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МУНДАРИЖА

АТРОФ-МУҲИТНИ МУҲОФАЗА ҚИЛИШ ВА БАРҚАРОР РИВОЖЛАНИШ

АТМОСФЕРА ВА ИҚЛИМШУНОСЛИК

БИОХИЛМА-ХИЛЛИК ВА БИОЛОГИК ХАВФСИЗЛИК

СУВ ВА СУВ РЕСУРСЛАРИНИ МУҲОФАЗА ҚИЛИШ

ЕР ВА ТУПРОҚ МУАММОЛАРИ, ЕР РЕСУРСЛАРИДАН ОҚИЛОНА ФОЙДАЛАНИШ

ЧИҚИНДИЛАР УТИЛИЗАЦИЯСИ

ЭКОЛОГИК СОФ ТЕХНОЛОГИЯЛАР

ЭКОЛОГИК ТАЪЛИМ ВА ТАРҒИБОТ

ЭКООЛАМ

OROL DENGIZI MINTAQASIDA CHANG VA QUM BO'RONLARI KO'CHISHINING SO'NGGI 30 YIL ICHIDAGI ILMIY-TADQIQOT ISHLARI TAHLILI

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Annotatsiya. *Orol fojiasini butun dunyoda insoniyatning tabiatga halokatli ta'sirining namunasi sifatida ko'rish mumkin. Orol dengizining ekologik muammosi Markaziy Osiyo uchun so'nggi ellik yil ichida sezilarli ta'sir ko'rsatdi. Orolbo'yi mintaqasi hududlari bo'yicha so'nggi 30 yillik tadqiqotlar tez-tez chop etilib kelinmoqda va ingliz hamda rus tilida chop etilgan maqolalarning bir qismini ko'rish mumkin. Ammo bu 30 yil davomida Orol dengizi bo'yicha tadqiqot ishlari turli mavzu va yo'nalishlarda olib borilgan. Mazkur maqolada yillar bo'yicha tadqiqotlar tahlili, qaysi olimlar tomonidan ilmiy ishlar chop etilganligi va mablag'lar tahlili o'tkazildi. Chop etilgan Scopus ma'lumotlar bazasida ingliz tilidagi maqolalar tahlil qilindi. Ma'lumotlar Scopus bazasida 1992-yildan 2021-yilgacha chop etilgan maqolalar davrini qamrab oldi. Ushbu tadqiqotda Orol dengizida qaysi olimlar tomonidan, yillar bo'yicha olib borilgan tadqiqotlar va yirik tadqiqot institutlari kabi toifalarni ko'rib chiqish orqali amalga oshirildi. Tadqiqot natijasida ushbu sohadagi dolzarb ilmiy ishlar muammolari haqida bilim va ko'nikmaga ega bo'lish imkoniyatini beradi.*

Kalit so'zlar: *Orol dengizi, chang, qum bo'ronlari, maqolalar, adabiyotlar, ekologik muammolar.*

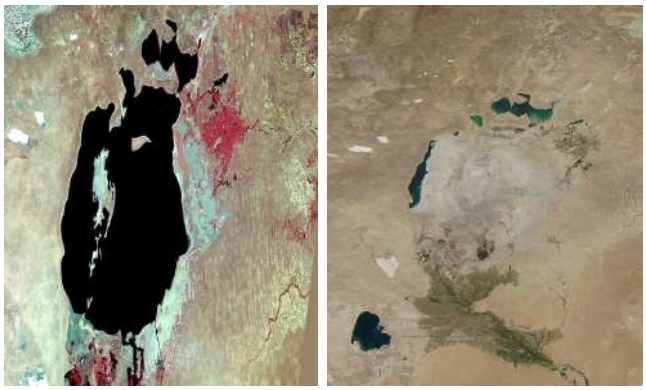
Аннотация. *Трагедию острова можно рассматривать как пример разрушительного влияния человечества на природу во всем мире. Экологическая проблема Аральского моря оказала значительное влияние на Центральную Азию за последние пятьдесят лет. Исследования регионов островного региона за последние 30 лет часто публиковались, и некоторые из статей, опубликованных на английском и русском языках, можно найти здесь. Однако в течение этих 30 лет исследовательская работа по Аральскому морю велась по разным темам и направлениям. В данной статье проведен анализ исследований по годам, которыми ученые опубликовали научные работы, а также анализ фондов. Были проанализированы англоязычные статьи, опубликованные в базе данных Scopus. Данные охватили период статей, опубликованных в базе данных Scopus с 1992 по 2021 год. В этом исследовании это было сделано путем рассмотрения таких категорий, как, какие ученые проводили исследования в Аральском море, по годам и по основным научно-исследовательским институтам. В результате исследования предоставляется возможность приобрести знания и навыки о проблемах актуальной научной работы в данной области.*

Ключевые слова: *Аральское море, пыльные и песчаные бури, статьи, литература, экологические проблемы.*

Abstract. *The tragedy of the island can be seen as an example of the destructive influence of mankind on nature throughout the world. The environmental problem of the Aral Sea has had a significant impact on Central Asia in the last fifty years. The past 30 years of research on the regions of the island region have been published frequently, and some of the articles published in English and Russian can be found here. However, during these 30 years, the research work on the Aral Sea was carried out in different topics and directions. In this article, an analysis of research by years, which scientists published scientific works, and an analysis of funds was conducted. English-language articles published in the Scopus database were analyzed. The data covered the period of articles published in the Scopus database from 1992 to 2021. In this study, it was done by looking at categories such as which scientists conducted research in the Aral Sea, by year, and by major research institutes. As a result of the research, it provides an opportunity to acquire knowledge and skills about the problems of actual scientific work in this field.*

