of 50 cm of ground water level (especially at the beginning of May), a twenty-year-old poplar plantation on it gives us as much wood supply as a sixty-year-old alder grove. F. Pallotta (1968) concluded in his studies that *Populus cv, robusta* and *pj-214* (Euro-American hybrid species) showed relatively rapid growth under Hungarian conditions. They are therefore extremely common species; The author points out that the named poplars grown in nutrient-poor soil conditions are strongly affected by entomopathies, while on fertile soil they are less affected and grow quite well.

German scientists attach great importance to poplar cultivation in the country; for example, Karel Mraz (1968) points out that enterprises where wood is used for the production of wooden boards, for the production of furniture, etc., preference should be given to poplar. Albrecht Krumsdorff (1965), studying the issues of growth and development of fast-growing poplars, found out that the annual income received from one poplar is 2.5 marks.

A lot of attention has been paid to the testing of poplar species in Canada and the USA (L. Zufa, 1969). He recommends 16 poplar clones for the "Quebec" province, 10 fast-growing poplar clones for the Ontario region, and notes that the following hybrids show the best growth and development at the age of six years: *Populus alba x eurpameriacana*-214 h=7.4 m; d=10 cm; *Populus alba x eurpameriacana* I-45/51 h=6.6 m; d=10 cm; *Populus alba x dividiana* h=7.4 m; d=10 cm; *Populus alba x Sieboldi* h=7.1 m; d=10 cm. The height of the rest of the hybrids was 4.6-5.7 m. The author indicates in his research that Canadian poplar has shown good growth on swampy soils in Beverly and Wainfleet. In the first case, the average height (h) of the 20-year-old poplar plantation was 18.6 m. Diameter (d) was 30 cm. And in the second case, the average height of the 35-year-old Canadian poplar tree did not exceed 30.6 m-cm, and the diameter - 30 cm.

According to our observations, the Canadian poplar, even on the Colchis lowland, is characterized by a rather fast growth, but this type of poplar is highly damaged by the gnats on swampy soil, which leads to its death, so it is not advisable to grow Canadian poplar in Colchis. In Canada, as early as 1966, a production plantation of 806 ha of hybrid poplars was planted for the production of high-quality paper and plywood.

Soviet scientists made a great contribution to the selection and testing of varieties of fast-growing poplar. I would like to draw attention to one nuance that impressively demonstrates the importance of forest selection: The well-known scientist-researcher in the field of selection of woody plants A. S. Yablokov (1962) notes the misconception of some scientists that forestry is fundamentally different from agriculture in that it deals with wild plants and claims that it is "impossible" to "domesticate" them. Therefore, they considered the selection of forest species unpromising. The concept of breeding as a science that studies the breeding of new species of agricultural animals and plants and the improvement of old ones is quite consistent with forestry as well, since the main goals and methods of selection, such as breeding new varieties of woody species and studying the issues of variety testing, from the point of view of improving the varietal composition of woody species in forestry, planting, etc., are not different from the selection of agricultural plants. The work of selection and variety testing of woody plants in forestry and greening gives the same useful results as in the selection activities of any field of agricultural cultural plants. One of the first Georgian scientists who correctly understood the importance of the selection of forest woody species, tirelessly promoted and tried to conduct scientific research and practical activities in this field on a large scale, was Professor Solomon Kurdiani (1932).

A.S. Yablokov (1952) considers the main tasks of selection of woody plants to be: 1. Selection for general rapid growth of plants and breeding and reproduction of durable varieties; 2. Selection to increase the viability of plants to strengthen resistance to pest-diseases; 3. Selection for improving the quality of the assortment of wood and other products obtained from the plant; 4. Selection for increasing frost resistance, drought resistance and resistance to soil silt; 5. Selection for shade tolerance and long-term flooding due to river flooding; 6. Selection for improvement of green construction and decorative qualities, etc.

According to the explanation of Russian scholars: A. S. Yablokov (1941, 1963), Bogdanov (1965), Ivannikov (1959, 1966), Orlenko (1957), their studies on poplar species originating in different geographical regions prove that there are different forms of rapid growth of poplars. In addition, they indicate that for the selection of relatively fast-growing forms of the plant, it is recommended to select the best forms (clones) according to the growth and development of poplars under the same germination conditions. Poplar polyploid forms can rarely be found in nature. Of these, triploids are sometimes characterized by rapid growth and reach large sizes. In addition, it is necessary to clarify that quite often poplar interspecies hybrids are several times higher than wild type hybrids in terms of growth capacity, height and diameter. It is also worth noting that poplar interspecies hybrids are more flexible in adapting to new environmental conditions. That is why such plants acclimatize with the same success in different geographical areas. They are relatively more resistant to diseases and have many other advantages. The above-mentioned facts once again confirm the perspective of poplar interspecies hybrids originating from different locations.

Detailed methodical guidelines for the technology of breeding poplar interspecies hybrids can be found in the works of A. V. Albensky, Dyachenko (1940), L. P. Bogdanov (1950, 1958, 1959, 1965), A. P. Bochkov (1954), L. S. Yablokov (1956, 1962), L. V. Albensko (1959). Prof. N. E. Gensen (1937) as a result of 18 years of work brought out new species of hybrid poplar and somewhat increased the yield of plants that provide raw material for the production of cellulose. The author cites the comparative data of cellulose obtained by hybrid poplar and other cellulose-yielding plants per 1 ha: flax straw - 112 kg, cotton - 162 kg, corn straw - 560 kg, poplar plantation under the best natural conditions - 1400 kg, poplar plantation with the correct organization of care - 2240 kg, new poplar hybrids - 8960 kg. As can be seen from the data, the cellulose produced from the new hybrid poplar improved by the selection method is 64 times higher than the quantitative indicator of the cellulose obtained from the poplar species originating in natural conditions. The comparison of these verified statements clearly shows that there are great potential opportunities for the further development of mountain forestry in Georgia. Despite the best soil-climatic conditions and, most importantly, in terms of economic, ecological and social conditions, in the weakly swampy area of the Colchis lowland, there is a promising prospect for the creation of industrial plantations of valuable wood species from a technical point of view, extensive scientific research work and practical production trials, if we do not take into account the scientific research and practical work that we have started, have not yet been carried out.

5.4. Purpose, object and methodology of the research

We think that, considering all the above, in the conditions of the Colchis lowland, there can be no two opinions about the necessity and importance of selection of valuable, highly productive woody species, testing of varieties and creation of industrial purpose plantations for the survival and resuscitation-development of the mountain forest of Georgia.

For a separate natural-climatic zone of Georgia, a number of scientific studies determined the main range of tree-shrub plants for the production of forest crops (Kurdiani, 1930; Hinkul, 1939; Mirzashvili, 1933; Gulisashvili, 1935; Abashidze, 1949a; 1949b; Tcharelishvili, 1955, 1958; Bendukidze, 1956; Matikashvili, 1961, 1977; Bregvadze, 1963; Metreveli, 1956). 65; Gedenidze, Matishvili, 1968; Kanchaveli, 1968; Khidasheli, 1971a, 1971b, 1973; Papunidze, 1974, 1975a, 1975b, 1975c; Gedenidze, Papunidze, 1975a, 1975b; Khidasheli, Papunidze, 1976, Papunidze 1981(a), etc.). In Georgia, there are few selection works on the testing of varieties of poplar, willow, plane, tulip tree and other fast-growing high-yielding woody species. In the literary sources, we do not find any material of scientific research conducted on these issues in order to utilize the weakly marshy lands of Colchis. The main product of the forest, wood, as the main material resource for paper production, is quite expensive. Therefore, the development of agrotechnics and technology is of great national importance, as well as for the creation of wood material resources for the Enguri-plant and industrial enterprises of the country. However, a more important and certain difficulty is the selection of durable, highly adaptable woody species for such wetland soil conditions and humid climatic zone as the Colchis lowland. In terms of growth intensity and acclimatization, from the precious wood species, trials were conducted on such varieties as balsam and red-veined poplar, oriental plane, weeping willow, tulip tree (*Liriodendron*), swamp cypress, glyptostroboid metasequoia, swamp, weymouth and frankincense pine, saw and swamp oak, resinous liquidambar (amber tree), lafnia tree, etc. – 50 species in total. The selection of the place for the plantings was carried out with the arrangement of the root system of the test plants according to the access of ground water on the grassy soil of the weakly marshy meadow. A total area of 6.5 ha was allocated for trials. Tulip tree, metasequoia, bog and incense pine plantations showed less adaptation to these conditions. Adaptation of serrated oak, amber tree was determined by only 15%, good adaptability and fast growth are characteristic of willows (90%), but their wood, due to the lack of proper technology in our country, is rarely used - Due to its fragile technical characteristics, willow wood is considered unsuitable for industrial purposes (81% - firewood; 13% - faggot). Swamp oaks and sycamores are characterized by good adaptability (70%), but grow slowly. Almost 100% acclimatization and good growth and development are characteristic of balsam and red-veined poplars, as well as oriental plane/sycamore.

Grassy-sandy and silty-sandy slightly marshy soils of the meadow have very hardened and insufficient physical properties. Much attention was paid to the study of the physical properties of the soil by R. V. Williams (1936, 1950), V. V. Dokuchaev (1898), B. I. Makarov and E. I. Frenkel (1956) who came to the conclusion with their research that improvement of soil structure contributes to improvement of physical properties of soil. Tilling the land improves the physical properties of the soil, regulates the gas exchange balance between the soil and atmospheric air. The exchange of gases between soil and atmospheric air is a very good indicator of soil fertility. All this depends on the type of soil, its cultivation, and physical, chemical and biological characteristics. V. P. Stratapovich Metelkin (1956) determined that the lack of structure and density of the soil, as well as the proximity of groundwater, caused unsatisfactory aeration and deterioration of the soil water regime. A. C. Bertrand and G. Konke (1954), on the basis of studies, came to the conclusion that for normal growth of plants, the degree of diffusion of O_2 in the soil should be 16.0% with the degree of diffusion between the free airs of the atmosphere. It was also confirmed that under the conditions of soil density of up to 1.5 g/cm^3, the root system of woody species cannot penetrate deep into the soil and plants grow poorly, while under the conditions of soil density of 1.2 g/cm^3, plants develop freely. E. Epstein and G. Konke's (1959) studies indicate that loosening compacted soil helps to improve its physical properties and air concentration. C. Lundegorod (1937) proved by his studies that the diffusion coefficient decreases with increasing soil moisture. The author notes that the more water there is in the soil, the less free air space it has and the diffusion resistance is significantly higher. Air-dry soil contains 50-60% air. If the amount of water is 25%, the air space is reduced by half, as a result of which the diffusion resistance increases by two times.) In his work "New studies on the improvement of soil structure" G. E. Rozon (1956) writes: “...Crylium, known as AH, is currently being developed in East Germany and is the double ammonium salt of polyacrylic acid. The use of this drug in the soil improves its structure. In the US, Crylium-type drugs were released: CD-186 and CD-189. These preparations, depending on the crops, help to increase the yield by 15-45%. But some crops (sugar beet) do not respond to its introduction into the soil. The advantage of polyacrylate lies in its speed of action. The structure is stabilized over several days.

The meadow-grassy, sandy and sandy-silty soil of the Rion river valley is characterized by high density and weak marshes. The quality of soil wetlands was determined by the development of herbaceous plants characteristic of wetlands and its location in the depth of ground water. On these lands, groundwater is located at a depth of 1.0-1.5 m, and in such cases, grassy plants typical of marshes cover 25-30% of the soil surface. The physical properties of this soil were studied by the Wagner method. Non-capillary porosity in untreated (wasteland) soils was 6.0%, capillary porosity was 44.0%, total porosity was 50%.The overall density of the soil and the insignificant non-capillary porosity also lead to poor drainage and insufficient aeration in the sandy soil of the Rioni lowland. As it is known, the water conductivity of the soil of the Kolkheti plain is very important. Especially during intense, long rains, during river overflow and flooding of the area. Also, when the snow melts (the latter rarely happens here), the water cannot penetrate deep into the soil and remains on its surface (in some places for days, months, and sometimes even years). This is what causes the swamping of the soil. Water remaining on the surface of the area leads to the deterioration of all elements of the physical properties of the soil. Despite the sandy composition of the soil, uncultivated (wasteland) soils are characterized by strong compaction and poor water permeability. So, for example, a 10-centimeter water level placed in a cylinder vessel specially used to study the water permeability quality absorbs into the soil depth for an average of 193 minutes (the test was repeated 10 times). Deep plowing and cultivation of the soil drastically changes the non-capillary porosity (to about 14-15%), while the capillary porosity remains at the level of 40-42%.Our data show that plowing and cultivation increase non-capillary porosity by 123-150%. It significantly increases the water permeability of the soil, and it also promotes soil aeration. In such a case, the water level of 10 cm from the cylinder, plowed and cultivated soil depth (when soil moisture is 25%) reaches an average of 24 minutes (experiment repeated 10 times). Through multiple tests on soil water permeability, it was defined that the smallest soil fractions, together with water, move smoothly in the direction of greater porosity. That is why, according to our tests, water absorption in the depth of the soil lasts only 20-30 minutes. However, uniform deep plowing of the soil and subsequent cultivation improves the physical properties of the soil, including gas exchange between the soil and atmospheric air.

As is known, the concentration of CO_2 and O_2 are the main determinants of soil air. The concentration of CO_2 and O_2 in soil air was studied by B. N. Makarov's (1957) method. The research showed that the air in the surface part of the meadow-grassy, sandy-silty, uncultivated (wasteland) soil contained 0.86% CO_2 and 17% O_2, in the depth of 40-50 cm the concentration of CO_2 increased by 1.82 %, O_2 accounted for 16.4%.Such a composition of oxygen in the soil is quite sufficient for the normal development of the root system of plants, but in rainy weather, which is not rare here, the picture changes - after the rain, the oxygen concentration on the soil surface decreases to 15.0% and at a depth of 40-50 cm does not reach to 12.0%. In addition, it was determined that the concentration of CO_2 increases significantly - on the surface of the soil it was 3.6%, and at a depth of 40-50 cm - 6.9%. In such conditions, the process of feeding plants with oxygen is disturbed.

In the case of total soil processing (plowing) and cultivation, such strong undesirable fluctuation of oxygen and carbon dioxide concentration was not noticed - the concentration of oxygen in the air of the plowed soil surface was 20.1%, CO_2 - 0.16%, the concentration of oxygen at a depth of 40-50 cm was 19, It did not drop below 86%, and the concentration of CO_2 did not exceed 0.34%.

After the end of long rains, the soil surface air contained 19.9% oxygen and 0.34% carbon dioxide. At a depth of 40-50 cm, the concentration of oxygen did not drop below 19.0%, while CO_2 did not exceed 0.82%. These data lead to the conclusion that soil plowing and cultivation improves not only its physical properties, but also aeration and has a positive effect on the growth and development of woody species.

The research area, where the above-mentioned soil studies were carried out, is located on the left bank of the Rioni River (16-18 km away from the city of Poti). The relief is straight, the plants are mainly grassy, and the bedrock is sea alluvium. The vertical section of the soil is characterized by the following data:

A-20 cm - straw-gray, in the dry state - with a gray-brown tint, non-structural, loose, abundantly penetrated by the roots of herbaceous plants, moist, sandy, transition to the next layer gradually; slightly spluttering;

B-30-80 cm - brown-gray, dry-gray, loose, loose, moist, sandy, slightly spluttering;

C-80-120 cm - gray, non-structural, loose sand, humid, spluttering.

These soils are uniform in morphological features, and in mechanical composition they belong to sandy soil. (Table 34). Microaggregate analysis shows that the excess fraction is 0.05-0.01. The chemical composition of this soil was also analyzed, the data of which are presented in Table 35.

Table 34

Mechanical and microaggregate composition of soil samples of the research object

№	Sampling depth, cm	Mechanical composition, with Kaczynski						
		Specific gravity	1–0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001
1	2	3	4	5	6	7	8	9
1	0-20	2,68	0,38	32,13	48,62	5,72	4,25	7,86
	30-80	2,71	0,33	21,91	56,35	12,61	0,70	7,04
	80-120	2,72	0,23	19,47	61,02	2,59	11,05	4,07
2	0-20	2,64	2,03	39,96	34,29	7,51	7,07	7,95
	30-70	2,66	0,63	72,70	11,54	0,90	9,18	3,79
	80-100	2,75	5,17	59,46	24,66	1,20	3,27	4,89
3	0-20	2,65	0,48	34,02	51,23	1,03	9,51	2,16
	30-80	2,67	2,50	12,88	67,40	0,70	4,45	8,40
	80-120	2,69	4,63	67,09	18,50	1,18	1,45	4,52

Table 34 Cont.

Microaggregate Composition					
1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001
10	11	12	13	14	15
0,34	21,22	64,73	13,50	0,19	0,02
0,15	21,57	67,57	10,06	0,22	0,43
0,79	11,54	72,80	14,42	0,29	0,16
0,34	34,12	44,62	8,84	11,51	0,47
0,57	47,54	39,59	12,66	0,24	0,40
0,87	59,07	39,24	0,20	0,46	0,16
3,38	34,99	44,29	8,57	8,66	0,11
0,86	51,93	46,49	0,09	0,09	0,59
2,92	71,65	25,28	0,06	0,07	0,12

Table 35

Data of chemical analysis of slightly marshy meadow-graasy-sandy soil

Sampling depth, cm	Humus, %	Total Nitrogen, %	Assimilable phosphorus- P_2O_5 in 100 g soil	Potassium in 100 g soil	pH – water suspension
0-20	1,45	0,07	2,4	4,0	8,05
30-80	1,18	0,05	2,4	3,2	8,20
80-120	1,06	0,05	1,6	2,2	8,10

It can be seen from the digital data that the grassy soil of the meadow has very little humus and is poor in nutrients, the acidity of the soil solution is of an alkaline reaction, - pH ranges from 8.05 to 8.2.

