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CLIMATE CHANGE AND ADAPTIVE MANAGEMENT: THE DYNAMICS OF NATURAL AND SOCIO-ECONOMIC RISKS AND SUSTAINABLE DEVELOPMENT OF RURAL COMMUNITIES IN THE KYRGYZ REPUBLIC

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ИЗМЕНЕНИЕ КЛИМАТА И АДАПТИВНОЕ УПРАВЛЕНИЕ: ДИНАМИКА ПРИРОДНЫХ И СОЦИАЛЬНО-ЭКОНОМИЧЕСКИХ РИСКОВ И УСТОЙЧИВОЕ РАЗВИТИЕ СЕЛЬСКИХ СООБЩЕСТВ В КЫРГЫЗСКОЙ РЕСПУБЛИКЕ

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Abstract

The world is constantly changing and from time to time there are the risks which affect individuals and the community as a whole. By their nature, these risks can be positive (e.g., rain on a hot day) or negative (natural disasters). They may affect small groups of people (for example, family or village community), or big ones (region or country). Finally, they can occur suddenly (e.g., natural disasters or migration) or gradually (e.g., demographic shifts, and \ or changes in environmental conditions).

Keywords: risks, vulnerability, rural communities, adaptation, adaptive management.

Аннотация

Мир постоянно меняется, и в нем то и дело возникают риски, которые влияют на отдельные лица и на сообщество в целом. По своему характеру эти риски могут быть позитивными (например, осадки в жаркий день) или негативными (стихийные бедствия). Они могут влиять на небольшие группы людей (например, на семью или сельскую общину), либо на большие (на регион или страну). Наконец, они могут происходить внезапно (например, стихийные бедствия или миграции) или постепенно (например, демографические сдвиги, и/или изменения условий окружающей среды).

Ключевые слова: риски, уязвимость, сельские сообщества, адаптация, адаптивное управление.

Introduction

Exposure of people to risk is determined by the environment in which they exist. For example, exposure of a house to flooding risk in the event of flooding is determined by its location, which is largely characterized by areas of a pilot study for the past 2 years [6]. Hence, the vulnerability occurs when people are particularly susceptible to damage from the negative risk due to a combination of large exposures, the weakness of internal conditions or institutional vacuum and inadequate risk management. For example, poor households with little assets and unstable income may be particularly vulnerable to increased food prices. Therefore, risk management – the process of counteracting the risk, preparing for it and adapting to its effects.

Many of the recently published scientific works about the risk problems within the context of, for example, climate change, highlight the important role that can be played by the risk management in improving the sustainability of rural communities to the negative risks. However, the risk management has another very important role: helping people and communities to successfully use the effects of positive shocks and, thus, contributing to the growth of welfare. In fact, the successful use of the effect of positive risks is critical for gradual increase of the people's stability against negative risks. For example, a farmer may have more chances to survive the drought, if he reasonably manages harvests collected during the years of heavy rainfall.

Thus, the purpose of risk management – both to reduce the damage and to increase the benefit of people who face and take the risk.

Given the complexity of the relationship between environmental change and the development of local communities, it is worth noting that the climate threats, for example, do not always automatically lead to the displacement of people, and migration may be an adaptation strategy. In this case, the assessment of vulnerability of different social groups [11] can serve as a basis for developing special measures for vulnerability reduction¹.

Studies to assess the threats related with climate change or other natural processes should be aimed at collecting data on the victims as a result of environmental changes. Characteristics of these changes are extremely important to develop proactive response measures and to expand capabilities in this area. Such studies require extensive interaction between experts in the field of social and natural sciences, including database development experts.

Previous experience local communities in the Kyrgyz Republic, as in all countries of Central Asia, in the framework of the planned economic system in the former Soviet Union, relates to the management and implementation of activities on the top-down principle and sectorally focused development initiatives. At the moment, it became necessary to organize re-training to the success of the partnership bottom-up approach. The knowledge, skills and attitudes necessary for the implementation of activities on the bottom-up principle within the framework of the local development model is significantly different when it is under the control of the state only to provide services on a territorial basis. Using a new conceptual approach to the development of the capacity of local communities, involves the use of "demand and availability" strategy and addressing the specific needs and capabilities of each individual, rural organizations in each locality [5].