Keywords: *Aral Sea, dust and sand storms, articles, literature, environmental problems.*

Kirish. Orol dengizi O‘rta Osiyo pasttekisligida joylashgan yirik sho‘r suvli ko‘l edi[1]. Hududdagi katta baliqchilikni qo’llab-quvvatlashdan tashqari, dengiz mintaqaviy transport uchun eng muhim yo’nalishlardan biri bo’lib xizmat qilgan. 1960-yildan boshlab Orol dengizi tez quriydi va sho‘rlanadi[2]. Bu, asosan, Amudaryo va Sirdaryoning ikki irmog‘ini quritib, deltalariga jiddiy zarar yetkazgan sug‘orishning beqaror kengayishi natijasidir[3]. So’nggi o’ttiz yillikda sohaga doir ekologik muammolar bo’yicha tadqiqotlar va ilmiy ishlar ko’paydi[4]. Ushbu tadqiqotdan asosiy maqsad 1992-2021-yillar davomida Orolbo‘yida chang bo‘ronlari va changning ko‘tarilish muddati masalasi bo‘yicha chop etilgan maqolalarni ko‘rib chiqishdan iborat. Ushbu tadqiqotga muvofiq, biz 1992-2021-yillar davomida xalqaro Scopus ma’lumotlar bazasida chop etilgan 118 ta maqolani to‘pladik, ko‘rib chiqdik va tahlil qildik hamda Orolbo‘yining ekologik muammolarini tushunish uchun ma’ruzalar to‘plandi[5]. So‘nggi uch o‘n yillikda Orol dengizining tez qisqarishi dengiz havzasidagi ekologik muhitning tezlik bilan yomonlashishiga olib keldi (1-rasm).



1992-yil **2021-yil**

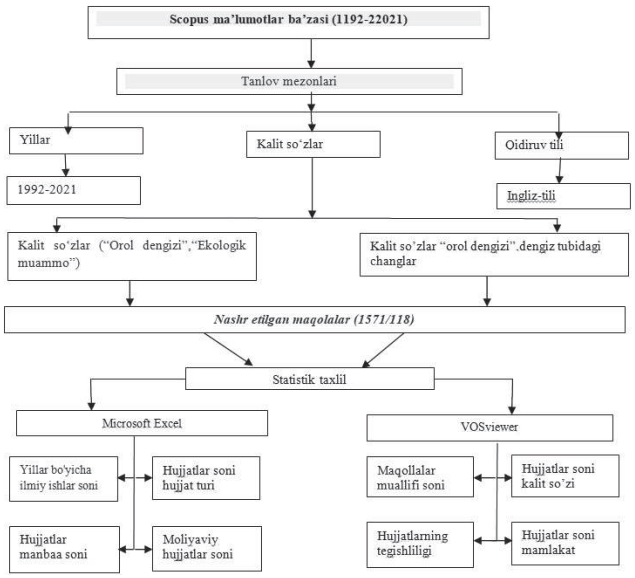
1-rasm. 1992-yildan 2021-yilgacha Orol dengizining qisqarishi (Source:http://earthdata.nasa.gov)

Orol dengizi havzasida sho‘rlanish va cho‘llanish jarayonlari tobora kuchayib bordi. Shu bilan birga, hududlardagi suv resurslari muammosi dengiz havzasidagi ekologik inqirozni yanada kuchaytirmoqda[6]. Shuning uchun ham ushbu mintaqadagi ekologik o’zgarishlarning tendentsiyalari va sabablarini ochib berish muhim ahamiyatga ega[7,8]. Orol dengizi hududining boy ekotizimlariga katta zarar yetkazildi. Bunda yer osti suvlari sathining pasayishi natijasida ko‘lga oqib tushadigan daryolarning qirg’oqlari katta zarar ko‘rgan, bu esa hudud cho‘llanishining kengayishiga olib kelgan[9]. Orol dengizi yuzasida to’plangan tuzlar deyarli hech narsa o’smaydigan qatlamlarni hosil qiladi[10]. Asosiy va irmoqli suv oqimlari bo’ylab noyob o’rmonlarining kengligi keskin qisqartirildi. 90-yillardan boshlab butun dunyo Orol dengizining ekologik muammosidan xabardor bo’lib, ushbu tadqiqotga doir ilmiy izlanishlar boshlandi[11]. Shuning uchun ham shu davrdan boshlab Orol dengizining tez qurishi bosqichi boshlandi. Mintaqada cho‘llanish jarayonlarining tezlashishi natijasida yangi cho‘l — Orolqum cho‘li paydo bo‘ldi[12]. So‘nggi bir necha o‘n yilliklarda Orolqum cho‘li mintaqadagi chang va tuz bo‘ronlarining yangi “qaynoq nuqtasi”ga aylandi[9]. Chang bo’ronlari va ularning kelib chiqishi haqidagi ma’lumotlarni tahlil qilish va tadqiq qilish ishlari boshlandi[3]. Ushbu tadqiqotda mavzuga doir bo’lgan ilmiy ishlarni tahlili amalga oshiriladi. Yangi Orolqum cho‘lida yer qoplamining o‘zgarishlarini tahlil qilishga alohida e’tibor beriladi[13]. Orolqum cho’lidan ko’tarilgan chang bo’ronlari ta’siri tobora kuchayib bordi. Yer yuzasi qoplamining asosiy o‘zgarishi o‘simliklar va mayda suv havzalarining sezilarli darajada qisqarishi, sho‘r botqoqlar va qumli massivlar maydonining sezilarli darajada ko‘payishi bilan bevosita bog’liq[14].