In the test area, groundwater is located at a depth of 100-120 cm. During intense rains, the groundwater level rises to a depth of 70 cm. On the surface of the plowed soil of the test area, up to 35 cm, water ponding during rain is not observed. Rainwater is evenly absorbed in the depth of the soil, and on uncultivated soil, water soaks for 3-10 days, which worsens the physical properties of the soil.

Before planting poplar or other species, the main work process is primary soil treatment. Further good growth of plants, their adaptation and normal development depend on the correct and careful cultivation of the soil. Primary soil treatment is done at a depth of at least 35 cm. Deep, plantation (70 cm) plowing should be done when the tillable horizon of the soil allows deep plowing. In other cases, primary (main) plowing should be carried out to the permissible depth of the plowing horizon, not less than 35 cm deep.

The correct selection of the area for poplar culture determines its growth and development, the overall condition and productivity of the plantation. On loamy, light mechanical composition, well-aerated, neutral reaction, moderately moistened high fertility soil, poplar plants grow best and are characterized by high durability.

For the cultivation of poplar plantations, it is more or less necessary to have easily water-permeable and nutrient-rich soil. Plots with ground water at a constant high level (50 cm and above) are less useful for poplar culture, but poplars easily adapt to slightly swampy soils.

The best conditions for the good growth and development of poplars are riverside meadows and floodplains, as well as riverside sandy, sandy-loamy and alluvial-grassy soils. Short surface flooding of the soil surface fully satisfies the ecological and biological requirements of the poplar, especially if it is saturated with rich mineral substances.

The correct selection and preparation of the soil for growing poplar is one of the prerequisites for high adaptability and good growth of the culture, which is manifested in the rapid growth of above-ground organs, interdependence and mutual stimulation between the assimilated apparatus and the absorbing roots. In the area allocated for the cultivation of poplar crops, before plowing, uprooting and cleaning of thorn-peas, bushes and other weeds, filling of pits formed as a result of uprooting, and leveling of the area are carried out using the latest technical means. After that, the plot is plowed. Cultivation of soil for growing crops improves its physical properties and water regime, facilitates easy delivery of nutrients to plants and reduces the harmful effects of weeds on crops. For the plain conditions of the Colchis lowland, where there is no danger of soil washing away, it is better to cultivate the entire soil. The plowed soil is harrowed. If the soil, by its mechanical composition, is meadow-grassy, sandy-silty, as we said above, it is plowed not less than 35 cm deep, and heavy loam not less than 50 cm deep. Such a method of land cultivation helps to evenly absorb rainwater deep into the soil and preserve moisture until early spring.

In order to create a healthy, best poplar plantation, great importance is attached to the quality of cuttings prepared for planting, as well as to the observance of their preparation terms, storage conditions, etc. The graft is made of one-year shoots. The best is considered to be a shoot that has sprouted from the roots. A graft made of crown is much more difficult to grow and grows poorly. Prepared sprouts are stored together, to protect them from drying out, they should be tied into cones, each containing 100 sprouts and buried in moist sand, it is better if we place them in a shed or in a specially designated closed building. The sprouts should be buried in a place protected from the sun, which will protect the soil from drying out and the sprout from untimely germination. All poplar species have an important biological feature of vegetative propagation by means of cuttings and peduncles, whereby a large part of poplar species are rooted by 90-100%, and some species by 25-30%, some species do not propagate by cuttings and peduncles at all, such as, for example, weeping willow and the Euphrates willow.

In practice, a fairly common method of poplar propagation is to propagate them by winter cuttings. One-year shoots of dormant buds of different lengths and diameters are used for this. In practice, it is very important to determine the most suitable time for making a cutting through trials. Good results have been obtained with our research. Cuttings were made in late autumn, winter or early spring, 2-3 weeks before budding. In addition, for practical purposes, it is necessary to know the optimal dimensions (length and diameter) of the planting cuttings corresponding to the soil of the plot allocated for culture, which greatly depends on the formation of a strong root system and, in the first year, the healthy development of the cutting. On the moist soils of the Colchis lowland, very short, one- or two-bud - 5-8 cm long cuttings also take root quite well, but we should also keep in mind that such a cutting does not grow more than 30 cm per year and it is very easily overwhelmed by ordinary grass or vegetation cover.

According to our observations, the cuttings made 2-5 days before planting or on the same day for growing balsam and red-veined poplar did not give good results. The yield of such grafts did not exceed 22-25%.

At the beginning of January, we prepared balsam and red-veined poplar shoots in a special bed, and willows from trees planted on the banks of the Rioni river. The cuttings were kept in moist sand in the open air until February 24. At the end of February (February 25-26), we placed them in water for two days. Then the cuttings were cut to a length of 20-25 cm and transplanted to a permanent place. The growing of poplar (especially balsam poplar) cuttings made in this way amounted to 95-100%.The shoots are cut into cuttings with secateurs, but it is better to cut them with a sharp knife. The shoot is cut so that the upper cut should be 1-2 cm above the last leaf bud. The cut is smooth and indirect. Cutting at the lower end of the graft is done directly below the leaf bud; this promotes intensive callus development and abundant root formation. Practice has shown that a larger (1.5-2.0 cm) cutting of balsam poplar develops a stronger shoot than a thin one (0.8-1.0 cm). Cuttings of poplar, willow and other species should be planted in early spring, as soon as possible before the beginning of vegetation. It is unacceptable to dry the roots of cuttings or seedlings, this significantly reduces their growth. The growth of cuttings or seedling cultures and its subsequent success depends a lot on the care of planting. From the very first year of cultivation, loosening of the soil in the crops, fight against weeds and pests, protection from cattle should be carried out, and this should continue until the envelopes of the crops are tied. This measure contributes to the gas exchange (air exchange) of carbon dioxide and oxygen between the internal and external areas, as well as to the improvement of all elements of the soil, including its physical properties.

Near the city of Poti, close to the left bank of the Rion River (location "Sagorodo") on cordian-belt and sandy soil in 1971, with different layouts (1.0 X 1.0 m, 2.5 X 2.5 m, 4.0 X 4 ,0 m, 6,0 X 6,0 m) we planted the plantations of the above named test trees and plants. On the plot, care, combination of mineral fertilizers, options of their different dosages were used. A control variant was also allocated for the variant installed in all trials. In some plots, the influence of soil cultivation on the growth of this or that species of plant was studied, in some areas the effectiveness of cultivation and complete mineral fertilizer (NPK), etc. Ammonium sulfate ($NH4NO3$), active substance N-34%, potassium fertilizers - chlorpotassium ($KC1$), active substance $K20$-54%, phosphorus - superphosphate, active substance $P205$-20% were used for feeding plants with nitrogen fertilizer.

It is known from literature sources that poplar seedlings, especially in the initial stage of growth, require more feeding with nutrients and moist soil than older seedlings. This is explained by the fact that poplar seeds or cuttings contain a limited amount of nutrients, which are only sufficient for sprouting. Sprouts, especially in the first year of growth, have a very weakly developed root system. Naturally, such a plant needs easily accessible nutrients from the very first day of its existence. The total supply of nutrients is different in different soils, and the nutrient elements available to young plants with weakly developed roots are not in sufficient amount in the soil. As S.I. Slukhai (1958) notes, in nutrient-poor sandy and silty soil, 30 t/ha of organic fertilizer and 8.0 t/ha of superphosphate should be applied. As it is known, phosphorus in manure is twice less than nitrogen and potassium. Therefore, in acidic soil, superphosphate should be replaced with phosphorite flour. Phosphorite flour should be added to the soil with half the dose of superphosphate. The composition of the fertilizer depends on the external properties of the soil and plants. If the branch of the graft is small in size and has discolored leaves, it is necessary to feed it with nitrogen fertilizer. If the leaves are green, but the plant grows slowly, it needs phosphoric fertilizer, if the plant is in an unhealthy state, it is necessary to feed them with a complete mineral fertilizer - NPK.

In the Colchis lowland, where there is quite a large amount of precipitation, and the soil has a light mechanical composition, fertilizer can be introduced into the soil superficially, by mixing, and later it will be absorbed during soil loosening or cultivation. Poplar plants do not grow quickly on poor sandy soil. To create high-yielding poplar plantations, especially when nutrients in the soil are insufficient, it is necessary to improve the soil-ground conditions to accelerate the growth of crops. The best way to improve the nutrient-poor soil is to use mineral fertilizers.

Phosphorus and potassium fertilizers should be added to the soil 20-30 days before the start of vegetation. This is related to their weak ability to move in the soil. In order to reach the roots and be better assimilated by the roots, the fertilizer needs to penetrate deeper into the soil. Nitrogen fertilizer should be applied to the soil 3-5 days before the start of vegetation. A high effect is given by the use of nitrogenous mineral fertilizer in the form of two-time feeding, at the beginning of the primary plant's vegetation, and the secondary - in the form of nitrogen fertilizer only in the month of July.

On the grassy-cloddy soil of the Colchis plain, which we have already described above, we applied mineral fertilizers around the plantings, with their subsequent hoeing. According to options, the following doses of mineral fertilizers, active substance, were used on one root of planting: 1) - control; 2) - N - 20 gr. + N – 20 gr. P - 40 g, K - 20 g; 3) - N - 34 gr. + N - 34 gr. P - 50 g; K - 30 g; 4) - N - 40 gr. + N - 40 gr. P – 60 gr. K – 40 gr. Then, every year, doses of nitrogen fertilizers were used: N - 60 g. + N – 60 gr. and phosphorous and potassium: P - 80 gr., K - 60 gr.

Of the existing crops, mainly the issues of the growth process of those woody species that are successfully used in the pulp and paper industry and are characterized by the best growth and development indicators have been analyzed and evaluated. For the purpose of comparative data, some indicators of growth and development of natural alder plants were also evaluated. The obtained digital indicators of plant growth and development of the studied species were processed by the variational statistics method. However, special attention was paid to the data of significant difference (t) and probability of confidence (W%). The essential difference was calculated by the formula: t= $\frac{M2-M1}{\sqrt{m_1^2+m_2^2}} \geq 3$ and the probability of confidence – in W%.

5.5. Research results, conclusions and suggestions

Table 36 shows the analysis of growth rates of three-year poplar, oriental plane and willow crops grown on 1,0 X 1,0 m, 2,5 X 2,5 m, 4,0 X 4,0 m, and 6,0 X 6,0 m of control, cultivated and frozen soils according to individual layouts and options. As we can see, the average height of the balsam poplar planting in the 1.0 X 1.0 m layout on the cultivated plot was 3.8 m; and on the control soil - 2.5 m. The difference is 1.3 meters. In the case of the option, where five-fold cultivation was carried out in the first year, three-fold cultivation in the following years and complete mineral fertilizer was also used on the plot, the height of the three-year-old balsam poplar was 5.4 m, by 216%, i.e. twice more than in the control plot, and it exceeded the poplar in the cultivated plot by 142.1% in height. The accuracy of the test in these plots ranges from 0.9 to 1.6. The significant difference between the variants (confidence coefficient-t) ranges from 23.0 to 45.3. On the cultivated soil, the average diameter (thickness) of the same poplar, from the root system, at a height of 10 cm, was 5.0 cm, 43.0% more compared to the control variant. And, on the soil of the combined use of cultivation and complete mineral fertilizers, the average diameter was 5.6 cm, 89% more than the control plot. Only 32% more than the cultivated plot.

In the case of red-vein poplar, the three-year vegetation reached 4.1 m on cultivated soil, and 2.6 m on the control plot. Where mineral fertilizers were used along with cultivation, the average height of poplars reached 5.0 m. Along with care and feeding, the size of the diameter also increased significantly.

Similar to poplars, the oriental plane crops are distinguished by a significant advantage. One-year seedlings 35-40 cm long were used to grow the planes. The height of the three-year oriental plane reached 2.6 m in the control variant, 3.9 m in the cultivated soil alone, and 5.0 m in the soil with the combined use of cultivated and mineral fertilizers. In diameter, respectively: 4.0 cm, 6.0 cm and 10 cm. Willows are characterized by almost the same growth and development both in height and thickness.

On the land area of 1.0 X 1.0 m layout, during the first two years multiple (as needed) cultivation works are carried out. In the third year - three times. In the third year, the tree branches are closely packed, however, there is still less noticeable interspecific differentiation of the plants.

Table 36

Data on growth in height and thickness of three-year trial crops in relation to tillage, plant nutrition and placement

Placement and name of the species	Control		Cultivated Soil				Cultivation + NPK			
	Height (h) m	Diamete r(d) cm	Height (h) m		Diameter (d) cm		Height (h) m		Diameter (d) cm	
	M ± m	M ± m	M ± m	Difference (t)	M ±m	Difference (t)	M ± m	Difference (t)	M ± m	Difference (t)
1	2	3	4	5	6	7	8	9	10	11
1,0 x 1,0 ∂										
Balsam poplar	2,5±004	3,5±0,03	3,5±0,03	23,0	5,0±0,08	4,8	5,4±0,05	45,3	6,6±0,12	25,1
Red-vein poplar	2,6±0,06	3,0±0,05	3,0±0,05	19,2	5,0±0,06	25,6	5,0±0,10	20,6	5,5±0,10	22,4
Oriental plane	2,6±0,09	4,0±0,05	4,0±0,05	12,6	6,0±0,06	25,6	5,0±0,05	33,3	10,0±0,15	37,9
Drooping willow	3,1±0,04	4,0±0,06	4,0±0,06	21,2	6,2±0,08	22,0	5,0±0,08	21,2	6,5±0,10	21,4
Southern willow	3,0±0,07	4,2±0,08	4,2±0,08	8,8	6,4±0,09	18,3	4,8±0,02	24,7	7,5±0,08	29,2
2,5 x 2,5 ∂										
Balsam poplar	2,0±0,05	2,5±0,08	2,5±0,08	13,6	4,1±0,09	14,9	4,0±0,04	31,0	6,0±0,12	26,4
Red-vein poplar	2,0±0,08	2,3±0,09	2,3±0,09	19,3	4,4±0,04	20,7	5,0±0,05	32,4	5,6±0,07	28,1
Oriental plane	2,0±0,06	3,8±0,06	3,8±0,06	14,2	5,0±0,07	12,0	4,8±0,06	32,4	9,9±0,06	66,3
Drooping willow	2,6±0,08	4,5±0,04	4,5±0,04	14,0	6,0±0,09	15,2	4,1±0,03	17,5	7,0±0,06	36,0
Southern willow	2,5±0,06	4,4±0,06	4,4±0,06	19,7	6,3±0,14	12,7	4,1±0,04	22,5	7,0±0,07	28,6
Tulip tree	1,0±0,04	0,7±0,04	1,4±0,04	7,1	1,3±0,04	10,6	1,9±0,04	15,9	2,1±0,03	28,0
4,0 x 4,0 ∂										
Balsam poplar	1,8±0,04	1,7±0,08	2,7±0,05	13,9	3,0±0,09	11,1	4,3±0,12	23,3	4,4±0,12	18,8
Red-vein poplar	1,7±0,07	2,6±0,06	2,6±0,06	9,7	4,9±0,19	11,1	6,3±0,06	19,9	6,3±0,06	41,7
Oriental plane	2,3±0,06	2,2±0,05	3,0±0,02	10,6	3,9±0,03	30,6	5,2±0,12	13,2	5,2±0,12	22,0
Drooping willow	2,1±0,10	2,1±0,10	2,9±0,07	6,7	3,2±0,17	6,2	4,9±0,13	12,9	4,9±0,13	18,0
6,0 x 6,0 ∂										
Balsam poplar	3,0±0,01	3,0±0,01	3,1±0,04	21,1	6,1±0,12	26,3	3,9±0,07	25,4	7,1±0,08	47,6
Red-vein poplar	2,3±0,04	2,3±0,04	3,1±0,04	17,8	4,3±0,10	17,7	4,1±0,06	29,0	5,0±0,01	60,1
Oriental plane	2,9±0,14	2,9±0,14	2,4±0,06	4,2	5,0±0,07	12,6	4,1±0,08	19,9	6,6±0,16	16,0
Drooping willow	3,8±0,18	3,8±0,18	3,9±0,06	5,8	5,4±0,37	4,0	4,7±0,13	9,4	8,1±0,34	11,4
Southern willow	3,8±0,16	3,8±0,16	4,0±0,06	8,2	6,4±0,39	7,8	4,8±0,12	11,2	8,7±0,10	26,0

The beginning of drying of the lower branches of the balsam poplar plantation and the disappearance of the herbaceous vegetation cover are observed. The withering of the lower branches of the red-veined poplar, eastern cedar and willows, which was not noticed in this period.

In the control plot with a layout of 2.5 x 2.5 m, the average height of balsam poplar reached 2.0 m, and in the area where cultivation was carried out alone, the average height reached 3.0 m, and in the soil where full mineral fertilizer was applied along with cultivation (NPK) was applied, the poplar of this species grew up to 4.0 m in height. If we take the data of the control plot as a 100% indicator, then soil cultivation accelerates the growth by 50%, and with it, mineral fertilizers are used - by 100% compared to the control, in thickness, respectively - by 64 and 100% (2, 5 cm).

