

**Russian State Agrarian University -**

Moscow Agricultural Academy named after K. A. Timiryazev

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**DEVELOPMENT OF LAND RECLAMATION  
AND WATER MANAGEMENT FOR FOOD  
SECURITY AND CONSERVATION**

**BIODIVERSITY UNDER CLIMATE CHANGE**

**CLIMATE CHANGE IN AFRICA**

**Bibliographic list of literature**

**for students and lecturers**

**Russian State Agrarian University – Moscow Agricultural Academy  
named after K. A. Timiryazev**

**Moscow 2025**

Development of land reclamation and water management for food security and biodiversity conservation under climate change in Africa: a bibliography/compiled by: B. V. Shabanov, A. G. Tsyurulnik, S. V. Kislyakova; ed. P. A. Berberov; K. A. Timiryazev Russian State Agrarian University- MSHA (Moscow), Central Scientific Library named after N. I. Zheleznov. -Moscow, 2025. -71 c.

Translation into English - Master of Engineering and Technology Strizhnikov O.A. Editor of the English text - I.G.Bondarik, PhD, Chief Researcher

The problem of climate change is not only a scientific problem today, but also an economic and political one. In African countries, according to researchers, the main problem will be to provide food for the population, due to the presence of such dangerous factors as droughts, floods, precipitation variations. According to experts' estimates, the impact of global warming on agriculture will be ambiguous, negative consequences may be combined with positive ones.

The bibliographic list has been prepared to help students, postgraduates, and can also be used by teachers of the K.A. Timiryazev Russian State Academy of Agricultural Sciences to prepare for training sessions.

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# **6th African Regional Conference on Irrigation and Drainage (ARCID)**

Date: April 14-18, 2025

Venue: Abuja Continental Hotel, Abuja, Nigeria



## **WELCOMING ADDRESS BY THE PRESIDENT OF THE INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE (ICHD) TO THE 6TH AFRICAN REGIONAL CONFERENCE TO BE HELD IN ABUJA, NIGERIA, 14-18 APRIL 2025**

**Distinguished guests, honoured delegates, esteemed colleagues...**

It is with great pleasure and great honor that I welcome you all to the 6th African Regional Conference on Irrigation and Drainage (ARCID) of the International Commission on Irrigation and Drainage (ICID), which is being held under the theme "Monitoring the crisis of irrigation development and water Resources Management in Africa." As President of ICID, I am truly pleased to witness the unification of minds dedicated to solving one of the most pressing problems of our time.

Africa, with its diverse landscapes and growing agricultural needs, is facing a critical moment in ensuring sustainable water management practices. The importance of irrigation and drainage systems cannot be overemphasized in ensuring food security, reducing poverty and promoting economic growth across the continent.

The choice of Abuja, Nigeria, as the host city for this important conference underscores the commitment of African countries to address the water management crisis head-on. Nigeria, with its rich agricultural heritage and visionary policies, provides an appropriate backdrop for our discussions.

Over the coming weeks, we will have the opportunity to engage in meaningful dialogues, share best practices, and forge partnerships that will pave the way for innovative solutions to meet the challenges ahead. While we are discussing irrigation development, water security, climate change, and socio-economic impacts, let's be guided by the principles of sustainability, inclusivity, and cooperation.

Therefore, I encourage each of you at this conference to actively participate in the sessions, exchange ideas, and contribute through your experience to developing a course for a water-based future in African countries. Together, we can turn challenges into opportunities and realize our shared vision of a planet where everyone has access to water for sustenance and prosperity.

Once again, I cordially welcome all participants and wish you all a fruitful and productive conference. Let's embark on this journey with renewed determination and optimism.

Thank You!

**Doctor Marco Arcieri**

President of the International Commission on Irrigation and Drainage (ICID)

WELCOMING SPEECH BY THE CHAIRMAN OF THE  
ICID–AFRICAN REGIONAL WORKING GROUP (AFRGG) AT THE  
6TH AFRICAN REGIONAL CONFERENCE, SCHEDULED TO BE  
HELD IN ABUJA, NIGERIA, ON APRIL 14-18, 2025

Dear delegates and other invited participants.

It is a great honor for me to welcome you all to the 6th African Regional Conference on "Addressing the Crisis in Irrigation Development and Water Resources Management in Africa." As Chairman of the African Regional Working Group, I humbly stand before you today among such distinguished delegates and experts in this field.

Africa is facing unprecedented challenges when it comes to irrigation development and water resources management. With a rapidly growing population, changing climatic conditions, and increasing water scarcity, the needs for a sustainable solution have never been more urgent.

At this conference, we have the opportunity to share knowledge, share best practices, and collaborate on developing innovative strategies to address these pressing issues. Together, we can work to ensure access to clean water for all, improve food security, and promote economic growth and development across the continent.

I encourage each of you to actively participate in the discussions, interact with other delegates, and contribute to the search for effective solutions. Let's use the power of collective action to overcome the challenges we face and pave the way for a brighter future for Africa.

Thank you!

Dr. Mohamed Wahba

Chairman of ICID – African Regional Working Group (AFRWG)

## The preface

This bibliographic index is dedicated to the 6th African International Conference on Irrigation and Drainage, which will be held on April 14-18, 2025 in Nigeria. (**6th African Regional Conference on Irrigation and Drainage (ARCID) Date: 14th – 18th April 2025 Venue: Abuja Continental Hotel, Abuja, Nigeria** – <https://6arc2025.org.ng/>) The staff of the Problem Laboratory of RSAU-MTAA, together with the staff of the Department of Ecosystem Water Management of VNIIGiM RAS (I.G.Bondarik, PhD, Chief Researcher), were invited to this conference. In this regard, it became necessary to systematize the available materials and create a "Thematic bibliographic index" to draw the attention of researchers and designers to the accumulated experience of Russia in the field of land reclamation and water management.

The list of literary sources includes the works of the Problem Laboratory (2010-2014) on the justification of the need for land reclamation in the Republic of Burundi and a huge body of literature selected by the staff of the Bibliographic Department of the N.I.Zheleznov National Library of the RSAU-MTAA.

The series of works that were carried out by the staff of the RSAU-MTAA PL for the previous congresses and webinars of the ICID continues. [[https://icid-ciid.org/inner\\_page/183/](https://icid-ciid.org/inner_page/183/)] and were presented on the website PL RSAU-MTAA <https://www.timacad.ru/about/struktura-universiteta/nauchnye-podrazdeleniia/problemnaia-laboratoriia>

In previous works, general directions of development of land reclamation and water management in the context of climate change were discussed using the example of the Russian Federation. The works presented in this bibliographic index specify these issues in relation to the African continent. Preliminary studies performed in the Problem Laboratory (2010-2014) on the example of land reclamation development in Burundi showed the possibility of applying the developed methodology for the continent as a whole.

It is shown that, first of all, it is necessary to assess the level of impact on the main environmental factors (primarily on the water regime) during climate change. Due to the fact that this process is multiparametric, it is necessary to choose an indicator that will, on the one hand, integrally characterize changes in environmental conditions that significantly affect the productivity of biocenoses, and on the other, allow the system to be managed using land reclamation methods.

The magnitude of the runoff change during climate change was chosen as such a parameter. The runoff change forecast was carried out by the Institute of Water Problems of the RAS [<https://www.iwp.ru/about/news/ko-dnyu-rossiyskoy-nauki-izbrannye-rezultaty-2021-goda/otseneny-globalnye-izmeneniya-v-21-veke-summarnogo-ispareniya-s-poverkhnosti-sushi-i-rechnogo-stoka-/?ysclid=lrrok59i3j152921282>].

This indicator integrates precipitation, evaporation, and, to a certain extent, groundwater recharge.

The runoff change forecast relative to the existing values was performed for all continents of the World, including Africa (IVP RAS). On the African continent, the flow in the Congo River basin is projected to change (decreasing flow) and the Niger River basin (increasing flow). And also, there are certain changes in a number of other places on the African continent.

Such a forecast gives reason to fear changes in the water regime on agricultural lands, which may lead to food problems.

In addition, changes in the moisture content of natural biocenoses can lead to a loss of ecological stability of natural systems, and this will worsen the processes of oxygen reproduction by natural systems during photosynthesis and lead to the need to intensify air mass transport over long distances (hurricanes, typhoons, etc.).

Previous studies have shown that when natural conditions change, it is necessary to develop precise land reclamation and precise water management in advance, as tools for a green economy.

The sequence of steps for the development of this activity is shown in the materials presented in the development [https://www.timacad.ru/uploads/files/20221114/1668414167\\_razr\\_EVOIZE.pdf](https://www.timacad.ru/uploads/files/20221114/1668414167_razr_EVOIZE.pdf)

and in the development [https://www.timacad.ru/uploads/files/20230407/1680861747\\_vidy\\_melior.pdf](https://www.timacad.ru/uploads/files/20230407/1680861747_vidy_melior.pdf)

**Scientific Director of the Problem Laboratory RSAU-MTAA**

**Doctor of Technical Sciences, professor. Shabanov V.V.**

# OFFICIAL DOCUMENTS

**1. THE AFRICAN WATER RESOURCES VISION FOR 2025: EQUITABLE AND SUSTAINABLE USE OF WATER RESOURCES FOR SOCIO-ECONOMIC DEVELOPMENT, ADOPTED IN 2000 WITH THE ADOPTION OF THE MDGS WITH THE SUPPORT OF THE AFRICAN DEVELOPMENT BANK AND THE UNITED NATIONS ECONOMIC COMMISSION FOR AFRICA, IDENTIFIED AT THE 5TH AFRICAN WATER WEEK, HELD IN SENEGAL. - Dakar, 2014. p. 35. – Text: direct**

2. "WATER FOR SUSTAINABLE DEVELOPMENT" : INTERNATIONAL DECADE FOR ACTION, 2018-2028 General Assembly Distr.: General 7 February 2017 Seventy-first session Agenda item 19 a 16-22804 (R) Resolution adopted by the General Assembly on 21 December 2016 [on the report of the Second Committee (A/71/463/ Add.1)] 71/222. - Text. : direct

**3. REPORT ON WORLD DEVELOPMENT AND CLIMATE CHANGE / [prepared by. International Bank for Reconstruction and Development; translated from English by N.V. Zaborin et al., edited by A.V. Bondarenko et al.] - Moscow : The Whole World, 2010. – 417 p. : ill. – bibliogr. at the end of the article is the text. : direct**

**4. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC). -**  
URL: <http://www.ipcc.ch/> - (Date of request : 10.01.2025)

**5. THE UNITED NATIONS CONVENTION TO COMBAT DESERTIFICATION IN THOSE COUNTRIES EXPERIENCING SEVERE DROUGHT AND/OR DESERTIFICATION, ESPECIALLY IN AFRICA. Paris, June 17, 1994** URL: <http://cawater-info.net/library/rus/desert.pdf> - (Date of request : 10.01.2025)

**6. UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE : adopted on May 9, 1992**  
URL: [https://www.un.org/ru/documents/decl\\_conv/conventions/climate\\_framework\\_conv.shtml](https://www.un.org/ru/documents/decl_conv/conventions/climate_framework_conv.shtml) - (Date of request : 10.01.2025)

**7. THE STATE OF THE WORLD'S LAND AND WATER RESOURCES FOR FOOD PRODUCTION AND AGRICULTURE. SYSTEMS AT THE LIMIT :**  
**the FAO Synthesis report. – Rome, 2021. URL: <https://doi.org/10.4060/cb7654ru>**  
- (Date of request : 10.01.2025)

**8. THE STATE OF FOOD SECURITY AND NUTRITION IN THE WORLD BY 2024. FINANCING TO ELIMINATE HUNGER, FOOD INSECURITY AND MALNUTRITION IN ALL ITS FORMS : report / FAO; IFAD; UNICEF; WFP; WHO. - Italy, Rome. – 286 p. - URL: [https://translated.turbopages.org/proxy\\_u/en-ru.ru.0b2c8a7e-67909fa2-7c5d20ea-74722d776562/https/clevnet.overdrive.com/media/11042686](https://translated.turbopages.org/proxy_u/en-ru.ru.0b2c8a7e-67909fa2-7c5d20ea-74722d776562/https/clevnet.overdrive.com/media/11042686)** - (Date of request : 10.01.2025)

Six years after 2030, trends in hunger and food insecurity are still not moving in the right direction to end hunger and food insecurity (SDG target 2.1) by 2030. Indicators of progress towards the global nutrition goals also show that the world is not on track to eliminate all forms of malnutrition (SDG target 2.2). Billions of people still lack access to nutritious, safe and sufficient food. Nevertheless, progress in many countries offers hope that it is possible to get back on track to eradicate hunger and malnutrition. Implementing the policies, investments and legislation needed to reverse current trends of hunger, food insecurity and malnutrition requires adequate funding for food security and nutrition. While there is broad agreement on the urgent need for increased funding for food security and nutrition interventions, the same cannot be said for a common understanding of how this funding should be defined and tracked. The report provides a long-awaited definition of food security and nutrition financing and recommendations for its implementation. It provides recommendations for the effective use of innovative financial instruments and reforms to the food security and nutrition financing architecture. Developing a common definition of food security and nutrition financing and how to track, measure and implement it is an important first step towards sustainably increasing the financial flows needed to eradicate hunger, food insecurity and all forms of malnutrition, and to ensure access to healthy food for all today and tomorrow.

# INTERNATIONAL LEGAL ASPECTS OF

**9. Abaturova, V. THE USE OF HUMAN RIGHTS PROTECTION MECHANISMS IN SOLVING THE PROBLEM OF GLOBAL CLIMATE CHANGE / V. Abaturova, E. Blizetskaya // International justice. – 2023. – № 4 (48). – Pp. 37-57. – Text : direct.**

**10. Bukuru, J. B. INTERNATIONAL LEGAL COOPERATION ON THE USE AND PROTECTION FROM POLLUTION OF TRANSBOUNDARY WATER RESOURCES IN AFRICA / J. B. Bukuru, A.M. Solntsev // Legal paradigm. - 2017.- Vol. 16, No. 1. - pp. 186-193. <https://elibrary.ru/item.asp?id=29916010> - (date of request : 09.01.2025)**

States on the use and protection from pollution of transboundary water resources in Africa. As an example of such cooperation, the Lake Tanganyika basin is analyzed, as well as the regulatory framework of one of the coastal States of the Republic of Burundi. The adoption of international treaties, the creation of joint bodies for the management of transboundary water resources, as well as the implementation of international standards at the national level are extremely important.

