IRSTI 68.31 **DOI https://doi.org/10.37884/3-2023/29**

B. Mambetov [1], T. Kerteshev [1], B. Maisupova [2], A. Utebekova [1], D. Sagynbek [1]*

[1]Kazakh national agrarian research university, Almaty, Republic of Kazakhstan,
mambetov.bulkair@kaznaru.edu.kz, kerteshev.talgat@kaznaru.edu.kz, arunia190482@mail.ru,*
Daniyar_18.95@mail.ru
[2]NCJSC «S.Seifullin Kazakh Agrotechnical Research University»,
Astana, Republic of Kazakhstan, bagila.maisupova@mail.ru

RESEARCH WORK ON THE DRIED BOTTOM OF THE ARAL SEA

Abstract

The Aral ecological crisis occupies a special place among global problems and is the result of the largest human meddling in the environment on the planet. The shrinking of the Aral Sea exposed another global catastrophe: anthropogenic desertification.

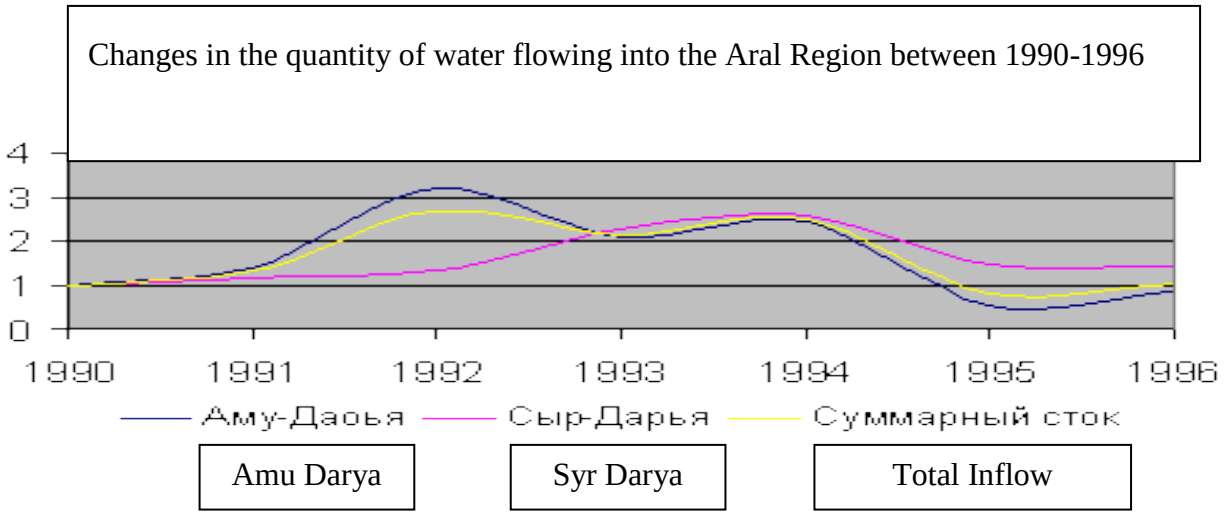
Before the Aral Sea began to dry up, it was considered to be the fourth biggest lake in the world by area after the Caspian Sea, Lake Superior (North America), and Lake Victoria (Africa). The degradation of the Aral Sea began in the 1960s when larger portions of the Syr Darya and Amu Darya were diverted for irrigation and to provide for the household needs of Turkmenistan, Uzbekistan, and southern Kazakhstan. As a result, the sea significantly withdrew from its shores and exposed the seabed, which was covered in sea salts contaminated by pesticides and other chemicals [1,2].

In today's day and age, desertification is one of the world's most serious problems. Desertification bears unexpected and undesirable consequences for mankind. The increasing land degradation accelerates the lowering of agricultural yields, which will eventually lead to the impoverishment of the local population and will cause people to migrate from their homes. For this reason, desertification is one of the most worrisome problems facing mankind today. The mitigation of the consequences of desertification can only be done by the application of large-scale action on the national and international levels with the participation of private investors.