There are various reasons why the local communities and local institutions do not play a more effective role than at present in the development of rural areas. These include internal conflicts, lack of education, experience and skills, psychology of addiction, the presence of a sense of ineffectiveness, the dominance of some local groups, unfavorable political environment, in the framework of centralized government, psychology of paternalism, certain financial interests and disagreements on ethnic or other social problems.

Despite the massive population migrations within and outside the country and the region as a whole, nearly two-thirds of the population in the Kyrgyz Republic, as well as in other countries in the Central Asian region, live in rural areas and rural development is the turning mechanism in the overall economic strategy in Central Asian countries.

Almost all countries in the region have adopted a number of programs and projects to combat poverty and improve the general welfare of the rural population. Such strategies include restructuring and modernization of agriculture, encouraging the development of agro-industries and the creation of special economic zones in rural areas, strengthening of social facilities and fiscal incentives. Such programs and projects are aimed at reducing poverty, creating jobs and improving the overall well-being of rural people.

To achieve sustainable development of local communities, the challenge is to facilitate the institutionalization process through which local communities could develop local organizations, and to meet their own needs on the ground. Public organizations, institutions in rural areas may become the main tools that are responsible for managing the development of the local community [5].

¹ Ibid. Levels of social vulnerability of the population. Appendix 2.

Materials and research methods

Environmental changes are often related to climate change – global warming – the process of a gradual increase in the average temperature of Earth's atmosphere. However, the rise in temperature of the surface layer of the atmosphere – the most important and significant of all changes of climate variables. Such a change, however, is not the only one. Such climate changes can occur also by: 1) increasing the temperature amplitude (growth of climate continentality), 2) changes in the amount and the uneven rainfall (the level of precipitation increases on average and decreases in dry regions), 3) the overall reduction of the area of mountain and surface glaciers as well as the melting of the permafrost. The main contribution to climate change is also made by human activities, accompanied by the release of greenhouse gases.

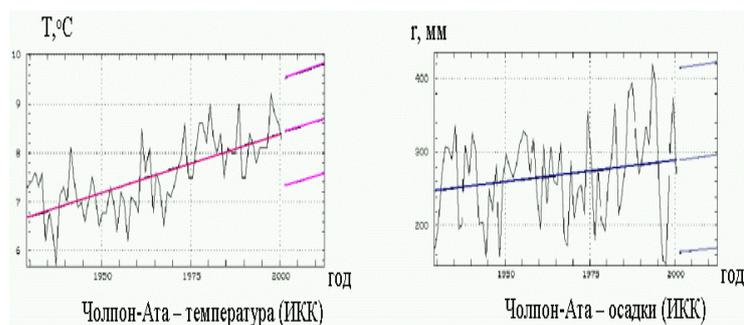


Fig. 1. Dynamics of air temperature and precipitations (1925-2000, Cholpon-Ata station, Kyrgyzstan) [8]

There is an increase in their concentration in the atmosphere and, as consequence, increase of surface air temperature.

For complex mountain territory of Kyrgyzstan, according to the instrumental observations, the increase of the average annual temperature in the 20th century was significantly higher than globally on the Earth by 1.6°C with a rate of change in the territory in the range of $0,6...2,4^{\circ}\text{C}$ [13]. Annual precipitation on average within the territory is almost unchanged (an increase of 23 mm or 6%). However, there is a clear trend of increasing from 1-2 to 20-30% in all climatic regions of Kyrgyzstan, except the Inner Tien Shan. The current level of world science does not allow us to predict the future climate, even within a single century. For its estimation, climate scenarios are used which are produced by global climate models (GCM). The spatial resolution in the horizontal model is up to 250 km, while the vertical – up to 1 km, which allows to allocate territorial cells in the general matrix of climate change on our planet.

In general, according to researchers, the quality of climate calculations by GCM can be recognized, if not yet fully satisfactory, but as very encouraging, at least for the sub-continental scale and from seasonal to inter-decadal resolution. However, none of the models and none of the climate scenarios may be the best in terms of their high reliability.