The average height of the red-vein poplar plantation reached 2.0 meters in the control (unfertilized) variant. Only on cultivated soil - 3.6 meters (that is, 80% more). The average height of this poplar reached 5 meters on the option of combined cultivation and full mineral fertilizers, compared to the unfertilized one, by 150%, i.e. 1 m more than the balsam poplar. The increase in diameter is 91% more than the cultivated plot alone, and 144% (5.6 cm) more than the control in the combination of cultivation and mineral fertilizers (NPK).

Oriental plane reached a height of 2.0 m in the control plot, soil cultivation accelerated its growth to 3.4 m, that is, by 70%, and with the combined action of cultivation and NRK to 4.8 m (compared to the control, 240 % more). Drooping and southern willows have the same biological characteristics, so they show almost the same growth and development. The average height of willows in the control area was 2.6 and 2.5 m, respectively: 3.8 and 3.8 m in the cultivated soil, and 4.1 and 4.1 m in the NPK+ cultivated plots. Here too, depending on the importance of cultivation and care, the acceleration of growth in height was noticed. Moreover, the growth in the diameter of the above-mentioned willows is more intensive than in the case of poplars and plane, but on the fertilized plot this difference with poplars decreases more or less, and plane in this case accelerated the growth in diameter more than other species.

Tulip-tree saplings were planted with 2.5 x 2.5 m spacing. It should be noted that it showed less effect on the control area; in three years, its thickness reached 1.0 m, cultivated - 1.4 m; and on the cultivated +NPK option - 1.9 m. The tulip-tree is characterized by the same slight increase in diameter. Observation of tulip-tree’s growth for two years showed that she did not grow at all, and her increase was only a few centimeters per year. Height increased mainly in the third year. Due to the small number of trees of this species, they were mainly planted in 2.5 x 2.5 m layout, and a few pieces were planted in 4.0 x 4.0 m layout, therefore the growth indicators of tulip-tree were analyzed in 2.5 x 2.5 mm layout plots.

The test species on the layout options at 4.0 x 4.0 m are characterized by the following growth indicators: at the end of the third year, the height of the balsam poplar in the control area was 1.9 m, on the cultivated soil it grew to 3.0 m, and on the

NPK+ cultivated plot its average height was 4.0 m; in the first case by 58%, in the second case by 210% more compared to the control variant. With cultivation, the diameter increases by about 75%, and where mineral fertilizer was supplied to the soil along with cultivation - by 123%.In this arrangement, the red-veined poplar showed a fairly good growth, its height reached 1.8 m in the control area, 2.7 m in the plot where the cultivation continued, i.e., 0.9 m compared to the control (50%) more. The average height on the cultivated area with mineral fertilizer increased to 4.3 m. As we can see, cultivation and use of mineral fertilizer have a positive effect on growth in diameter and height. In the same layout, the Oriental plane was characterized by the following growth data: on the control soil, it grew to an average height of 1.7 meters, on the cultivated plot to 2.6 m, i.e., an increase of 53% compared to the control, its average height on the fertilized-cultivated soil was 3, 7 m. The effects of cultivation and fertilizer increased the oriental plane height by 2.0 m or 118% compared to the control plot. The drooping willows and southern willows also showed nearly equal growth in both height and diameter.

It should be noted that in the case of planting seedlings with an arrangement of 4.0 X 4.0 m, more intensive and faster growth of herbaceous plants is observed than in plantings with an arrangement of 2.5 X 2.5 m. As we said above, in plantations with a layout of 1.0 X 1.0 m, due to the disadvantage of the high-frequency illumination regime, the herbaceous, i.e., as it is used in forestry, live forest cover develops very weakly and gradually disappears in accordance with the denser compaction of plantations. Also, it is worth noting the fact that in the case of 4.0 X 4.0 m and 6.0 X 6.0 m layout, the projection of the crown extends over a larger area than 2.5 X 2.5 m and 1.0 X 1.0 In plants with m layout. We should add to all the above the fact that the plants with 6.0 x 6.0 m layout were also characterized by different growth data. In the control area, three-year-old balsam poplar reached 1.9 m, on the cultivated soil the average height increased to 3.1 m and exceeded the height of the control poplar by 1.2 m. It reached 3.9 m on cultivated+NPK soil. As it can be seen from the above, soil cultivation increased the height of balsam poplar by 63% compared to the control plot, and with cultivation, mineral fertilizer (NPK) application increased by 105%. The diameter of this poplar, compared to the control, increases by 103 and 137% according to care and nutrition. The average height of the 3-year-old red-veined poplar plant in the cultivated field of this layout increased by 3.1 m (67% more) compared to the control (2.1 m), and in the plots where the complete mineral fertilizer of NPK was applied along with the cultivation In the face, the average height of the poplar reached 4.1 m (95% more than the control). The same picture was obtained in the indicators of growth in diameter, where the diameter of the red-veined poplar on the control variant was 2.3 cm, on the cultivated soil - 4.3 cm (86% more), on the cultivated + NPK soil it was 5.0 cm, i.e. it increased by 117% compared to the control area.

The Oriental plane reached an average height of 2.1 m in the control area for three years, and 2.4 m on the cultivated soil (here, for some reason, soil cultivation did not affect the growth acceleration in the height of the chadar, and the process reduction did not exceed 14%).On cultivated soil, where mineral fertilizers were also used, the plane height reached an average of 4.1 m (95% more). Unlike other woody species, the plane was characterized by a high intensity of growth in diameter, if we do not include test plants with a layout of 6.0 X 6.0 m, here, on the cultivated + NPK option, this species somehow lagged behind balsam poplar and willow in terms of diameter growth. On cultivated+NPK-fertilized soil, the drooping and southern willows showed quite good growth in height - 4.7 and 4.8 meters, i.e. 43% more than the control area, and the increase in diameter exceeded 100%.It should be noted that soybeans were sown on an area of 300-300 m^2 under each of the red-veined poplar and oriental plane plants of this layout, in order to study the effectiveness of green manure on the growth and development of the plants. This trial lasted for three years. In the fall, only soybean seeds were harvested. The green mass (straw) remained in place to improve soil fertility. Three-year trials showed that humus in the 0-20 cm thick soil layer under both plants increased by 2.0% on average, compared to the control area, and total nitrogen content by 0.10%. At a depth of 30-80 cm, humus was 1.35%, nitrogen - 0.07%.

If we compare these data with the data of the chemical analysis of grass-cloddy (clay) soil, we can conclude: using soybeans as a green manure for three years, increases humus on the soil surface (in the 0-20 cm layer) by 0.55%, and nitrogen by 0.03%. Due to this, the average height of the red-veined poplar increased to 4.0 meters - 90% more than on the control plot. A similar growth was shown by the oriental plane, whose average height reached 4.1 m. These indicators once again confirm the high efficiency of using soy as a green fertilizer under woody species - it accelerates plant growth and enriches the soil with the main nutrient element - nitrogen.

All the above-mentioned growth indicators of the test cultivar plantings clearly raise the question of test poplars and planes (also other valuable fast-growing woody species can be tried) as promising cultivars. After developing the habits of timber resources by developing sophisticated agro-techniques and creating plantations on the weakly swampy soils of the Colchis lowland, real opportunities will be created to reduce the overexploitation of natural wood resources. In this way, we will contribute to the restoration and renewal of the low-productivity, degraded and deforested natural forests of the mountain, to return them to the useful forestry cycle and, along with the increase in productivity, to restore the water regulation, soil protection, resort, recreational and other useful functions, and the smooth supply of the country's enterprises with the valuable wood raw materials they need.

It is also worth noting the fact that in the first year of growing the trial plantations, large numbers of brown-tail, gypsy and winter moths spread throughout Georgia. These pests appeared in the trial area and in the surrounding alder forest in the month of May. Newly hatched caterpillars damage the buds in a state of expansion, multiply massively after the leaves open, start eating the leaves and defoliate the trees in a large area of the forest. V. i. Gusev, M. N. Rimsky-Korsakov et al. (1951) note that in the initial stage, the caterpillars of gypsy moths are covered with long hairs and aerophores, by means of which they can easily move by water and wind over long distances and infect nearby forests, gardens and other plantations. Massive reproduction (explosion) of gypsy moths occurs once in 7-8 years. A fruit tree that is damaged by the caterpillars of gypsy moths does not bear fruit in the current and future years. The brown-tail moth begins by eating the bud, as soon as the leaves open, it continues to eat it, in case of massive reproduction, it can defoliate large areas of the forest. Brown-tail caterpillars also cause oak acorns to die. The forest covered with the golden-tailed caterpillar usually re-leaves in the second summer, but it is very often infected with the fungus Microsphaera alphitoides, which infects the gray-covered, weakened trees with secondary pests (the bark beetle, the wood borer, and the Capricorn beetle) and often causes the death of the trees. Plants are not less harmed by the winter moth. According to literary sources, these caterpillars mostly damage orchards, but in case of massive reproduction, they often cause great damage to forests as well. At first, the caterpillars feed on buds prepared for opening, then on leaves. Usually, caterpillars weave webs in leaves and hide in them. Caterpillars of the above-mentioned pests multiplied massively in 1971-1972, both in western and eastern Georgia. 50% of the leaves of the alder forests of the Colchis plain were completely covered by this pest. In our test plots, it completely destroyed 50-60% of the leaves of poplars, willows, planes, tulip-trees, swamp oaks and other species. But did not cause substantial growth arrest in our test woody species. Similar facts have been described by many scientists, including G. Kanchaveli and Sh. Supatashvili (1968). In 1973, pests did not appear on our test plot, therefore, the growth rates of plants on cultivated and fertilized soil in this one year exceeded the growth rates of the previous two years (1971-1972).

The comparative data of the above test options confirm that the best growth rate indicators in three-year forest crops according to layout were revealed in plantings of 1.0 X 1.0 m and 2.5 X 2.5 m layout. But, in the first case, it is impossible to carry out cultivation and apply mineral fertilizers to the soil using mechanization. At a distance of 2.5 x 2.5 m, it is possible to carry out cultivation and apply mineral fertilizers to the soil with the help of mechanization. As for the plantings in the 4.0 X 4.0 m and 6.0 X 6.0 m layout options, despite the superiority of the previous layout options, the planting in these layouts has a fairly good growth. It should be noted that agricultural crops are planted along with woody species in such relatively distant plantations. This practice is implemented in many European countries. For some reason, the practice of growing woody species and agricultural crops together is not accepted, at one time it was strictly prohibited.

We should add to all of the above the fact that with the three-year planting cycle on the test plots, the plantations, according to the rules adopted in forestry, moved into the category of forested area. A special instruction for creating plantations of highly productive forest species in the slightly swampy area of Colchis was developed and published (Gedenidze, Papunidze, Manvelidze 1975).

It is known that the main mass of the root system of young woody plants is located in the soil layer up to 20 centimeters deep, but in the following years of growth, when the root system reaches the ground water, the roots of forest species develop abnormally and become weak, and all this, over time, contributes to the premature aging and fading of the young plant. Taking into account all these aspects, we worked out the issues of dependence of the location of the root system of the test plants with the ground water.

From the analysis of the considered indicators, it can be concluded that in all variants of the test, at the optimal maturity of cutting trees (at the age of 15 years), the root system does not reach the ground water and the distance between them varies within 20-40 cm. Against the background of all the mentioned, it is necessary to note the fact that the root system of the plant in the frozen soil does not need to obtain nutrients from a long distance in order to feed the underground and above-ground organs.

As it is known, in forestry, the optimal rotation of forest cutting has been adopted. This is the period (cycle) required for the growth and formation of groves of such composition and structure that fully meet the demand for wood products. Therefore, in our experiments, it was necessary to determine the optimum age for cutting forest crops, which is mainly related to the number of plantations, especially the determination of technical maturity. Therefore, the optimal age of cutting is considered to be the age that corresponds to the period of maximum productivity and ensures obtaining the necessary size and quality assortments for economy.

Based on all of the above, in order to solve the task of determining the optimal age of cutting the planting of peered test crops, the maximum yield per unit area of the wood assortment, taxation data were processed on trial plots in the 3rd, 6th, 9th and

13th years. All kinds of sanitary measures were carried out on the test plots, which contributed to the good growth and development of the test species, improving the current addition. From the data obtained from our observations in the 15th year, it can be seen that monocot young poplar, willow and plane crops, which are planted with 1.0 X 1.0 m, 2.5 X 2.5 m, 4.0 X 4.0 and 6.0 X 6.0 m spacing, differentiation of trees is noticeable: Trees with good growth and stunted growth are separated. As it is known, the essential external characteristics of the forest are density, thickness and height. In our experiments, the differentiation of trees depends not only on their placement, but also on soil loosening and treatment (cutivation) with fertilizers, which should be considered a completely regular pheomenon. The more frequent the planting (for example, 1 X 1m), as a result of competition, the trees begin to differentiate at an earlier age, with the growth of age the differentiation becomes more difficult - the difference in appearance and growth becomes sharper. As for the differentiation of plantings located at a greater distance, here, as a result of less competition between trees, the differentiation is not expressed. Taxation indicators of trees according to the age of the forest culture show that in three-year-old young cultures, densely planted trees develop best in height and diameter, especially in 1.0 X 1.0 m spacing (Table 36). At the age of six years, the picture changes: the trees of dense planting lag behind the trees in growth, and at the age of fifteen years, this difference is even more profound (Table 37). The current and average increments of tree growth in 2.5 x 2.5 m, 4.0 x 4.0 m and 6.0 x 6.0 m layout crops are almost equal. As for the effect of using mineral fertilizer, it is high in all the options mentioned above. So, for example, in the arrangement of 1.0 X 1.0 m in three-year crops, where fertilizers were not used, the height (h) of the trees of all the test species varies from 2.5 to 3.1 m, the diameter (d) - 3.0-4, within 2 cm. In case of fertilizer application, their height (h)-4.8-5.4 m and diameter (d)-5.5-10.0 cm vary. and 2.5 X 2.5 m, 4.0 X 4.0 m and 6.0 X 6.0 m during placement, respectively: (h)- 1.0-2.6 m. (d)-0.7-4.5 cm and (h)-1.9-5.0 m and (d)-2.1-9.9 cm (Table 5.3). The height of all species of ex-year forest crops of 1.0 X 1.0 m layout, without receiving fertilizer, is (h)-3.4-4.1 m, and the diameter (d)-2.8-5.0 varies within cm, and in the case of using fertilizers, their height (h) is 4.0-7.6 m, and diameter (d) is within 4.9-7.8 cm. in other layouts respectively: varies between (h)-4.0-5.8 m, (d)-3.7-7.0 cm; (h)-6.4-8.2 m, (d)-7.0-9.6 cm. At the age of 15 years, the average height (h) of the trees of the unfertilized version of 1.0 X 1.0 m layout is 7.2-8.2 m, and the diameter (d) is 6.7-8.0 cm. In case of fertilization with fertilizers, their average indicators are respectively: (h)-10.3-14.4 m and (d)-8.2-11.5 cm. In other layouts respectively: (h)-10.6-11.9m, (d)-11.8-19.9cm, (h)-15.9-27.7m, (d)-14.6-30 is equal to 2 cm. However, we should take into account the fact that the fertilizer affects the increase in height more than the diameter.

Table 37

Growth rates of a 15-year trial plant plantation in relation to spacing and layout

Placement and name of the species	without fertilizer		with fertilizer					
	Height, (m)	Diameter from1,3m, (cm)	Height, (m)	%	Difference (t)	Diameter from1,3m, (cm)	%	Difference, (t)
1	2	3	4	5	6	7	8	9
1,0 x 1,0 m								
Balsam poplar	8,2±0,20	8,0±0,24	11,5±0,34	140,2	8,7	11,5±0,22	143,8	10,6
Red-vein poplar	7,2±0,25	6,3±0,15	14,4±0,16	200,0	24,0	8,2±0,29	130,2	5,8
Oriental plane	7,4±0,22	6,5±0,17	10,3±0,15	139,2	10,7	11,1±0,28	170,8	13,9
2,5 x 2,5 m								
Balsam poplar	11,2±0,25	11,8±0,25	27,3±0,15	243,8	57,5	15,2±0,29	128,8	89,5
Red-vein poplar	11,0±0,26	12.7±0,30	27,1±0,18	246,4	50,3	14,6±0,16	115,0	5,6
Oriental plane	11,2±0,29	14,6±0,22	18,2±0,20	162,5	20,0	16,9±0,31	115,8	6,0
Tulip tree	8,8±0,25	11,7±0,21	12,6±0,22	143,2	11,9	16,8±0,20	143,6	17,6
4,0 x 4,0 m								
Balsam poplar	11,5±0,17	14,3±0,21	25,0±0,15	217,4	58,7	26,8±0,33	187,4	32,0
Red-vein poplar	11,4±0,18	13,7±0,37	27,7±0,37	243,0	40,8	25,1±0,33	183,2	21,5
Oriental plane	11,4±0,27	19,9±0,31	15,9±0,23	139,5	12,5	26,8±0,33	134,7	15,3
6,0 x 6,0 m								
Balsam poplar	10,6±0,27	14,7±0,26	20,7±0,47	195,3	18,7	26,7±0,37	181,6	26,7
Red-vein poplar	11,9±0,23	14,0±0,21	21,8±0,39	183,2	22,0	30,2±0,37	215,7	36,8
Oriental plane	11,2±0,29	17,8±0,25	15,9±0,23	142,0	12,7	28,0±0,52	157,3	26,8

The results of mathematical processing of the main characteristics of trees (height, diameter) prove a fairly high accuracy of measurement. The accuracy of the test ranges from 0.7-1.5% in height and 1.5-2.0%, rarely - up to 2.7-2.9% - in diameter. The great effect of the action of mineral fertilizers is indicated by the difference indicators in all test options (t >3).