Keywords: *Aral sea, afforestation, phytomelioration, saxaul, tamarix, forest reclamation plantations, reclamation plantings.*

Introduction

The Aral Sea ceased to exist as a unified body of water when in 1986 the Small and Big Aral Seas fully separated and in turn fragmented into a number of other bodies of water.



The change and lowering of the amount of water entering the surrounding the Aral Sea directly influenced the trends in the evaporation of the Aral Sea, which is clearly reflected on the mappings

of shrinking sea from 1960 to 2009 and correspondingly set the conditions for the growth of the ecological crisis in the Aral Basin from 1966 to 2000. The trends of the Aral Sea's evaporation are supported by the indicators on the following chart showing the stages in the growth of the ecological crisis in the Aral Basin from 1966 to 2000.

The Drying of the Aral Sea Over Time

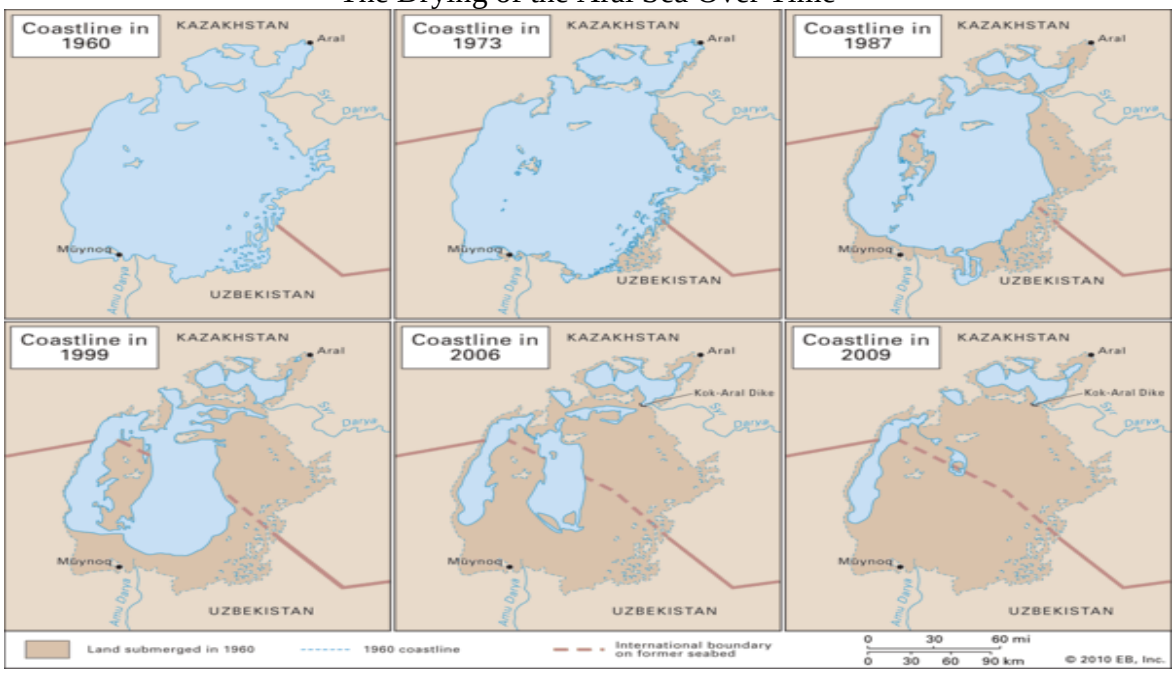


Table 1 - The Growth of the Ecological Crisis in the Aral Sea Basin (the period from 1966-2000)

Indicators	Unit of Change	1966	1976	1996	2000
Area of the "new" salt desert, which arose as a result of the drying of the sea	km^2	0	13020	38000	42000
The physical mass of salt, dust, and pollutants within the boundaries of the salt desert	Millions of tons	0	500	2300	3300
The area across which salt and dust is spreading	Thousand km^2	0 (actually had lessened the spread and had a beneficial influence on an area of 68900 km^2	100-150	250-300	400-450
The increase in the carriage of salts and dust	Kg/ha	0	100-200	500-700	700-1100
The population in the zones subject to the influence of this ecological crisis	Thousands of people	0	500-600	3000-3500	3500-7000