**11. Kuzovkin, A. I. THE CLIMATE SUMMIT IN ROME AND THE CLIMATE CONFERENCE IN GLASGOW IN 2021 / A. I. Kuzovkin // Microeconomics. – 2022. – No. 1. – pp. 91-97. – Text : direct**

**12. Pekarnikova, M. E. ANTHROPOGENIC CLIMATE CHANGE AND INTERNATIONAL LEGAL ACTIVITIES TO MITIGATE THEIR CONSEQUENCES : part 2. Implementation of climate legal acts at the present stage and their prospects / M. E. Pekarnikova, A. B. Polonsky // State and Law. – 2021. – № 5. – pp. 118-124. – Text : direct**

The activities on the legal regulation of control over anthropogenic emissions of greenhouse gases and aerosols at the international and national levels are analyzed

**13. Khvatkov, R. S. MEASURES TO COMBAT DESERTIFICATION TAKEN BY THE UNITED NATIONS IN THE FRAMEWORK OF INTERNATIONAL COOPERATION / R. S. Khvatkov, N. O. Moiseeva // Digital Science. - 2023, No. 12. - pp. 35-59. - URL : <https://elibrary.ru/item.asp?id=57693024> - (date of request : 10.01.2025)**

The problem of desertification, especially anthropogenic desertification, dates back to the origins of agriculture itself and, together with the growing need for food, has accompanied humankind throughout its historical development. Increasing crop yields were achieved at the cost of increasing anthropogenic pressure on the environment, and overgrazing, slash-and-burn farming and other irrational forms of nature management were inevitably accompanied by irreversible soil degradation. This is what led to the emergence of a significant part of modern deserts, including the largest desert on the planet Earth - the Sahara. Thus, from the very first stages of human civilisation development, extensive methods of farming led to extremely negative ecological consequences. Today, with the growth of the world's population and the development of technologies and scales of management, the problem of desertification has become global, which is manifested not only in the environmental, but also in the social and economic spheres - that is, global desertification through the main components of the triune concept of sustainable development affects the fulfilment of its goals. Countries in the arid belt tend to have lower levels of economic development, with higher levels of poverty and hunger, and their populations are more likely to suffer from health problems and lack of clean freshwater.

Of course, such a significant obstacle on the way to sustainable development could not fail to attract the attention of the world community and, first of all, the UN. Thus, in 1994, the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (UNCCD) appeared, where the term 'desertification' (desertification) was defined as land degradation in arid, semi-arid and dry sub-humid areas as a result of various factors, including climate change and human activity. Undoubtedly, the solution to such a global problem, affecting, according to various estimates, from 10 to 20 per cent of the land area, is possible only through the joint efforts of the world community, which can and should be coordinated by the United Nations. Therefore, it becomes relevant to study the role of the United Nations in combating desertification, which is impossible without a clear understanding of the natural essence of the desertification process and an idea of the current state of the issue.

Thus, the purpose of this work was to study the system of measures to combat desertion adopted by the international community under the auspices of the United Nations.

To achieve the goal, the following tasks were set: to study the process of desertification and methods of its prevention from an environmental point of view, to consider the history of the creation and principles of functioning of the system to combat desertification, built under the auspices of the United Nations, to study the global state of the issue.

## FEATURES OF CLIMATE CHANGE IN AFRICA

**14. Balandin, R. CLIMATE RECLAMATION : WE USED TO TALK ABOUT LAND AND SOIL RECLAMATION. IS IT POSSIBLE TO IMPROVE THE CLIMATE? / R. Balandin // Light. – 2010. – No. 4. – pp. 4-7.  
– Text : direct**

According to some forecasts, the average annual temperature of the troposphere may rise by several degrees, which threatens droughts, the rapid onset of deserts, and the melting of glaciers.

**15. THE IMPACT OF CLIMATE CHANGE ON THE EFFICIENCY OF THE "WATER – ENERGY -FOOD" INFRASTRUCTURE: THE EXPERIENCE OF EAST AFRICA / A. L. Chupin, A. H. Ulusov, A. I. Hersey, I. H. Ulusov // Financial Economics. - 2023 - No. 5. - pp. 70-72.  
<https://elibrary.ru/item.asp?id=53945688> - (date of request : 10.01.2025)**

The need to evaluate the effectiveness of large infrastructure in rapidly developing African countries is widely recognized, but rarely practiced. In this study, the authors consider major investments in the water, energy, and food sectors for two major river basins in Africa. The authors combined a detailed interpretation of the observed and modeled behavior of the climate system with hydrological modeling and performance indicators that are relevant to decision-making. The projected risks for the middle of the 21st century for the Rufiji River in Tanzania are similar to the current ones, and for the Malawi River, the Broader future risks exceed those observed in the 20th century.

In both basins, a repeat of the multi-year drought of the early 20th century will call into question the viability of infrastructure development. Long-term development that highlights past and future changes in variability, in the broader context of climate information interpretation and decision-making, is crucial for assessing risk to infrastructure.

**16. Gavrilova, N. G. THE IMPACT OF CLIMATE CHANGE ON AGRICULTURE AND FOOD SECURITY IN AFRICA: report, abstracts / N. G. Gavrilova; Timiryazev Moscow State Agricultural Academy University (Moscow), pp.36-39. — Electron. text data. // COLLECTION OF ARTICLES based on reports by scientists of the K.A. Timiryazev Russian State Agrarian University and other universities and research institutions at the International Scientific Conference of the teaching staff dedicated to the 155th anniversary of the K.A. Timiryazev Russian State Agricultural Academy, which was held on December 2-4, 2020. Issue 293 part 2. Moscow, 2020. — Collection: Conferences of the Russian State Agricultural Academy named after K. A. Timiryazev. — Collection: TLC reports. — Free access from the Internet (reading, printing, copying). — Access mode : <http://elib.timacad.ru/dl/full/doctsha-293-2-2021-9.pdf> . - Title page. the screen. - The electron. the version of the original publication. — <URL:[http://elib.timacad.ru/dl/full/doctsha-293-2-2021-9 .pdf](http://elib.timacad.ru/dl/full/doctsha-293-2-2021-9.pdf)>. - (accessed : 01/10/2025)**

Climate change creates additional barriers to food production. In Africa, where more than 70% of the population lives off agriculture, a downturn in the industry caused by the effects of climate change and a rapid increase in population could lead to a food collapse. Climate change is global in nature, and scientists determine that the impact of these changes has a detrimental effect on tropical arid and semi-arid areas, for example, in sub-Saharan Africa. Due to climate change, the amount of precipitation and groundwater available for agricultural production is decreasing.

Vast territories are subject to desertification and other degradation. An increase in average annual temperatures causes disruptions in the growing cycles of crops, a decrease in biodiversity and the melting of glaciers in the mountains. Due to changes in precipitation, some rivers (Nile, Zambezi, Congo, etc.) and lakes (Chad) become shallow and dry.

The United Nations Intergovernmental Panel on Climate Change (IPCC) has registered a decrease in the production of traditional food crops caused by climate change. In Sudan, Ethiopia, Eritrea, and Zambia, sorghum production decreased; in Ghana— corn; in Sudan, millet; and in the Gambia, peanuts. This has led to an increase in extreme poverty in sub-Saharan Africa.

**17. Gromova ISLAND, SUB-SAHARAN AFRICA: THREATS OF GLOBAL CLIMATE CHANGE / O. GROMOVA // ASIA AND AFRICA TODAY. - 2018. - No. 3. - pp.56-61.- Text : direct**

Global climate change has a different effect on African men and women, taking into account their different social and economic roles and status in the family and society, unequal access to social, economic and natural resources. The socially unprotected and vulnerable, as well as the less educated and the poorest segments of the African population - women and children - are particularly strongly feeling the adverse impact of climate change on their living conditions.

**18. Lobanov, V. A. APPLICATION OF THE RESULTS OF STATISTICAL AND PHYSICO-MATHEMATICAL MODELING TO ASSESS THE FUTURE CLIMATE OF CENTRAL AFRICA / V. A. Lobanov, M. T. Mami, E. Nzambimana // Hydrometeorology and atmospheric physics: modern achievements and development trends : proceedings of the II International Scientific and Practical Conference. Saint Petersburg, 2024. - pp. 67-72. - URL : <https://elibrary.ru/item.asp?id=67957339> - (date of request : 10.01.2025)**

To estimate future air temperatures and precipitation in Central Africa, it is proposed to use both the results of an assessment of current changes based on statistical modeling of multi-year series, and adjusted scenario estimates until the end of the 21st century based on the selected physico-mathematical climate model most suitable for the region. It was found that the most suitable models with average deviations from observational data for the territory under consideration are up to 2°-3°C is the French IPSL model, the Chinese BCC model. Based on the selected models and the most realistic scenario, adjusted values of average air temperatures and precipitation for three 30-year periods until the end of the 21st century and their spatial distributions were obtained.

**19. Makarov, I. A. GLOBAL PROBLEMS OF CLIMATE, WATER AND FOOD FROM THE PERSPECTIVE OF THE THEORY OF THE PUBLIC GOOD / I. A. Makarov // International Economics. – 2011. – No. 5. – pp. 24-29. - Text : direct**

**20. Mamboleo, M. THE IMPACT OF CLIMATE CHANGE AND HUMAN ACTIVITY ON THE ECONOMIC VIABILITY OF LAKE VICTORIA IN EAST AFRICA / M. Mamboleo // Economics of environmental management. - 2023. - No. 3. - pp. 3-12. - URL : <https://elibrary.ru/item.asp?id=53865178> - (date of request : 10.01.2025)**

**Understanding how environmental changes and human activities affect the quantity and quality of water is vital for maintaining aquatic ecosystems and making optimal use of freshwater resources. A household survey on the impact of climate and human activities on the economic sustainability of Lake Victoria was conducted in Kenya's Lake Victoria region. Among the indicators used to analyze the impact of climate change and human activity on the economy of the Lake Victoria basin were declining lake revenues, decreased fish catches, water pollution, fish species extinction, alien invasion, and declining biodiversity. The results of this study showed that there is a significant correlation between these variables and the economic activity of Kenyan counties located near Lake Victoria.**

**21. Mami, Magbini T. THE CLIMATE OF CENTRAL AFRICA AND ITS CHANGES IN THE PRESENT AND FUTURE / Magbini T. Mami, V. A. Lobanov // Hydrometeorology and atmospheric physics: modern achievements and development trends : proceedings of the All-Russian Scientific and Practical Conference. - St. Petersburg, 2023. - pp. 129-133. - URL : [https://elibrary.ru/query\\_results.asp](https://elibrary.ru/query_results.asp) - (date of request : 10.01.2025)**

The long-term series of monthly mean air temperatures and precipitation at 65 meteorological stations in Central Africa are examined to assess the influence of climatic changes on the dynamics of long-term averages. Quantitative estimates of air temperature increases in different seasons of the year are obtained, which reach 2.2-2.4 °C in the southern mountainous and eastern regions in all seasons and additionally in the summer monsoon in coastal areas and in the spring intermonsoon period in the north. In the central part of the territory, the average temperature increase does not exceed 0.5-0.6 °C. The territory-wide average temperature increase in all months reaches 2.0 - 2.3°C by the end of the 21st century, and spatial distributions of future temperatures are derived from estimates at selected weather stations, which show the greatest increase in the north of the region near the Sahel. In general, the wet period is characterised by a decrease in rainfall across Central Africa, with the largest decrease of up to 37% percent in the north of the territory, while the dry period shows an increase in rainfall on the Atlantic coast (Gulf of Guinea) and in the mountainous areas of the eastern part of the territory, reaching 15 mm in January.

**22. Mami, M. P. FEATURES OF CLIMATE CHANGE IN CENTRAL AFRICA / M. P. Mami, V. A. Lobanov // Problems of atmospheric physics, climatology and environmental monitoring : reports of the IV International Scientific Conference. - Stavropol, 2022. - pp. 154-161. - URL : <https://www.elibrary.ru/item.asp?id=49469498> - (date of request : 10.01.2025)**

**23. Mami, M. T. ASSESSMENT OF FUTURE PRECIPITATION IN CENTRAL AFRICA ACCORDING TO THE CMIP PROJECT SCENARIOS / M.T. Mami // Fundamental and applied aspects of the development of modern science : a collection of scientific articles based on the materials of the XII International Scientific and Practical Conference. Ufa, 2023. pp. 51-66. URL : <https://elibrary.ru/item.asp?id=53924717> - (date of request : 10.01.2025)**

To estimate future precipitation before 2100 in Central Africa, a methodology has been developed that takes into account both current changes and future adjusted scenario values of the CMIP5 and CMIP6 projects when choosing the most appropriate physico-mathematical climate model. The Norwegian NorESM1 model was chosen as the most effective of the 20 climate models considered for this territory based on a comparison of precipitation observations at meteorological stations and the results of a historical experiment over a joint period. Based on the results of the average scenario (4.5 W/m<sup>2</sup>), it was found that during the rainy season, precipitation is expected to decrease in the north near the Sahel and in the west near the Gulf of Guinea and increase precipitation in the east of the territory under consideration. During the dry season, precipitation will increase both in the arid regions in the north and south, as well as in the humid equatorial rainforest zone.

**24. ASSESSMENT OF MODERN CHANGES IN ATMOSPHERIC PRECIPITATION IN CENTRAL AFRICA / M. M. Tokpa, V. A. Lobanov, A. I. N. Mkhanna, S. V. Morozova, M. A. Alimpieva // Bulletin of the Udmurt University. Biology series. Earth Sciences. - 2023. - Vol. 33, No. 2. - pp. 217-232. - URL : <https://elibrary.ru/item.asp?id=54356305> - (date of request : 10.01.2025)**

Long-term series of monthly precipitation totals of seasons from the beginning of observations to 2022 at 57 meteorological stations in central Africa have been studied to assess the impact of climate change on precipitation dynamics in this part of the African continent. The spatial and temporal distributions of precipitation for the dry and wet seasons were obtained and it was found that the lowest amount of precipitation is observed from November to March, and the highest - from April to October. According to the type of intraannual precipitation changes, four homogeneous climatic regions were identified and an assessment of the changes in each of them was given.

Different methodological approaches were applied to assess changes in precipitation in the months of wet and dry seasons of the year. In general, no significant changes in the dynamics were found, however, a general tendency of precipitation decrease in the wet season months and its increase in some parts of the territory in the dry season months of the year was established. The decrease in the wet season months ranged from -25.5 mm to -138.5 mm or 0.8-1.2 RMS, and an increase in some areas of 52.8 mm and 68.1 mm or 0.8-1.1 RMS. During the dry season, the largest decrease occurred in the northern and central regions, reaching -31.6 mm (0.88 RMS) in February, while a significant increase occurred in the coastal areas of the Gulf of Guinea, reaching 15 mm (2.0 RMS) in January.

**25. Saenko, A. N. FINANCING ACTIVITIES TO BATTLE CLIMATE CHANGE AND SPIRITUAL ENERGY TRANSITION IN AFRICA: NEW STRATEGIES AND INSTRUMENTS / A. N. Saenko // Modern Economy Success. - 2023. - № 1. - C. 300-308. - URL : <https://www.elibrary.ru/item.asp?id=50168909>- (date of access : 10.01.2025)**

Climate change remains one of the greatest challenges to Africa's post COVID-19 recovery and sustainable development. Addressing this challenge requires increased financing from both domestic and external sources to combat climate change. The article examines new strategies and financial instruments that could facilitate an equitable energy transition on the African continent. The author focuses on the current international financial architecture for climate change action in Africa, the financing needs for this action. Resource mobilisation to address climate change in Africa must go beyond UN negotiations and high commitments to practical steps and implementation, using a range of market and non-market approaches specific to country needs. Sharing the burden of responsibility is as important as actually delivering on commitments. Particular attention is given to new sources of finance for climate resilience.