It is known that the overall yield of forest species at a certain age of crops and, accordingly, the level of intensification of forestry is determined by the quantitative and qualitative indicators of timber, especially softwood. This in itself depends on the growth and development of the given species, the arrangement (density) of planting, agro-techniques, the feeding of crops with nutrients and many other factors. In our trials, the most wood per unit area was obtained from plantings of 2.5 x 2.5 m and 4.0 x 4.0 m layouts. This is explained by the optimal conditions for growth and development, as well as the location of plantings on the area (Table 38).

Table 38

15-year planting taxonomic indicators of test plants in relation to fertility and disposition

Placement and name of the species	Number of plants 1 ha pieces	Without fertilizers				With fertilizers			
		Security %	Number of left trees 1ha	Cross section M2	Stock M3	Security %	Number of left trees 1ha	Cross section M2	Stock M3
1	2	3	4	5	6	7	8	9	10
1,0 x 1,0 m									
Balsam poplar	10000	47,4	4736	22,7	192,2	48,0	4804	37,0	254,0
Red-vein poplar	10000	43,6	4356	13,0	94,1	45,3	4532	22,8	146,1
Oriental plane	10000	41,4	4136	12,4	61,2	42,2	4224	39,0	161,0
2,5 x 2,5 m									
Balsam poplar	1600	86,5	1384	14,4	184,8	92,0	1472	25,5	324,7
Red-vein poplar	1600	84,0	1344	16,2	202,5	90,5	1448	23,1	298,3
Oriental plane	1600	82,5	1320	21,2	195,1	89,0	1408	30,3	212,1
Tulip tree	1600	11,6	176	1,8	6,4	11,0	188	3,9	21,9
4,0 x 4,0 m									
Balsam poplar	625	87,4	546	8,3	113,0	88,5	88,5	29,7	351,2
Red-vein poplar	625	88,0	550	7,7	99,7	92,0	92,0	27,1	360,6
Oriental plane	625	83,0	519	15,4	155,0	85,0	85,0	28,6	178,6
6,0 x 6,0 m									
Balsam poplar	278	94,0	261	4,2	99,6	94,5	94,5	14,1	137,2
Red-vein poplar	278	92,5	257	3,8	134,6	93,0	93,0	17,7	189,2
Oriental plane	278	89,0	247	5,8	69,7	90,0	90,0	14,7	84,1

Table 39

Current and average increments of 15-year trial plantings in relation to distribution and placement

Placement and name of the species	average increment						Last 3 years current increment (average)			
	In height m		In diameter cm		Stock 1 ha-m3		In height m		In diameter cm	
	without fertilizer	With fertilizer	without fertilizer	With fertilizer	without fertilizer	With fertilizer	without fertilizer	With fertilizer	without fertilizer	with fertilizer
1	2	3	4	5	6	7	8	9	10	11
1,0 x 1,0 m										
Balsam poplar	0,54	0,77	0,53	0,77	12,8	16,9	0,62	0,87	0,57	0,75
Red-vein poplar	0,48	0,96	0,42	0,55	6,3	9,7	0,60	1,02	0,72	0,60
Oriental plane	0,49	0,69	0,43	0,74	4,1	10,7	0,57	0,77	0,44	0,75
2,5 x 2,5 m										
Balsam poplar	0,75	1,82	0,79	1,01	12,3	21,6	0,84	1,64	0,96	0,96
Red-vein poplar	0,73	1,81	0,85	0,97	13,5	19,9	0,94	1,60	0,84	1,01
Oriental plane	0,75	1,21	1,01	1,13	13,0	14,1	0,80	1,50	1,08	1,15
Tulip tree	0,59	0,84	0,84	1,12	0,84	1,4	0,63	1,11	0,74	0,96
4,0 x 4.0 m										
Balsam poplar	0,77	1,67	0,95	1,79	7,5	23,4	1,10	1,50	1,00	2,01
Red-vein poplar	0,76	1,85	0,91	1,67	6,6	24,0	0,98	1,36	0,88	1,48
Oriental plane	0,76	1,06	1,33	1,79	10,3	11,9	0,96	0,97	1,40	2,33
6,0 x 6,0 m										
Balsam poplar	0,71	1,38	0,98	1,78	6,6	9,1	1,04	1,46	0,94	1,98
Red-vein poplar	0,79	1,45	0,93	2,01	9,0	12,6	0,88	1,38	0,97	1,98
Oriental plane	0,75	1,06	1,19	1,87	4,6	5,6	1,16	1,33	1,78	2,35

From Table 39 it can be seen that 15-year-old crops of trial plantations in different locations in diameter and height mean and current light addition significantly increase crop productivity. These figures are higher in 2.5 x 2.5 m, 4.0 x 4.0 m and 6.0 x 6.0 m layout than in 1.0 x 1.0 m layout plantings. It is also noteworthy that at 1.0 x 1.0 m and 6.0 x 6.0 m spacing, the current increase in height and diameter of all types of 15-year-old crops, both on fertilized and unfertilized (control) soil, prevails over the average increase. This is explained by the fact that in the given options, the plantings have not yet reached maturity. The height gain in the 2.5 x 2.5 m and 4.0 x 4.0 m layout crops exceeds the average growth of the plants only on unfertilized soil. In the case of adding fertilizers to the soil, the current increase gives way to the average increase. The described fact indicates that adding mineral fertilizers to the soil of experimental crops and feeding the plants contributes to earlier ripening of the experimental varieties.

According to the comparative data of the average rate of growth in height and diameter of plants with 1.0 X 1.0 m and 2.5 X 2.5 m arrangement, it is confirmed that these indicators are almost identical in both cases, or slightly different from each other. In case of using other layout methods, the small amount of wood per unit area is mainly caused by unfavorable conditions for the growth and development of plants (in the case of 1.0 X 1.0 m layout) and the lack of plantings on the area (in the case of 6.0 X 6.0 m layout). But, as the data show, the amount and supply of wood per unit area, in case of feeding with mineral fertilizers according to the arrangement of the plants of the test species, increases significantly. So, for example: balsam poplar - 1.0 X 1.0 m - by 32%; 2.5 X 2.5 m - by 75%; 4.0 X 4.0 m-by 212%; 6.0 X 6.0 m - by 38%; Red-vein poplar - 1.0 X 1.0 m - by 54%; 2.5 X 2.5 m - by 47%; 4.0 X 4.0 m-by 264%; 6.0 X 6.0 m - by 40%; Oriental plane-1.0 X 1.0 m-by 161%; 2.5 X 2.5 m-8%; 4.0 X 4.0 m - by 16%; 6.0 X 6.0 m - by 22%. As we can see, in the case of using mineral fertilizer, balsam and red-vein poplars show the greatest increase in the case of 4.0 X 4.0 m arrangement, and the oriental plane - in the case of 1.0 X 1.0 m arrangement (layout). Plantations of the test species, 1-5 years after planting, were characterized by slow growth, but plant death did not occur at this age. However, after five years, the tulip-tree plants were less adaptable to the grassy-soil conditions of the heavy mechanical composition meadow. All this has led to a high mortality rate for this species. As for the preservation of balsam and red-veined poplar plantations, on the 2.5 x 2.5 m layout area, it was 84.0-86.5% without fertilizer, and 90.5-92.0% on fertilized soils. 82.5-89% preservation of the eastern chadar was obtained under the conditions of 4.0 x 4.0 m and 6.0 x 6.0 m planting arrangements, which is the main condition for good growth of plantations, increase of wood per unit of area and stock.

Thus, during the performance of forestry and cultural works of a certain scale under the given conditions, great importance is attached to the selection of promising species, their optimal arrangement, which, with its feeding area, ensures the preservation of plants, normal growth and development and the accumulation of a large stock of wood in a relatively short period of time.

The process of crown formation is one of the most important biological features of plant growth and development. The speed of the trees growing side by side and the degree of development of weeds under the crops depends on it.

Fig. 6. balsam poplar 4 x 4 m. A 15-year plantation (on frozen soils) with an average height of 25 meters

In order to accelerate the compaction of tree canopy and soil shading in crops, as is known in forestry, shade-tolerant woody-shrub phytocenosis-forming culture types are used. However, as Kh. P. Budaev, S. E. Budaeva, E.C. Dambaev (1982) indicate, the good development of poplar of the forest strip of one species in the forest-steppe zone is possible with careful tillage of the soil and timely pruning of the plants. This will ensure good aeration of the crops and help to increase their aerodynamic efficiency.

Fig. 7. Balsam poplar 6 x 6 m. 15-year plantation of the layout (on fertile soils), the average height of which reaches 25.8 meters

Another example: in a 1.0 x 1.0 m layout on frozen soil, six-year-old test species form 75-82% canopy compaction of seedlings. As a result, the light-loving weed grass cover under the planting disappears. In plots of 2.5 x 2.5 m, this process begins at the age of ten, and in the case of 4.0 x 4.0 m and 6.0 x 6.0 m, at the age of 14. At the same time, it is established that on the soil fertilized with fertilizers, this process takes place 2-3 years faster than in the case of the control (unfertilized) version. In a word, all this clearly indicates that the density of crops determines the quantitative and species composition of weeds under forest crops, and this is directly related to the placement of plantings, age and plant nutrition conditions. Finally, we must conclude that when developing a program for cultivating high-yielding forest crops, we should take into account as much as possible and select a model of creating such productive forest crops, where all the above-mentioned aspects will be taken into account. According to the method developed by L. Kairiukshtis, A. Yuodvalkis, I. Yonikasas, A. Barakauskas, the optimal density of the forest, in the models created according to the growth and development of individual phases of maximally productive plantations, cannot be the same conditions. The optimal density of young culture should be considered to be the density that excludes the negative interaction of individuals, ensures the maximum growth of the trunk in height and diameter, as well as the maximum number of trees per unit area. The optimal number of trees is determined by the spatial parameters of a well-developed vine and the specific distance between vines (Yuodvalkis, Ionikas, Barakauskas, 1986). According to the same authors, the optimal density of mid-age and adolescent plantings should be considered as the density that ensures the intensive current increase of the desired species of plants, the increase of overall productivity and the maximum accumulation of wood stock at the adult age of the plantings. The optimal number of trees per unit area is determined by the area of the horizontal extension of the tree, taking into account the optimal compaction of the canopy and the maximum density of trees at the compacted age. As a result of research conducted in Bulgaria, N. Vassiliev (1979) came to the conclusion that poplar plantations intended for large-scale construction timber should usually be planted at a distance of 5.0 x 5.0 m, and for pulp-paper production at a distance of 3.0 x 3.0 m is enough. Guided by the above-mentioned criteria and scientifically based methods of optimal frequency of planting, we developed an appropriate model for the cultivation of promising, highly productive, fast-growing forest crops in the weakly swampy area of the Colchis lowland. Based on the results of many years of research work and practice, it can be concluded that the most optimal layout for poplar and plane plantations on the slightly swampy soil of Colchis is 2.5 x 2.5 m and 4.0 x 4.0 m. The fact that one hectare of twenty-year-old alder forest on the swampy soils of Colchis gives us 20 cubic meters of wood is worthy of attention. Our 15-year industrial plantation of test poplar species in different locations gives us much more wood stock than an alder forest grove. So, for example: balsam poplar-1.0 X 1.0 m-254.0 m3/ha; 4.0 X 4.0 m-351.2 m3/ha. Red-veined poplar-

(2.5 X 2.5 m)-298.3 m3/ha; 4.0 X 4.0 m - 360.6 m3/ha. Good results have been obtained in the case of crops of 1.0 X 1.0 m, 2.5 X 2.5 m, and 4.0 X 4.0 m layout of the oriental plane.

Fig. 8. A 20-year-old alder grove with an average height of 16.5 m and the diameter is 13 cm

It is necessary to take into account the fact that the wood of poplar and oriental plane, with the characteristics of the assortment and technical properties necessary for the public economy, is much higher quality than the wood of alder.

5.6. Economic efficiency of growing industrial plantations of fast-growing woody plants

As can be seen from the results of the experiment, artificially grown industrial purpose plantations of fast-growing woody species of poplars and planes on the slightly swampy lands of the Colchis lowland are characterized by a fairly large production.

It was determined that the effectiveness of the growth and development of the test plants directly depends on the arrangement of trees, soil fertility and the correct use of agrotechnological methods of land cultivation. It improves the qualitative indicators of trees, current and average growth, yield of wood per unit area, significantly reduces the technical maturity of the forest and cutting turnover, etc. In addition, it should be noted that economic effectiveness does not always follow the implementation of a number of measures. Therefore, it is necessary to study the economic effectiveness of the data obtained as a result of the conducted tests, in our case - the economic effectiveness of the use of fertilizers and the selection of plant species.

Based on the study and analysis of the literary sources used in our and foreign publications about the economic effectiveness of measures to create plantations of woody forest species, in our tests, using appropriate standards, the economic effectiveness of planting industrial plantations of fast-growing, precious wood species (poplars, plane) on weakly swampy lands of the Colchis lowland was calculated. The total sum of costs, including the costs related to the use of fertilizers per unit area, according to the trial options was determined. In addition, the income obtained from the sale of wood per unit of area was determined (according to the purchase prices valid during the trial period). Based on the results of fifteen years of data, the economic effect was calculated as the average wood stock per hectare of the plant species recommended for production. On the one hand, by contrasting the received income with the sum of the total costs and, on the other hand, by comparing the additional received income with the additional costs related to the use of fertilizers, the economic efficiency of applying fertilizers was determined, depending on the options (Table 40).

From the data presented, it can be seen that the 2.5 x 2.5 m and 4.0 x 4.0 m layout plants are distinguished by the high profitability level and the best indicators of net profit, based on the growth and development of the test plants. In addition, the effectiveness of those plants that were fertilized with fertilizers is visible.

So, for example, the level of profitability of the balsam poplar of the 2.5 X 2.5 m layout increases from 61 to 138.1%, of the 4.0 X 4.0 m layout option - from 20.6 up to 194.4%. Red-vein poplar - in 2.5 X 2.5 m layout - from 76.8 to 118.7%, and in the 4.0 X 4.0 m layout with fertilizers, the level of profitability exceeds 200%.

Table 40

The economic effectiveness of planting plantations of industrial woody plants on weakly swampy soils of the Colchis plain
(According to the prices valid during the trial period, in troubles)

Trial plants name	Planting layout (m)	Experiment variations	Total direct cost in roubles	including			overhead cost, (10%)	total costs on 1 ha	Income on 1 ha	Net profit	profitability, in %
				Salary accrued, in rouble	Fertilizer costs	Costs of planting material in roubles					
1	2	3	4	5	6	7	8	9	10	11	12
Balsam poplar	1,0X1,0	control	2549,3	1949,3	-	600,0	254,9	2804,2	3651,8	847,6	30,2
	1,0X1,0	with fertilizer	4332,9	2568,2	1164,7	600,0	433,3	4766,2	4826,0	59,8	1,2
	2,5X2,5	control	1878,5	1882,5	-	96,0	197,9	2176,4	3503,6	1327,2	61,0
	2,5X2,5	with fertilizer	2355,7	2031,0	228,7	96,0	235,6	2591,3	6169,3	3578,0	138,1
	4,0X,4,0	control	1912,4	1874,9	-	37,5	191,2	2103,6	2147,0	43,4	20,6
	4,0X,4,0	with fertilizer	2060,3	1933,0	89,8	37,5	206,0	2266,3	6672,8	4406,5	194,4
	6,0X6,0	control	1888,6	1871,9	-	16,7	188,7	2077,5	1892,4	-	-
	6,0X6,0	with fertilizer	1954,4	1897,6	40,0	16,7	195,4	2149,8	2606,8	457,0	21,2
Red-vein poplar	1,0X1,0	control	2549,3	1949,3	-	600,0	254,9	2804,2	1787,9	-	-
	1,0X1,0	with fertilizer	4332,9	1568,2	1164,7	600,0	433,33	4766,2	2775,9	-	-
	2,5X2,5	control	1817,5	1882,5	-	96,0	197,8	2176,4	3847,5	1671,1	76,8
	2,5X2,5	with fertilizer	2355,7	2031,0	228,7	96,0	235,6	2591,3	5667,7	3076,4	118,7
	4,0X,4,0	control	1912,4	1874,9	-	37,5	191,2	2103,6	1894,3	-	-
	4,0X,4,0	with fertilizer	2060,3	1933,0	89,8	37,5	206,0	2266,3	6851,4	4585,1	202,3
	6,0X6,0	control	1888,6	1871,3	-	16,7	188,9	2077,5	1557,4	479,9	23,1
	6,0X6,0	with fertilizer	1954,4	1897,7	40,0	16,7	195,4	2149,8	3594,8	1445,0	67,2
Oriental plane	1,0X1,0 m	control	4349,3	1947,3	-	2400	434,9	4784,2	1162,8	-	-
	1,0X1,0 m	with fertilizer	6132,9	2568,2	1164,7	2400	613,3	6746,2	3959,0	-	-
	2,5X2,5 m	control	2266,5	1882,5	-	384,0	226,6	2493,2	3706,9	1213,7	48,7
	2,5X2,5 m	with fertilizer	2643,7	2031,0	228,7	384,0	264,4	2908,1	4029,9	1121,8	48,6
	4,0X,4,0 m	control	2024,9	1874,9	-	150,0	202,5	2227,4	2945,0	717,6	32,0
	4,0X,4,0 m	with fertilizer	2172,8	1933,0	89,8	150,0	217,3	2390,1	3393,4	1003,3	42,0
	6,0X6,0 m	control	1938,6	1871,9	-	66,7	193,9	2132,5	1324,3	-	-
	6,0X6,0 m	with fertilizer	2004,4	1897,7	40,0	66,7	200,4	2204,8	1597,9	-	-

As can be seen from the data, poplars grown on unfertilized soils are ineffective (unprofitable). The yield level is quite high in case of 6.0 x 6.0 m arrangement of red-vein poplar (from 23.1 to 67.2%). One fact is worth noting: the results of the oriental plane of the 1.0 X 1.0 and 6.0 X 6.0 m layout, both on fertilized and unfertilized soils, are unsatisfactory (unprofitable). However, fertilizing 2.5 X 2.5 m and 4.0 X 4.0 m plantings of the same species with fertilizers gives us a satisfactory economic effect. It is true that it is slightly different from the economic efficiency of the non-fertilized variant and, therefore, the compensation of additional costs from maintenance and conventional agrotechnical measures is insignificant, but, nevertheless, in the future, with the use of fertilizers in the mentioned variant, we should expect a significant increase in the profitability of highly productive forest crops - timber yield, profit and income per unit area.