The ecological crisis in the region surrounding the dried seabed of the Aral Sea is very alarming. Already 6 million hectares of new land has formed after the water evaporated. In the 1920s, a similar ecological catastrophe occurred in the United States of America, although to a much lesser degree. In that case, the dried up lakebed was fed by a pipeline and periodically irrigated by a sprinkler system across the entire area. In the end, not only was the transfer of sand and salt prevented, but also local flora returned thanks to sufficient watering.

In the Republic of Kazakhstan, lands covered by saxaul cover 6.1 million hectares or about one-half of forest covered land across all Kazakhstan. The black saxaul (*Haloxylon ammodéndron)* is the most wide-spread variant covering over 4.4 million hectares or 72.1% of all saxauls. The white saxaul (*Haloxylon persicum*) covers 1.7 million hectares and the *Haloxylon ammodendron* covers about 5 thousand hectares [3,4].

Research methods and objectives of research

The black saxaul is the most common variety of saxual in Kazakhstan: it grows both in damp environments where the water table is at a depth of 3-6 m and in harsh environments where the water table is at a depth of 30 m or more. Under the best growing conditions with an easily accessible water table, the saxaul withstands salinization up to 2.460% of dense residue, and up to 1.550% of sulfur for example.

The black saxaul is typically located on floodplains, in old, dried river beds, on alluvial plains, in sandy sediments, and in between sand dunes. The most productive groups of black saxaul grow in Almaty, Zhambyl, and Kyzylorda Oblasts [5,6]. The largest area of black saxaul coverage in located in Kyzylorda Oblast where it covers 3.1 million hectares. However, most of these areas are thinly planted, and this low density weakens the defensive functions of the black saxaul.

The reproduction of black saxaul is carried out by natural regeneration and by the creation of forest cultures.

Successful natural regeneration is usually seen under the best growing conditions and after a good fruiting of the saxaul. The creation of forest cultures resulted in a wide reproduction of the saxaul. So, preference is given to planting saxauls only in light soils, in particular, in sandy sediments [7,8]. The planting of saxauls is recommended as the best way to create a forest on the seabed of the former Aral Sea.

Now, for the successful cultivation of black saxaul, the ground is plowed to a depth of 0.5 m a year before planting in order to plant these forest cultures below the salty crust. Also, sandy sediments collected in the plowed areas during the summer and moisture acquired during the winter and spring contribute to the success of the planting of these forest cultures.

For the conditions of the Aral region, the cheapest and longest-lasting method to create forests are those founded on the cultivation of saxaul plantations. After all, the saxaul is a local breed which can withstand heat and significant salinization of the soil. Also, saxauls, like other forest groups in the same community of dwarf shrubs (such as chogon, *kochia*, *halocnemum strobilaceum*, *kraschenninnikovia ceratoides*, *salsola orientalis*) and herbaceous plants (*climacoptera, astragalus,* and others), fulfill important roles in preventing soil erosion and in improving the soil quality. Besides these roles, having formed rather stable and productive pastures, saxauls may serve as the basis for transhumance and create a new habitat for rare varieties of plant and animal kingdoms.

So, since the beginning of the 1990s, the forest science and production institutions have been carrying out experimental work on afforestation in the Aral Sea region. For example, between 1988 and 1993 foresters from Kyzylorda Oblast with the assistance of the International Consortium "Aral" planted about 54 thousand hectares of saxauls on the seabed of the former Aral Sea to prevent soil erosion.

This work halted from 1995 until 2002 due to financial reasons. Then the Aral and Kazalin Forestry Institutes created about 25 thousand hectares of plantations, among those more than 2.6 thousand hectares of saplings, at the expense of funds for environmental defense from the oblasts' budget.

In 2005, The International Found for Saving the Aral Sea allocated funds for sowing saxaul across 1000 hectares and planting them across 100 hectares.