It is necessary for any area to have a number of climate scenarios, which describe the full range of possible future climatic conditions. The explanation for this can be found in the fact that man-made climate change depend on the development of economy and technology, distribution of the population and cooperation between the countries and regions with different levels of development. Integrally, all these factors are expressed through of greenhouse gas emission scenarios.

At the local level, where natural processes occur more often, various hazards (risks) may appear, overcoming and management of which includes people's adaptation to environmental changes. The most important aspect of adaptation is the correct perception and evaluation of the possible risks [4], especially in mountainous areas where there is a big number and expansion of such processes.



Fig. 2. The movement of the landslide down the hill

However, the mere detection of natural hazards (risks), despite the importance of their study, is not enough. It is also needed to identify and develop compromise solutions to overcome obstacles to risk management, ranking them in order of priority and overcoming them by efforts of individuals and rural communities and state institutions. In fact, many crises and setbacks in development are the result of inadequate risk management. No less important is the fact that many of the opportunities are not used by people and communities due to the lack of willingness to take risks, and when it is required to take the risk, and they do not do it – this is called the "risk of inaction" [10].

One of the reasons for such "liberal perception of" natural disasters is the level of well-being and income of local rural population. A significant number of people in rural areas are poor or living on the edge of poverty. Currently, the overall poverty rate is 2 thousand 314 soms per capita, and extreme poverty – 1 thousand 354 soms².

Such a high level of poverty leads to greater impoverishment in cases of occurrence of natural hazards (risks). More than 37% of the population in the studied areas live on less than \$ 1.25 per day. For instance, in 2002, the rate of extreme poverty line was set at 4604 soms per capita (in 1996 this figure was 2199 soms per year). Given the above figures on the poverty status, the population of the country, is almost back to the situation in the mid 90s. In addition, in our country there are currently 115 thousand households, whose income per family member does not exceed 640 soms. They include more than 336 thousand children [15].

As known, the agriculture has a significant share in the economy of the Kyrgyz Republic, which employs most of the population. However, in practice it is difficult to assess to what extent natural disasters will affect the economy of our country. For this reason, a study [2] was undertaken in order to obtain a more accurate estimate of the long-term regional impacts on the basis of current policies (the so-called baseline scenario or the scenario under normal conditions), as well as to determine the likely impact of natural processes on individual communities and regions of the country as a whole. The important fact is whether we properly assess the environmental risks? [3]. The temperature of the surface air layer is close to the thresholds beyond which warming could lead to the reduction rather than the increase in agricultural production.

Results and discussions

By climatic conditions, the Kyrgyz Republic belongs to the zone of risky agriculture. Reduction of water resources, the change in temperature due to climate change will have a direct impact on the reclamation condition, quality of the land and crop yields, and, consequently, on the country's food security. Climate change will affect the availability of food, access to food, stability of food supplies and consumption. Fertility of arable land as a result of climate change will reduce, and the area of deserts and semi-deserts will expand from 15.0% (in 2000) to 23.3%-49.7% (2050).

² Note: earnings of \$ 1.25 per day or 90 som is a widely used indicator of extreme poverty.. It is 2700 soms per capita.

Territory and productivity of alpine pastures may also reduce to 50%, while the predicted loss of spring and autumn ephemeral pastures will be almost 70%.

The study of changes in average annual runoff for the period from 1940 to 2015 was conducted in four river basins of the Tien Shan mountain system: Naryn (Internal Tien Shan), Talas (northwestern part), Chuy (northern part) and a basin of Issyk-Kul lake (north-eastern part). The study of runoff changes was carried out based on data from Kyrgyzhydromet observation network [7]. Hydrological data on the following gauging stations were used: Naryn river – Naryn town, Talas – vil.Ak-Tash, Al-Archa river – mouth of Kashka Suu river (a tributary Chu river), Chon Dzhargylchak river – timber mill settlement (Issyk-Kul lake basin).