Thus, based on the results of the conducted research and the analysis of the data we observed, we have the right to assert: Using progressive technology, we will be able to achieve optimal age (rotation) of 15-year-old hardwood plantations of trial varieties of woody trees in the weakly swampy area of the Colchis lowland, on a completely healthy basis, i.e. the period (cycle) that is needed for the growth and formation of artificial forest crops of such a structure, which will satisfy as much as possible the use of high-quality wood products for the public economy.

From the above, the following conclusion can be drawn: if we take the fifteen-year cutting cycle of trees and plants of the above-mentioned prospective species, and for this, an area of 1000-1500 ha is allocated in the weakly swampy area of Colchis, it will be possible to annually obtain the amount of wood stock that was allowed by the forest management of Georgia, i.e., as we said above, 432 thousand m^3. This will solve serious economic, ecological and social problems in terms of reducing excessive industrial deforestation in the country's mountain forests, Also, the problems of restoring and renewing forests and improving the protective functions of mountain forests from the point of view of the public economy, which are so necessary for the country, will be solved.

5.7. General guidelines and practical suggestions

1. The quality of the wetlands of the Colchis lowland should be determined using a simple method, namely, the spread of grass cover (sedge, rush, marshpepper etc.) per unit area and the depth of the ground water.
2. Strongly swampy soils (peat swamps and strongly swampy soils) include those areas where 80-100% of the herbaceous cover characteristic of a swamp is covered per unit area, and ground water is at a depth of 15-30-40 cm. Such areas are mainly located in the coastal strip of the sea (8-10 km). The mentioned soils are unsuitable for the cultivation of plantations of fast-growing woody forest species due to the presence of excess moisture and anaerobic conditions.
3. Moderately waterlogged soils occupy a transitional stage between strongly swampy and weakly swampy soils. On the unit area of the soils of such areas, the herbaceous cover characteristic of swamps is spread 40-70%, and the ground water is at a depth of 50-70 cm and below. Such soils are also unusable

for growing plantations of fast-growing woody varieties without carrying out amelioration measures. These soils are mainly distributed in Jurkveti, Nigvziani, Chaladidi, Shua Khorga, Orule, First Otobaya, Kvemo Barghvebi massifs.

4. Weakly swampy soils include the areas away from the Black Sea coast, which are separated from the above massifs in the south, and extend to the Samtredia-Sokhumi railway line in the north. The living cover characteristic of a swamp extends to 40% per unit area. These soils, in addition to ground water, contain surface water that collects in non-capillary pores. Groundwater is located at a depth of 1.2-1.5 m and sometimes lower. The aeration of these soils is satisfactory, but to what extent it deteriorates during the rainy period. In these regions, it is advisable to grow forest crops of fast-growing woody species.
5. The selection and allocation of weakly swampy soils for the cultivation of fast-growing woody species (poplars, planes, willows, etc.) should be carried out by a group of specialists with the participation of a surveyor, a soil scientist and an engineer of forest crops.
6. To determine the quality of wetlands, it is necessary to visit the areas in advance. The degree of spread of grass cover characteristic of wetlands, as well as the depth of groundwater standing should be determined. The depth of groundwater standing is determined by digging temporary wells on the area.
7. To grow plantations of fast-growing forest species, the soil should be prepared one or half a year in advance.
8. The areas selected for the plantation of fast-growing forest species must first of all be cleaned from the roots of trees and plants to a depth of 35-40 cm. Stumps and roots are collected into pulp and burned. Pits created during uprooting should be well dug. Stumps should be uprooted using the latest special uprooting machinery.
9. Along with the cleaning of weakly swampy areas, it is necessary to organize a drainage network, the frequency of which depends on the type of soil and its humidity, the heavier the mechanical composition of the soil, the higher the moisture content in it. Therefore, it is necessary to arrange a more frequent drainage network on such soils. For weakly marshy soils with heavy mechanical composition, it is enough to organize a 100 m long reclamation channel on 1 ha, and for 2 ha of light mechanical composition, a circular channel of 100 m is enough.
10. The depth of the water channel should be 1.0-1.2 m. The width of the channel at its base is 1.5 m. The operational period of channels of this form is quite long.
11. After cleaning the area and laying water channels, in order to improve the structure of the soil and enrich it with nutrients necessary for plants, we apply green fertilizers – green manure, organic or mineral fertilizers. Soybeans, broad

bean, burclover, clover and others can be used as green manure. From organic fertilizers, peat or manure should be used at 30 tons per 1 ha, from complete mineral fertilizers (NPK) ammonium nitrate, chlorpotassium and simple superphosphate should be used.

12. In the first year of growing crops of fast-growing woody species, with equal spreading over the area, complete mineral fertilizers from the active substance should be applied in the following dose per 1 ha: N- 34%-90 kg, P2O5 18-20%-90 kg, K20 -54%-60 kg.
13. In order to improve aeration and water management properties in weakly swampy soils, it is necessary to carry out deep plowing, not less than 30-35 cm. The heavier the mechanical composition of the soil, the deeper it should be plowed. Deep plowing also activates the positive action of microorganisms.
14. The primary tillage of the soil is produced by a three-body suspension plow ПН –3 – 40. The depth of cultivation of grassy sandy soils of the meadow should not be less than 35 cm, and the depth of cultivation of alluvial clay soils should not be less than 40-45 cm. The width of plow blades should be 120 cm.
15. Soil plowing should be done in late fall or early spring. Soil preparation (pruning) on the Colchis lowland is best done in early spring. If the deeply plowed soil consists of large clods, and their further treatment with a rake could not be done, it is necessary to cross-plow this area again. After that, the soil treatment is continued with the BDH-3 rake. The water coming to the surface of the soil treated in this way will gradually seep into the depth of the soil.
16. During the rainy season, the soil settles and compacts, its physical properties deteriorate, so it is necessary to loosen such soils with a cultivator after each rain. In plantations of fast-growing woody varieties grown on weakly swampy soils of the Colchis lowland, cultivation should be done at least 5-6 times a year.
17. Cultivation improves the physical properties of the soil, mainly its water-holding properties and aeration.
18. In order to obtain cuttings of poplars and willows, it is necessary to create a nursery plantation, which will make it possible to produce a certain amount of cuttings every year. An area that does not flood with water should be allocated for mother plantations.
19. On the areas selected for the mother plantation, the following should be studied: water management properties of the soil, aeration, the soil should be checked from the entomological and phytopathological point of view, the mechanical and chemical composition of the soil should be examined.
20. On the areas selected for the farms, measures for the spatial organization of the territory should be implemented: separation of roads and paths, patterns and quarters, tracks for building windbreaks, etc. After the division of the area, the mentioned area is fenced and all preparatory works (clearing of trees,

bushes, stones, uprooting of roots and burning of waste) are carried out for planting mother plantations.

21. The mother plantations should be arranged on the soil with the correct surface. It should be created on the basis of cuttings of poplar and willow cuttings. It is not excluded to create mother plantations with rooted cuttings. When transplanting such cuttings, the shoots are cut off at a height of about 10 cm to obtain abundant shoots, but it is better to establish a mother plantation by transplanting cuttings in situ.
22. For the mechanized maintenance of the mother plantation and to obtain more high-quality cuttings per unit area, it is necessary to plant a layout of 2.5 X 2.5 m or 1600 poplar and willow planting material per 1 ha.
23. Planting cuttings should be done with a pike or a simple dibble. Planting of cuttings is carried out by lowering the lower cutting into the ground. On the surface of the glass should remain the upper part of the cutting with a length of 8-9 cm, on which there will be one undamaged bud. The soil should be compacted tightly to the graft (cutting) so that there is no void around the graft. A properly planted graft is hard to dislodge from the ground.
24. Maintenance of the mother plantation on the weakly swampy soils of the Colchis plain mainly involves loosening the soil with cross-cultivation in rows and between rows. Loosening can be carried out to a depth of 10-15 cm. During the vegetation period, it is necessary to carry out 5-6 times cultivation and the same amount of hoeing around the seedlings.
25. The need for soil loosening-cultivation and hoeing around seedlings is limited by the speed of weed growth and the formation of a crust on the soil surface after rains.
26. Soil loosening should be carried out from the end of March to September. During this period, the shoots of the cutting grow rapidly and require a large amount of moisture.
27. During a long drought, especially in the first year of cultivation, when the shoots and the root system are still tender, abundant and frequent watering of the plants is necessary.
28. Balsam and red-vein poplars, drooping willows, southern willows and white willows grow well on the slightly swampy soils of the Colchis lowland. The first two types of willows are smaller trees compared to white willow, so white willow should be preferred.
29. Poplars, willows and, among them, planes, compared to other types of trees and plants, are characterized by a plastic root system and are well adapted to the slightly swampy soils of the Colchis lowland. Therefore, it is advisable to spread poplars, willows and oriental plane on these soils.

30. Only one-year shoots are used as cuttings. Poplar and willow cuttings should be made in the mother plantation after their growth and defoliation. That's why it is necessary to root the outcrop and decorate the tree crown and stamp every day. As a result of conducting the mentioned operations, we ensure the production of high-quality and large-quantity cuttings.
31. In the mother plantation, the rooting of the cuttings, the decoration of the mother tree and the stem should be done in the second and subsequent years after the mother plantation is planted. In the first year, the shoot of the mother graft itself is cut at a height of 10-15 cm, and in the following years it is cut at a height of 5-10 cm from last year's cutting.
32. Cultivation of crown and stamp should be carried out in such a way as to obtain as many equally developed shoots as possible.
33. Rooting of the shoot is done with special scissors, and stamping of the stem is done with garden shears or a hand saw (it depends on the thickness of the twig or branch).
34. The best time to make cuttings is winter (especially for balsam poplar), or late autumn, when the plant has finished growing and the leaves have already fallen.
35. One-year shoots to be used as grafting material must have well-developed, undamaged buds. It should not have side shoots. Thin and short (50 cm and shorter) shoots should not be used as cuttings, as they are characterized by weak growth and low germination percentage.
36. Poplar cuttings should be kept cut until spring. Sprouts should be protected from drying out and swelling of the buds. Without observing these rules, the sprouts partially or completely lose the ability to live.
37. After making poplar cuttings, they are sorted according to length and thickness. 60-100-150, etc. Long shoots are sorted separately, then they are bundled into cones in the amount of 100-100 pieces. Shoots tied into separate cones make it easier to calculate the yield of the cuttings and protect the shoots from drying out. Mechanical damage to shoots and buds should not be allowed at the time of sorting and binding.
38. Conical shoots should be planted in a pit or box under a closed shed following the following rules: first a layer of sand is laid, then the cone-like shoots are laid in a single layer. Then a 10-15 cm thick layer of sand is laid on it again and the shoots are arranged. This continues until the pit or box is filled. Cuttings stored in this way are in a dormant state until spring, but physiological processes are still taking place in them, which contributes to their high storage capacity until spring. This is more noticeable on the shoots of balsam poplar, the flowering of the cuttings made in the spring does not exceed 20-25%, and the cuttings made in the manner described above retain the ability to bloom up to 80-95%.

Therefore, balsam poplar cuttings should be made in winter and should be kept in sand until spring in strict compliance with the rules described above.

39. Poplar cuttings can be stored in the open air, in special pits, as described above, so that a back is made from the top of the pit, and straw, sedge, etc. must be arranged on the back to prevent rainwater from cuttings packed in the pit. It is better to store cuttings in a special covered shed.
40. Willow cuttings can be made in the spring before bud swelling. The cutting efficiency of willow prepared in spring is 95-100%, so it is not mandatory to make it in winter, as well as poplar cuttings. This will avoid additional costs of winter storage of willow cuttings.
41. Poplar shoots should be removed from the pit in early spring, three days before planting cuttings. The shoots should be placed in water for two days (running water is better), cut into cuttings on the third day and planted immediately.
42. The length of cuttings should be proportional to soil moisture and air. For slightly swampy soils of Colchis, the length of cuttings is sufficient to be 20-25 cm.
43. A cutting knife or scissors should be used to make the cuttings. The cutting of the graft should be smooth and inclined to the middle of the thumb, so that rain water does not stop on the cutting and does not cause it to rot. Cutting the graft in this way also reduces the evaporation area.
44. The cutting of the top of the graft is made at a distance of 1-2 cm from the top of the bud. Making the bottom cut right at the beginning of the bud. This contributes to the formation of callus as well as the intensive emergence of roots.
45. During the production of cuttings, they should be sorted according to which part of the shoot it is made from. The first quality cuttings include cuttings with a thickness of 1.2-1.5 cm at the top. Such cuttings give a high (90-95%) percentage of growing and their bulk is characterized by intensive growth.
46. Second-class cuttings include all those grafts whose thickness on the upper part varies within 0.8-1.0 cm. The yield of second-grade cuttings is 60-70%.
47. Third grade cuttings include those cuttings whose thickness on the upper part is within 0.6-0.8 cm, their thickness is determined by 30-40%. Cutting quality decreases from the bottom of the shoot upwards, and cuttings less than 0.6 cm thick are considered suitable.
48. Planting of cuttings is done at the end of February or the beginning of March in a very short period (1-2 days). Cuttings should be planted in moist soil.
49. The cuttings must be protected from the wind, otherwise their germination percentage will be low.
50. Planting of poplar and willow cuttings on slightly swampy soils of Colchis should be done in a layout of 2.5 X 2.5 m. In such an arrangement of poplars

and willows, mechanized cross-cultivation is possible in them and, most importantly, in such an arrangement, the planting is characterized by good growth indicators.

51. In the first vegetation period, it is necessary to carry out at least six cross-cultivation and two-time harrowing around the seedlings. If the cultivation is carried out with a width of two meters, then around each seedling there will be an uncultivated area of 0.25 m^2, and it is 0.25 m^2 x 1600 seedlings = 400 m^2 area per 1 ha, that is, a single weeding around the seedlings is 4% of the entire area per ha.
52. In subsequent years, every spring, it is necessary to carry out one-time light plowing at a depth of 18-20 cm and 4-5 times cross-cultivation. In the second and third year, it is preferable to carry out three-time and two-time tilling around the seedlings. In the fourth and subsequent years, the canopy begins to tie and the grass cover around the seedlings gradually disappears. Therefore, it will no longer be necessary to dig around the seedlings, but only four times a year cultivation will continue.
53. They should be filled in the second and third year after planting the poplar and willow plantation. Filling is done with the same varieties in autumn or early spring with 2-3-year-old seedlings, the height of which should be the height of the planting in the plantation.
54. In order to get a good growth, along with the cultivation of the soil, we should add mineral fertilizers in the form of NPK to the plants.
55. Phosphorus and potassium fertilizers should be applied in early spring, at the moment of covering the plowed soil, that is, 25-30 days before planting cuttings, and for subsequent years 15-20 days before the beginning of vegetation. Nitrogenous fertilizers should be applied 1-2 days before planting poplar and willow cuttings, and in subsequent years at the beginning of vegetation, in early June - for two-time feeding of seedlings.
56. As mentioned, in the first year of growing crops, complete mineral fertilizers (NPK) should be applied evenly over the area at the dose given in clause 27. In the following years, from the economic point of view and in order to increase the efficiency, it is necessary to apply fertilizers to the roots.
57. Depending on the amount of the active substance, the dose of fertilizing with mineral fertilizers per root is as follows: in the 2nd year of growing crops: N- 20 g + N-20 g, P-40 g, K-20 g; in the 3rd year: N-34 gr+N-34 gr, P-50 gr, K-30 gr; In the 4th year: N-40 gr + N-40 gr, P-60 gr, K-40 gr. In subsequent years, the doses of mineral fertilizers remain unchanged for 10-12 years.
58. Poplar and willow plantations grown by the method described above provide us with up to 300 m3 of high-quality timber for 1 ha in 12-15 years.