In 2006, the German Technical Cooperation Organization donates the same amount.
Since 2007, within the bounds of the project "Saving the Forests and Increasing the Forest Cover Across the Territory of the Republic" financed by the World Bank, 79.0 thousand hectares of forest plantations are planned to be planted on the seabed of the former Aral Sea. In fact, in three years this project created 34.3 thousand forest plantations: in 2011 - 14.154 thousand hectares, from which there were 11.8 thousand hectares sown in the fall; in 2012 - 15.1 thousand hectares; in 2013 - 5.1 thousand hectares of meliorative saxaul plantations. Due to the low survival rate of sowing the saxaul forest cultures in 2013 and 2014, it was decided to end the production of saxaul seeds.

As shown by the data, in only a quarter of a century the foresters of the Kyzylorda Oblast Forestry Institute and other international groups conducted afforestation work on about 125 thousand hectares of the Kazakhstani portion of the dried seabed of the Aral Sea.

Results of the study

The primary goal of the phytomeliorative work on the dried seabed of the Aral Sea is the accelerated, effective cultivation of the sediments in the Aral region including the creation of forest-meliorative plantations or hotspots for semination. As a result of this work, the created forest cultures, of which a small quantity survived, in 3-5 years began to bear fruit, seed the surrounding area, and overall aid the cultivation of the dried seabed of the Aral Sea.

In the present, the technology of cultivating forest-meliorative plantations on the dried seabed of the Aral Sea is scientifically developed and successfully applied in production. These techniques have been mastered by the specialists at the Aral and Kazalin State Institutes for the Conservation of the Forest and Animal Worlds and other organizations working in the sphere of afforestation.

The reconnaissance survey of the created forest-meliorative plantations allowed us to determine three types of forest growing conditions and the prioritize their development.

For conditions on plains the following schemes of forest plantations are recommended.

1. *Complete Coverage by Forest Cultures.* The main goal of the forest-meliorative work on the lands of the dried seabed of the Aral Sea is to prevent or to significantly lessen erosion. The demands are better answered by the complete coverage of the target area by forest plantations. So, on the soils in the desert zone that can sustain a forest, it is advisable to create plantations by forest culture type. On these soils it is recommended to create saxaul and tamarix cultures with rows 5-6 m apart and saplings every 1.0-1.5 m.

Between the ages of 5-12, the height of the trees reaches 0.7-2.5 m, and the diameter of their trunks is about 2-5 cm. If the condition of the plantation is good, the average growth is about 10-15 cm per year.

The grass component of the forest cover is sparse (up to 25%) and mostly salsola, atriplex, chogon, and *krascheninnikovia*.

2. *Meliorative Plantations.* Meliorative plantations should be created not only under the same conditions of the forest cultures, but also on loamy soils with a sandy cover. In a production order plantation may be created even on soils with a difficult lithology. On these soils the cultivation of saxaul, tamarix, and *halocnemum strobilaceum* is possible.

The placement of the plantations of saxaul and tamarix is 65 m and 35 m. However, by our observations the most advisable spacing is 35m, for there the presence of viable growth around seedlings is observed and the grass cover increases.

Meliorative plantations create two-rowed plantings. Saxaul and tamarix are planted with a spacing of 4-5 m, and the planting material every 1.5-2.0 m. Under tough vegetative conditions it is recommended to plant sarsazan with a spacing of 1 m between saplings.

3. *Hotspots of Semination* Hotspots of semination are created on all types of soil, including on honeycomb and ridged, mobile sand where afforestation is difficult. The main goal is obtaining seeds for natural reproduction. These plantations are inserted between the sand dunes and may have any configuration or cover any area. If mechanized planting is possible, it is done in the form of planting saxaul, tamarix, and sarsazan saplings. For these, the planting of tamarix is not recommended since it requires very moist soil to produce seeds.