Orolda chang va qumlarni tashish diapazoni, intensivligi va davomiyligi atmosfera qobig’ida bo’ladigan o’zgarishlar va ularning dinamikasi bilan belgilanadi[15,16]. Ilmiy tadqiqotlar va chop etilgan maqolalarda Markaziy Osiyo va uning iqlimiga eng kuchli ta’sir ko‘rsatuvchi parametrlar sifatida uchta omil muhokama qilinadi[14,17]. Bu omillar qatoriga Orol dengizining qurishini ham kiritishimiz mumkin. Orol dengizining qurishi va uning o‘rnida hosil bo‘lgan Orolqum cho‘lida hosil bo’lgan cho‘kindilari tufayli zaharli ifloslantiruvchi moddalar yuqori konsentratsiyaga ega, shuning uchun dengiz tubida paydo bo‘ladigan qum changlari ham zaharli bo‘lishi mumkin[18,19]. Masalan, Orol dengizi suvi cho‘kindisi tarkibidagi tuzlarning kukunli qoldig‘i bo‘lib, o‘zining kristall tuzilishi tufayli o‘pka to‘qimasini yorib yuborishi mumkin va o‘pka kasalliklarining asosiy sabablaridan biri hisoblanadi[20–22]. Shuningdek, 2000-yillarda dengiz qurigan tubidagi tuz va changining inson salomatligiga ta’sirini tahlil qilish bo’yicha bir nechta ilmiy tadqiqotlar hamda ilmiy izlanishlar o’tkazildi. Ushbu tadqiqot ishlarida qum va chang zarralari tashish jarayonida ularning fizik-kimyoviy xususiyatlari o’zgarishi va qisman turli alomatlar va kasalliklarga olib kelishi, kimyoviy reaksiyalarga kirishishi mumkin va buni mintaqadagi mayda qum changlarining ta’siri bilan bevosita bog’lash mumkin. [23].

2. Metodologiya

Mazkur tadqiqot ishida 1992-2021-yillar davomida jami 1689 ta nashrlar yuklab olingan va Scopus ma’lumotlar bazasidan ikki guruh kalit so‘zlardan foydalangan holda ko‘rib chiqilgan, birinchisi: “Orol dengizi” va “Ekologik muammo” (1571 ta maqola), ikkinchisi: “Orol dengizi” hamda “chang”. (118 ta maqola). Tadqiqotda qancha maqola nashr etilganligini va yillar bo‘yicha sonini bilish uchun Orol dengizi va ekologik muammolarga oid barcha maqolalar kalit so‘zlarining birinchi guruhidan tanlab olindi[5]. Ikkinchi kalit so’zlardan foydalanib, chang va qum bo’ronlari muammolariga bog’liq barcha ilmiy nashrlar tanlangan[24]. Tadqiqotda maqolalar nashr etilgan yiliga ko‘ra toifalangan[25]. Shundan so’ng, barcha ko’rib chiqilgan maqolalar uchun ma’lumotlar bazasi kengaytirildi, jumladan nashr etilgan yil va turi, muallifning ismi, bog’langan mamlakat, jurnal nomi, iqtiboslar, ko’chkini baholash uchun qo’llaniladigan model turi va modelga kiritilgan tur omillar **(2-rasm).**



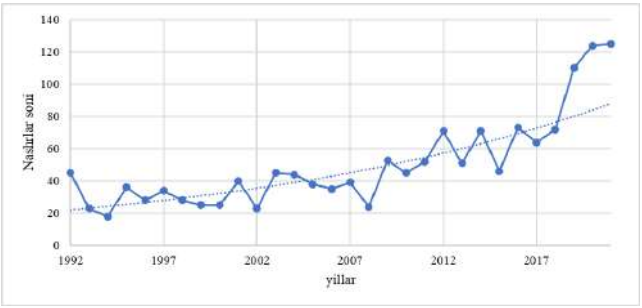
2-rasm Tadqiqot uchun metodologiya sxemasi.

Maqolalar bilan tanishib chiqqandan so'ng, hududda changning paydo bo'lishiga ta'sir qiladigan omillarga Microsoft Excel va VOS viewer dasturiy vositalaridan foydalangan holda statistik tahlil qo'llanildi.

3. Natijalar va muhokama

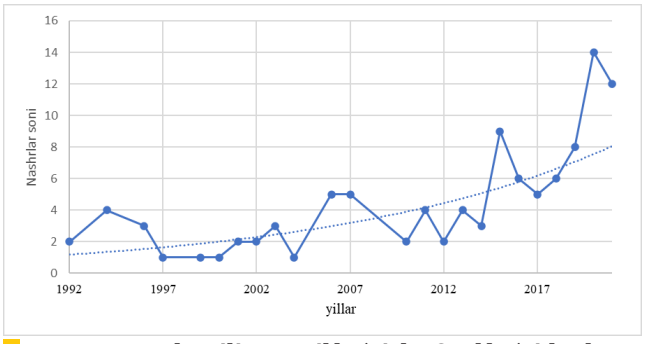
3.1. Nashrlar tendentsiyasi

1992-2021-yillarda Orol dengizi ekologik muammolari bo'yicha 1689 ta maqola chop etilgan (1,2-rasm), olingan maqolalarning 1571 tasi 1992-2021-yillarda (Orol dengizi, Ekologik muammolar) kalit so'zlar asosida chop etilgan. Yiliga o'rtacha chop etilgan maqolalar soni 54 tani tashkil qilgan. Birinchi o'n yillikda (1992-2002-yillarda) o'rtacha 32 tani, so'nggi o'n yillikda (2011-2021) o'rtacha 86 tani tashkil etadi. Tadqiqot natijalarimiz yana shuni isbotladiki, 2012-yilgacha xalqaro jurnallarda chop etilgan maqolalar soni ortib bormoqda, keyin esa sezilarli o'sish tendentsiyasi kuzatildi (1-rasm).