All rivers have glacier and snow feeding, gauging stations (SG) are located at the outlet of the mountain valleys up to the water intake points where water is taken for household, municipal and industrial needs, i.e. they have a natural runoff. In the basins of listed gauging stations there are observation data on meteorological parameters on the following weather stations: Naryn town (altitude of the weather station is 2040 m above sea level), Ak Tash in the Talas basin (2150 m asl), Ala-Archa (2100 m asl), Chon-Ashu in the Issyk-Kul lake basin (2802 m asl).

In order to identify characteristics of runoff, the difference integral curve was built which shows two hydrological cycles on all the listed watercourses: decrease of the water content in the period from 1940 to 1989 (1993) and increase of water content from 1990 (1994) to 2015. In the Ala-Archa river relatively stable period is observed from 1973 to 1993 but since 1994 there is a steady increase in annual average river runoff.

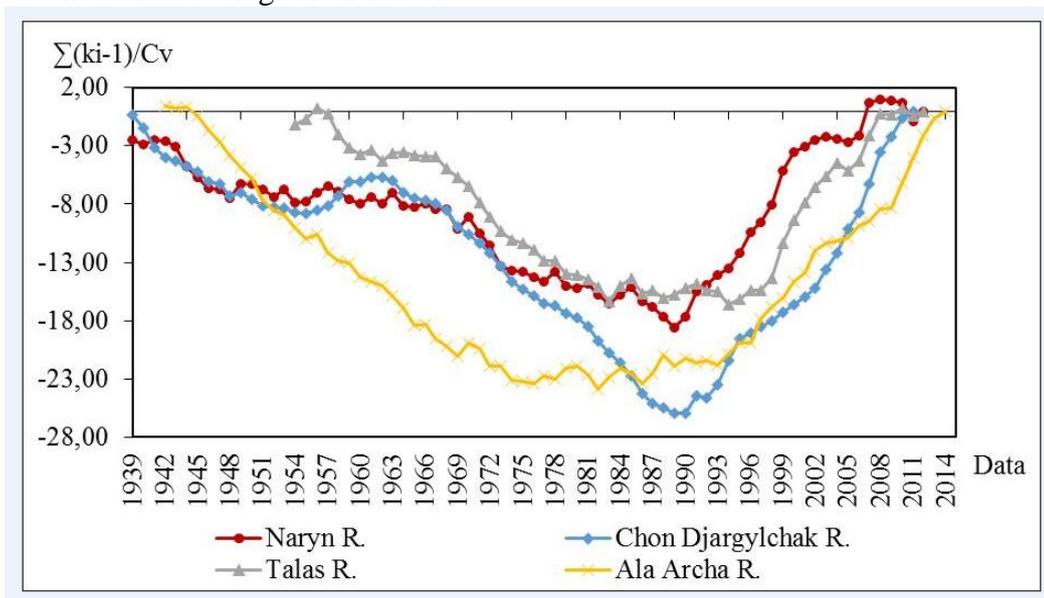


Fig. 3. The difference integral curve of the average annual flow of the rivers of Naryn, Talas, Ala-Archa and Chon-Dzhargylchak

In intra-annual distribution of river flow for the period from 1994 to 2015 in comparison with the period from 1940 to 1993, there is an increase in the water content during the months of seasonal snow melting (from February to June) by 1-2% on average and in the months of glacier melting (July - August), on the contrary, there is a decrease in runoff by 2-4% per month. With this trend the maximum values of runoff during floods will shift to earlier dates, and, consequently, intra-annual river regime will change from glacier-snow feeding to snow-glacier and snow feeding. Nextly, we refer to the characteristics of climatic factors influencing on the flow of the rivers studied.