These studies show that those saplings planted in the spring have the highest survival rate. Thus, in 3-4 years of testing the survival rate of the saxaul reached 65%, tamarix - 34%, and sarsazan 79%. In the fall they reached 24%, 34%, ad 24% respectively. So, early spring, immediately following the thaw, is the best time for planting as it provides the highest survival rate for the saplings. Spring planting should be completed in a highly compressed period of time not lasting more than ten days. The factor that increases the survival rate the most is the removal of the sandy crust from the soil (planting sapling in already prepared furrows) which increases the survival rate of the saxaul by 9.1 - 12.8%. Surrounding the tree trunks with sand dunes led to positive results in four out of five cases. There, the survival rate rises by 6.8%. The preliminary digging of furrows in the sand (with a depth of 20-23 cm and a width of 25-30 cm at the top) positively affects not only the survival rate, but also the growth of the plants. For example, between 2009 and 2010, in the planting of saxaul, the survival rate of those plants in furrows was 6.8% higher than the control (Table 2). The most significant

differences (in the survival rate of 11%, and growth - 5-7 cm) were seen in those furrows dug north to south with a mound of soil on the eastern side.

Now the government is applying urgent measures to prevent the negative socio-economic and ecological effects of desertification. According to the project "Saving the Forests and Increasing the Forest Cover Across the Territory of the Republic," between 2008-2014 58,882 thousand hectares of saxauls were planted.

Table 2 - Materials for the sowing and planting of black saxaul on the dried seabed of the Aral Sea between 2008 and 2014.

No.	Organization conducting the sowing and planting	Planting of Saplings, hectares	Survival Rate, %	Sowing of seeds, hectares	Survival Rate, %
2008					
1.	Individual Enterprise (IE) "A. Yesimov"	500	50		
	Total	500	50		
2009					
1.	Limited Liability Partner (LLP) "Zhasyl Olke"	1000	50		
2.	IE "A. Yesimov"	2000	49		
3.	IE "U. Yermanov"	1000	51		
4.	Aral State Institute (SI)	500	50		
5.	LLP "SK Maksat LTD"	500	50		
	Total	5000	50		
2010					
1.	LLP "Zhasyl Olke"	500	0		
2.	IE "A. Yesimov"	2000	23.5		
3.	IE "U. Yermanov"	500	0		
4.	Kazalin SI	1750	36	1000	2
5.	Aral SI	1750	32.5	1000	2
	Total	6500	21	2000	2
2011					
1.	LLP "Zhasyl Olke"	1090.3	4.9		
2.	IE "A. Yesimov"	1622.2	5	2269.6	2
3.	IE "U. Yermanov"	1064.1	5		
4.	Kazalin SI	2756.3	0	1056.8	3
5.	Aral SI	2756.3	0	1539.5	1
		9289	4	4865.9	2
2012					
1.	LLP "Zhasyl Olke"	2060	31.6		
2.	IE "A. Yesimov"	2000	0		
3.	IE "U. Yermanov"	1680	30		
4.	Aral SI	1840	0		
5.	Kazalin SI	2520	15	500	2.5
	Total	10100	13	500	2.5
2013					
1.	LLP "Zhasyl Olke"	2550	0		
2.	IE "A. Yesimov"	2530	45		
	Total	5080	22.5		
2014					
1.	LLP "Zhasyl Olke"	1609.4	24		
2.	IE "A. Yesimov"	2477.35	32		
3.	IE "U. Yermanov"	2500	28		
4.	Kazalin SI	2530	25		
5.	Aral SI	1531.25	27		
	Total	10648	27		
	Total for all years	47117	27	7365.9	2.16

In 2008, the planting was done by only one individual enterprise "A.Yesimov" across an area of 500 hectares. The survival rate was 50%. In 2009, the planting was carried out by five organizations across an area of 5,000 hectares with an average survival rate of 50% with standard deviation of 1%. One must take note, that during the studied years, precipitation during the spring and summer was around 150 mm which increased the survival rate of the forest cultures.