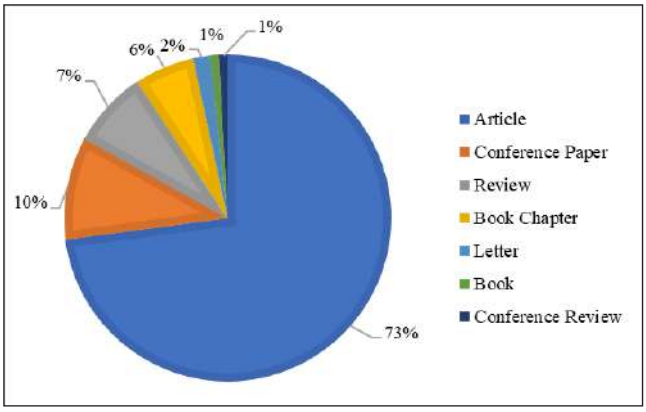
3-rasm. Orol dengizining ekologik muammolari mavzusidagi maqolalar nashr etilgan yil bo'yicha.

1992-yildan 2021-yilgacha Orol dengizida chang va uning oqibatlari haqida 118 ta maqola chop etilgan. Orolning ekologik muammolariga bag'ishlangan maqolalarni ko'rib chiqish. Bu maqolalar 2015-yildan so'ng ko'paya boshladi. 2010-yillarga kelib bu hududlarda chang va chang bo'roni muammosi keskinlashdi va asosiy ilmiy tadqiqotchilar aynan e'tiborini ushbu yo'nalishga qaratishdi va tadqiqot natijalari 2015-yildan e'lon qilindi.



4-rasm. Nashr qilingan yil bo'yicha Orol bo'yida chang mavzusidagi maqolalar soni.

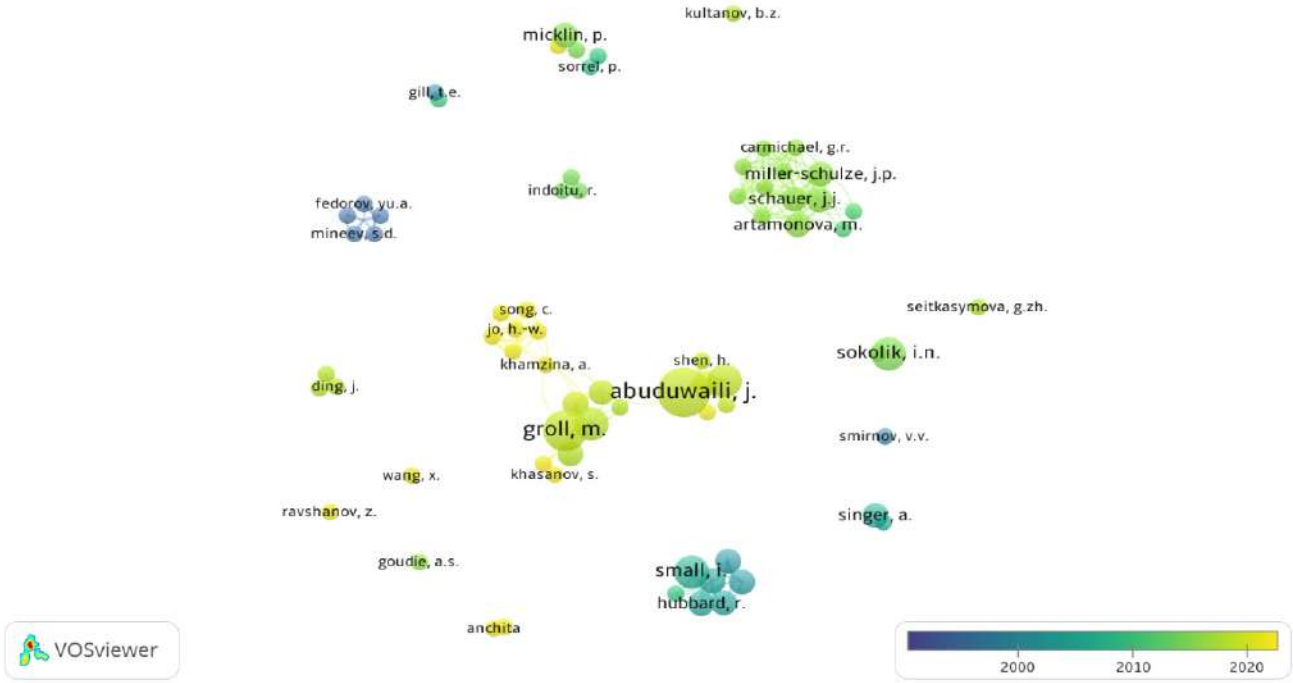
Bundan tashqari, bizning tadqiqotimiz shuni ko'rsatadiki, 118 ta maqolaning aksariyati 86% yoki 73% ilmiy jurnal maqolalari, keyingi navbatda konferentsiya materiallarida 12% yoki (10%) maqola, 9% yoki (7%) taqriz maqolalari, 7 (6%) kitoblar va boshqalar hamda darsliklarda chop ettirilgan (5-rasm).