The main areas of new sources of finance for a just energy transition and wider action are green finance, carbon markets, domestic finance and increased private sector participation. The reasons for increased global coordination of climate finance are highlighted and conclude with recommendations on how all parties can provide Africa with more equitable access to finance to support its energy transition.

**26. Cheubu, Djumbissie F.L. MANAGEMENT OF GENERAL WATER RESOURCES IN AFRICA IN THE CONDITIONS OF CLIMATE CHANGE / F.L. Cheubu Djumbissie // Digital economy: trends and prospects of development in Russia and the world : conference proceedings. - Moscow, 2021. - C. 444-451. - URL : <https://www.elibrary.ru/item.asp?id=46602790> - (date of access : 10.01.2025)**

**27. Shelomentsev, A. G. PROBLEMS OF SOCIAL AND ECONOMIC ADAPTATION OF THE POPULATION TO THE CONDITIONS OF GLOBAL CLIMATE CHANGE: APPROACHES AND SOLUTIONS // A. G. Shelomentsev, K. S. Goncharova // Food Policy and Security. - 2022. T. 9, № 4. - C. 377-402. - URL : <https://www.elibrary.ru/item.asp?id=49861006> (date of access : 10.01.2025)**

Climate change causes a wide range of social, environmental and economic impacts in all spheres of life. This determines the significance of population adaptation to climate change, which in recent decades has become one of the priority goals facing the governments of many countries. The article defines the interdisciplinary area of research into the problems of population adaptation to climate change, summarises and typologises the main approaches in this area, and identifies the specifics of taking into account factors of different nature depending on the specific territory.

The analysis and generalisation of scientific works covering the countries of Europe, Asia, Asia-Pacific, Africa, North and South America, etc., allowed us to identify the following main directions in the study of the area under consideration: the problems of adaptation of the population of rural areas and farms as the most sensitive sphere to climate change; consideration of adaptation processes in planning development and settlement; assessment and forecasting of threats, risks and consequences of adaptation; specifics of the influence of socio-cultural and political factors; and the impact of climate change on the adaptation of the population. The sociocultural approach allowed us to consider the problem of adaptation of the population taking into account the influence of not only economic, but also social, national-cultural, demographic and ethnic factors. The results obtained can be used in the development of programmes for the adaptation of regions and national economies to the processes of global climate change.

**28. Shabanov, V. V. POVERTY IN RICH NATURE / V.V. Shabanov, N. Niyonzima // VINITI. Deposited manuscript No. 309-B2012 07/16/2012. – Text : direct**

**29. Shabanov, V. V. POSSIBLE CLIMATE CHANGE AND AGRICULTURE OF THE REPUBLIC OF BURUNDI / V.V. Shabanov, N. Niyonzima // VINITI Deposited manuscript No. 313-B2012 07/20/2012. - Text : direct**

## **FOOD SECURITY AND DIGITALIZATION OF AGRICULTURE IN AFRICA**

**30. Gavrilova, N. G. AFRICAN FOOD SHORTAGES: CAUSES AND TRENDS** / N.G. Gavrilova // Agrarian Science for Agriculture : proceedings of the XIX International Scientific and Practical Conference. Barnaul, 2024. pp. 20-22. URL: <https://www.elibrary.ru/item.asp?id=65355778> - (date of request : 09.01.2025)

Before colonization, the African continent was fully self-sufficient in food. Today's Africa is the most "starving" continent in the world. The purpose of the study was to identify unique historical and economic factors that have influenced the current state of food insecurity on the continent. It has been established that digital transformation of the agricultural sector is necessary to ensure food security in Africa.

**31. Gavrilova, N. G. INTRODUCTION OF MODERN TECHNOLOGIES IN ORDER TO INCREASE THE ECONOMIC EFFICIENCY OF COCOA PRODUCTION IN AFRICA** / N. G. Gavrilova // Economics of agricultural and processing enterprises. - 2022. - No. 11. - pp. 66-75.- Text : direct

**32. Gavrilova, N. G. THE STATE AND PROSPECTS OF FOOD SECURITY IN WEST AFRICAN COUNTRIES IN THE CONTEXT OF AGRICULTURAL LAND DEGRADATION** / N. G. Gavrilova // International Agricultural Journal. - 2024. - Vol. 67, No. 3. - URL: <https://www.elibrary.ru/item.asp?id=68005635> - (date of request : 01/21/2025)

The article determines that the agricultural sector in West Africa is dynamically improving efficiency indicators, but such rates are not enough to meet the nutritional needs of the population. The article examines one of the reasons for the backwardness of West African agricultural production - land degradation. It is mainly a consequence of inappropriate human activities, including the expansion of agricultural areas and the use of backward resource management methods. But natural factors also have a huge impact on soil loss from circulation. There is a growing number of people vulnerable to hunger in the region, whose activities are directly related to the land - farmers and pastoralists. Countries are taking a number of steps to stop the process of land degradation, but it is happening at a slow, inefficient pace.

**33. Gavrilova, N. G. SUSTAINABLE DEVELOPMENT OF AGRICULTURE IN SUB-SAHARAN AFRICA: THE ROLE OF RURAL ENTREPRENEURSHIP** / N. G. Gavrilova // Topical issues of sustainable development of the agro-industrial complex : proceedings of the national scientific and practical conference with international participation dedicated to the 90th anniversary of the Faculty of Agronomy of Irkutsk State Agrarian University. - Irkutsk, 2024. - pp. 99-104. - URL: <https://www.elibrary.ru/item.asp?id=65696758> - (date of request : 09.01.2025)

Sub-Saharan Africa (SSA) is struggling with rapid urbanisation, which has left the agricultural sector understaffed. The issue of unemployment among the large youth population is also acute. The article discusses one way of ensuring sustainable development of the agricultural sector in Sub-Saharan Africa, namely rural entrepreneurship development. Rural entrepreneurship is expected to counteract urbanisation and attract people, especially young people, back to the agricultural sector. Rural entrepreneurship, in addition to its already defined objectives, should contribute to poverty reduction, improve the continent's food security and introduce modern technologies into small-scale production. Some of the most popular areas of rural entrepreneurship include crop production, animal husbandry, agro-processing, agricultural services, agro-tourism and organic farming. But all these endeavours are not widespread enough. And despite the many strategies and initiatives that have been developed, Sub-Saharan Africa still faces challenges in attracting people to agriculture and managing urbanisation. However, the continent continues to work hard to build a sustainable agricultural sector that can support the livelihoods of large parts of the population and ensure food security.

**34. Gavrilova, N. G. DIGITAL TRANSFORMATION IN AGRICULTURE IN THE COUNTRIES OF WESTERN AFRICA (EXAMPLE OF COTE D'IVOIRE)** / N. G. Gavrilova // Actual Issues of Agrarian Science. 2024. № 50. C. 54-64. - URL: <https://www.elibrary.ru/item.asp?id=65587056> - (date of access : 09.01.2025)

This article explores the potential of digital technologies in the development of the agricultural sector in West African countries, with a focus on Côte d'Ivoire. Despite the significant role of agriculture in African economies, the use of digital technologies is characterised by low efficiency, which negatively affects the food security of states. Digital technologies should increase the efficiency of agricultural production and improve food supply.

The article assesses the possibility of widespread adoption of digital developments in agriculture in Côte d'Ivoire, where media, communication and information sharing, Internet use, etc. are gaining popularity. The global network is used to make calls using messengers, participate in social networks, to browse content, obtain information on goods and services, use email, purchase goods and services, online banking, etc. In other words, users' preference is for the simplest services that do not require special skills. The digital services currently prevalent in Ivorian agriculture are focused on meeting the needs of smallholder farmers producing their main export commodity (cocoa beans), who are mostly uneducated and poor, i.e. not fluent in modern technology and not in possession of expensive means of communication. Counselling services through SMS, chatbots, through social media, through recorded videos, etc. are common. The adoption of digital services in the agricultural sector is not progressing at the desired pace and the article identifies the factors hindering this. The government of Côte d'Ivoire is making many efforts to accelerate the adoption of digital technologies in the agricultural sector and transform agriculture.

**35. Gavrilova, N. G. 60 YEARS OF INDEPENDENT DEVELOPMENT: THE STATE OF AGRICULTURE IN AFRICA / N. G. Gavrilova // IACJ. - 2020. - №5. - URL: <https://cyberleninka.ru/article/n/60-let-nezavisimogo-razvitiya-sostoyanie-selskogo-hozyaystva-v-afrike> - (date of address: 11.11.2022).**

This article focuses on the state of agriculture in the 17 African countries that gained independence in 1960. These include several countries in Central Africa (Cameroon, Central African Republic, Chad, Democratic Republic of Congo, Gabon, Republic of Congo and Cameroon), West Africa (Benin, Burkina Faso, Côte d'Ivoire, Mali, Mauritania, Niger, Nigeria, Senegal, Togo), the East African state of Somalia and the island country of Madagascar. With the advent of independence and the shift of government attention from supporting agricultural production to financing the extractive industries, agriculture declined in almost all of the countries under consideration. Demand for food continued to increase in line with population growth, and food security was eventually disrupted in these countries. In the 1990s, active attempts to revive agricultural production began. Agrarian transformation programmes helped to slow down the rate of degradation of the sector.

The current state of agriculture in the countries under consideration does not fully provide food for the population. Many of the factors considered in this study limit the sustainability of agriculture.

**36. Golovina, S. G. INSTITUTIONAL INNOVATIONS IN AGRICULTURE IN AFRICAN COUNTRIES: THE EXAMPLE OF BENIN / S. G. Golovina //**

Actual problems of science and education in the context of modern challenges : proceedings of the XXII International Scientific and Practical Conference. - Moscow, 2023. - pp. 561-566. - URL: <https://www.elibrary.ru/item.asp?id=54271107> - (date of request : 01/21/2025)

Most often in the scientific literature, there are studies devoted to all kinds of institutional innovations in agriculture in developed countries. However, from the point of view of rural development, the processes observed in countries at a different (lower) level of development of society (and the agricultural sector) are of interest to science. As part of one of the ongoing projects, a study of the experience of institutional transformation in a number of African countries such as Nigeria, Gambia, Benin and others has been undertaken, and this article therefore presents some generalisations concerning the development of the agricultural sector of the economy and rural areas in Benin. The conclusions of the paper are that, firstly, institutional innovations are the result of evolutionary transformation processes in the sector, secondly, the country has a well-structured network of stakeholders in the development of the sector, and thirdly, the transformations noted in the paper lead to increased incomes of pastoralists, strengthening their lobbying positions in public and government structures. The paper concludes by outlining the factors contributing to further innovations in the sector and in the rural space as a whole.

**37. THE INNOVATIVE VECTOR OF AGRICULTURAL SCIENCE DEVELOPMENT : a collective monograph; editors: V. B. Korolev, E. V. Koroleva, S. A. Mishakova, O. V. Rakhimova. / Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, Moscow State Academy of Veterinary Medicine and Biotechnology - K.I. Scriabin MBA, Kaluga Institute of Additional Professional Education in the field of Agriculture - Moscow, 2022. – 324 p. - URL: <https://www.elibrary.ru/item.asp?id=47929906> - (date of request : 09.01.2025)**

The thematic sections of the monograph reveal modern methods of organizing agro-industrial production.

A number of chapters of the monograph have been prepared in foreign languages (English, German), which present the international experience of introducing breakthrough technologies in the field of agriculture (Germany, the People's Republic of China, African countries).

**38. Kamara, P. PROBLEMS AND OPPORTUNITIES OF AGRICULTURAL DEVELOPMENT IN WEST AFRICA / P. Kamara // Management. - 2022. - 4. - pp. 38-45.- Text : direct**

The article is devoted to the study of the challenges and opportunities for the development of the agricultural sector in West Africa. The aim of the study is to identify ways to improve the efficiency of agricultural production and yields in West Africa. The task is to search, identify, develop and implement the most effective methods and algorithms for the realisation of the designated goal, as well as the problems and obstacles on this path. The article describes the current state of agriculture in this sub-region. The author considers modern problems of agriculture in this territory, gives examples of agriculture in other regions of the world for comparison with West African agriculture. Intensive agriculture of various countries is examined as an option for the development of the West African region. External factors affecting the development of agriculture in West Africa are examined, in particular climatic changes, increasing average annual temperature. Attention is paid to the question of finding a new way of climate-resilient agricultural development. Opportunities and problems related to the application of agroecology are analysed on the example of the Republic of Senegal.

**39. Morozova O. S. THE GEOPOLITICAL CONSEQUENCES OF THE PROBLEM OF FOOD SECURITY IN AFRICA / O. S. Morozova // Concepts of development and effective use of the scientific potential of society : a collection of articles based on the results of the International Scientific and Practical Conference. - Sterlitamak, 2024. - pp. 50-52. - URL: <https://www.elibrary.ru/item.asp?id=61261274> - (date of request : 10.01.2025)**

The article discusses issues related to the food security situation in Africa. The connection between the existing and worsening food problems on this continent and the development of geopolitical tensions is shown. Measures to stabilize the food crisis and possible options for Russia's participation in providing assistance to African countries are proposed.

**40. Noskov, A. Y. REFORMING AGRICULTURE IN MOROCCO: PROBLEMS AND PROSPECTS** / A.Y. Noskov // Agrarian Scientific Journal, 2017, No. 2, pp. 80-86. - URL: <https://elibrary.ru/item.asp?id=28428019> - (date of request : 09.01.2025)

Morocco's agricultural sector has demonstrated successful growth and achievements in recent years. However, the country has serious problems and challenges typical of developing countries, which are being overcome by a wide range of measures. The Moroccan Government is striving to create an agricultural model that is a model for many African countries. According to the author, access to investment resources, sound government policy, natural resources and hard work of the country's inhabitants can not only bring Morocco to a leading position in the region, but also become the basis of the "green revolution" of the Black Continent.

**41. Pryazhnikova, O. N. DIGITAL AGRICULTURE IN AFRICA: MAIN DIRECTIONS OF DEVELOPMENT** / O.N. Pryazhnikova // Economic and social problems of Russia. - 2023. - № 1 (53). - Pp. 86-100. - URL: <https://elibrary.ru/item.asp?id=50490762> - (date of request : 09.01.2025)

The review examines agricultural digitalization practices in African countries and their positive impact on agricultural production, as well as factors hindering the digitalization of the industry. It is noted that the main directions of the development of digital agriculture in African countries are related to digital consulting and information services, the formation of market relations, supply chain management, access to financial services, data collection and analysis.

**42. Revenko, L. S. FOOD SECURITY OF SMALL ISLAND DEVELOPING STATES OF AFRICA** / L. S. Revenko, O. I. Soldatenkova, N. S. Revenko // Asia and Africa today. - 2024. - No. 8. - pp. 22-32. - URL: <https://www.elibrary.ru/item.asp?id=68538444> - (date of request : 10.01.2025)

The food security of small island developing States (SIDS) in Africa is one of the most important economic, social and humanitarian issues. The African continent as a whole accounts for a third of the world's hungry. For MOSTRAG, the picture is even more acute due to the specifics of their geographical location, the structure of the economy, the level of development of agriculture and food production. The most difficult food security situation is in Guinea-Bissau and Cape Verde.