In 2010, 2011, 2012, and 2013, the survival rate of the saxaul was not very high (between 5-30%). In some areas the survival rate was even 0-5%. However, it is necessary to point out that this situation was indicative of the entire project. Throughout the project not one organization of those who took part in the project did not notice a low to an absolutely nonexistent survival rate. For example, the Limited Liability Partnership "Zhasyl Olke" in 2010 saw 0% survival, in 2011 - 4.9%, in 2012 - 31.6%, in 2013 - 45%. The same deviation in survival rate of the black saxaul forest cultures was also seen by other participating organizations. In this case, it is telling of the unsuccessful selection of location for planting.

The lowest survival rate was seen in 2011. There was a deficit of moisture both in the soil and in the air, since in this year there were tough weather conditions during the spring and summer when there was less than 100 mm of precipitation during the vegetative period, During the fall inventory the survival rate of the planting was 0-5% which was evaluated as unsatisfactory. However, as noted above, the plants that survived 3-4 years were already aiding nearby saxaul seedlings grow.

The huge territory of the dried seabed does not allow one to quickly afforest it using the methods usually used in the deserts of Kazakhstan, since that territory is constantly growing. In 2006 the dried area was 5.18 million hectares [9], and in the present is up to 6 million hectares [10]. In connection with this, for the acceleration of afforestation on the dried seabed the principles of local or hot-spot afforestation must be used, that is, create mass meliorative forest plantations with a joint introduction of hot-spots of semenation.

Since the height of the saxaul and tamarix under the conditions of the dried seabed does not pass 3 m, we consider that a 30-35 m spacing between plantations is the most advisable for two-rowed plantations. Those areas left for 3-4 years will begin to seed that land which will lead to the full afforestation of the dried seabed.

Forest-meliorative plantations will be created in two rows in already dug furrows.

Conclusions

The ecological situation surrounding the Aral Sea is not only a problem for the Central-Asian republics, but also for the whole world. The first step in the struggle against erosion is the afforestation of this region, but in connection with the fact that this region is distinguished by its wide variety of soil conditions, which means that the cultivation of erosion-preventing plantations is done with huge difficulties.

The main task of the phytomeliorative work on the dried seabed of the former Aral Sea is the accelerated and effective cultivation on the silt of the Aral region, including the creation of forest-meliorative plantations or hot-spots of semenation.

The reproduction of saxual received the best results by means of the creation of forest cultures. To conclude, our studies show that the survival rate of these forest cultures depends from 5% up to 51% on the environmental conditions of any given year.

References

1. Drop in the Water Level of the Aral Sea. Wikipedia.org http://http-wikipediya.ru /wiki/ Снижение уровня Аральского моря

2. The Aral Sea. The Republic of Kazakhstan, Natural Conditions and Resources. Almaty, 2006. p. 270-277.

3. Kushlin A., Veyen. Ch., Sattan U. Stabilization of Salt Runoff - World Bank technical document. 2003 - p. 42-43.

4. Kaverin V.S., Salimov B.A., Shakhmatov G.F. Methodical Recomendations for the Afforestation on the Dried Bottom of the Aral Sea. Shchuchye, 2009, p. 24.

5. Sychev A.A., Yerkinbekov D.K. Applications of Agrotechnology and Their Influence on the Effectiveness in Creating Black Saxaul Forest Cultures. Materials from the applied-science conference: "The Modern Condition of the Problem and Prospects for the Growth on Specially Preserved Natural Territory of the Republic of Kazakhstan," Burabai, 2010, p. 65-69.

6. Р.С.Ахметов, Мамбетов Б.Т., Кентбаев Е.Ж., Д.А. Досманбетов, Б.Б. Есимбек Termsfor creation of forest crops of blac saxaul (Haloxylon aphyllum) in west Kazakhstan. Қорқыт ата атындағы Қызылорда университеті Хабаршы республикалық ғылыми әдістемелік журналы Ауыл шаруашылық ғылымисериасы. 2022жылы, №4 (63), p.112-118

7. Абдегалиева А.Е., Мамбетов Б.Т., Бекнияз Б., Джабасов А.М., Келгенбаев Н.С. Космические методы определения оценки выноса масс пыли и шлейфах выноса бурь. НАУКА И МИР Международный научный журнал, № 1 (101), 2022, с. 31-36, ISSN 2308-4804.