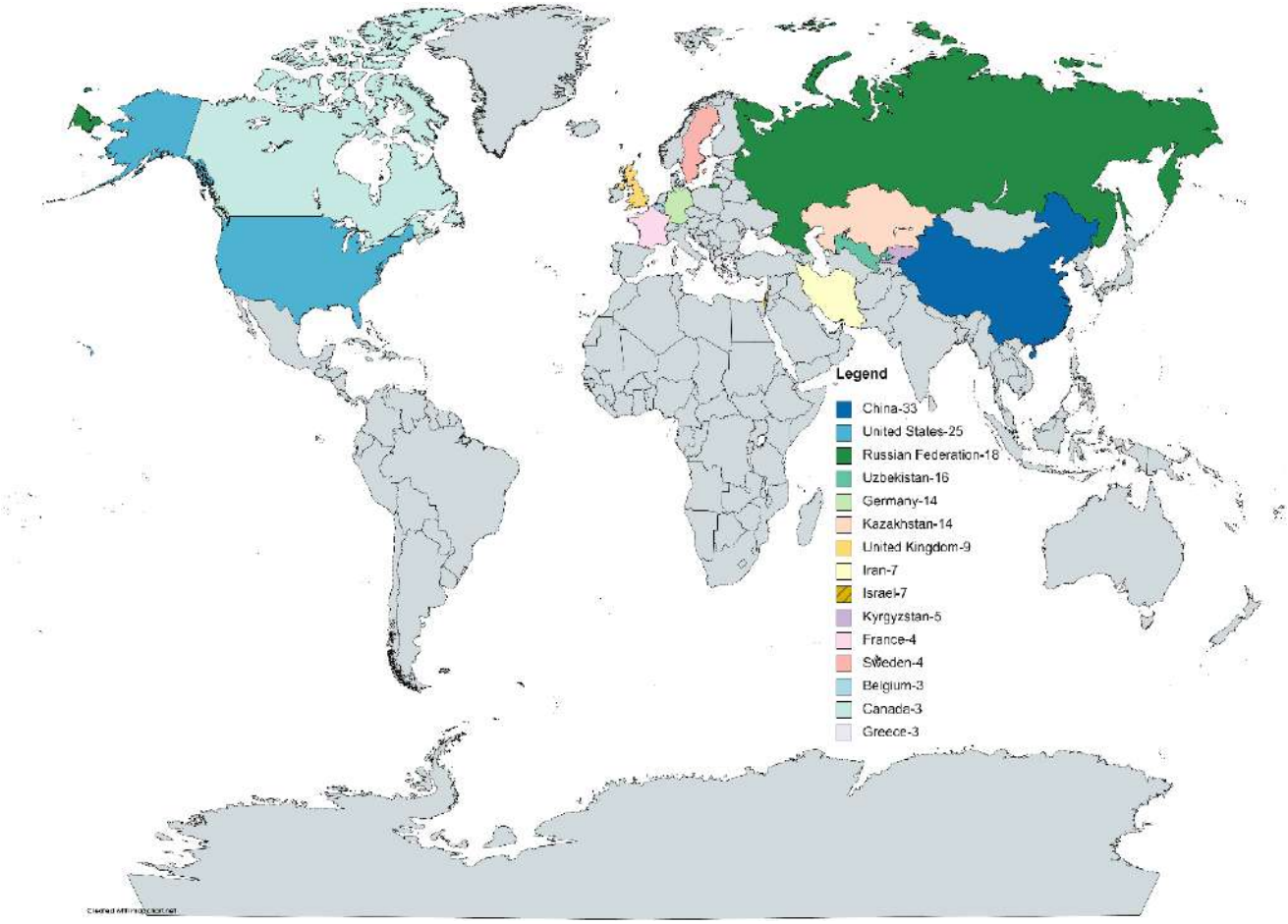
5-rasm. Ko'rib chiqilgan nashrlar turi.

Mazkur tadqiqotda olib borilgan tahlillarimiz shuni ko'rsatdiki, 1992-2021-yillarda Orol dengizining chang va chang bo'ronlari bo'yicha 13 davlatdan 57 nafar olim tadqiqot va ilmiy ishlar olib borgan. Olimlar orasida Abuduwalii 8 ta nashriyot bilan ustunlik qildi, 6 ta maqola bilan Groll, 5 ta maqola bilan Opp va Semenov, 4 ta tadqiqot natijalari bilan Aslanov va Issanovalar tadqiqot guruhida keltirilgan. Tadqiqotning qizig' tomoni shundaki, Miklin, Dannils, Oxara, Shauer, Artamonova, Ding, Ma, Ge, Vereshagina va Singer kabi o'nta mualliflarning har biri Orol dengizidagi chang va chang bo'ronlari haqida jami uchta maqola yozgan. 43 tadqiqotchidan 29 tasi 1992-2021-yillarda bitta maqola yozganligi bilan ajralib turadi (6-rasm).

Ilmiy ishimizda chop etilgan maqolalarni vaqt bo'yicha tahlil qilsak. Fedorov, Singer va Small kabi olimlar guruhlari 1990-yillarda nashr etilgan va hozirda bu yo'nalishda nashr etilgan maqolalar mavjud emas, Schauer va Atamanova boshchiligidagi guruh o'z ilmiy tadqiqotlarini 2000-yillarda nashr etgan. Bu yo'nalishda 2010-yildan keyin Abuduwaili va Opp, Groll guruhlari o'z maqolalarini nashr etganini ko'rish mumkin. Shu bilan birga, Xamzina, Anchita, Vang, Ravshanov



6-rasm. 1991-2021-yillarda eng ko'p yozilgan maqola mualliflari ro'yxati.