Given the common challenges in ensuring food security, primarily a high degree of economic and environmental vulnerability, African MOSTRAGS have different approaches to solving them. Only some of them (Seychelles, Mauritius) have government programs or strategies aimed at a comprehensive solution to the problem of food security. International organizations are providing great assistance in ensuring food security for the population of African RAVINES.

**43. PON THE SUSTAINABLE DEVELOPMENT OF AGRICULTURE IN THE COUNTRIES OF TROPICAL AFRICA IN THE FIGHT AGAINST HUNGER, POVERTY AND ENVIRONMENTAL DEGRADATION. (KENYA)** // Environmental safety in agriculture. Abstract Journal, 2003, No. 1, p. 232. - URL: [https://www.elibrary.ru/query\\_results.asp](https://www.elibrary.ru/query_results.asp) - (date of request : 10.01.2025)

**44. Sayenko, A. N. ANALYSIS OF THE IMPACT OF LAND DISPUTES ON THE ECONOMIC DEVELOPMENT OF AFRICAN COUNTRIES AND THE PROCEDURE FOR THEIR REGULATION** /A.N. Sayenko // Economics of construction. - 2024. - No. 6. - pp. 22-25. - URL: <https://www.elibrary.ru/item.asp?id=68496510> - (date of request : 10.01.2025)

Africa is generally considered to be one of the most economically backward regions. Agriculture is the mainstay of GDP in many of its countries. However, within Africa itself, there is a great deal of variation between regions. One of the main areas of agriculture is farming and crop cultivation. Researchers in recent years have been actively exploring Africa's potential opportunities related to land and its resources. Such opportunities could be a major factor in the development of the region's economy. But at the same time, there are a number of land-related issues that act as key drivers of conflict in many African countries. This article examines the impact of land issues and disputes related to land use. The author focuses on dispute resolution mechanisms to enhance economic development through land use. Equally, ensuring equitable and efficient utilisation of land for the economic growth of the region will provide solutions to many problems. Land issues are of particular concern today when factors such as population growth, climate change, food systems and increasing demand for energy and feed are fuelling intense competition for land and increasing pressure on land resources.

**45. Saenko, A. N. Expanding the economic potential of AFRICA through the development of agriculture / A. N. Saenko // Moscow Economic Journal. - 2023. - T. 8, № 8. - URL: <https://elibrary.ru/item.asp?id=54485604> - (date of access : 21.01.2025)**

The article discusses the issues of improving the economic potential of Africa through the development of agriculture. The factors of the need to strengthen sustainable food systems and agriculture in Africa have been studied, which will contribute to the development of the economy and improve the economic performance of the country.

Agricultural support programmes implemented in African states over the last ten years (African Emergency Food Facility, Technologies for Agricultural Transformation in Africa (TAAT), Smallholder Agricultural Productivity and Commercialisation Project (SAPEC), etc.) are reviewed. Preliminary results of the agricultural programmes reviewed are presented, demonstrating improvements in Africa's economic and social performance. Through the implementation of international and state projects, improvements in living conditions, including increased availability of agricultural and livestock products in African states are noted. Positive changes in the country's landscape are explored, influencing improvements in climatic conditions and the efficiency of agricultural technology adoption. Prospects are presented for further unlocking Africa's economic potential through agricultural development both domestically and in foreign economic interaction with international partners in terms of exporting and importing agricultural commodities.

**46. Sayenko, A. N. THE CURRENT STATE OF AGRICULTURE IN AFRICA / A. N. Sayenko // Innovation and investment. - 2024. - No. 7. - pp. 68-71. - URL: <https://www.elibrary.ru/item.asp?id=68616163> - (date of request : 10.01.2025)**

The article examines the state of agriculture in Africa as one of the most important strategic directions for the development of the continent's economy. The focus is on the introduction of new climate yield control systems for smallholder farmers in Africa. The development of agriculture is considered from the point of view of ensuring the sustainable development of the economy. The importance of agriculture in the current year 2024 is emphasized in terms of its central and strategic role in the development of Africa. This is the new key to economic growth, improving living standards, reducing poverty, and strengthening food security and nutrition.

The analysis is based on data on the total volume of investments in this area. These indicators have not reached the required level necessary for solving strategically important tasks. The author concludes that significant investments of both public and private financial resources are needed at all stages of value creation in agriculture, including both small and large agricultural enterprises, in order to ensure that agriculture can realize its full potential and ensure growth that will lead to fundamental changes and prosperity of countries in Africa.

**47. Sviridov, V. Y. RUSSIAN FERTILIZERS AS AN ELEMENT OF STRENGTHENING THE FOOD SOVEREIGNTY OF AFRICA / V. Y. Sviridov, T. A. Andreeva // Scientific Notes of the Institute of Africa of the Russian Academy of Sciences. - 2024. - № 2 (67). - Pp. 170-185. - URL: <https://www.elibrary.ru/item.asp?id=68022274> - (date of request : 10.01.2025)**

Over the past few years, against the background of the pandemic and other crisis phenomena in world markets, the issue of ensuring the food sovereignty of African countries has regained key importance for international relations.

However, it is not only important for food sovereignty to ensure uninterrupted supplies of food products, but also to gradually localise their production in Africa, which requires an increase in fertiliser consumption, making the transition from the concept of 'food security' to 'food sovereignty' urgent. In general, it can be argued that the problem of Africa's food sovereignty is not related to land scarcity, but primarily to Africa's position in global production chains in world food markets and its dependence on imports of finished products. The key role in maintaining dependence on imports is played by influential lobbying and financial-industrial groups, intermediaries linked to transnational corporations, traders and a number of international actors. Structural imbalances in economic development have prevented most African countries from producing fertilisers domestically, which has led to an increase in fertiliser imports. In recent years, Russian exporters have managed to significantly strengthen their presence in African food and agricultural markets, increasing their share of fertiliser shipments to 20%. This article analyses the main trends on the way to achieving food sovereignty in Africa, primarily in the context of the dynamics of fertiliser consumption and application, and for the first time in the scientific literature provides an analysis of the strategy of major Russian exporters in the fertiliser markets of African countries.

**48. Sedova, Yu. G. AGRICULTURAL EXPORTS FROM RUSSIA TO AFRICA INCREASED BY A QUARTER IN 2023 / Yu.G. Sedova Agricultural Science. - 2024. - No. 7. - p. 18. - URL: <https://www.elibrary.ru/item.asp?id=69144289> - (date of request : 10.01.2025)**

During the panel discussion "Russia - Africa" of the XXVII St. Petersburg International Economic Forum (SPIEF-2024), held on 06.06.2024, a wide range of issues of Russian-African cooperation were discussed, in particular, the expansion of areas of cooperation in the agro-industrial complex and ensuring food security of the countries of the African continent.

**49. MODERN TRENDS IN THE PRODUCTION OF THE MAIN CATEGORIES OF FOOD IN CENTRAL AFRICAN COUNTRIES / A.M. Hassan, D. M. Madiyarova, G. F. Tiago, V. A. Tikhomirova // Financial Economics. – 2024 - No. 1. - Pp. 87-92. - URL : <https://elibrary.ru/item.asp?id=60034280> - (date of request : 12/23/2024)**

The research paper examines current trends in the production of major food categories in Central African countries. The paper discusses the challenges of agriculture, including climate change, lack of infrastructure and limited access to capital. Health and food safety challenges, including lack of quality control and product safety, are also discussed. It analyses the major problems in food production and transport resulting from climate change, the distortion of the ecological system as a whole and its individual components, and the lack of productive level control of food quality, which reduces food safety. In addition, the article highlights the theories of modern economists dealing with the issues of environmental destabilisation and environmental security, the risks associated with these processes in the sphere of food supply in African states. As a result of the analysis, conclusions were formulated about the need to increase the quality of production and control activities in the sphere of food supply of the population of the Central African countries to ensure food security of the population of the region in the future. The main problems in food production and transportation are analysed, which are the result of climatic changes, deformation of the ecological system as a whole and its individual components, as well as the lack of productive level control over the quality of food products, which reduces their safety. In addition, the article highlights the theories of modern economists dealing with the issues of environmental destabilisation and environmental security, and the risks associated with these processes in the sphere of food supply in African states.

Based on the results of the analysis, conclusions were drawn about the need to increase the quality of production and control activities in the field of food supply to the population of Central African countries in order to ensure the food security of the region's population in the future.

**50. Spirienkov, V. D. THE CRISIS IN THE FERTILIZER MARKET AND ITS IMPACT ON FOOD SECURITY IN SUB-SAHARAN AFRICA / V. D. Spirienkov // Society: Politics, Economics, Law. - 2024. - № 5 (130). - Pp. 84-93. - URL: <https://www.elibrary.ru/item.asp?id=67219283> - (date of request : 10.01.2025)**

This article examines the assessment of the role of the crisis in the fertilizer market in 2022-2023 in the deterioration of food security in sub-Saharan Africa. It has been concluded that the increase in the number of undernourished people to 262 million (23% of the population) in 2022 in sub-Saharan Africa is largely determined by the inability to increase agricultural production within the country. In turn, it was the events in the fertilizer market that led to a reduction in the available supply and an increase in prices on the world market that prevented African farmers from increasing fertilizer application to increase yields. The article also analyzes the factors that prevented African countries from adapting to the crisis in the fertilizer market, following the example of developed countries.

**51. Handelsman, J. HOW THE EARTH CAN HELP SAVE THE EARTH / J. Handelsman // In the world of science. – 2021. – No. 8/9. – pp. 154-158. The methods of agriculture that contribute to the conservation of carbon in the soil, which can limit the intensity of erosion and climate change, are considered.**

**52. Chapichev, M. D. THE MAIN DIRECTIONS OF AGRICULTURAL DEVELOPMENT IN AFRICA / M. D. Chapichev // Today and tomorrow of the Russian economy. - 2024. - № 1 (119). - Pp. 235-243. - URL: <https://www.elibrary.ru/item.asp?id=67326434> - (date of request : 10.01.2025)**

The article provides an analysis of the level and state of agricultural development in Africa at the present stage. Based on the analysis of a number of indicators characterizing the current state of agriculture in Africa and its resources, the author comes to the conclusion that the countries of the continent still have untapped opportunities, and, consequently, limitations. The possibilities of developing the agricultural sector on the continent in terms of ecology, climate sustainability and the so-called "circular economy" are being explored.

According to the author, these areas can have a decisive positive integrated impact on the development of agriculture, as well as increase the interest of foreign partners in the African agricultural sphere. The author concludes that solving the remaining challenges will allow African countries not only to strengthen food security, but also to increase foreign trade in agricultural products, including with the Russian Federation. This, in turn, will allow African countries to increase food production, ensure infrastructure development, increase the availability of finance, boost the development of sales markets, provide support to small farmers, introduce modern technologies and more successfully prevent climate change.

**53. Chikh, I. N. FOOD SECURITY IN THE MIDDLE EAST AND NORTH AFRICA / I. N. Chikh // Vostochny Courier. - 2024. - No. 1. - PP. 134-141. - URL: <https://www.elibrary.ru/item.asp?id=68518788> - (date of request : 10.01.2025)**

Food security is one of the most important components of the welfare of the State, its independence and national security. Not all countries are able to fully meet the need for food on their own. The countries of the Middle East and North Africa, due to their geographical location and climatic conditions, are most susceptible to food security problems, including the problem of providing water resources. Therefore, this region is particularly experiencing food crises and sharp spikes in food prices. In turn, this entails internal political and regional conflicts. This paper provides an overview of the problems of ensuring food security in the Middle East and North Africa, compares the degree of threats to various countries in the region, and analyzes their approaches to solving this problem.

**54. Shabanov V. V. THE GLOBAL FOOD PROBLEM AND WAYS TO SOLVE IT FOR THE COUNTRIES OF CENTRAL AFRICA ON THE EXAMPLE OF THE REPUBLIC OF BURUNDI / V.V. Shabanov, N. Niyonzima / VINITI Deposited manuscript No. 310-B2012 07/16/2012. - Text : direct**

**55. Shkvarya, L. V. DIGITALIZATION IN AFRICAN COUNTRIES AND THE ROLE OF INTERNATIONAL COOPERATION / L. V. Shkvarya // Scientific Review. Series 1: Economics and Law. - 2024. - No. 1. - pp. 103-113. - URL: <https://www.elibrary.ru/item.asp?id=67350529> (date of request : 10.01.2025)**

The situation on the African continent today is paradoxical: on the one hand, it is one of the most resource-rich continents, including the "labor" factor, and on the other, the continent's countries remain the poorest and least developed in socio-economic terms, with many production, infrastructure, transport, financial, food and other problems.

The article substantiates the necessity and possibility of digitalization development in Africa and the fundamental role of international cooperation in this process. Digitalization will provide solutions, in whole or in part, to Africa's problems such as economic growth, agriculture and food security, access to basic services, efficient public services, enhanced connectivity, job creation, enhanced entrepreneurship, improved access to financial services, etc.

The article identifies the features of the digitalization process in African countries - the penetration of mobile communications, the growth of e-commerce, the development of digital financial technologies, mobile payment services, investments in technology startups, the impact on agriculture, access to education, job creation, government digital initiatives, cross-border trade. It is shown that in Africa, in all its regions, although to varying degrees, efforts to introduce digital solutions have intensified, mainly based on cooperation with China, India and other countries with a higher level of digital development.

**56. Shlenskaya, S. M. NATIONAL STRATEGIES OF AGRARIAN DEVELOPMENT: BURUNDI, MADAGASCAR, RWANDA, TANZANIA / S. M. Shlenskaya // Agriculture in sub-Saharan Africa: achievements, challenges, prospects. - Moscow, 2019. - pp. 69-83. - URL: <https://www.elibrary.ru/item.asp?id=43151334> - (date of request : 10.01.2025)**

The article describes the main provisions contained in the documents defining the strategic direction of agricultural development in four East African countries.

## **PROBLEMS OF USING AFRICA'S WATER RESOURCES**

57. Barinov, A. K. ACCESS TO CLEAN WATER IN AFRICAN COUNTRIES / A.K. Barinov, G.K. Sugakov // Bulletin of the Russian Academy of Sciences. 2024. - Vol. 94, No. 6. - Pp. 550-559. - URL: <https://elibrary.ru/item.asp?id=69153370> - (date of request : 09.01.2025)

The active socio-economic development of Africa makes the problem of access to clean water in the countries of the continent extremely urgent. The need to improve the relevant infrastructure is recognised not only by national governments in the macro-region, but is also becoming an important task for international development institutions, including African ones. In particular, the African Development Bank Group has prepared the 'Water Resources Utilisation Strategy for 2021-2025', which is the first of its kind in the world. The article collects, systematises and analyses quantitative indicators that reflect the access of the population and economic actors to clean water, as well as the financing of this area and its place in global strategies (Sustainable Development Goals 2015-2030, Millennium Development Goals 2000-2015) and African ones (Agenda 2063). The authors conclude that modern African approaches to expanding access to clean water and new infrastructure projects imply efficient systematic use of water resources not only within the national borders of the continent's countries, but also at sub-regional and macro-regional scales. From the point of view of the Russian-African partnership, in addition to investments in infrastructure, technology transfer can play a special role. Priority African markets for the introduction of Russian technologies in the field of water treatment and purification include countries where the problem of water supply is particularly acute and which are oriented towards co-operation with Russia. These include Burkina Faso, Niger, Egypt, Sudan, Algeria, and Zimbabwe.