8. Мамбетов Б.Т., Майсупова Б.Д., Шоманов Ж.Ш. Досманбетов Д.А. Определение динамики влажности почвы за вегетационный период в зависимости от обработки и механического состава почв. Ізденістер, нәтижелер. Исследования, результаты, 2019. - №3(83). – С. 336-342.

9. Досманбетов Д.А., Мамбетов Б.Т., Майсупова Б.Д. Отбор и размножение наименее поражаемых галлообразующими вредителями форм саксаула черного. Вестник государственного университета имени Шакарима г. Семей. - 2019. - №4 (88) . – С.240-244.

10. Novitskiy, Z.B., Wucherer W., Dimeyeva L., Ogar N. (Eds.), (2012). Aralkum - a Man-Made Desert. Ecological Studies (Analysis and Synthesis), 218. Springer, Berlin, Heidelberg.

11. https://doi.org/10.1007/978-3-642-21117-1_1636 (Accessed on November 14, 2022) Also: Central Asian Research Journal of Water Resources (2021) 7(1): 1-36

Б.Т. Мамбетов [1], Т.С. Кертешев [1], Б.Д. Майсупова [2],
А.Д. Өтебекова[1]*, Д.А. Сағынбек [1]

[1]Қазақ ұлттық аграрлық зерттеу университеті, Алматы, Қазақстан Республикасы,
mambetov.bulkair@kaznaru.edu.kz, kerteshev.talgat@kaznaru.edu.kz, arunia190482@mail.ru, Daniyar_18.95@mail.ru*

[2] «С. Сейфуллин атындағы Қазақ агротехникалық зерттеу университеті» КеАҚ, Астана қаласы, Қазақстан Республикасы, bagila.maisupova@mail.ru

АРАЛ ТЕҢІЗІНІҢ ҚҰРҒАҒАН ТАБАНЫН ЗЕРТТЕУ ЖҰМЫСТАРЫ

Аңдатпа

Арал экологиялық дағдарысы жаһандық проблемалар арасында ерекше орын алады және адамның планетадағы қоршаған ортаға ең үлкен араласуының нәтижесі болып табылады. Арал теңізінің азаюы тағы бір жаһандық апатқа әкелді, ол-антропогендік шөлейттену.

Арал теңізі құрғай бастағанға дейін ол Каспий теңізінен, Супериор көлінен (Солтүстік Америка) және Виктория көлінен (Африка) кейінгі көлемі бойынша әлемдегі төртінші көл болып саналды. Арал теңізінің деградациясы 1960 жылдары Сырдария мен Амудариянын үлкен учаскелері Түрікменстан, Өзбекстан және Оңтүстік Қазақстанның тұрмыстық қажеттіліктерін суару және қамтамасыз ету үшін бөлінген кезде басталды. Нәтижесінде теңіз өз жағалауларынан едәуір алыстап, пестицидтермен және басқа химиялық заттармен ластанған теңіз тұздарымен жабылған теңіз түбін ашты [1,2].

Бұл күндері шөлейттену әлемдегі ең маңызды мәселелердің бірі болып табылады. Шөлейттену адамзат үшін күтпеген және жағымсыз салдарға әкеледі. Жердің деградациясының күшеюі егін өнімділігінің төмендеуін тездетеді, бұл сайып келгенде жергілікті халықтың кедейленуіне әкеліп соғады және адамдарды үйлерінен кетуге мәжбүр етеді. Осы себепті шөлейттену-бүгінгі адамзат алдында тұрған ең алаңдатарлық мәселелердің бірі. Шөлейттенуді жеңілдетуге жеке инвесторлардың қатысуымен ұлттық және халықаралық деңгейде кең ауқымды шаралар қабылдау арқылы ғана қол жеткізуге болады.

Кілт сөздер: Арал теңізі, орман өсіру, фитомелиорация, Сексеуіл, тамарикс, орман мелиорациялық екпелер, мелиорациялық екпелер.