7-rasm. Mamlakatlar tomonidan chop etilgan maqolalar
(ma'lumotlar manbai: Scopus va www.mapchart.net yordamida yaratilgan)

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TEMPORAL TRENDS IN TEMPERATURE AND PRECIPITATION VARIABILITY IN THE KASHKADARYA DISTRICT: A THREE-DECADE ANALYSIS

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Abstract. *The average temperature of the planet has risen by 1.1°C compared to the time before the industrial revolution. This increase is expected to continue. The concentration of carbon dioxide in the Earth’s atmosphere has increased by more than 40% since the industrial revolution, mainly due to the burning of fossil fuels. The Climate Research Unit (CRU) of the University of East Anglia provides a range of high-resolution climate datasets, including the High Resolution Gridded (HRG) dataset, which was used in this research. Besides, interpolation is a technique used in spatial analysis to estimate values of a variable at unsampled locations within a study area based on the values of the variable at sampled locations. According to the results, in Kashkadarya, precipitation amount was ranged in between 140 to 628 mm for 2000. It was found that higher precipitation was 628 mm reported in the North-Eastern part of Kashkadarya, which is mountainous area such as Shakhrisabz and Kitab districts. It was reported that the lowest precipitation 140 mm for the same period, which was observed mainly in flat area of the region, which is more dessert areas with lower amount greenness*

Keywords: *Climate change, precipitation, temperature, GIS, drought.*

Annotatsiya. *Sayyoramizning o'rtacha harorati sanoat inqilobidan oldingi vaqtga nisbatan 1,1 °C ga ko'tarildi. Bu o'sish davom etishi kutilmoqda. Yer atmosferasidagi karbonat angidrid konsentratsiyasi sanoat inqilobidan keyin, asosan, qazib olinadigan yoqilg‘ilarning yonishi hisobiga 40% dan ko‘proqqa oshdi. Ushbu tadqiqotda, Sharqiy Angliya universitetining Iqlim tadqiqotlari bo'limi (CRU) yuqori aniqlikdagi iqlim ma'lumotlar to'plami (High Resolution Gridded) dan foydalanilgan. Shuningdek, ushbu tadqiqotda, interpolyatsiya usulidan ya`ni bu fazoviy tahlilda o'zgaruvchining tanlanma joylaridagi qiymatlari asosida o'rganilayotgan hududdagi ma`lumotlar mavjud bo`lmagan joylarda o'zgaruvchining qiymatlarini baholash maqsadida foydalanilgan. Natijalarga ko'ra, Qashqadaryo viloyatida 2000 yilda yog'ingarchilik miqdori 140-628 mm oralig'ida bo'lgan. Qashqadaryoning shimoliy-sharqiy qismida, ya'ni Shahrisabz va Kitob tumanlari kabi tog'li hududlarda yog'ingarchilik miqdori 628 mm gacha ko'proq bo'lganligi aniqlangan. Ma'lum qilinishicha, ayni davrda eng kam yog'ingarchilik 140 mm bo'lib, bu asosan viloyatning tekislikda joylashgan hududlariga, ya'ni yashilligi past bo'lgan cho`l hududlarida kuzatilgan.*

Kalit so'zlar: *Iqlim o'zgarishi, yog'ingarchilik, harorat, GIS, qurg'oqchilik.*

Абстрактный. *Средняя температура планеты повысилась на 1,1°C по сравнению с периодом до промышленной революции. Ожидается, что этот рост продолжится. Концентрация углекислого газа в атмосфере Земли увеличилась более чем на 40% после промышленной революции, в основном за счет сжигания ископаемого топлива. Группа климатических исследований (CRU) Университета Восточной Англии предоставляет ряд наборов климатических данных с высоким разрешением, включая набор данных с координатной сеткой высокого разрешения (HRG), который использовался в этом исследовании. Кроме того, интерполяция — это*

метод, используемый в пространственном анализе для оценки значений переменной в точках без выборки в пределах изучаемой области на основе значений переменной в точках выборки. Согласно результатам, в Кашкадарье количество осадков колебалось от 140 до 628 мм за 2000 год. Было установлено, что более высокое количество осадков было 628 мм в северо-восточной части Кашкадарьи, которая представляет собой горную местность, такую как Шахрисабзский и Китабский районы. Сообщалось, что наименьшее количество осадков 140 мм за тот же период наблюдалось в основном в равнинной части региона, которая является более пустынной, с меньшим количеством зелени.

Ключевые слова: *изменение климата, осадки, температура, ГИС, засуха.*

1. Introduction.

The global mean temperature of the Earth has undergone a substantial increase of 1.1 °C relative to the pre-industrial epoch, and it is anticipated to exhibit a persistent upward trend [1,2]. Following the onset of the industrial revolution, there has been a notable surge of over 40% in the concentration of carbon dioxide (CO2) within the Earth's atmosphere, primarily ascribed to the combustion of fossil fuels. The Arctic's ice cover has been diminishing at an average rate of approximately 13.3% every ten years, resulting in a rise in sea levels and alterations in meteorological patterns [3,4]. The phenomenon of climate change is inducing a higher frequency and greater intensity of extreme weather incidents, such as hurricanes, heat waves, and droughts. Furthermore, the consequences of climate change tend to have a disproportionate impact on marginalized groups, including individuals and communities with limited financial resources and indigenous peoples.

The effects of climate change on water resources management have global ramifications. Uzbekistan, a landlocked country located in Central Asia, is particularly vulnerable due to its semi-arid climate, limited water resources, and heavy reliance on agriculture [5,6]. The country is dependent on the Amu Darya and Syr Darya rivers, which provide water for its population, agricultural practices, and industrial activities [2,7]. However, due to its location in one of the world's driest regions, Uzbekistan is already experiencing severe water scarcity and management obstacles.

The agricultural sector in Uzbekistan consumes 90% of the country's water supply, which is already under stress. This demand is anticipated to rise with the growth of the population and economic expansion, intensifying the need for proper water resource management [8,9]. Climate change is expected to aggravate the existing water scarcity in Uzbekistan due to various factors. The rise in temperature and modifications in precipitation patterns could potentially decrease the water flow in rivers and increase evaporation rates, resulting in reduced water availability for both agricultural and domestic purposes. Furthermore, the glaciers in the mountainous regions that serve as the sources of the rivers could experience melting, which may lead to a long-term decline in water supply [10].