**58. Berezhnov, A.I. MODERN PERCEPTION OF THE PROBLEM OF WATER SCARCITY IN AFRICAN COUNTRIES A.I. Berezhnov // Asia and Africa today. - 2024. - No. 11. - pp. 40-48. - URL: <https://www.elibrary.ru/item.asp?id=74024989> - (date of request : 10.01.2025)**

The article analyzes how water scarcity on the African continent is perceived in the United Nations, Russia and the African countries themselves. Water is linked to important items on the UN Sustainable Development Agenda. 2018-2028 has been declared the international 10th anniversary of action "Water for Sustainable Development". The author examines the UN's vision of the water problem on the basis of two indicators that often appear in the reports of this international organization and its subordinate structures, namely: access to water supply services and the level of water stress.

These parameters are compared with data from public opinion polls conducted by the Afrobarometer African Research Center and Google Trends search query statistics. In order to identify the views of the Russian public about the water problem in Africa, works of literature, as well as publications of the TASS news agency, were analyzed.

**59. Berthe, F. THE PROBLEM OF WATER SUPPLY TO THE POPULATION IN THE MODERN WORLD IN THE COUNTRIES OF THE GULF OF GUINEA / F. Berthe // Innovations and investments. — 2019. — No. 2. — URL: <https://cyberleninka.ru/article/n/problema-vodosnabzheniya-naseleniya-v-sovremennom-mire-v-stranah-gvineysk-zaliva> - (accessed : 09.01.2025)**

**60. Vasiliev, A.M. THE WATER OF THE NILE. present. the past. THE FUTURE / A.M. Vasiliev, E. A. Yelkina // Asia and Africa today. - 2024. - No. 11. - pp. 31-39. — URL: <https://elibrary.ru/item.asp?id=74024988> - (date of request : 10.01.2025)**

Hydropolitics has become an important part of international relations in both North Africa and sub-Saharan Africa. This article analyses the crisis caused by Ethiopia's construction of the Renaissance Dam on the Blue Nile. Approximately 3/4 of the water comes from the Ethiopian highlands and the country considers it its sovereign right to build the Grand Ethiopian Renaissance Dam. The aim is to increase electricity production in a very poor country to develop the economy and solve social problems. Egypt is 97 per cent dependent on getting its quota of water from the Nile. Its agriculture is based on irrigated farming, and the hydroelectric power plant of the high-rise Aswan Dam contributes significantly to the country's economy. The construction and filling of the Ethiopian Dam has led to a high degree of tension between Cairo and Addis Ababa. In 2024, the conflict shifted to the Horn of Africa as well. Egypt, along with Eritrea, began supporting the internationally recognised Somali government, while Ethiopia established cooperation with Somaliland, a breakaway part of Somalia. So far, the confrontation has not escalated to the use of military force.

**61. Volkov, S. N. WATER DEFICIT AND SECURITY PROBLEMS IN AFRICA // African conflicts and crises: causes and solutions : a collective monograph ; Centre for the Study of Russian-African Relations and Foreign Policy of African Countries, IAFR RAS. - Moscow, 2019. - C. 24-30. - URL: <https://www.elibrary.ru/item.asp?id=44732890> - (date of request : 09.01.2025)**

**62. Grishina, N. V. WATER RESOURCES OF AFRICA SOUTHERN SAKHARA: POSSIBILITIES AND PROBLEMS OF USE / N. V. Grishina - Moscow, 2022. - 228 c. — URL: <https://www.elibrary.ru/item.asp?id=48230102> - (date of request : 09.01.2025)**

The monograph is devoted to a number of problems related to the state of water resources and various areas of water use in sub-Saharan Africa. Attention is focused on the role of the water element in traditional culture, the influence of natural, climatic and anthropogenic factors on the quality and availability of water in cities and rural areas, the possibilities of mitigating water scarcity, and the formation of sanitary and hygienic living conditions for the population. A special place is given to the activities of international and intra-continental organizations for the joint use of transboundary rivers and lakes, as well as national and international action programmes for the rational use of water resources in sub-Saharan Africa. The monograph may be of interest to specialists dealing with this topic, as well as to undergraduates and postgraduates studying the problems of African countries.

**63. Grishina, N. V. ECOSYSTEMS OF LARGE RIVERS IN WEST AFRICA: PROBLEMS OF RATIONAL USE FOR SOCIO-ECONOMIC DEVELOPMENT / N. V. Grishina, L. N. Kalinichenko // Asia and Africa today. - 2024.- No. 10. - pp. 49-57. — URL: <https://elibrary.ru/item.asp?id=72707614> - (date of request : 09.01.2025)**

The article deals with topical issues of water use in large rivers of West Africa: Gambia, Senegal and Niger. It is emphasised that the ecological balance of these rivers is seriously damaged by rapid population growth and active economic development of coastal territories, construction of hydraulic engineering facilities, and often excessive exploitation of fossil resources, which inevitably leads to pollution of river waters, harms the populations of their inhabitants and, as a result, poses a threat to food security and human health. In order to achieve sustainable economic development, the issues of effective water resources management taking into account climate change, application of modern technologies of water use and water purification are among the priorities. The activity of transboundary organisations on joint use of river basins is analysed. The authors conclude that the conservation of water resources requires an integrated approach to assessing their condition and rational use for economic development and improving the living standards of the population.

**64. Kozintsev, A. S. WATER SECURITY IN THE MIDDLE EAST AND NORTH AFRICA: NEW FACETS OF AN OLD PROBLEM / A.S. Kozintsev // ESPR. — 2021. — №1 (45). — URL:**

<https://cyberleninka.ru/article/n/vodnaya-bezopasnost-na-blizhnem-vostoke-i-v-severnoy-afrike-novye-grani-staroy-problemy> - (date of request: 21.01.2025).

The article discusses the problem of water supply in the Middle East and North Africa. The analysis focuses on the specifics of the allocation of water resources and the causes of their scarcity, as well as the main structural factors of water security. It was noted that the interaction of the Middle Eastern states in the field of water resources management is characterized by high conflict and is not accompanied by the adoption and implementation of constructive programs. The main types of water conflicts are highlighted and the features of their occurrence are noted. A number of examples (Egypt and Syria) show how inefficient management of water resources leads to socio-political destabilization.

**65. Konstantinova O. V. On THE PROBLEM OF ACCESS TO CLEAN WATER IN AFRICA / O.V. Konstantinova // Asia and Africa today. 2024. - No. 12. - pp. 65-72. — URL: <https://elibrary.ru/item.asp?id=75134697> - (date of request : 09.01.2025)**

The world's environmental situation is currently deteriorating due to population growth, urbanisation, agricultural and industrial wastewater pollution. This is particularly noticeable in water-stressed regions, one of which is Africa. The paper identified the necessary and sufficient levels of access to clean water in Africa and predicted how these would change given the changing demographic, socio-economic and politico-military situation. The growing African population increases the demand for water for thirst and domestic needs, requires more food, leading to increased water withdrawals for agriculture and food production. In addition, military and political tensions on the continent are causing large numbers of Africans to move across borders, increasing the pressure on host countries, increasing water scarcity, weakening sanitation, and leading to an increase in diseases caused by poor quality water. In order to solve the problem of water deficit in Africa, it is necessary to adopt comprehensive programmes for water sector development and increase its investment, raise public awareness and train specialists in the field of water use.

**66. Kouassi, K. M., Bukharitsin, P. I. WATER MANAGEMENT PROBLEMS OF CENTRAL AFRICA IN CONDITIONS OF UNCERTAINTY OF CLIMATE CHANGE AND ANTHROPOGENIC IMPACTS / K. M. Kouassi, P. I. Bukharitsin // Bulletin of the Astrakhan State Technical University. - 2012. - № 1 (53). - Pp. 37-40. — URL: <https://elibrary.ru/item.asp?id=17712696> (date of request : 09.01.2025)**

**67. Mensah, K. M. COMPETENCE OF THE ECONOMIC COMMUNITY OF WEST AFRICAN COUNTRIES (ECOWAS) IN THE FIELD OF AGRICULTURE AND THE USE OF NATURAL RESOURCES / K. M. Mensah // Gaps in Russian legislation. - 2014. - No. 2. - pp. 314-316. <https://elibrary.ru/item.asp?id=21618036> (date of request : 09.01.2025)**

The article talks about ECOWAS, the Economic Community of West African States and its role in regulating agriculture and the utilisation of natural resources. ECOWAS is the largest and most comprehensive of the regional organisations in West Africa. In the face of climate change, West Africa, like the rest of the continent, has been regularly shaken by recurrent food crises. These crises are the result of multiple factors, both natural and human in origin. This article discusses the competences of ECOWAS in the area of agriculture and the utilisation of natural resources, including water resources.

**68. Orlov, E. V. PROBLEMS OF WATER RESOURCES OF THE REPUBLIC OF CHAD / E. V. Orlov // Journal of Natural Science Research. - 2024. - Vol. 9, No. 1. - pp. 39-42. — URL: <https://elibrary.ru/item.asp?id=61325340> (date of request : 09.01.2025)**

The article deals with the main problems of water resources of the State of Chad, located in the central part of Africa. In the north of the country there are no permanent watercourses, but only temporary ones. In the southern part there is Lake Chad, into which the rivers Shari and Logon flow. Due to the lack of modern drainage systems, the water bodies are polluted by sewage. In addition, Lake Chad is becoming very shallow. Oil production also pollutes water resources. In order to promptly solve the problems, it is necessary to allocate funds for the construction of modern water supply and drainage systems, to increase the water availability of the country's water bodies by transferring runoff from the Congo River, and to use the experience of qualified foreign specialists in the field of environmental protection and integrated use of water resources.

**69. WATER RESOURCE PLANNING AND MODELING TOOL FOR ASSESSING LAND-USE CHANGES IN THE LUWUVHU WATERSHED, SOUTH AFRICA** // RJ 19I. General issues of chemical technology. - 2006. - No. 21. — URL: <https://elibrary.ru/item.asp?id=9805615> - (date of request : 09.01.2025)

**70. Popova, K. Y. FORMATION AND PROBLEMS OF WATER RESOURCES USE IN EGYPT** / K. Y. Popova // Economics of agricultural and processing enterprises. - 2021. - No. 8. - pp. 57-59. — URL: <https://elibrary.ru/item.asp?id=46526537> - (date of request : 10.01.2025)

The article discusses the formation and use of Egypt's water resources as the most important producer of agricultural products not only in the Middle East, but throughout Africa. The intensification of agricultural production in an arid climate requires an increasing volume of water consumption, which implies, on the one hand, an increase in the water area of artificial origin, and on the other hand, the introduction of measures to conserve water and search for its sources, primarily through desalination.

**71. Pospelov, V. K. PROBLEMS OF ENSURING THE WATER NEEDS OF AGRICULTURE IN EGYPT** / V. K. Pospelov // Kazan Science. - 2013. - No. 12. - pp. 128-130. — URL: <https://elibrary.ru/item.asp?id=21153311> (date of request : 09.01.2025)

The paper outlines some issues of providing water resources for agriculture in Egypt in the changed geopolitical conditions in the countries of Northeast Africa. As an example, the situation with the provision of Egypt with the most important types of agricultural products - wheat and rice.

**72. Sabunchi, Al A.A. Problems of water supply in developing countries of Asia and Africa** / A. A. Al Sabunchi // ZNiSO. - 2011. - №7. - URL: <https://cyberleninka.ru/article/n/problemy-vodosnabzheniya-razvivayuschih-sya-stran-azii-i-afriki> - (accessed : 01/10/2025)

The rational use of natural resources is the number one task for the whole world, while water resources are practically indispensable in many areas of the modern economy and industry. At the same time, it should be noted that many African countries are characterized by an uneven distribution of water resources. We have the following situation: a large shortage of water resources in areas where powerful water users are concentrated, namely in the south and east, and sufficient water levels in the north and west of the African continent

**73. Savateev, A. A. WATER RESOURCES ARE A CRUCIAL FACTOR IN THE DEVELOPMENT OF AGRICULTURE IN TROPICAL AFRICA / A.A. Savateev // Economics and entrepreneurship. -2014. - № 2 (43). - Pp. 75-81. — URL: <https://elibrary.ru/item.asp?id=21157942> - (date of request : 09.01.2025)**

The demand for water in the world has generally tripled since the 1950s, but freshwater reserves have not grown, on the contrary, they have been declining. In this article, the author analyzes the relationship of irrigation agriculture and the climatic conditions of Sub-Saharan Africa with the food security of the region. The article concludes that the eight sub-Saharan African countries have significant differences in food security. Taking into account the arid climate, high temperatures, and the lack of modern agricultural machinery and skilled labor, the author concludes that the solution to the food problem is possible if a modern and well-connected irrigation network is created and only with the support and interest of the governments of the countries under consideration.

**74. Savateev, A. A. IRRIGATED AGRICULTURE IS THE PRIMARY CONDITION FOR THE DEVELOPMENT OF AGRICULTURE IN TROPICAL AFRICA // Mining Information and Analytical Bulletin (scientific and technical journal). Separate article (special issue). - 2013. - No. 11. - 9 p. - Text : direct**

The reasons for the low economic efficiency of agriculture in sub-Saharan Africa are analyzed. It is shown that in the current conditions, the simplest and most effective way out of this situation should be the introduction of irrigated agriculture, preferably in the form of small-scale projects corresponding to limited farm areas.

**75. Sokova, Z. N. WATER SUPPLY IN AFRICA IN THE CONTEXT OF THE PRINCIPLES OF SUSTAINABLE DEVELOPMENT / Z. N. Sokova // Water conservation, land reclamation and hydraulic structures as the basis for the formation of agricultural clusters in Russia in the 21st century : collection of reports of the XVIII International Scientific and Practical Conference. – Tyumen. - 2016. pp. 161-166. — URL: <https://www.elibrary.ru/item.asp?id=26325116> - (date of request : 10.01.2025)**

The decline in water availability is part of the socio-ecological crisis on the African continent. The problem of water scarcity is most acute in various regions of North Africa and the Sahel. The search for solutions to the challenges of water supply and sanitation is included in national and international strategies and is considered in the context of creating a healthy environment and ensuring sustainable development.