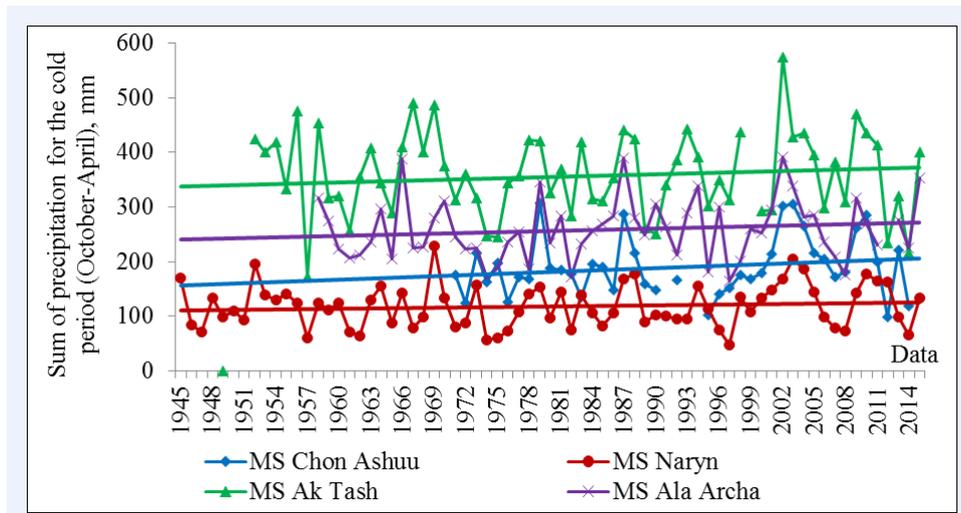


Fig. 4. Changing the sum of precipitation for the cold period (October-April) from 1945 to 2015 on the meteostations Naryn, Chon-Ashuu, Ak-Tash and Ala Archa

The most significant impact on the average annual river flow is made by seasonal accumulation of snow in the cold period (October-April), which tends to increase by 30-50 mm on average for the period from 1945 to 2015 (Fig. 4).

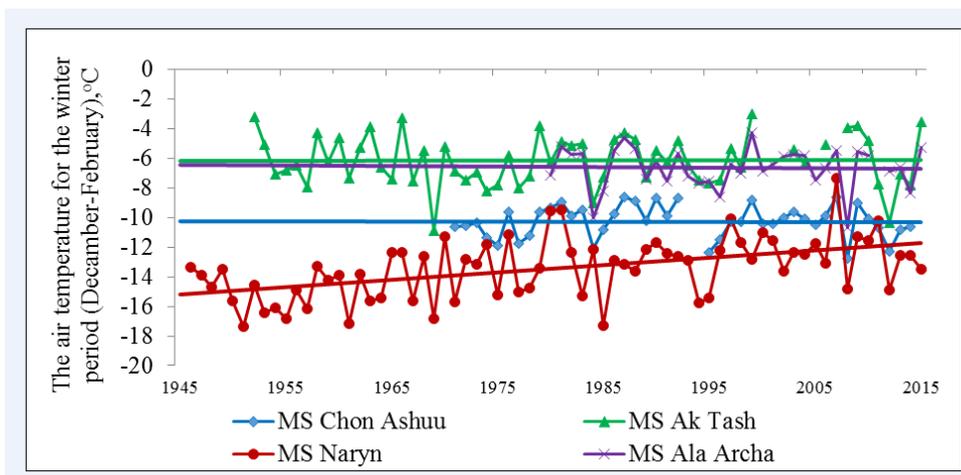


Fig. 5. Changing the air temperature for the winter period (December-February) in °C from 1945 to 2015

The air temperature change analysis shows its rise in the spring and autumn periods by 1-3°C according to the data from four meteorological stations, and only at the Naryn weather station the air temperature is steadily increasing in all seasons. Transition of positive air temperature through 0°C over the last 10-20 years has been observed 10-15 days earlier, and in the direction of negative temperatures later than in the period from 1945 to 1990.

Accordingly, the period of melting of seasonal snow cover begins earlier and ends later than in the period from 1940 to 1990. It leads to a shift of the flood peaks to earlier dates and increase of the role of the seasonal snow melting in the intra-annual distribution of flow in comparison with the melting of glaciers in the highlands of Tien Shan.