Б.Т. Мамбетов [1], Т.С. Кертешев [1], Б.Д. Майсупова [2],
А.Д. Утебекова[1] *, Д.А. Сагынбек [1]
Казахский национальный аграрный исследовательский университет,
г.Алматы, Республика Казахстан, mambetov.bulkair@kaznaru.edu.kz,
kerteshev.talgat@kaznaru.edu.kz, arunia190482@mail.ru, Daniyar_18.95@mail.ru*
[2]НАО «Казахский агротехнический исследовательский университет им.
С.Сейфуллина», г. Астана, Республика Казахстан, bagila.maisupova@mail.ru

ИССЛЕДОВАТЕЛЬСКИЕ РАБОТЫ ВЫСОХШЕГО ДНА АРАЛЬСКОГО МОРЯ

Аннотация

Аральский экологический кризис занимает особое место среди глобальных проблем и является результатом крупнейшего вмешательства человека в окружающую среду на планете. Сокращение площади Аральского моря привело к еще одной глобальной катастрофе: антропогенному опустыниванию.

До того, как Аральское море начало высыхать, оно считалось четвертым по величине озером в мире по площади после Каспийского моря, озера Верхнее (Северная Америка) и озера Виктория (Африка). Деградация Аральского моря началась в 1960-х годах, когда большие участки Сырдарьи и Амударьи были отведены для орошения и обеспечения бытовых нужд Туркменистана, Узбекистана и Южного Казахстана. В результате море значительно отошло от своих берегов и обнажило морское дно, которое было покрыто морскими солями, загрязненными пестицидами и другими химическими веществами [1,2].

В наши дни опустынивание является одной из самых серьезных проблем в мире. Опустынивание влечет за собой неожиданные и нежелательные последствия для человечества. Усиливающаяся деградация земель ускоряет снижение урожайности сельскохозяйственных культур, что в конечном итоге приведет к обнищанию местного населения и заставит людей покидать свои дома. По этой причине опустынивание является одной из наиболее тревожных проблем, стоящих сегодня перед человечеством. Смягчение последствий опустынивания может быть достигнуто только путем принятия широкомасштабных мер на национальном и международном уровнях с участием частных инвесторов.

Ключевые слова: Аральское море, эрозия, фитомелиорация, саксаул, тамарикс, лесомелиоративные насаждения, мелиоративные насаждения.

ҒТАМР 37.29.15 **DOI https://doi.org/10.37884/3-2023/30**

*Т.А. Тілләкәрім[1,2]*ORCID, А.М. Кауазов[1] ORCID, А. Гауфров[3] ORCID, С.Б. Саиров[2] ORCID*

[1]әл-Фараби атындағы Қазақ ұлттық университеті, Алматы қ., Қазақстан,
tillakarimtursyn@gmail.com, kauazov.azamat@kaznu.kz*
[2]«Қазгидромет» РМК, Астана қ., Қазақстан, sairov_s@meteo.kz
[3]Неміс жер туралы ғылымдарды зерттеу орталығы (GFZ), Потсдам, Германия,
gafurov@gfz-potsdam.de

НҰРА-САРЫСУ СУШАРУАШЫЛЫҚ АЛАБЫНДА ҚАР ЖАМЫЛҒЫСЫ ЫЛҒАЛ ҚОРЫНЫҢ УАҚЫТТЫҚ-КЕҢІСТІКТІК ӨЗГЕРУІ

Аңдатпа

Мақалада Нұра-Сарысу сушаруашылық алабында тұрақты қар жамылғысының орнатылуы, бұзылуы, орташа күндер саны мен қар жамылғысы ылғал қорының уақыттық-кеңістіктік өзгеруі және оның статистикалық сипаттамалары берілген. Жұмыстың негізгі мақсаты қар жамылғысының ылғал қорының өзгеру динамикасын зерттеу болып табылады, өйткені қар жамылғысы климаттық, гидрологиялық және гляциологиялық процестерде