**76. Torsida, S.F.M. INTERNATIONAL COOPERATION IN THE FIGHT AGAINST HUNGER AND SHORTAGE OF DRINKING WATER IN AFRICA / S.F.M. Torsida // Proceedings of the XXII All-Russian School of Young Africanists. - 2023. - pp. 101-106. — URL: <https://www.elibrary.ru/item.asp?id=60012176> - (date of request : 10.01.2025)**

**77. Chol Deng Alak AFRICA AND WATER / Deng Alak Chol // Asia and Africa today. - 2008. № 2 (607). - Pp. 62-64. - URL: <https://www.elibrary.ru/item.asp?id=12844540> - (date of request : 10.01.2025)**

**78. Chumanova, A. REALIZATION OF THE RIGHT TO WATER IN AFRICA A. Chumanova // Proceedings of the conference "School of the young Africanist". - 2013. - No. 4. - P. 110. — URL: <https://www.elibrary.ru/item.asp?id=20918514> - (date of request : 10.01.2025)**

**79. Shabanov, V. V. MONITORING OF WATER BODIES IN MODERN CONDITIONS: A MONOGRAPH / V. V. Shabanov, V. N. Markin; Russian State Agrarian University - Moscow Agricultural Academy named after K. A. Timiryazev (Moscow). — The electron. text data. Moscow: RGAU-Moscow Agricultural Academy named after K. A. Timiryazev, 2016. 151 p. — Collection: Monographs. — Access mode : <http://elib.timacad.ru/dl/full/4078.pdf> . - Title page. the screen. — <URL:<http://elib.timacad.ru/dl/full/4078.pdf>>. (date of request : 10.01.2025)**

**80. Shabanov, V. V. THE WATER REGIME OF THE SOILS OF THE RUSIZI RIVER BASIN AND THE PRODUCTIVITY OF AGRICULTURAL CROPS (REPUBLIC OF BURUNDI). / V. V. Shabanov, N. Niyonzima // Environmental management. - 2013. - No. 4. - pp. 15-20.**

The paper considers the issues of forming a monitoring system for water bodies. Three levels of observations are proposed: survey, based on the use of aerospace remote sensing systems; reconnaissance, using the capabilities of unmanned aerial vehicles (UAVs); ground-based, instrumental. The parameters obtained at all levels of monitoring can be entered into modeling systems and make it possible to predict the behavior of a water body depending on changes in natural and anthropogenic impacts.

**81. Shabanov, V. V. MONITORING THE CONDITION OF THE SHORES AND THE REGIME OF USE OF WATER PROTECTION ZONES / V. V. Shabanov, V. N. Markin. — pp.6-11. — Electron. text data. // Environmental management. — 2014. — Issue 4. — Collection: Journal "Environmental Management". — URL : <http://elib.timacad.ru/dl/full/gmgup-01-2014-04.pdf> . - Title page. the screen. - (date of request: 04/13/2023)**

The issues of improving state monitoring of water bodies through the use of integrated methods, including aerospace systems for remote sensing of the Earth, unmanned aerial vehicles, ground-based facilities combined with scientific and analytical support (computational monitoring), are considered. The parameters obtained at all levels of monitoring are used in modeling systems to predict the state of a water body depending on changes in natural and anthropogenic impacts.

**82. Shabanov, V. V. THE POTENTIAL FOR THE DEVELOPMENT OF COOPERATION BETWEEN RUSSIA AND AFRICAN COUNTRIES IN THE FIELD OF WATER RESOURCES MANAGEMENT / V. V. Shabanov // Economic sciences. - 2024. - No. 238. - pp. 378-383. <https://elibrary.ru/item.asp?id=75196169> - (date of request : 09.01.2025)**

The article discusses the problems and challenges in the field of water resources management that African countries face in connection with socio-demographic changes on the continent. The article also analyzes the efforts and intentions of the Russian Federation in supporting African countries in the field of water resources management. The author touches upon the countries' cooperation in the field of water desalination and exploration technologies, technology and knowledge exchange, as well as the potential for cooperation in resolving international conflicts related to water resources. Russia is demonstrating its willingness to partner with African countries on equal terms, which highlights the potential for developing cooperation.

**83. Shelabina, E. V. THE PROBLEM OF WATER SCARCITY IN AFRICA / E.V. Shelabina, A.A. Generozova // Days of Student Science : a collection of reports of a scientific and technical conference based on the results of research work by students of the Institute of Hydraulic Engineering and Energy Construction of the National Research University MGSU. -Moscow, 2020. - pp. 351-360. — URL : <https://elibrary.ru/item.asp?id=43104352> - (date of request : 09.01.2025)**

With significant water reserves, African countries are experiencing increasing water scarcity due to rapidly growing cities and large settlements.

Inefficient use of resources, chronically overloaded water supply systems, difficulties with long-term investments and the lack of an integrated action plan based on long-term, systematic scientific research only exacerbate the problem. The treatment of water bodies and water supply systems is often hampered by the transboundary factor, as most water bodies are located simultaneously on the territory of several states, which makes this problem also inter-State. The lack of coordinated interventions to address these issues, as well as poorly developed legislative frameworks for water use and environmental protection measures, are a feature of the water scarcity problem in Africa. However, only addressing all the problems caused by water scarcity, such as ensuring water supply for the population and improving the water quality of water bodies in general, can improve the health of the population as well as ensure sustainable economic development of the region and its economic stability.

**84. Edelstein, K. K. HYDROLOGY OF MATERIALS : textbook / K. K. Edelstein.** - Moscow, 2024. - 297 c. [https://elibrary.ru/query\\_results.asp](https://elibrary.ru/query_results.asp) - (date of request : 09.01.2025)

The textbook provides up-to-date information on the global hydrological cycle, water balance, and land-based water resources. The processes of formation and transformation of continental water masses and geographical factors determining the specifics of external and intra-continental water and salt exchange are presented. The structure of the external and internal water exchange in Europe, Asia, Africa, North and South America, Australia and Antarctica, the distribution on their territories of the average annual values of the components of the water balance and types of intra-annual fluctuations in precipitation, evaporation and river runoff, water resources and water composition in the largest water bodies, the specifics of their use in the water management of the countries are considered..

**85. Shorina, T. S. SOIL RECLAMATION : a textbook / T. S. Shorina;** Orenburg State University. Orenburg : OSU, 2012. 190 p. – Text : direct

The textbook discusses the main types of soil reclamation, the structure of drainage and irrigation systems, types and chemistry of soil salinization and methods of their reclamation, and issues of agroforestry. The textbook is intended for classroom and independent work of students in the course "Soil reclamation" of the basic part of the professional cycle. It is intended for full-time students in the field of 021900.62 Soil Science

# THE PARTICIPATION OF THE WORLD COMMUNITY IN THE DEVELOPMENT OF AGRICULTURE IN AFRICA

**86. Deutsch, T.L. BRICS REGIONAL POLICY IN AFRICA / T.L. Deutsch //** Bulletin of International Organizations: Education, Science, New Economy. - 2015. - Vol. 10. - No. 2. - pp. 206-228. — URL : <https://www.elibrary.ru/item.asp?id=23917320> - (date of request : 10.01.2025)

The article analyses the problems of relations between the new international actor BRICS and African countries. The author set out to identify the political and economic interests in Africa of both BRICS as a whole and each member country, to examine various aspects of BRICS co-operation with Africa and to assess their impact on African economies and African development. The BRICS' attention to Africa stems from the importance of Africa's resource potential, the success of African economies, and Africa's growing political weight in international relations. The BRICS expects to demonstrate the benefits of South-South co-operation by using Africa as an example. The BRICS African Agenda envisages assistance to the countries of the continent in addressing such issues as sustainable development, energy and food security, mutually beneficial trade, infrastructure development, agriculture, technology and innovation, health, education, responses to crises and conflicts. All these issues are vital to Africa. Africa's trade with the BRICS is growing faster than its trade with traditional partners and than the BRICS countries' trade with each other. The BRICS countries are significant donors and investors to the continent. Their focus is on African infrastructure. Soft power plays an important role in the BRICS policy arsenal: the BRICS are actively involved in the health and education sectors of African countries, transferring technology, innovation and expertise to them. China is a leader in financial assistance and investment. India prioritises new technologies and services. Brazil is also increasing its co-operation with Africa, using in its policies the links that exist between Portuguese-speaking countries. Its special focus is agriculture. Russia is behind other BRICS members in terms of co-operation with Africa, but this has been changing in recent years. Russia participates in international aid programmes in Africa and Russian companies operate on the continent. A new BRICS member, South Africa, is positioning itself as Africa's regional leader, a 'gateway' to the continent. Its advantages are rich resources, a strong financial and banking sector, and practical experience in regional economic integration.

The BRICS countries are united by their interest in creating a just and democratic world order; they make a notable contribution to addressing African security challenges. All BRICS countries participate in UN peacekeeping missions on the continent. Attention to Africa's needs, growing economic assistance unencumbered by political conditionalities, trade and investment boom, and protection of Africa's interests in international organisations have made the BRICS an attractive alternative to the West for Africans. Although the BRICS countries have so far acted as competitors in Africa, they are keen to establish co-operation and their growing contribution to the development of the African economy has been well received on the continent.

**87. Kasatkina, A. A. FOREIGN CAPITAL AND PROBLEMS OF USING AGRICULTURAL LABOR RESOURCES IN WEST AFRICAN COUNTRIES / A.A. Kasatkina // Trends and Management. - 2013. - No. 4. - pp. 73-82. - URL : <https://www.elibrary.ru/item.asp?id=21169261> - (date of request : 09.01.2025)**

Taking into account the nature of production relations in agriculture in West African countries, which is expressed in the fact that foreign and national private capital, as well as the public sector, function mainly in the sphere of sales (purchasing, marketing, supply and credit institutions), the author pays special attention to the analysis of secondary production relations, which, in his opinion, are mainly responsible for the decrease in demand for agricultural labour force. The author believes that the regulation of transnational corporations in modern conditions is carried out by supranational international political institutions, and the influence of sovereign states on socio-economic processes in society is declining. The author argues that the long-term policy of the state in the field of foreign economic relations should become an important component of the national development strategy. The author also argues that today economic exchange is not only inseparable from such issues as the sectoral distribution of productive capacities, the structure of the consumption system and the priority to be given to the production of material goods, but is also closely linked to the irrational use of natural and human resources.

Therefore, the author believes, as long as agriculture in West African countries is at the initial stage of the development of capitalism (the establishment of capitalism in the sphere of circulation), the trade exchange of industrialized countries with African countries will be a determining factor in the existence of unemployment and underemployment of agricultural labor resources.

**88. Kuzmina, V. M. United Nations ASSISTANCE TO AFRICAN COUNTRIES IN THE FORMATION OF CLIMATE-SUSTAINABLE AGRICULTURE / V. M. Kuzmina, M. A. Parkhomchuk // Proceedings of the Southwestern State University. Series: Economics. Sociology. Management. - 2024. - Vol. 14, No. 4. - pp. 18-29. — URL : <https://elibrary.ru/item.asp?id=73163497> - (date of request : 10.01.2025)**

Africa is a mirror and the quintessence of modern international processes. The continent is facing a huge number of problems, some of them quite existential. But at the same time, there is an active search for ways to solve them. The purpose of the work is to examine the experience of developing climate-sustainable agriculture using the example of individual African countries and the role of the United Nations in this process. The article describes the conditions and reasons for the formation of climate-sustainable agriculture in the African region.; to assess the policies of the Governments of Kenya, Tanzania, Ethiopia, and Rwanda on the formation of climate-sustainable agriculture. The comparative research method was used in the study of agricultural development programs in African countries; chronological and historical methods of studying legal documents, programs of the United Nations, FAO, NEPAD, Kenya, Tanzania, Ethiopia, Rwanda, aimed at the formation of climate-sustainable agriculture; statistical research method for using data from the statistical databases Globaleconomy and World Health Organization. The introduction of new technologies in agriculture is a prerequisite for saving the environment, which is under pressure from two sides - global climate change and unprecedented population growth and its needs.

One of the most important areas is to increase agricultural productivity, and the solution to this urgent task will depend on the introduction of new technologies: seeds, fertilizers, irrigation, plant protection, etc. The implementation of climate-sustainable agriculture programs and technologies in African countries requires significant funding and institutional and legal training.

**89. Lapina, E. O. CHINA'S INVESTMENTS IN AFRICAN COUNTRIES / E. O. Lapina // Investments and digital innovations. Collection of materials of the International Forum. - 2019. - pp. 132-139. — URL : <https://www.elibrary.ru/item.asp?id=44861999> - (date of request : 10.01.2025)**

From the middle of the twentieth century to the present, China and Africa have been linked by a complex system of economic relations. China, which is rapidly developing, needs natural resources (oil, gas, aluminum, iron and copper ores), and agricultural products. In addition, Chinese enterprises need new markets for their products. African countries, in turn, need modern technologies and financial resources to develop their industries, as well as to solve serious social problems such as unemployment, hunger, and diseases. China is currently implementing the “Going Out” economic development strategy, which involves financing the economies of other countries, including African countries. The targets of China's foreign direct investment in Africa are countries with high potential for industrial production growth. Thanks to China's investment policy, many social problems in some African countries have been significantly reduced, if not solved.

**90. Makarova, I. V. INTERNATIONAL INTEGRATION: RUSSIA'S TURN TO THE AFRICAN CONTINENT / I. V. Makarova // Scientific Review. Series 1: Economics and Law.- 2024. - No. 4. - pp. 41-47. - URL : <https://www.elibrary.ru/item.asp?id=69205292> - (date of request : 09.01.2025)**

The article is devoted to the theoretical understanding of the forms of integration that are not covered by the classical integration model, but are clearly formed and inherent in the new integration world economic order within the framework of cumulative integration. The problem of Russia's international integration is revealed through the primacy of such characteristic features as moral norms, environmental aspects, knowledge, and imperatives are: the economic sovereignty of countries, the preservation of national interests, and the growth of universal well-being.

The author considers the African continent as one of the priorities of Russia's international integration as having significant potential for economic development and strategic importance for the development of the global economy. There is a bilateral interest between Russia and African countries in developing technological partnerships in various fields, such as mining, energy, agriculture, space, etc.

**91. Morozov, V. P. THE ROLE OF FOREIGN DIRECT INVESTMENT IN THE DEVELOPMENT OF AGRICULTURE IN SUB-SAHARAN AFRICA / V.P. Morozov // International trade and trade policy. - 2015. - № 3 (3). - Pp. 66-75. — URL : <https://www.elibrary.ru/item.asp?id=24222945> - (date of request : 10.01.2025)**

The article presents the dynamics of foreign direct investment in sub-Saharan Africa, as well as their role in this region. In African conditions, attracting investments in agriculture helps to significantly increase the efficiency of using the main factors of production - land and labor. Of particular importance is the attraction of foreign investment in the African agricultural sphere for the development of fixed assets - capital facilities of farms, construction and modernization of rural infrastructure (warehouses, dams, roads, etc.). The article shows that investments in fixed assets and the attraction of local labor are the determining factors for the growth of agricultural productivity.