Aside from decreasing water availability, climate change may heighten the occurrence and intensity of extreme weather phenomena like droughts and floods, posing a threat to water infrastructure and disrupting water supply further [11]. These situations can cause economic losses and intensify social and political tensions. Uzbekistan has been implementing various measures to improve water management and boost water efficiency, including modern irrigation systems and water-saving technologies, minimizing water waste from leaking pipes, and promoting the cultivation of water-efficient crops. However, there is still a necessity to take more action to guarantee the sustainable use of water resources against the impacts of climate change.

The Kashkadarya region, located in the southeastern part of Uzbekistan, is particularly vulnerable to the adverse impacts of climate change due to its positioning in the most water-scarce and arid region of the country [12-14]. The area has a continental climate, with hot summers and cold winters, and an annual precipitation level of approximately 200-300 mm that is unevenly distributed throughout the year. The Kashkadarya River, which originates in the Pamir Mountains of Tajikistan and flows through the region before flowing into the Aral Sea, is the primary source of water in the area. The river is extensively utilized for various purposes such as irrigation, drinking water supply, and hydropower generation. However, its flow fluctuates significantly, depending on the amount and timing of snow and glacier melt in the upstream areas [11].

Global warming is predicted to cause significant changes in temperature and precipitation patterns in Uzbekistan's Kashkadarya region and other parts of the country, as per climate models. The Intergovernmental Panel on Climate Change (IPCC) anticipates a temperature rise of 3-5°C by the end of the 21st century in Central Asia, along with a 10-20% decrease in annual precipitation [1]. The impact of these changes will likely exacerbate the region's current water scarcity concerns, which are amplified by inefficient irrigation practices, population growth, and elevated water demand from various sectors. One of the most notable impacts of climate change on water resources in Kashkadarya is likely to be a reduction in water availability. As temperatures increase and precipitation decreases, the quantity of water in the Kashkadarya River and its tributaries is expected to drop, affecting the region's agriculture and economy. Uzbekistan is a top producer of cotton globally, and the crop heavily relies on water from the Kashkadarya River for irrigation. A reduction in water availability can result in a decrease in cotton yields, which could have significant repercussions for the country's economy and employment [15].

The impact of climate change on water resources in the region of Kashkadarya is expected to include a higher frequency and severity of droughts, which can have various adverse effects on agriculture, livestock, human health, and the envi-

ronment [12]. A severe drought in 2018 already caused crop yield reductions and a shortage of drinking water. Moreover, climate change is expected to alter the timing and volume of river flows, which may affect irrigation, drinking water, and hydropower generation. The direct impacts of water scarcity on different users can lead to conflicts, migration, and negatively impact social well-being [7]. These impacts are compounded by the inefficient use of water resources, population growth, and increasing demands for water from different sectors. Cotton, one of Uzbekistan's significant crops, is heavily irrigated using water from the Kashkadarya River, and a decline in cotton yields due to water scarcity could have a significant impact on the country's economy and employment.

2 Materials and Methods

2.1. Study area

The Kashkadarya region, situated in the southern part of Uzbekistan, lies adjacent to the Pamir Mountains. The area is flanked by the Karakum Desert to the north, the Kyzylkum Desert to the west, and the Amu Darya River to the east. Kashkadarya is reputed for its fertile soil, which is conducive to agricultural practices [13].

Kashkadarya is renowned for its fertile soil composition, consisting of alluvial deposits and loess, which contain rich nutrients. The soil type prevalent in the region is sandy loam, characterized by a blend of sand, silt, and clay, making it optimal for cultivating crops such as cotton, wheat, and fruits. The region experiences a continental climate marked by hot summers and cold winters, with mean temperatures ranging from 7°C in January to 30°C in July. Kashkadarya receives the majority of its rainfall in the spring and fall, with an average annual precipitation of around 250mm. Its climate is considered arid, with low humidity levels and a high rate of evaporation [12].

2.2. Materials

Digital Elevation Model (DEM) was obtained from Earth-Data website(https://www.earthdata.nasa.gov/) to indicate location of study area, Kashkadarya.

The Climate Research Unit (CRU) of the University of East Anglia provides a range of high-resolution climate datasets, including the High Resolution Gridded (HRG) dataset [16], which can be accessed via their website: https://crudata.uea.ac.uk/cru/data/hrg/. The HRG dataset is a high-resolution global land surface dataset, with a spatial resolution of 0.5 degrees (approximately 55 km at the equator). It includes monthly data on temperature and precipitation, as well as derived variables such as potential evapotranspiration and soil moisture [17,18]. The dataset covers the period from 1901 to 2019, and is based on observations from weather stations around the world. The HRG dataset is widely used by researchers, policymakers, and others for a variety of purposes, including climate change research, agricultural planning, and water resource management. The dataset is freely available for download, and can be accessed via the CRU website. Users can download the entire dataset or subsets of the data based on specific regions or time periods.

In addition to the HRG dataset, the CRU provides several other high resolution climate datasets, including the Climatic Research Unit Time-Series (CRU TS) dataset, which is a gridded dataset of monthly climate variables covering the period from 1901 to present, and the Hadley Centre Sea Ice and Sea Surface Temperature (HadISST) dataset, which is a high resolution dataset of sea surface temperature and sea ice extent. These datasets can also be accessed via the CRU website.