59. Oriental plane culture is more often cultivated in Georgia. It is a heat-loving variety and can be grown up to 1000 m above sea level. Plane is a light variety and does not tolerate shading, it grows well on moisture-rich soils. It can be grown in dry areas only with frequent watering. It cannot tolerate swampy places. It has a great need for soil richness. It grows well on deeply loosened soils, it cannot fully adapt to thin stony soils.
60. Oriental plane is propagated by seeds, sprouts and cuttings. It is not damaged by early and late frosts, so it is quite possible to grow it in open places. Plane is a fast-growing variety, it is preferable to grow it in the form of pure groves. We consider it permissible to sow alder in the second-third year of plane plantations on the Colchis lowland as a plant that enriches the soil with nitrogen.
61. Since plane seeds almost every year and its seeds are characterized by good germination ability, it is preferable to plant its plantations with seedlings.
62. Plane seeds are placed in pods and they should be collected in well-lit healthy, from the so-called plus trees, which are characterized by fast growth, straight trunk and other positive economic properties.
63. Decaying of plane pods and shedding of seeds begins in winter and continues until the beginning of vegetation, so pods should be collected before its decay - in December and January. The seeds have matured for a long time by this time.
64. Seeds must be collected from pre-selected seed trees; pods should be collected in dry weather. Pods are collected by hand, with a special brush or other cutting tools.
65. A 10-12 cm wide rake is attached to a 5-6 meter high stick. The length of the rake teeth should exceed 10 cm, the distance between the teeth should be 1.0-1.5 cm. The teeth should form an angle of 60-80 degrees to the axis of the rake.
66. In the process of collecting the pods, a fabric mat should be laid under the tree. This increases the productivity of work (no seeds are lost). The collected heads are transported to a roofed building, laid on special shelves with a thickness of 60-80 cm.
67. After 10-15 days of drying, the dried pods are transferred to the seed warehouse until they are used. In the warehouse, it is stored in separate boxes, glass containers or bags in the amount of 25-30 kg.
68. Plane-tree seed storage should be dry, semi-dark, should not be heated. 0 to 50 is accepted as the best temperature for storage of pods. The seed warehouse should have well-arranged ventilation.
69. Seeds that have been tested in the seed control laboratory are suitable for sowing. After conducting the analysis, the laboratory sends a certificate of seed

suitability to the warehouse or manufacturer. Testing of seeds is carried out in a laboratory every year.

70. In the certificate issued by the control laboratory, the percentages of seed germination, humidity, purity and suitability for storage, the weight of 1000 seeds in grams, the number of seeds in 1 kg and the place of their collection should be mentioned separately.
71. In order to preserve the ability of the seeds to germinate, it is necessary to grind the pods before sowing.
72. The ability of seeds to germinate varies between 4-5%. 1000 seeds weigh 3.5-4.5 grams. There are up to 248,000 seeds in one kilogram.
73. The soil in the nursery should be prepared in the same way as for the mother plantation. If the roots of weeds are left in the soil, they need to be cleaned with a multi-tooth rake.
74. Before sowing the seeds, the nursery should be divided into beds. The method of arrangement of sowing beds is different depending on the climatic conditions: in the subtropical regions of Western Georgia, especially on the Colchis lowland, raised beds are arranged. The height of the beds should be 10-20 cm higher than the soil surface. In dry conditions, beds are arranged approximately 10 cm lower than the ground surface. In moderately humid conditions, beds are arranged at the level of the ground surface. Arrangement of beds should be done about 2-3 weeks before sowing.
75. The width of seedbeds should be 1.0-1.2 meters. All work can be done on beds of this width without stepping on the beds. The length of the beds depends on the configuration of the plot. The width of the paths between the beds should not exceed 35-40 cm.
76. After arranging the beds, their surface should be well loosened, straightened, and at the same time during these works it is possible to add mineral fertilizers to the beds in accordance with the rules and doses given above.
77. Sowing should be done as soon as possible in order to obtain uniform and simultaneous germination of the oriental plane. It is preferable to sow in the first or second decade of March.
78. At least 150 g of seeds should be sown on one square meter of usable area for frequent germination. It depends on the suitability of the seed. Therefore, in 1 ha sowing section, if we consider 6000-6500 square meters as a useful area, up to 900 kg of plane seeds are sown (seed weight is implied by pods).
79. During the calculation of such sowing norms, the feature of acceptable oriental plane seeds is taken into account, that the ability to germinate in soil conditions is reduced by one-two compared to germination in laboratory conditions.
80. Around the beds, a 1.5-2.0 cm deep hole (tilth) is made with a wooden marker. Sowing rows can be separated from each other by 20 cm.

81. Before sowing, the crushed pods are mixed with the same volume of sand. In order to sow the seeds evenly, we take a pre-watered measure in which enough seeds mixed in sand are thrown, which is enough to sow one or several rows.
82. The seeds sown in a row are covered with humus soil up to 0.5 cm thick, after that the bed should be compacted with a special wooden hill. Compaction of the soil surface helps in uniform and simultaneous germination.
83. The sown seeds should be irrigated systematically so that the soil moisture is up to 35-40% (compared to the total water capacity). The soil of such moisture is tested by holding it with the hand, when it is compacted by hand, it should not fall apart by itself. The first watering should be done a few minutes before sowing, and the second - on the same day, after sowing.
84. To prevent rapid drying of the surface of the beds, it is necessary to cover the beds with moss, sawdust, stubble or other similar material.
85. Elevated beds should be irrigated with fine sprinkler irrigation, lowered beds can be irrigated by blast of water.
86. The beds should be watered as soon as the seed layer dries. The entire space of the root system of the sprouted seedlings should be kept moist by frequent watering.
87. Before obtaining germination, it is necessary to round off the beds from weeds. A delay in the first rounding leads to a strong development of weeds. The soil of such moisture is compacted by hand and does not dissolve on its own.
88. The first watering should be done a few hours before sowing, and the second one on the same day after sowing.
89. To prevent rapid drying of the surface of the beds, it is necessary to cover the beds with moss, sawdust, stubble or other similar means.
90. Elevated beds should be irrigated with fine sprinkler irrigation, lowered beds can be irrigated by blast of water.
91. The beds should be watered as soon as the seed layer dries. The entire space of the root system of the sprouted seedlings should be kept moist by frequent watering.
92. Before obtaining germination, it is necessary to round off the beds from weeds. The delay in the first rounding leads to the strong development of weeds and the destruction of a large amount of the crop.
93. Caring for the plane-tree seedlings includes shading, watering, spreading the seedlings, rounding, loosening, mulching, fighting against pests and diseases, cleaning the paths from weeds, etc.
94. The frequency of watering the seed depends on the intensity and frequency of rainfall, as well as the speed of drying of the soil layer in which the root system of the seed is located. It is necessary to maintain high humidity (35-40%) in the

soil for about a month, when their root system is still weak. Maintaining high moisture in the soil helps the intensive growth and strengthening of the root system.

95. Irrigation should be carried out twice a day: early in the morning before 9 o'clock and in the evening between 4-5 o'clock. 5-8 liters of water is needed to irrigate 1 sq/m of useful area. After the emergence of the third leaf of the seedling, it is watered once a day. Daily watering is carried out for 1.5 months. After that, the plant is watered as needed. For humid areas of Western Georgia, watering can be stopped 1.5 months after the date of germination, and for dry areas from the end of September.
96. Sometimes, in case of lack of water, we have to apply to surface soil loosening and mulching. This will help retain moisture in the soil.
97. To prevent crust formation on the soil surface after rain, it is necessary to loosen the soil. Weeding should be accompanied by loosening the soil.
98. Weeding in the rows is done by hand, and between the rows with a small hoe or a special tool. Weeds should be removed immediately after their appearance, especially during the first period of plane germination.
99. Weeding and loosening of sprouts in the oriental-plane nursery should be carried out at least seven-eight times from the beginning of April to September. Gravel weeds should be removed from the beds in pre-prepared pits or special designated areas.
100. After the massive emergence of the plane (after 2-3 days), they should be protected from direct sunlight by shading. Shading is necessary even on cloudy days. The duration of shading should be determined in relation to weather conditions. The duration of shading of crops should not be less than 25-30 days in the cloudy period, and less than 40 days in the dry weather.
101. Crops should be shaded with shields, the ratio of shade and light should be one to one, with shields size 120 X 200 cm. If we don't have shields, relatives can be shaded with leafy branches.
102. Bandage is also used to shade the crops, which is stretched over the crop beds at a height of 30-50 cm and is fixed at the ends on the stakes inserted in the corners of the beds.
103. After passing the shading period, it is necessary to gradually accustom the crops to full daylight. Therefore, shade shields, branches or bandage should be opened before 11 am and in the afternoon, after about 5 pm. Such tempering is enough to be carried out for a week so that the duration of lighting gradually increases. After a week, the shields are completely gone.
104. The care of the plane crops also includes their lighting. Lighting of the crop should be carried out 15-20 days after the germination of the seedlings. Lighting is carried out in such a way that up to forty of the best-developed

sprouts remain in a row per 1 meter long. With such a calculation, we will get up to one hundred and sixty well-developed seedlings from 1 square meter of sowing area. During lighting/thinning, only weak sprouts should be removed.

105. The sprouts in the seedbeds remain until autumn or until February of the next year. In the fall, cutting of seeds is carried out before the start of cultural work - before the frosts. In the spring, the seed is uprooted before the budding in the third decade of February.
106. The crop should be cut in such a way as to damage the root system less, so it is necessary to cut the crop to a depth of about 25 cm. After selecting the crops, they are sorted and packed into cones of 100 pieces. Crops bound in cones should be buried quickly in sunny and windy weather so that the roots do not dry out.
107. If we transport the crops over a long distance, it is necessary to pack them in a bast, sack, sedge, etc., so that the root system does not dry out. Wetting the root system is not excluded.
108. Wet moss or sawdust is laid when the crop is moved to a short distance. Cones are arranged next to each other on it. They are covered with wet moss and then they can be transported.
109. Pits are made on plowed, brushed soils for planting the oriental plane crop: 1600 pits per 1 ha, with a layout of 2.5 X 2.5 m.
110. Planting and further maintenance of the oriental plane is carried out in the same way as poplar and willow crops.

Chapter 6

Main Measures to Optimize the Use of Forest Resources of Ajara

Our concept of rational use of forest vegetation in Ajara and its protection is based, firstly, on the modern idea of the forest as one of the main vital components of the biosphere, performing a set of ecological functions at the level of all scales, including global ones.

Secondly, we proceeded from the fact that the forest resources of the republic concentrate a large amount of biological, technological raw materials, wood, valuable for the introduction of indigenous species of trees and shrubs and other unique and endangered plants. All this resource potential should be rationally used to meet the growing needs of society.

In developing the concept, we used the results of research by outstanding scientists of the forests of the Caucasus and our own (Rolov, 1908, 1928; Krasnov 1906, 1913; Kurdiani, 1930; Ketskhoveli, Sosnovsky, 1931; Ketskhoveli, 1935; Tumajanov, 1937; Grossheim, 1946; Gulisashvili, 1940,1956,1961,1964,1965; Abashidze, 1948; Gigauri, 1956,1960,1980; Makhatadze, 1958,1965,1966; Metreveli et al., 1959; Margvelashvili et al., 1961; Nakhutsrishvili, 1963; Prilipko, Zansiev, 1963; Aptsiauri, 1967; Kharaishvili, 1971; Matikashvili, 1972, 1977; Makhatadze, Urushadze, 1972; Dolukhanov, 1973; Koval, 1974; Gulisashvili, Makhatadze, Prilipko, 1975; Targamadze et al., 1976; Khidasheli, Papunidze, 1976; Papunidze, 1981, 1987; Safarov, 1986 and others).

Covering almost 65% of the republic's area, forest vegetation maintains the ecological stability of the region, which is characterized by extremely difficult natural conditions and a high population density, ensuring its normal life.

However, due to historical reasons, limited land resources, as a result of unsystematic logging, lack of natural pastures, development of subtropical agriculture, expansion of urbanized and recreational areas, the forest vegetation cover of Ajara is largely disturbed and modified by humans.

Studies have found that these changes in forest cover are mainly negative. They manifest themselves mainly in the processes of changing plantations from valuable species to the derived non-forest phytocenoses, in a decrease in the density of forest stands, simplification of their structure, a decrease in biological productivity, and lead to the loss of the ability of forest ecosystems to self-restore by the main forest-forming species. In some vertical-belt complexes, the optimal forest cover of catchments is disturbed, the climatic boundary of the subalpine forest is lowered and its degradation occurs. As a result of intensive anthropogenic activity, forest reserves of valuable food, medicinal plants, genetic fund, introduction and wood resources have decreased.

Naturally, all the above-mentioned changes that have occurred in the forest vegetation of Ajara can lead to a further loss of its ecological and resource potential, if the use of forests and their protection are not based on the scientific basis of rational, sustainable use of these unique natural resources.

The concept of rational use of forest vegetation and its protection is covered in detail in the work. It includes both strategic tasks of nature management and forestry in the future, and a system of forestry and other measures built on the basis of our comprehensive research aimed at preserving and improving the forests of the region, the practical implementation of which should be immediate.

Forest Cover of the Republic

Taking into account the multifunctional role of the forest vegetation of Ajara and, first of all, the functions of the mountain-forest belt in maintaining the ecological balance in the region, we include, first of all, the need to stabilize the forest cover of the republic at the modern level to the strategic tasks of nature management and forestry. Its further decline and decrease in the density of forest cover can lead to the activation of negative environmental processes and phenomena. The modern average forest cover of the territory of the republic is 65%. One of the municipalities of Ajara, which differs from others in its relatively low forest cover, is Khulo. Its secondary forest cover is 52%. Unlike the average forest cover of Georgia, which does not exceed 38%, it would seem, at first glance, it is much higher in the Khulo municipality and meets the optimal standards. However, this area is characterized by the most complex natural features and, first of all, orographic ones, which are the reasons for the development of erosion processes, mudflows, avalanches here. Floods, avalanches and other natural disasters are often observed here.

Based on the results of our comprehensive forestry-ecological and biogeocenotic studies, we came to the conclusion that it is necessary to increase the average forest cover of the territory in the Khulo municipality to 75%. This extremely important task for the implementation of forestry should have a long-term program and be carried out in several stages. At the first stage, the forest cover should gradually increase and by the year 2030 it should be brought to a level of at least 60%. In the following years (2030-2035), the average forest cover of the Khulo municipality should reach the optimal, from an ecological point of view, norm - 75%.

At the first stage of the program until the year 2030, the following objects in the Khulo municipality need environmental protection by afforestation of watersheds: the sources of the Achariskali River, the western, south-western and northern slopes of the Arsiani Range; high-mountain parts of the Goderdzi and Badishi passes; Beshumi resort area; zones of concentration of rural settlements (Didi Ajara, Riketi, Khikhada, etc.). The modern forest cover of the Shuakhevi municipality is 68%. It is also a disadvantaged ecological area. According to our calculations, based on the results of research, the average forest cover of this area should be gradually increased to 75%.

At the first stage, by 2030, it is necessary to increase the forest cover of the Shuakhevi municipality to 73%, and at the second, by 2035, to bring it to the optimal norm. The first stage of these works in the region should provide for increasing the forest cover of the drainage basins of the Skhaltistskali and Chirukhistskali rivers, afforestation of Mount Gomi, in the territories where the villages of Nagvarevi, Tsablana, Skhalta, Tabakhmela, Olodauri, Tbeti and others are concentrated.

The Keda municipality has a forest cover of 80%, which is the highest figure in the republic. From an ecological point of view, the forest cover of this area can be considered optimal, without setting the task of increasing it. However, there are quite a lot of scattered treeless areas in the catchment areas, which are the source of erosion, which systematically damage the national economy.

Therefore, forestry is faced with the task of neutralizing the above-mentioned centers of possible environmental disaster by afforestation without increasing the total forest cover of the region. These areas are concentrated mainly in the villages of Vesadilokeli, Abuketi, Merisi and others.

In the future, we can expect an increase in recreational and other anthropogenic loads on the forests of the Khelvachauri and Kobuleti municipalities. These forests control the water supply and water quality of the cities of Batumi, Kobuleti and adjacent settlements.

In this regard, the forestry enterprises of these municipalities face an equally urgent task of increasing the area of green zones of settlements in order to preserve and increase the potential of their water protection, soil protection and water regulatory functions. In each specific case, this task should be solved on the basis of projects developed by specialized design organizations.

For the ecological stabilization of natural complexes in the republic, where climatic conditions permit, it is desirable to use subtropical fruit and technical woody plants for afforestation purposes. At the same time, the economic effect of the use of the land fund will significantly increase.

Reconstruction of Degraded Plantations

As established by our research, in the conditions of Ajara in the catchment areas with high forestation, forest ecosystems do not perform quite effectively soil-protective, water-regulating and other useful functions, due to the low density of forest stands, changes in their species composition and productivity. Therefore, the second, no less important national economic task is the reconstruction of low-density plantations and their transformation into normally closed high-performance plantations of valuable forest-forming species.

Significant areas of degraded plantations are found in chestnut, hornbeam and oak formations. They are represented mainly by overgrown forest ecosystems, with a low stock (40-70 m3), poor quality of wood and powerfully developed evergreen undergrowth.

These plantations grow mainly in Kobuleti, Khelvachauri and Keda forestry enterprises.