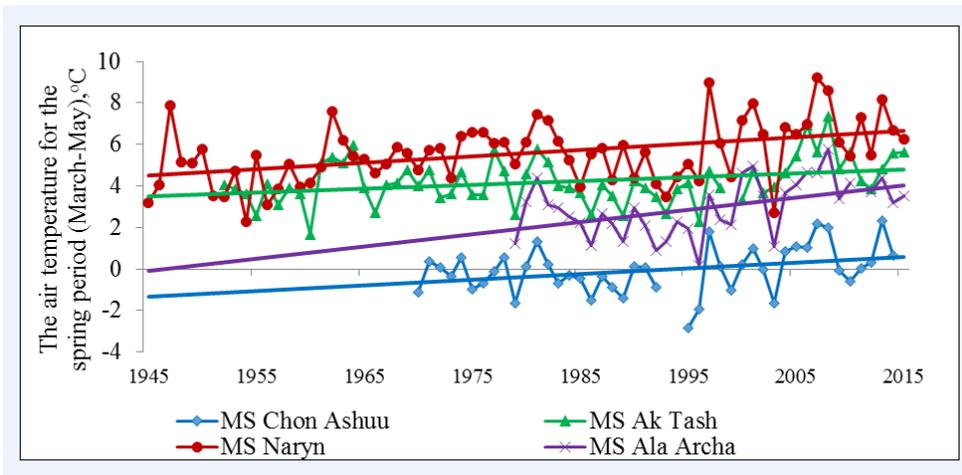


Fig. 6. Changing the air temperature for the spring period (March-May) in °C from 1945 to 2015

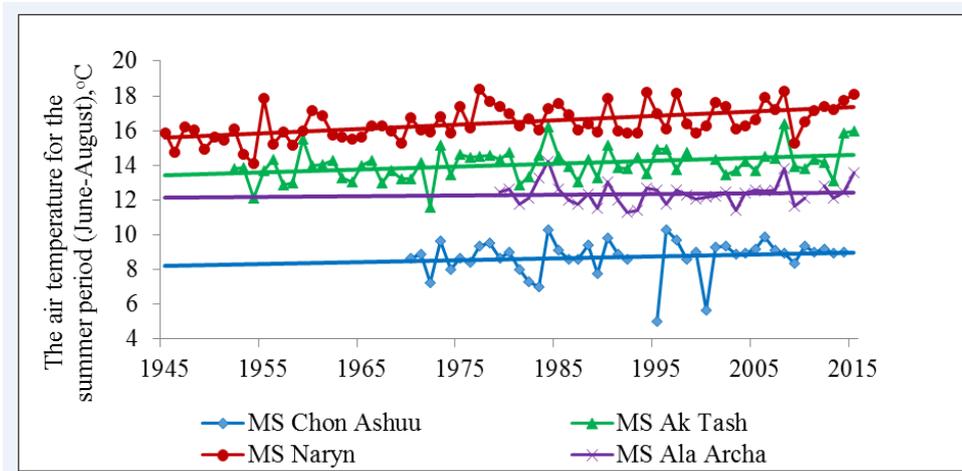


Fig. 7. Changing the air temperature for the summer period (June-August) in °C from 1945 to 2015

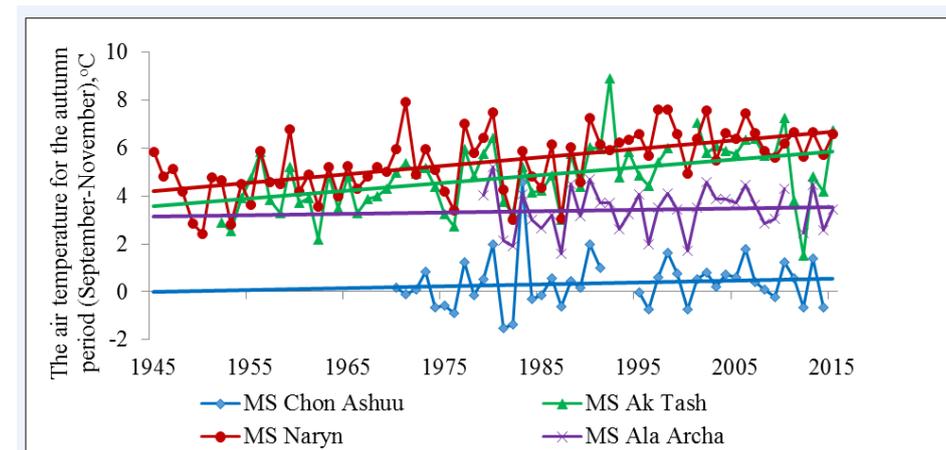


Fig. 8. Changing the air temperature for the autumn period (September-November) in °C from 1945 to 2015