**92. Serbina, E. M. INTERNATIONAL ASPECTS OF THE ACTIVITIES OF THE EXIMBANK OF CHINA AND THE AGRICULTURAL DEVELOPMENT BANK OF CHINA / E. M. Serbina // Society and Economics. - 2023. - № 11. - Pp. 140-151. — URL : <https://www.elibrary.ru/item.asp?id=57171540> - (date of request : 10.01.2025)**

The article analyzes some aspects of the international activities of China's political banks - the Export-Import Bank of China (Eximbank of China) and the Agricultural Development Bank of China (BRSHK). In light of the decisions of the CPC National Congress emphasizing the importance of expanding "openness to the outside world," promoting "high-quality development of the Belt and Road Initiative," improving the quality of trade cooperation, as well as "prioritizing agricultural development" and continuing the fight against poverty, the role of banks as tools for solving export-import financing issues (The Eximbank of China) and the financing of international agricultural projects (BRSHK) is relevant. Banks closely cooperate with financial organizations and associations of ASEAN member countries due to the significant volume of trade and economic cooperation between China and ASEAN. Eximbank develops financing for the development of deposits and infrastructure facilities on the African continent, which serves as a platform for testing technologies and gaining experience in conducting international projects. BRSHK pays great attention to financing agricultural projects in Africa, where there is a demand for foreign technologies for cultivating land, growing, harvesting and storing products in order to increase the efficiency of the agricultural sector.

For China, participation in projects provides an opportunity to share agricultural experience, test and improve its developments, and contribute to the development of agriculture in its country. The author notes that the theses of the CPC Congress on "expanding openness to the outside world", as well as the priority of "green development", reveal a new development potential for banks in the international arena. The article concludes that in the 14th five-year period, there has been an expansion of cooperation between China's Eximbank and BRSHK with ASEAN member countries and Africa, including financing infrastructure projects, the agricultural sector, and stimulating the development of "green" technologies through the issuance of thematic bonds.

**93. TRENDS AND PROSPECTS OF AGRICULTURAL DEVELOPMENT IN SUB-SAHARAN AFRICA. (FRANCE)** // Economics of agriculture. Abstract journal. - 2004. - No. 3.- p. 713. — URL : <https://www.elibrary.ru/item.asp?id=8377639> (date of request : 10.01.2025)

**94. Khaustova T. V., Soklakov A. A. PROSPECTS OF TRADE COOPERATION BETWEEN THE REGIONS OF RUSSIA AND THE COUNTRIES OF THE AFRICAN CONTINENTAL FREE TRADE ZONE (ON THE EXAMPLE OF THE KURSK REGION)** / T. V. Khaustova, Soklakov A. A. // Izvestiya Yugo-Zapadnogo gosudarstvennogo universiteta. Series: Economics. Sociology. Management. - 2023. - Vol. 13, No. 3. - pp. 39-52. — URL : <https://elibrary.ru/item.asp?id=54334265> (date of request : 10.01.2025)

In modern conditions, in Russia's cooperation with foreign partners, there are trends towards changing traditional global value chains and changing logistics directions. In this regard, Russia needs to address the issue of expanding trade cooperation with new partners and forming more sustainable value chains. The study is based on the statistical collection and analysis of information on the volume, structure and dynamics of foreign trade with the countries of the African Continental Free Trade Area. The analysis of the main indicators characterizing the mutual foreign trade of Russia and its regions with the countries of the African Continental Free Trade Area is carried out. The main trading partners among African countries and the conditions for expanding partnerships with them have been identified. It is concluded that the countries of the African Continental Free Trade Area are the main market for certain types of domestic agricultural products in the extractive and manufacturing industries, while Russian enterprises receive the raw materials they need from African countries. At the same time, the expansion of Russia's trade relations with African countries will be facilitated by the conclusion of agreements on the creation of free trade zones, primarily with Egypt as its main trading partner.

**95. Tsarev, P. G. COOPERATION BETWEEN RUSSIA AND AFRICA IN THE WATER SECTOR / P. G. Tsarev // Scientific Notes of the Institute of Africa of the Russian Academy of Sciences. - 2017. - № 2 (39). - Pp. 66-76. — URL : <https://elibrary.ru/item.asp?id=29862331> - (date of request : 10.01.2025)**

Russia is returning to Africa. The main task facing our country on this path today is to restore and strengthen economic ties with African States. One of the most important areas of cooperation between the Russian Federation and the countries of the "black continent" may be water. Africa is rich in water resources. At the same time, Africa is the second driest continent after Australia. Water resources are extremely unevenly distributed here: 51% in Central Africa, 23% in West Africa, and less than 3% in North Africa. Of the available fresh water, only 64% is treated in any way and can be considered relatively safe. Cooperation with African countries in the water sector can be very promising. Here you can select 2 blocks: 1) water for the needs of the population and 2) water for the development of territories. Water for the needs of the population is a set of measures to increase the quantity and improve the quality of drinking water, reduce water consumption through the use of modern technologies, changes in legislation and the introduction of educational programs. Water for territorial development is the implementation of projects in such areas as energy, transport, fishing, industry, agriculture. All the projects presented can be implemented fairly quickly within the framework of the African Business Initiative (ADI), a new organization that brings together representatives of government, business and the academic community, whose goal is to assist Russian companies in working on the African continent.

**96. Shestova D. A., Ivenin R. E., Gusev D. A. DEVELOPMENT OF A METHODOLOGY FOR CHOOSING THE CONFIGURATION AND TYPE OF SUPPLY CHAIN MANAGEMENT FOR AGRICULTURAL EQUIPMENT FROM THE EUROPEAN UNION TO SOUTH AFRICA AS PART OF THE IMPLEMENTATION OF STRATEGIC PARTNERSHIP AND THE POTENTIAL OF ECONOMICALLY DEVELOPING COUNTRIES // Trends in the development of logistics and supply chain management : a collection of articles by international scientific and practical conferences. - 2017. - pp. 381-387. — URL : <https://elibrary.ru/item.asp?id=28898707> - (date of request : 10.01.2025)**

The growth of the world's population predicted by scientists makes us think about solving the world food problem.

One solution may be to develop Africa's agriculture and realize its potential. However, one of the key problems in this area is the insufficient equipment of African farms with machinery. The purpose of this work is to develop a methodology for selecting the configuration and type of supply chain management for agricultural equipment from the European Union to South Africa. The main result of this work is the creation of an algorithm for selecting the configuration and type of supply chain management for agricultural machinery from the European Union to South Africa. An analysis of the port infrastructure was also carried out in terms of the possibility of processing oversized cargo, a price study was conducted and the algorithm was tested on a real case.

**97. Shuraev, I. A. THE IMPACT OF INVESTMENTS ON THE FINANCIAL STABILITY OF AGRICULTURE** / I. A. Shuraev // Development of the theory of financial stability : collection of articles of the 1st International Scientific and Practical Conference. - Novosibirsk, 2021. - pp. 190-193.- Text : direct

The sanctions imposed by a number of Western countries led to a sharp reduction in investment from abroad due to the unstable political situation, however, the counter-sanctions had a positive impact on the growth of agricultural products, primarily due to the introduction of import substitution programs. As a result, new directions have emerged for the development of exports to Africa, China and India. This has affected the financial stability of business entities in the agricultural sector as a result of the infusion of investments in each individual branch of agriculture.

# MEASURES TO COMBAT DESERTIFICATION, DEVELOPMENT OF LAND RECLAMATION

**98. A. Aidarov, I. P. PREVENTION AND CONTROL OF SALINIZATION OF IRRIGATED LANDS: a monograph** / I. P. Aidarov, T. P. Korolkova, A. I. Korolkov; rec.: V. H. Khachaturian, N. N. Ignatiev; Russian State Agrarian University - Moscow Agricultural Academy named after K. A. Timiryazev (Moscow). — The electron. text data. — Moscow, 2012. — 310 p. — Collection: Monographs. — Free access from the Internet (reading, printing, copying). — Access mode : [http://elib.timacad.ru/dl/full/s26012023zasolenie\\_pochv.pdf](http://elib.timacad.ru/dl/full/s26012023zasolenie_pochv.pdf) . - Title page. the screen. - The electron. the version of the original publication. — <URL:[http://elib.timacad.ru/dl/full/s26012023zasolenie\\_pochv.pdf](http://elib.timacad.ru/dl/full/s26012023zasolenie_pochv.pdf)>. - (date of request: 13.02.2023)

An assessment of the natural conditions of the main areas of irrigation of agricultural lands, research methods and equipment of experimental sites are given, and the results of pilot production studies are presented. The basic principles of justification of land reclamation measures for irrigation of lands in various natural zones are described.

**99. AIDAROV, I. P. PROBLEMS OF LAND RECLAMATION AND WATER USE** / I. P. AIDAROV, pp.5-19. Electron. text data. // Environmental management. — 2008. — Issue 2. — Collection: Journal "Environmental Management". — <http://elib.timacad.ru/dl/full/gmgup-01-2008-2.pdf> . - Title page. the screen. — <URL:<http://elib.timacad.ru/dl/full/gmgup-01-2008-2.pdf>>.- (date of request: 13.02.2023)

As a result of degradation processes, more than 14 million hectares of arable land are annually withdrawn from agricultural turnover. In accordance with the multi-variant scenario of changing agriculture in the future, while maintaining the current state of agriculture and irrigation, food production will fall to the level of 1900 by 2030, and the condition of agricultural land will deteriorate. These dangerous trends and forecasts of changes in the state of the biosphere require intensive research on the problems of agriculture and land reclamation, ensuring not only the growth of food production, but also the preservation of the biosphere.

**100. Aidarov, I. P. ECOLOGICAL FOUNDATIONS OF LAND RECLAMATION: a monograph** / I. P. Aidarov; references: I. P. Svintsov, V. N. Krasnoshchekov ; Russian State Agrarian University - Moscow Agricultural Academy named after K. A. Timiryazev (Moscow). — The electron. text data. — Moscow, 2012. — 177 p. — Collection: Monographs. — Free access from the Internet (reading, printing, copying). — Access mode : — URL : [http://elib.timacad.ru/dl/full/s26012023akol\\_osn\\_melior.pdf](http://elib.timacad.ru/dl/full/s26012023akol_osn_melior.pdf) . - Title page. the screen. - The electron. version of the original publication. - (date of request: 02/13/2023)

The current state of environmental management is considered, including an analysis of the interrelationship of environmental, social and economic factors. The causes and scales of degradation of natural ecosystems are analyzed. The article considers the composition and role of ecosystem services that determine the state of the natural environment and the well-being of the population.

**101. GLOBAL AGROFORESTRY PROJECTS AND THEIR IMPLEMENTATION** / K.N. Kulik, A.I. Belyaev, A.M. Pugacheva, A.A.Zykova // Bulletin of the Russian Academy of Sciences. - 2024. - Vol. 94, No. 1. - pp. 55-65. — URL : <https://www.elibrary.ru/item.asp?id=67918794> - (date of request : 10.01.2025)

Desertification of lands as one of the most acute environmental problems deserves special attention. Agroforestry management of territories is considered a recognized means of combating desertification. The article examines large-scale agroforestry projects initiated in the USA, the USSR, China, and African countries, development schemes, individual and common features of these projects, and implementation stages. The authors emphasize that Russia's experience in the field of agroforestry during the 19th-20th centuries. It was actively used in foreign countries, as the scientific achievements of Russian and Soviet scientists in the development of protective afforestation are recognized worldwide.

**102. Grishina, N. V. AFRICA: COMBATING DESERTIFICATION IN PLANS AND ACTIONS** / N. V. Grishina // Scientific Notes of the Institute of Africa of the Russian Academy of Sciences. - 2021. - No. 1 (54). - Pp. 98-107. — URL : <https://www.elibrary.ru/item.asp?id=44900281> - (date of request : 10.01.2025)

In recent decades, the global climate change issue has been actively discussed by the world community. The growing process of desertification has become one of the problems for hundreds of millions of Earth's inhabitants. In the coming years, more than 2 billion people could be seriously affected by the onset of deserts in North Africa, Central and Southeast Asia, Australia, Southern Europe, and parts of the Americas.

The most negative impact of the expansion of desert areas is experienced by States with weak economies, the predominance of primitive methods of land cultivation, suffering from a shortage of specialists in the field of bioecology and the lack of national programs to combat desertification.

**103. Dolmatov, G. N. MELIORATION AS AN INTEGRAL PART OF RATIONAL ENVIRONMENTAL MANAGEMENT / G. N. Dolmatov, O. I. Ivanova // Scientific and practical aspects of agro-industrial complex development : proceedings of the national scientific conference. - Krasnoyarsk, 2020. - Pp. 40-42.- Text: direct.**

The article discusses the types of land reclamation, tasks, methods, classification of devices, drainage and irrigation of soils and other issues of land reclamation.

**104. Eldyshev, Yu. N. THE SOIL IS LEAVING FROM UNDER THE FEET OF MANKIND / Yu. N. Eldyshev // Ecology and life. - 2010. – No. 3. – pp. 60-67. – Text : direct.**

The causes of desertification caused by both anthropogenic and natural factors (in particular, climate change) are described.

**105. Kovda, V. A. PROBLEMS OF DESERTIFICATION AND SOIL SALINIZATION IN ARID REGIONS OF THE WORLD / V. A. Kovda ; Russian Academy of Sciences, Institute of Physics and Chemistry. and biological problems of soil science. Moscow : Nauka Publ., 2008. 414, [1] p., [1] l. portr. : ill., K., tab.; 25 cm.; ISBN 978-5-02- 035586-6 – Text : direct**

**106. Ksenofontova, N. A. SAHEL COUNTRIES: DESERTIFICATION AND COUNTERACTION MEASURES / N. Ksenofontova, N. Grishina // Asia and Africa Today. – 2019. – No. 12. – pp. 64-67. – Text : direct**

Combating desertification in the Sahel countries as a global environmental challenge.

**107. Coulibaly, Tieman. ECOLOGICAL GEOGRAPHY AND PROBLEMS OF DESERTIFICATION IN WEST AFRICA (ON THE EXAMPLE OF THE REPUBLIC OF MALI) / Tieman Coulibaly : dissertation for the degree of Candidate of Geographical Sciences / Federal State Budgetary Educational Institution of Higher Professional Education "Saint Petersburg State University". - St. Petersburg, 2005. - 142 p. — URL : <https://www.elibrary.ru/item.asp?id=16063066> - (date of request : 10.01.2025)**

Ecological and geographical analysis was carried out to study desertification processes in West Africa; ecological and geographical zoning of the Republic of Mali; assessment of the impact of regional land use systems

on desertification processes; a system of measures to combat desertification in the Sahel-Sudanese zone.