One of the main measures to increase the productivity of such plantations is reconstruction (Gorshenin 1957; Gedenidze 1957; Dashkevich 1958; Bogashova 1959; Zheltov 1966; Zubov 1971; Khidasheli & Papunidze (1976); Khanbekov (1978); Khidasheli & Svanidze (1979).

The experiments carried out and organizational production checks allowed various researchers to recommend the most acceptable methods of forest reconstruction, corresponding to the characteristics of the regions where they carried out their experiments and production checks.

A.K. Charelishvili (1953) prefers the corridor method when reconstructing clearings with evergreen underbrush in Georgia. The same method of reconstruction is recommended by D.I. Antifeyev (1960) in the conditions of the Tellerman inter-forestry. The corridor method is also widely supported in the works of Z.N. Gryazev (1961), I.M. Nevzorov (1969), I.A. Pavlenko (1969), V.K. Asanov (1967), E. Konovalov and A. Kozlov (1971), P.A. Khidasheli and A.I. Mchedlishvili (1985), I.S. Mashaev (1966) and others.

The existing recommendations for the reconstruction of low-value forest plantations are mainly based on the technology of laying windows with a diameter of 15-20 m and cutting down narrow corridors across the slope, which do not allow mechanization of the processes of creating and maintaining forest plantations in order to reconstruct degraded plantations. Meanwhile, it is known that modern forestry practice in most cases denies those ecologically and biologically well-grounded methods of forest stand reconstruction that do not allow the mechanization of these works.

We have developed a strip (corridor) method of reconstruction, with the arrangement of corridors along the slopes, described in detail in the works (Khidasheli and Papunidze, 1976; Panchulidze and Khidasheli, 1979; Papunidze, 1981). The essence of this method is that the corridors in the stands are located along the slope, and the remaining strips have a width equal to the average height of the reconstructed stand (but not less than 5 m), a length of 50-70 m.

Preparatory work should be carried out on the sites planned for reconstruction: laying soil sections and sample plots, drawing up a material and monetary assessment of wood and green mass to be implemented, drawing up a reconstruction project and a technological scheme for performing work (Fig. 9).

Sections along the vertical slope are divided by horizontal trails 5 m wide, adjacent to corridors and protective strips 15 m wide. Horizontal trails are adjacent to vertical trails (5 m wide). The length of horizontal trails is determined by the double distance of skidding by mobile rope installations.

The length of vertical trails depends on the number of rows of sections of curtains and corridors located along the slope from top to bottom and on the skidding distance. The number of rows of sections (corridors and curtains) vertically and horizontally of the slope depends on its size and 100 m wide protective zones left at the top and sides of the reconstruction site.

Along the lower border of the plot between the horizontal trail and the timber road, a protective belt of at least 15 m width is also left.

The junction of roads to the site should be determined by the basic principle of operation of all skidding mechanisms from top to bottom. If the timber road is located downstream (downhill) of the reconstruction site, the cost of fuel and lubricants and time is significantly reduced, which is the main advantage in relation to the technology with the location of corridors along the horizontal sides of the slopes. In cases where it is impossible to bring the road to the lower border of the plot, the place of its adjoining can be chosen on either side, including from above. In this case, the technological scheme is developed taking into account the cargo flows of wood from bottom to top.

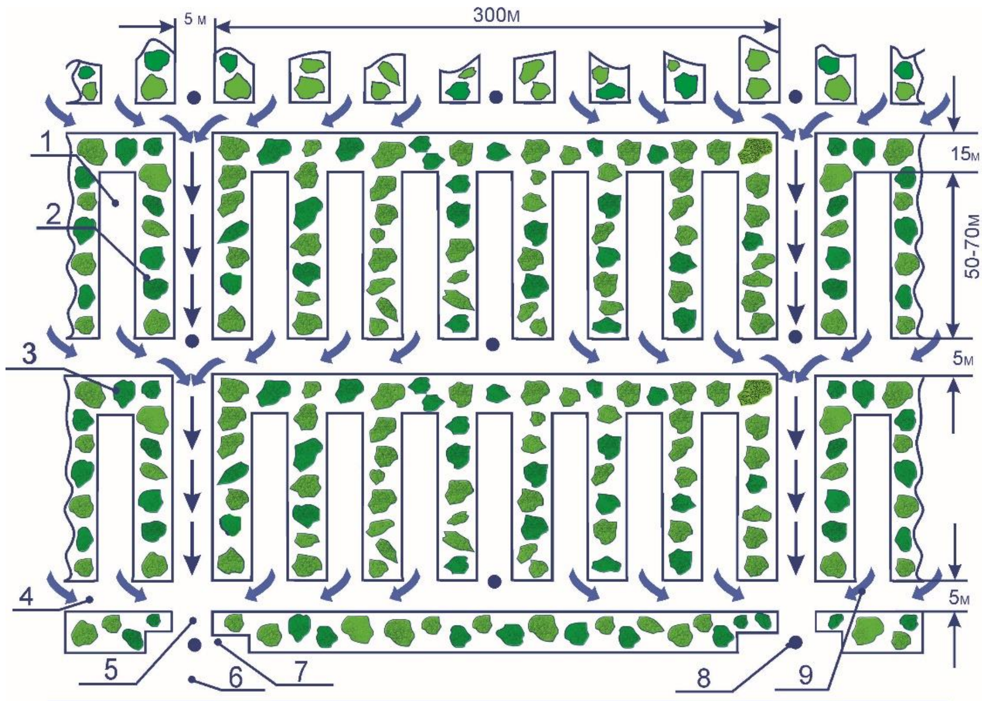

Fig. 9. Technological scheme of reconstruction with the direction of corridors along the slopes
1 - corridors; 2 - curtains; 3 - protective strips; 4 – horizontal drags; 5 - vertical dies; 6 – timber road; 7 – loading and unloading platforms; 8 - VTU parking lots; 9 – directions of cargo flows

The wood pulp of rhododendron is piled up along the edges of corridors so that it cannot interfere with tree felling, delimbing, and cutting whips.

Felling and cutting of trees in corridors is carried out after branding (if not all trees are produced in the corridors). For felling, cutting trees and cutting shrubs, you can use power saws, "Sekorn", ARUM-70 (based on the T-25 tractor). Trees left (in corridors) should be marked with paint. The rarest most straight-stemmed and healthy young seed and shoots specimens of chestnut (on healthy low stumps), as well as other valuable tree species and fruit and berry shrubs are left; pulling out of the corridors of harvested wood can be carried out manually using motor tools, skidders of the LT-400 type designed by RSRIFM with PEN drags designed by TBIL.

The divided timber is stacked in the corridors in heaps (packs), the dimensions and weight of which must correspond to the carrying capacity of the skidding equipment. Skidding is carried out by air-skidding equipment used in Georgia for narrow-strip thinning on slopes with a steepness of up to 40°. For skidding at a distance of up to 150 m (in all directions along the slope), a mobile rope installation PKU-IA (based on the self-propelled chassis T-16 M) of the VNIICHISK design is used. It is also possible to recommend (when skidding up to 175 m) the M-43 self-propelled rope installation (based on the TT-4 or TT-4 M tractor) designed by the Irkutsk branch of CRCIME and other types of VTUs.

At the reconstruction site, one VTU can be used in stages, or several units at the same time. When using one mobile rope installation, skidding begins from the outermost corridor; All the wood from the corridor is pulled out to the horizontal trails, then to the vertical ones and descends along them to the road.

Tree stumps in corridors to prevent the appearance of undergrowth are recommended (as in thinning operations) to treat with arboricides and diesel fuel.

In order to preserve the shoots of *rhododendron ponticum* in the corridors, soil preparation, planting of chestnut crops and caring for them should be carried out manually.

When reconstructing low-value stands without evergreen undergrowth on slopes up to 160 m, it is possible to mechanize soil preparation by sites (2x2 m) using a D-5IZA stump puller with a T-100MG tractor with its entry into the corridors along the trails. Planting holes on loosened (to a depth of up to 70 cm) sites can be prepared using a motor tool (IMS-0.3) or manually.

Planting of walnut crops and subsequent operations for their care are carried out with the help of motor tools: "Sekora", GMK-IG, etc., as well as manually.

Work on the reconstruction sites is completed by fencing them and installing signs (type of crops, year of laying, quarter, forestry, area of crops and the total area of the reconstruction site with protective belts and zones).

After closing the crops planted in the corridors, the second stage of reconstruction is carried out - crops are created on the site of the abandoned strips and trails according to the developed technological scheme. As research has shown, the technology of reconstruction of degraded plantations proposed by us provides optimal ecological conditions for the growth and development of crops from breeds of aborigines and some introduced species.

For ecological and resource purposes, it is advisable to switch to plantation forestry in unforested areas and in areas of sparse forest by creating crops from nuts, chestnuts, laurel, bamboo and other species.

Naturally, when introducing different species of trees into cultivation in each specific case, the correspondence of forest growing conditions of various vertical belts to the ecological requirements of plants should be taken into account.

Activities in Subalpine Forests

A special scientific approach is needed to the use of subalpine forests, where the interests of forestry, agriculture and recreation clash. Under the control of these forests are landslide processes, avalanches, mineral springs and, in fact, the entire water supply below the belts of the republic with fresh water of high quality. Therefore, the conservation of subalpine forests is a very important task.

The main task of forestry here is to increase the density of degraded forests.

Most of the remaining subalpine forests are characterized by a fragmentary location, small islands of forest and groups of plantations are often found, which is due to the influence of natural and anthropogenic factors. Hence the uneven distribution of seeds, which prevents more effective renewal. With the help of artificial afforestation, it is necessary to increase the completeness of plantations and thus improve the condition of subalpine forests.

In the presence of dense canopy vegetation that prevents the rooting of seeds, it is necessary to carry out its partial destruction. In strips 1.5-2 m wide or in "windows" (6-12 m in diameter), evergreen undergrowth and subalpine thickets are removed. Soil preparation in strips and "windows" cleared of undergrowth and subalpine thickets is carried out with the help of motorized hand units and ordinary hand tools. In subalpine conditions, the initial density of new plantings is important. In the subalpine zone, preference should be given to denser plantings, in comparison with other belts, in order to form an earlier closed canopy.

When producing forest crops or taking measures to promote natural regeneration, it is necessary to take into account that in treeless areas it is unacceptable to mineralize the soil over large areas, due to the processes of water and wind erosion. Therefore, it is preferable to sow seeds or plant 2-3-year-old seedlings on small plots of 1.5 x 1.5 m or 2 x 2 m.

On thin soils, digging trenches 0.5 m deep, 0.3 m wide and 6-10 m long gives good results. On soils prepared in this way, tree species grow well. In places protected from the wind, it is possible to plow strips 1-2 m wide for planting crops with the help of draught force.

In those places where, under the influence of cold winds in sparse spruce-fir plantations, self-sowing of tree species dies *en masse*, it is necessary to protect plants from the wind by creating windproof plantations of alder and willow. In mesophilic and moderately dry places, birch, mountain sycamore, red maple, highland maple, aspen, etc., can be used for this purpose.

After a while, it is necessary to regulate the canopy of protective crops by means of periodic thinning. This will improve the light regime for spruce and fir undergrowth and will contribute to the intensification of their growth.

Taking into account the results of international practice, a promising way to create forest crops in mountain conditions is the use of seedlings grown in containers in artificially created extreme conditions for growing planting material.

Our studies have shown that the subalpine forests of Ajara, in the middle and especially in the lower part of the subalpine zone, are relatively poor and simple in structure and floristic composition. The composition of rocks in subalpine forests is monodominant, especially manifested in the uppermost part of the subalpine zone, at an altitude of 1500-2000 m above sea level. However, the latter is not always and not everywhere possible.

It has been established that in artificial subalpine forests, plantations with Sosnowsky pine as a monodominant have not always turned out to be biologically stable.

Recently, especially in the last 20 years, in the forests of the highland zones of Georgia, first of all, in the Bogdanovi, Khulo, Akhalkalaki, Dmanisi, Tsalka municipalities, significant damage to plantations with Sosnowsky pine as a monodominant species has been repeatedly noted. Therefore, Sosnowsky pine in the highland zone of Ajara can be used in forest cultures in the formation of mixed plantations as an accompanying species.

As a result of long-term experiments, it was established that when reconstructing thinned and low-density forests of the subalpine zone of Ajara, preference should be given to eastern beech and Caucasian fir. You can also use oriental spruce, black pine, Caucasian pine, alpine maple, red maple. When we created experimental plantings in the subalpine zone, good results were obtained with European spruce and some species of hazel.

In the subalpine zone of Ajara, artificial reforestation should begin with sparse and low-density plantations, as well as in areas with evergreen underbrush of medium density. In treeless places, restoration work should be carried out on slopes with a steepness of more than 15-20°.

When planning reforestation and reconstruction measures in subalpine forests, it is necessary to take into account the needs of agriculture and livestock in providing fodder resources.

Therefore, in order to increase the productivity of animal husbandry in mountainous areas, for grazing cattle and haymaking, forest areas on slopes with a steepness of less than 15^0 should be used in compliance with preventive measures aimed at maintaining the stability of subalpine plantations.

On the other hand, in forest areas where the reconstruction or restoration of plantations is underway, it is necessary to systematically carry out such an event as "forest at rest". In practice, it is carried out by isolating such areas from the access of animals.

An equally important task in these conditions is the restoration, increase of productivity and biological stability of alpine pastures and hayfields. In addition, in the subalpine belt of Ajara, it is necessary to strictly regulate the rate of grazing, which does not exceed one animal per 4-5 hectares, at present this norm exceeds the permissible load by 10-15 times.

In conclusion, it should be noted that all reforestation works, primarily in the subalpine belt of Ajara, should begin on a 150-200 m strip adjacent to the upper border of the dark coniferous forest.

Taking into account the prospect of developing the high-mountain belt of the republic, which has a variety of recreational and other resources, the problem of increasing the upper limit of the subalpine forest, which over the past 30 years has decreased to 300-400, is urgent.

Our research has proved the possibility of implementing this difficult task in practice through the use of special silvicultural techniques.

Natural Regeneration and Felling

The future of Ajara's forests is determined mainly by the processes of natural regeneration. Any measures for artificial reforestation cannot replace and sufficiently compensate for their natural restoration. As our research has shown, this process proceeds unsatisfactorily in most types of forests of the republic or has completely stopped.

The main reserve for the restoration of forest phytocenoses here is the young generation of the forest, which appeared under its canopy before the felling of forest stands.

In this regard, the primary task of the forestry of the republic is to preserve self-sowing and undergrowth of preliminary origin during logging and other types of use. To achieve this goal, it is necessary, firstly, to introduce mechanisms into the logging technology that exclude damage to the soil cover and the destruction of the young generation of the forest. At the same time, in some special cases during logging, we do not exclude the possibility of using domestic animals for skidding harvested wood. Secondly, the effective use of the natural reforestation potential of beech and spruce-fir forests of Ajara can be realized through the organization of integrated forestry, a gradual decrease in the density of forest stands during felling in several stages and subsequent care of dense undergrowth of pre-felling origin with the removal of overmatured and other trees.

Studies have confirmed that the main reason for the unsatisfactory silvicultural condition of the forests of Ajara is intensive, unsystematic and industrially selective logging.

In order to increase and restore the resource and environment-forming potential of the forest vegetation of the republic, the forestry policy for the near future until 2020-

2030 should be based on the principle of sustainable, continuous use of the forest to meet the needs of the population and the national economy in wood and other forest resources.

In the light of the above, we come to the conclusion that it is inadmissible to use intensive industrial logging in the specific natural conditions of the region. Of the existing methods of felling, the most acceptable are voluntary-selective felling. The guiding principle of the intensity of felling in this case is the selection of timber in the amount of the average annual increase during the 10-year audit period and the limitation of logging in the mountainous part of the republic. In addition to voluntary-selective logging in the conditions of Ajara, group-selective felling is also permissible.

Without dwelling on the principles of selective farming set forth in the "Rules of Main Use of Felling in the Forests of the Georgian SSR (1968)", it should be noted that the most acceptable is the Swiss option, in which the diameter of the "windows" in stands of shade-tolerant species ranges from 8 to 12 m. In pine and oak plantations, the Bavarian variant of group-selective felling is expedient, in which 5-6 windows with a diameter of 15-20 m are laid on the first ha.

As shown by the studies (Svanidze, Khidasheli, Eganov, 1974; Khidasheli, Papunidze, 1976), special attention should be paid to the intensity of felling in spruce-fir forests. For example, 11-12% of the forest stand planned for felling is cut down at the first and second stages, 17% at the third stage, 21% at the IV and 26% at the V stage. At the last intake, 13 percent is cut down.

With the Swiss variant of group-selective felling, 8-10 windows are laid on the first hectare, while 6-8 percent is cut down at the first intake, 8-10 percent at II, 11-14 percent at III, 14-18 percent at IV, 17-22 percent at V-17-22 percent, and no more than 20-29 percent at VII (last) felling.

The Swiss variant of group-selective felling is very close to voluntary-selective felling. Therefore, their use is possible in those areas where it is advisable to carry out voluntary-selective felling. As a result of both of these felling, plantations of different ages are formed, which is of great conservation importance.

Studies have shown that the productivity of beech forests increases markedly by voluntary-selective felling of medium intensity, and at the same time the forest retains protective and climate-regulating functions.

In connection with some modification of the felling methods proposed for implementation, it will be necessary to amend the existing rules for main use of felling, approved by the Ministry of Forestry of the Georgian SSR in 1979.