Conclusions

Thus, the studies of the dynamics of changes in air temperature regime and precipitation regime, river flow resources show changes in the conditions of agricultural crop growing and their productivity. According to studies in the dynamics of natural processes, there is a tendency of shift

of peak values in the graphs of changes in temperature and precipitation, according to the data from weather stations in different locations in the Kyrgyz Republic. The temperature change analysis shows its growth in the spring and autumn period which has a negative impact on the growth of crops due to lack of positive temperatures in the vegetation period. At the same time, such dynamics of temperature values "positively" influences on the early snow melting and slope processes' activation in the mountains and in the areas of agricultural land use. The same trend is observed with regard to precipitation regime on the territory of the Kyrgyz Republic. During the period of vegetation and crop irrigation, there is a decrease of water content in the flow and flood periods shift to earlier periods that is favorable for the development of natural processes.

This situation often creates some problems with water content in the flow and its use on the territory of the Kyrgyz Republic, which has a negative effect on the yield of wheat, sugar beet and fruit crops in the Chui oblast, wheat and barley in Talas oblast and some crops in Jalal-Abad and Issyk-Kul oblasts. The projected decline in the yield of crop and livestock productivity may have a most negative impact on the population and will contribute to further increase of food prices, worsening socio-economic situation, especially, in rural areas. For example, if in 1980-1990, the grain yield averaged 34 centners per hectare (in weight after processing), in the period 1996-2010 it decreased and amounted to 25.2 c/ha in 2011. Reduction of grain yield by 8.8 centners / ha resulted in significant annual shortfall of grain. The consequence of all these problems was the lowering of self-sufficiency in basic foodstuffs. In the Kyrgyz Republic 1.3 mln. people or 25% of households already have a low level of food security [5].

Recommendations

Natural and socio-economic systems is inherent to variability, their state is always changing, especially in mountainous countries. The only question is how big these changes are over time. It is also important to know – with what certainty we can estimate such changes. And that is very important – which changes may be related to climate change, and which ones – with other factors. Finally, to what extent such changes can be predicted?

Climate change, according to researchers [9], will not be a limiting factor for sustainable economic development of Kyrgyzstan as a whole during the first half of the 21st century. However, the development of response strategies (in particular, adaptation measures) for the regions, systems and sectors is needed and should be a priority task of the state. Among these "preventive" measures, apparently, it should include tasks to develop approaches and methods of adaption to the impacts of climate change which are beneficial both for the environment, in general, and for the agriculture, the main type of activity of the population in the mountain areas. Among the most important approaches there should be climate-smart agriculture approach [1].

Due to climate change, the strength and frequency of climatic natural disasters will change. This will lead to an increase of the mudflow, landslide processes and, consequently, to the loss of land and increase of a number of emergency situations which may result in significant economic and human losses. During the period from 2007 to 2011 on the territory of the Kyrgyz Republic the greatest number of emergency situations was registered in 2010 – 439, the smallest number – in 2007 – 209, and 255 emergencies were registered in 2011. Most of them were the hydrological processes (mudflows, floods, landslides, avalanches, flooding) and the meteorological phenomena (wind, hail, snow, rain). The largest number of natural and climatic processes falls on mudflows and floods which account to 29% and there is a trend of their annual increase. Thus, in 2008 there were 83 cases, in 2009 – 93, in 2010 – 131. Next emergencies by frequency are landslides (6%) and avalanches (11%) [9].

In view of the above, in order to solve the problems related to rational water management and crop yield increase, it is necessary to widen the use of socio-economic methods of irrigation that promote the efficient use of water and land resources, the reform of the economic mechanism of water relations between the state and water users [12]. It should be aimed at the gradual development of the principle of payment for water use on the basis of a flexible tariff policy regulation. In the coming years, rates for services on the use of irrigation water should be increased.

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