**108. Lyashkov, M. A. FOREIGN EXPERIENCE IN THE USE OF DOMESTIC WASTEWATER FOR IRRIGATION PURPOSES / M.A. Lyashkov, Yu.Y.Ariskina // Ecology and water management. - 2022. - Vol. 4, No. 2. - pp. 15-31. — URL : [https://www.elibrary.ru/query\\_results.asp](https://www.elibrary.ru/query_results.asp)**

The use of domestic wastewater in irrigation reclamation is widespread in regions with a shortage of water resources, as well as an arid climate. These are India, Italy, France, Spain, Israel, Jordan, the USA, Poland, Africa, as well as Central, South and Southeast Asia (Bangladesh, Cambodia, China, India, Indonesia and Vietnam). Discussions. Currently, there is a significant increase in the volume of domestic wastewater, and the use of treated wastewater for agricultural production is a common practice worldwide. In Europe, from 964 million m<sup>3</sup>/year of treated wastewater is used in agriculture, 347 million m<sup>3</sup>/year in Spain and 233 million m<sup>3</sup>/year in Italy. The reuse of wastewater in Latin America is confirmed by the presence of large areas irrigated by both treated and untreated domestic wastewater. The development of pathogenic organisms that pose a threat to human health was not observed during irrigation of vegetable crops with purified domestic wastewater in the Middle East. The use of treated wastewater for irrigation purposes solves the problem of shortage of water resources, their utilization, has a beneficial effect on the physico-chemical characteristics of the soil, plant growth and development, reduces the cost of crop production by 10-20%, which is a decisive argument in favor of using wastewater in irrigation reclamation, in addition, saves from 25 to 50% of nitrogen and phosphorus fertilizers and increases crop yields by 15-27% compared to conventional irrigation.

**109. Meladze, T. INTERNATIONAL LEGAL ASPECTS OF COMBATING DESERTIFICATION IN AFRICA, T. Meladze // "School of the Young Africanist" : conference proceedings.- 2016. - No. 7. - pp. 135-136. — URL : <https://www.elibrary.ru/item.asp?id=27410698> - (date of request : 10.01.2025)**

**110. LAND RECLAMATION** : textbook / A. I. Golovanov, N. M. Shcherbakova, I. P. Aidarov, M. S. Grigorov, V. N. Krasnoshchekov, V. S. Kozhanov, S. A. Maksimov, L. F. Pestov, V.P. Pchelkin, G.A. Ryabkova, G. A. Senchukov, T. I. Surikova, Yu. I. Sukharev, V. V. Shabanov, A. P. Averyanov; editors: A. I. Golovanov, N. M. Shcherbakova; rec.: E. V. Kuznetsov, A.V. Shuravilin; Russian State Agrarian University - Moscow Agricultural Academy named after K. A. Timiryazev (Moscow). — The electron. text data. — Moscow, 2011. — 824 p. — Collection: Educational and methodical literature. — Free access from the Internet (reading, printing, copying). — Access mode : [http://elib.timacad.ru/dl/full/s09102024MZ\\_Shabanov.pdf](http://elib.timacad.ru/dl/full/s09102024MZ_Shabanov.pdf) . - Title page. the screen. - The electron. the version of the original publication. — <URL:[http://elib.timacad.ru/dl/full/s09102024MZ\\_Shabanov.pdf](http://elib.timacad.ru/dl/full/s09102024MZ_Shabanov.pdf)>. - (date of request : 01/10/2025)

The textbook outlines theoretical and methodological approaches to the problems of land reclamation, outlines the principles of land reclamation, examines the theory and practice of land reclamation in arid and waterlogged zones, pays attention to improving saline and acidic soils, describes for the first time the methods of thermal reclamation, considers the complex arrangement of watersheds, considers technologies for land reclamation of settlements and industrial lands, and provides an assessment methodology. The impact of land reclamation on the environment is described by modern approaches to the economic assessment of investment projects of land reclamation.

**111. LAND RECLAMATION AFFECTED BY ENDOGENOUS HYDROGEN** : a bibliographic index / comp. : V. V. Shabanov, A. G. Tsyrlunik, S. V. Kislyakova. - Moscow, 2024. – 73 p. - Text : direct

This index presents materials of a new direction of land reclamation – complex land reclamation degassed by endogenous hydrogen. The process of endogenous degassing can negatively affect the soil biota, disrupt the soil structure, change its acidity and, with intensive spring runoff, lead to the washing away of the soil layer. Such phenomena are especially dangerous in the Chernozem zone, therefore it is necessary to develop methods and technologies of complex land reclamation on these lands. Due to the fact that the topic is new and in order to familiarize a wider range of readers, the index contains literature in this area.

**112. Minashina, N. G. IRRIGATED DESERT SOILS AND THEIR RECLAMATION** / N. G. Minashina. Moscow : Kolos Publ., 1974. 364 p. - Text : direct

Soils are considered in genetic and meliorative aspects as special formations, due to the complex interaction of natural and irrigation-agricultural factors. The analysis of the soil cover during irrigation and in natural desert conditions is given for the reclamation assessment of soils, as well as to identify the most promising lands for development. A new classification of desert oasis soils is proposed, and the features of zonal soil formation under irrigation conditions are revealed. Much attention is paid to the origin, spatial distribution and migration of salts in soils and groundwater in oases.

**113. Marinka, Z. A. EXPORT OF RUSSIAN IRRIGATION SYSTEMS TO AFRICA: STATUS AND PROSPECTS** / Z. A. Murina, M. N. Danyukova, V. S. Dzhumasheva // Bulletin of MIRBIS. - 2024. - No. 2 (38). - pp. 31-43. — URL : <https://www.elibrary.ru/item.asp?id=68490110> - (date of request : 10.01.2025)

The African direction is of significant importance in Russia's modern foreign economic policy. One of the main problems in Africa is food security, which is becoming more difficult to solve every year due to demographic, economic, political, logistical and medical problems. Cooperation in the field of food security, along with energy and extractive industries, are key areas of cooperation between the Russian Federation and African countries. The food security of the region directly depends on land reclamation, the main and most in-demand area of which is irrigation. Aiming to assess the potential of irrigation as a way to overcome hunger problems in the region and explore trade opportunities between African countries and Russia in this area, the authors conducted a study of the global irrigation market, identified the role of Africa and Russia in this market, and suggested ways to cooperate. Russia has scientific, educational competencies and, most importantly, production facilities in this area, so it is concluded that there is potential for the development of trade and economic cooperation between the Russian Federation and African countries in the field of irrigation technology. In conclusion, it is concluded that although trade and economic cooperation in this area is currently low-intensity, in the future, increasing supplies of Russian irrigation systems to Africa will contribute to the development of relations between the countries of the region and Russia, as well as achieving the UN Sustainable Development Goals in the region.

**114. ON THE USE OF FRESH GROUNDWATER IN ARID REGIONS OF THE WORLD IN COMBATING LAND DESERTIFICATION** / Z. G. Zalibekov, S. A. Mamaev, A. B. Biarslanov, R.A. Magomedov, D.B. Asgerova, U.M. Galimova // Arid ecosystems. - 2019. - Vol. 25, No. 2 (79). - pp. 3-12. — URL : <https://www.elibrary.ru/item.asp?id=38513304> - (date of request : 10.01.2025)

The theoretical foundations and principles of the use of freshwater and its role in combating desertification and in harnessing the biological potential of drylands have been developed. The advantages of PPW in comparison with surface irrigation waters are revealed: protection from pollution, evaporation, protection of natural reserves and their natural renewability. The areas of arid lands by continent, differences in the depth of PPV and the parameters of the recommended type of drip irrigation are given on the example of one of the arid regions of the Tersko-Kuma artesian lowland. A natural renewal and occurrence close to the soil surface in the delta-alluvial plains of Eurasia are shown in comparison with the conditions of equatorial Africa.

**115. DESERTIFICATION AND FEATURES OF SOIL FORMATION PROCESSES IN THE MEDITERRANEAN ZONE OF THE LIBYAN JAMAHIRIYA** / L. L. Shishov [et al.], pp.95-108. Electron. text data. // Proceedings of the Timiryazev Agricultural Academy: A scientific and theoretical journal of the Russian State Agrarian University named after K.A. Timiryazev. — 1988. — Issue 6. — Collection: Izvestia TLCA Magazine. — <http://elib.timacad.ru/dl/full/14-1988-6.pdf>. - Title page. the screen. — <URL:<http://elib.timacad.ru/dl/full/14-1988-6.pdf>>.

**116. ENVIRONMENTAL MANAGEMENT: Textbook** / ed. : A. I. Golovanov , N. M. Shcherbakova; rec.: I. P. Aidarov, A.D. Gumbarov; Russian State Agrarian University - Moscow Agricultural Academy named after K. A. Timiryazev (Moscow). — The electron. text data. — Moscow, 2008. — 552 p. — Collection: Educational and methodical literature. — Free access from the Internet (reading, printing, copying). — Access mode : [http://elib.timacad.ru/dl/full/s16102024Prirodoob\\_Sh.pdf](http://elib.timacad.ru/dl/full/s16102024Prirodoob_Sh.pdf) . - Title page. the screen. - The electron. the version of the original publication. — <URL:[http://elib.timacad.ru/dl/full/s16102024Prirodoob\\_Sh.pdf](http://elib.timacad.ru/dl/full/s16102024Prirodoob_Sh.pdf)>. - (date of request : 10.01.2025)

The principles of rational use of natural resources and environmental management, geosystems as objects of environmental management, cultural landscapes, basic natural laws and modeling of natural processes are considered.

117. **DEVELOPMENT OF LAND RECLAMATION IN THE CONTEXT OF CLIMATE CHANGE:** A bibliographic index of literature / comp. : V. V. Shabanov, A. G. Tsyurulnik, S. V. Kislyakova ; Russian State Agrarian University - Moscow Agricultural Academy named after K. A. Timiryazev (Moscow), Central Scientific Library named after N. I. Zheleznov. — The electron. text data. — Moscow, 2023. — 60 p. — Collection: Bibliographic indexes. — Access mode : <http://elib.timacad.ru/dl/full/s16112023Shabanov2M.pdf> . - Title page. the screen. — <URL:<http://elib.timacad.ru/dl/full/s16112023Shabanov2M.pdf>>. - (date of request : 10.01.2025)

The bibliographic index includes works carried out in different years and developing quantitative methods for substantiating the choice of various types of land reclamation not only on agricultural lands, but also on lands of natural ecosystems – drainage basin reclamation, etc. The bibliographic list has been prepared to help students and postgraduates, and can also be used by teachers of the Russian State Agricultural Academy named after K.A. Timiryazev to prepare for training sessions.

118. Smetanin, V. I. **THE PROBLEM of LAND DESERTIFICATION AS ONE OF THE MAIN CHALLENGES to MODERN HUMANITY** = The problem of land desertification – as one of the main challenges to modern humanity / V.I. Smetanin, H. Kasi. — pp.44-52. — Electron. text data. // Environmental management / Prirodoobustroystva. — 2024. — Issue 3. — Collection: Journal "Environmental Management". — Free access from the Internet (reading, printing, copying). — <http://elib.timacad.ru/dl/full/gmgup-06-2024-3.pdf>. - Title page. the screen. - <https://doi.org/10.26897/1997-6011-2024-3-44-52>. — <URL:<http://elib.timacad.ru/dl/full/gmgup-06-2024-3.pdf>>. — <URL:<https://doi.org/10.26897/1997-6011-2024-3-44-52>>. - (date of request : 10.01.2025)

The purpose of the research is to analyze the causes of land desertification, find ways to curb the rate of desertification and restore previously desolate lands. Areas with a hot climate, minimal precipitation and strong winds are susceptible to desertification. The annual precipitation does not exceed 200... 50 mm, and in some places it does not occur at all for a number of years. The soil layer in such territories is poorly developed, vegetation covers less than half of the earth's surface, and in some cases is practically absent. Groundwater is usually mineralized. In such natural conditions, soil degradation is observed in territories, fertility is lost, and biodiversity is decreasing, which eventually leads to their desertification.

Using the analytical research method, the main causes of land degradation and its consequences leading to desertification of territories have been identified. Ways to reduce the rate of degradation of agricultural lands and restore previously deserted territories are proposed.

**119. Tsekhainesh, H. G. FEATURES OF THE DEVELOPMENT OF DESERTIFICATION PROCESSES IN NORTHEAST AFRICA AND MEASURES TO COMBAT IT / H. G. Tsekhainesh ; Moscow Agricultural Academy named after K. A. Timiryazev : abstract of the dissertation for the degree of Candidate of Agricultural Sciences. - Moscow, 1997. - 24 p. URL:<https://www.elibrary.ru/item.asp?id=19308848>**

The purpose of the research, which served as the basis for writing the dissertation, is to study the current state and identify the main trends and features of the development of desertification processes in Northeast Africa and to determine a system of measures to combat it.

**120. Chupakhin, V. M. REGIONAL ECOLOGICAL SCHEME FOR COMBATING DESERTIFICATION / V. M. Chupakhin ; ed. by A. G. Babaev. - Leningrad : Nauka, Leningrad Publishing House, 1990. - 158 p. - Bibliogr.: pp. 152-154. - ISBN 5-02-024679-4 : - Text : direct.**

The book substantiates the landscape-ecological approach in the development of regional ecological schemes for combating desertification as the main form of a pre-planned project document for rational use of natural resources. The article considers the natural and anthropogenic factors of desertification, the purpose, structure and content of the scheme, the principles and stages of its development, the information base and effectiveness of the scheme, the environmental assessment of the state of anthropogenic landscapes as an integral part of the scheme. Much attention is paid to landscape and environmental forecasting and issues of combating desertification through the development and implementation of regional environmental systems.

**121. Shabanov V. V., Markin V. N., Soloshenkov A.D. ISSUES OF SUBSTANTIATION OF THE NEED FOR PRECISE RECLAMATION REGULATION OF THE COMPLEX OF PLANT LIFE FACTORS AND SOIL BIOTA // PROBLEMS OF DEVELOPMENT OF AGRICULTURAL LAND RECLAMATION AND WATER MANAGEMENT COMPLEX BASED ON DIGITAL TECHNOLOGIES : proceedings of the international anniversary scientific and practical conference. 2019. - pp. 71-76. - (date of reference: 04/15/2023)**

**122. Shabanov, V. V. THE CONCEPT OF CREATING A SYSTEM OF ADAPTIVE MONITORING OF LAND RECLAMATION USING THE PRODUCTIVITY FUNCTION / V. V. Shabanov, A.M. Kasparyan ; University - Moscow Agricultural Academy named after K. A. Timiryazev (Moscow). — The electron. text data. — Collection: Conferences of the Russian State Agricultural Academy named after K. A. Timiryazev. — Collection: TLC reports. — Free access from the Internet (reading, printing, copying). — Access mode : <http://elib.timacad.ru/dl/full/doctsha-293-1 - 2021-9.pdf> . - Title page. the screen. - The electron. version of the pech. publication. — . (date of request: 04/13/2023) The concept of creating a monitoring system that adapts to measure the controlled factor (productive moisture reserves) in critical areas of the field, where a drop in the values of the productivity function is predicted below the optimal values.**

**123. Shabanov V. V. ASSESSMENT OF CHANGES IN ENVIRONMENTAL FACTORS IN THE RUSIZI RIVER BASIN IN THE TERRITORY OF THE REPUBLIC OF BURUNDI / V. V. Shabanov, N. Niyonzima /Environmental Management. - 2012. - No. 3. - pp. 30-35. - Text : direct**

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