In addition, it seems expedient and justified, in connection with the unsatisfactory state of the forests of the republic, to prohibit logging of the main use in Ajara for a period of 15-20 years with compensation for the shortage of wood for the needs of the population by releasing it from the multi-forested areas of the country.

Creation of Plantations from Fast-growing Tree Species

Due to the limited use of mountain forests for the needs of the national economy and the shortage of land resources, our concept of rational use and protection of the forests of Ajara provides for the wide involvement of low-swampy soils of the Colchis lowland to create plantations of fast-growing and highly productive tree species.

It should be noted that Colchis forests on swampy soils are widespread in Georgia. The existing practice of deforestation and uprooting of forest areas in order to develop subtropical crops is not scientifically justified and we consider it erroneous.

At present, we are already facing the negative environmental consequences of clear cutting of forests over large areas in the Colchis lowland. They are manifested in the secondary swamping of the territory, in the intensive development of soil deflation, and in the disappearance of many species of forest fauna endemic to Georgia.

Moreover, as agricultural practice has shown, the cultivation of subtropical crops in the territories freed from forests in the Colchis lowland is not economically justified due to the slow growth of subtropical fruit and industrial crops and very low yields. One of the reasons for the above is the incomplete understanding and underestimation of the agroforestry functions of the forest.

As our studies have shown, non-continuous felling of forests in large areas and felling of plantations in strips preserves its phyto-reclamation functions. In addition, with such a system of felling the Colchis forest, its ecological and social importance is preserved.

However, deforestation in the Colchis lowland should combine the optimal balance of interests of forestry and agriculture. Therefore, the development of forest lands is expedient only when there is a full guarantee of obtaining economically justified biological products.

The most optimal conditions for growing forest crops in the Colchis lowland, as our research has shown, are formed when leaving strips of mother plantations 100-150 m wide.

In the felled areas of the forest, preliminary uprooting of thickets and shrubs is carried out. If there are stumps on the site, they are uprooted by the K-GA (K-2A) stump machine and comb the roots out of the soil. Then continuous plantation plowing to a depth of 35-40 cm and harrowing are carried out.

In order to improve the structure of the soil, enrich it with nutrients in order to accelerate the growth and development of plants, it is necessary to use complete mineral fertilizers (saltpeter, potassium chloride and simple superphosphate).

Fertilizers should be applied around the seedlings in compliance with the following doses:

I year - N 20 gr. + N - 20 gr. P - 40 gr. K - 20 gr.

2 year - N 34 gr. + N- 34 gr. P - 50 gr. K - 30 gr.

3 year - N 40 gr. + N - 40 gr. P - 60 gr. K - 40 gr.

In the 4th and subsequent years, nitrogenous fertilizers should be applied annually, in the form of double fertilization, with the following doses: N - 60 gr. + N - 60 gr., and phosphorus and potassium fertilizers after a year, similarly: P - 80 gr., K - 60 gr.

Poplar cultivation is best done with winter cuttings and harvested in January on annual shoots. Cuttings harvested from shoots of stumps have the highest qualities. To protect against drying out, harvested cuttings should be stored in cold, closed rooms.

Planting cuttings of poplars, willows, seedlings of oriental sycamore and others is carried out in early spring before the beginning of the growing season in moist soil. After planting, soil cultivation is carried out 7-8 times for a year until the formation of a closed canopy of crops.

Studies show that the development of the cultivation of the most productive plantations on the slightly swampy soils of the Colchis lowland should be based on the models of the most productive forest. According to the method developed by us, the optimal density at individual phases of growth and development of the created models of maximum productive plantations should be different (Gedenidze, Papunidze, 1973, 1975).

We consider the optimal density of young crops to be the one that excludes the negative mutual influence of individuals and provides the maximum current increase in the height and diameter of the trunk to as many trees as possible. The optimal number of trees is determined based on the spatial parameters of the crowns of well-developed trees and the critical distance between the crowns (Juodvalkis et al., 1986). We consider the optimal density of middle-aged and ripening stands to be the one that provides the maximum current stock growth and total productivity, as well as a high intermediate and maximum stock by the age of ripeness.

Guided by the above criteria and methods for determining the optimal density of plantations, we have developed models of maximally productive crops for promising tested species. According to these models, the following crop density is recommended: for balsam poplar 1x1 m; 2.5x2.5m, 4x4m; for red-nerved poplar 2.5x2.5 m, 4x4 m; for the plateau - on the east 2.5x2.5 m.

As our research and the results of experimental plantings in the Colchis lowland on slightly swampy soils have shown, preference should be given mainly to balsam poplar, red-nerved poplar and oriental sycamore. Our long-term tests of about 50 species of plantations cultivated in this region did not give positive results.

However, as a result of breeding work carried out in recent years in various natural and climatic conditions of our country, fast-growing hybrid poplars, willows, etc. have been obtained or imported from foreign countries, which should be tested in certain zones of the republic in production conditions, including the Colchis lowland. On the basis of experimental tests of introduced species and the use of specially developed agronomic methods, the possibility of obtaining wood from one hectare of 15-year-old crops in the amount of up to 300-400 m3 was proved, which is 1.5-2 times higher than the productivity of natural alder plantations, the wood of which is significantly inferior in quality. The creation of such plantations is also accompanied by a certain environmental effect.

From our point of view, in the plan of economic development of the swampy areas of the Colchis lowland, in addition to the creation of plantations from fast-growing tree species, it should also be provided for the gradual reconstruction of low-productivity alder forests into more productive ones. The latter is necessary to create a raw material base for the paper industry and partially meet the needs of the population in wood and fuel.

In the context of the republic's transition to economic independence, this is of particular importance. In addition, the creation of a raw material base in the Colchis lowland makes it possible to reduce intensive logging in the mountain forests of the republic and increase their stability and protective potential.

Taking into account the current and future importance of the forest vegetation of the Colchis lowland, from our point of view, it is necessary to transfer the forests of this region from the II group to the first group of forests.

Protection of Rare and Endangered Plants and Introduction Reserves

Despite the optimal ecological conditions of Ajara, which contribute to the lush development of vegetation, many species of woody plants are on the verge of extinction, which is mainly caused by the irrational use of plant resources.

Some species, due to their bioecological features, are rarely found within their ranges, regardless of human economic activity.

The number of rare and endangered trees and shrubs reaches 58 species (Papunidze et al., 1978). The following plants require economic protection: *Taxus baccata Lun - perus rufescens Link.,J.sabina L.,J.pygmae C.Koch.,Salix Kikodzeae, Pterocarya pterocarpa Knth.,Betula Medwedewii Rgl., Ostrya carpinifolia Scop., Corylus colchica Albov., Quercus pontica C.Koch... dschorochensis C.Koch, Celtis australis L., Ficus colchica L.,Morus nigra L., Berberis vulgaris L.Laurus hobilis L., Ribes alpinum L., R.Biebers teinii Berlin,Cotono aster integerrima Medic.,Sorbus Boiss ieri Schneid,,S.subfusa Boiss.,S.colchica Zinscrl., S.graeca Hedl.,8. torminalis (L.) Crantz.,Pyracantha coc- cinea Roem.,Mespilus germanica L.,Rubus ideaus L.,Buxus colchica Pojark, Rhus coriaria L.,Evonimus lejophlea Stev B.Ketzchoveli Gatsch.,Staphylea colchica Stev.,S.pinnata L.,Acer pseudoplatanus L.,A.laetum C.A.Mey., Ziziphus jujuba Mill.,Rhamnus imeretina Bootb., Rh.microcarpa Boiss Hypericum androsaemum L.,H.inodorum Willd.,Cistus salvifolius L.,Daphne mezereum L., D. pontica L.,Hippophae rhamnoides L., Thelycrania Koenigii (C.K.Schneid.) Sanadse, Rhododendron Smirnovii Trautv.,Rh.ungernii Trautv.,Epigaea gaultherioides (Boiss et Ball.) Takht.,Arbutus andrachne L. Erica arborea L.,Diospyros lotus L.,Fraxinus oxicarpa L.. Willd, Phillyrae mcdwedewii Sed, Vitex agnus-castus Viburnum opulus L.*

In addition to floristic and phytocenological richness, Ajara is characterized by contrasts of vegetation. The preservation of the Colchis flora and wildlife monuments of Ajara in general is a very important task. Unfortunately, the increased interest of the population in communicating with nature, intensive agriculture, the development of animal husbandry, the use of various heavy equipment causes a reduction in the area of vegetation cover, impoverishes the floristic composition of the gene pool.

In our opinion, the most rational mode of exploitation of sites with rare endangered plants in the conditions of Ajara is the establishment of a reserve or close to a reserve regime.

We consider it expedient to single out the following sanctuaries on the territory of the Republic of Ajara: in the gorge of the Chorokhi and Acharistskali rivers, a strip 200 m wide, where many endemic and rare plants grow; part of the Kobuleti lowland, where *Osmunda regalis I.* and round-leaved sundew (*Drosera rotundifolia L.)* grow, sandstones at the mouth of the Choloki, where there are sea *pancracia (Pancratium maritimum L.),* coastal spark (*Asparagus litoralis stev.),* marine knotweed (*Diotla maritima (L.) sm*.); rocky slopes between Gonio and Sarpi, where southern carcass (*celtis australis L*.), laurel (*Laurus nobilis L.),* Venus hair (*Adiantum cappilus veneris L.)* are found; the gorge of the Natsvavitskali River, where *Epigaea gaultherioides (Boiss et Ball.)* Takht.) grows; rocky slopes in the Keda region, where Ajarian broom (*Genista adzharica M.Pop.)* grows; the vicinity of the village of Namonastrevi, where Ungern's rhododendron (*Rhododendron Ungernii Trawt*), Medvedev's birch (*Betula Medwedewii Rgl*.), Pontic oak (*Quercus ponticus C.Koch*.), Colchis holly (*Ilex colchica Pojark)*, medicinal laurel (*Laurocerasus officinalis Roem.),* field chestnut (*Castanea sativa Mill.);* plantations of strawberry tree (*Arbutus andrachane L*.) in the Shuakhevi municipality; plantations of hornbeam hop hornbeam (*Ostrya carpynifolia Scop.)* near the village of Olodauri; plantations of *Cryptogramma crista (L.) R.Br.Zinserl.),* Colchis mountain ash (*Sorbus colchica)*, Medvedev's birch (*Betula Medwedeni Rgl.)* and others on Mount Tbeti; plantations of brittle buckthorn (*Frangula alnus Mill.)* in the vicinity of Khulo near the villages of Bodzaura and Tabakhmela; plantations of angelica (*Angelica adzharica M.Pimen*), English sundew (*Drozera anglica Huds.),* intermediate sundew (*Drozera intermedia Hayne*) near the villages of Didachara and Danisparauli.

Protected areas allocated in the conditions of Ajara should be allocated not only for the protection of flora and fauna, but should also be the most important objects of organized recreation of workers. It is advisable to organize special sites in botanical gardens, experimental stations, and schools for the restoration and reproduction of relict and rare plants.

Botanic institutions should also intensify research work in the field of rare and endangered plants, as well as environmental advocacy among the population.

Conclusions

Long-term comprehensive studies of the forest vegetation of Ajara and various aspects of the multifunctional role of the forest have led to the following main conclusions and practical proposals:

1. The forest vegetation of Ajara is one of the most vital components of the large and complex ecosystem that represents the region of our research. Covering about 65% of the republic's area, forests control the ecological stability of the region, which is characterized by extremely difficult natural conditions and a high population density. They are a reserve of biological, technological raw materials and wood, unique for the introduction of foreign plant species.
2. Due to historical reasons, unsystematic logging, limited land resources, the development of subtropical agriculture and recreation, the forest vegetation of Ajara is much more disturbed and transformed by man than in other mountainous regions of Georgia.
3. The changes that have occurred in the natural forest cover of the region are negative. They are manifested in the processes of changing the main species of forest formers to low-value and industrial non-forest phytocenoses, in a decrease in the density of forest stands and the simplification of their structure, in a decrease in biological productivity and stability of forest ecosystems.
4. Under the influence of centuries-old anthropogenic impact, the natural pattern of the distribution of forest vegetation, due to the law of vertical zonality, has been violated. This is clearly manifested in the decrease in the upper and increase in the lower boundary of the natural forest in the high-mountain belt and the almost complete disappearance of virgin forests.
5. It has been established that felling of mountain forests in Ajara mainly determines the processes of natural regeneration. The main factors influencing this process are damage and destruction of undergrowth during logging, transformation of light conditions, deterioration of water-physical properties of soils and competitive relationships between the young generation of forests of understory and herbaceous plants.
6. In beech and spruce-fir plantations, the fullness of which has been increased to 0.1-0.2 as a result of a single felling, the processes of natural regeneration proceed unsatisfactorily or completely stop. In similar types of forest of high density (0.8-0.9), as a result of its reduction by one-time felling to 0.3-0.4 and even to 0.5, natural regeneration is also unsatisfactory. In plantations of oatmeal, underforest-asmen, forb and hazelnut forest types of medium density (0.5-0.6), in case of its gradual decrease by felling, regeneration is satisfactory.

7. The environmental consequences of various forms of anthropogenic impact on forest ecosystems in individual vertical belts are unequal. In the lower mountainous coastal belt, they are manifested in the change of indigenous types of subtropical mixed forests from elements of the Colchis relict flora to artificial phytocenoses. In the middle mountain belt, under the influence of anthropogenic loads, soil conditions deteriorate to a large extent, there is a degradation of chestnut and oak forests, accompanied by xerophytization of growing conditions and loss of protective functions of the forest. Similar changes in an even more pronounced form are observed in the subalpine belt.
8. As a result of the destruction of the subalpine forest and unorganized grazing of cattle in the Khulo and other forestry enterprises of Ajara, there is a massive death of undergrowth of the main tree species of forest formers due to a sharp deterioration of environmental conditions. This is the reason for the local violation of the optimal forest cover of the catchments and the lowering of the climatic boundary of the subalpine forest.
9. Due to the unsatisfactory current state of the forests of the republic and a number of factors limiting logging, it is a mistake to overestimate them as a large reserve of timber and even more so of high quality. At present, all harvested wood cannot meet the needs of the local population for building materials and fuel.
10. Mountain forest vegetation producing in different altitudinal zones performs a set of protective functions, including soil protection, water regulation, water protection and avalanche control.
11. It has been established that the soil-protective function of mountain forests is most contrastingly manifested through the values of solid runoff from catchments of different forest cover. Under all equal conditions, the maximum annual precipitation, in terms of its magnitude and intensity, corresponds to the most solid runoff. The quantitative values of this runoff are determined mainly not by the sum of precipitation, but by their intensity.
12. For the first time in the mountain forests of Ajara, in the region of excessive moisture, the specifics of the manifestation of the protective functions of the forest were revealed. It lies in the fact that the formation of solid runoff here occurs even in catchment basins with high forestation. In catchments with forest cover of 90, 80, and 35, the solid runoff is 15, 63, and 147 t/ha, respectively.
13. Unlike other mountainous countries, in Ajara, the quantitative parameters of solid runoff are primarily influenced by the low forest cover of the basins, the

density, completeness and silvicultural condition of mountain forest ecosystems.

14. It has been determined that the mountain forest vegetation of the excessively humid region of Ajara, in comparison with the forests growing in conditions of moderate moisture, is characterized by a relatively weakened manifestation of water-regulating functions. This is reflected in the fact that catchments with high and low forest cover differ little from each other in terms of water-regulating effect.
15. In the belts of broad-leaved and dark coniferous forests growing in the zone of confident moisture, the differences in the values of the total runoff are insignificant. Moreover, in the first case, there is a tendency to reduce runoff due to an increase in the forest cover of catchments, in the second there is an inverse relationship.
16. For the restoration of degraded forests of the republic, the creation of anti-erosion plantations of forest belts and landscaping works in Ajara, 5-6 million standard seedlings of various tree species are required annually. This problem can be most effectively solved by accelerating the cultivation of planting material, the proposed range of promising tree species based on the norms of application of organic and mineral fertilizers and agricultural techniques developed by us (Papunidze, 2020a). The economic feasibility of these measures is justified.
17. Due to the limited possibility of industrial exploitation of mountain forests in Ajara, in order to satisfy local consumers in timber, the economic feasibility of developing plantation forestry on the slightly swampy soils of the Colchis lowland has been proved wood 300-350m^3/ha (Papunidze, 2020b).
18. On the basis of the comprehensive studies carried out, the concept of rational use of forest vegetation of Ajara and its protection was developed. It includes strategic tasks of nature management and forestry for the future and a system of forestry and other measures aimed at increasing the ecological potential of the republic's forests and their protection.
19. Among the strategic tasks, the priority are: stabilization of the region's forest cover at the current level; reconstruction of low-productivity low-density plantations into normally closed and more productive ones; introduction of plantation forestry; prohibition of 15-20 years of floating felling in mountain forests; increase in the upper border of the subalpine forest; allocation of separate areas on the watersheds of rivers with a large number of relicts, both protected and other.

The system of a set of forestry measures for logging, reforestation, reconstruction of plantations, accelerated cultivation of planting material, creation of plantations, etc., as well as environmental measures based on the results of our research, have been partially implemented in the system of the Ministry of Forestry of the Republic of Georgia and are covered in detail in the work (Papunidze, 1990).

The main provisions of our concept are most expedient to use in the development of a long-term scheme for the integrated nature protection of Ajara (TerKSOP), which, along with the use and protection of all the resources of the region, should also reflect forest resources.

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