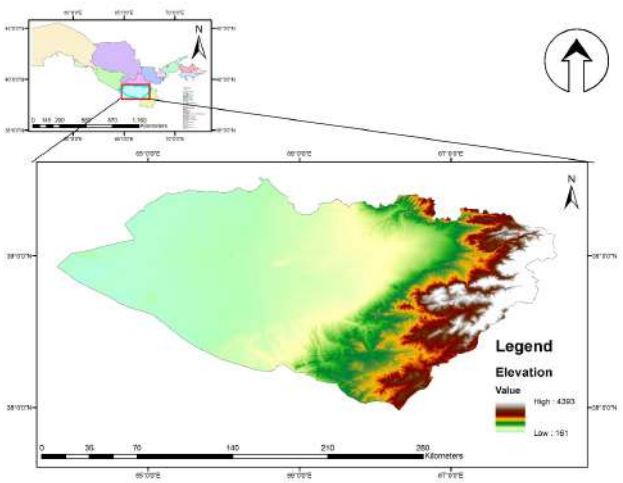

Fig. 1. Study site, Kashkadarya region.

2.3. Methods

In this research, ArcGIS 10 is a previous version of the ArcGIS software developed by Esri, a leading provider of GIS (Geographic Information System) software and services. It was released in 2010 and was followed by several subsequent versions.

Interpolation is a technique used in spatial analysis to estimate values of a variable at unsampled locations within a study area based on the values of the variable at sampled locations [19]. It is commonly used in various fields, including geography, environmental science, engineering, and computer graphics. Interpolation is important when we need to estimate values of a variable at locations where we have no data or where it is impractical or expensive to collect data. For example, we might want to estimate the concentration of a pollutant at an unmonitored location within a region, or we might need to estimate the elevation of a point on a terrain model [19,20].

There are many different interpolation methods, and the choice of method depends on various factors, including the type of data, the spatial distribution of the data, the size and shape of the study area, and the level of accuracy required. Some of the commonly used interpolation methods [16,19] include Inverse Distance Weighting (IDW), Kriging, Splines, and Radial Basis Functions (RBF). Interpolation can be used for different types of data, including point data (e.g., temperature readings), line data (e.g., river networks), and polygon data (e.g., land use data). The resulting interpolated surface can be visualized using various techniques, such as contour lines, heat maps, or 3D surfaces.

Inverse Distance Weighting (IDW) interpolation is a popular spatial interpolation method used to estimate the unknown values of a variable at unsampled locations [16]. It works by estimating the value of a variable at a given location as a weighted average of the nearby known values, where the weights decrease as the distance from the target location increases.

The general formula for IDW interpolation is [16]:

$Z(x,y) = \Sigma(1/di^p * Zi) / \Sigma(1/di^p)$

where Z(x,y) is the estimated value of the variable at location (x,y), di is the distance between the target location and the ith known value, Zi is the known value at the ith location, and p is a power parameter that determines the rate at which the weights decrease with distance. The IDW method assumes that the values of the variable being interpolated vary continuously across the study area and that the values at nearby locations are more similar than those at more distant locations [16]. However, it has some limitations, including the sensitivity to the selection of the power parameter and the tendency to produce unrealistic values at the edges of the study area. IDW interpolation is commonly used in a range of applications, including environmental monitoring, hydrology, and agriculture. It is available in most GIS software packages and can be applied to a range of data types, including point, line, and polygon data.

3 Results and Discussion

3.1. Changes in precipitation patterns over a period of thirty years

According to the results, in Kashkadarya, precipitation amount was ranged in between 140 to 628 mm for 2000. It was found that higher precipitation was 628 mm reported in the North-Eastern part of Kashkadarya, which is mountainous area such as Shakhrisabz and Kitab districts. It was reported that the lowest precipitation 140 mm for the same period, which was observed mainly in flat area of the region, which is more dessert areas with lower amount greenness (Fig. 2). However, in the next two decades (2010 and 2020), the amount of the precipitation was dramatically dropped (Fig. 3-4).

3.2. Variability of precipitation during three decades

The results of average temperature showed that there was not much discrepancy for three decades. For instance, in 2000, the average temperature was 6-18 °C. It was observed that the lowest temperature was 6 °C, which was in the mountain area of Kashkadarya, and in the flat part of the region was a bit hotter (16-18 °C), than the mountain area (Fig. 5). In the next decade (2010), the minimum temperature was change by 1-2 °C in the mountain area, however, it was stable in the flat areas of Kashkadarya (Fig. 6). Furthermore, in 2020, the temperature was decreased by 1-2 °C than the last two decades, in the mountain area, it was 6-17 °C (Fig. 7). Finally, it is important to enhance the resilience of communities and ecosystems in Kashkadarya to the impacts of climate change. This could include measures such as promoting the use of drought-resistant crops, restoring degraded lands, and implementing early warning systems that enable communities to prepare for and respond to climate-related hazards.

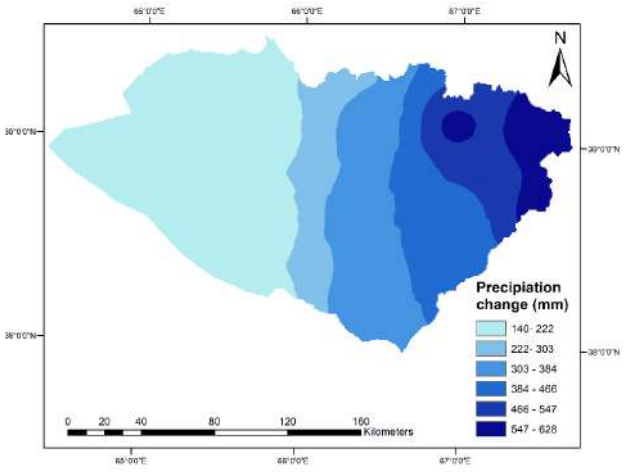

Fig. 2. Precipitation change in Kashkadarya region during 2000 (Source: Compiled by the authors).

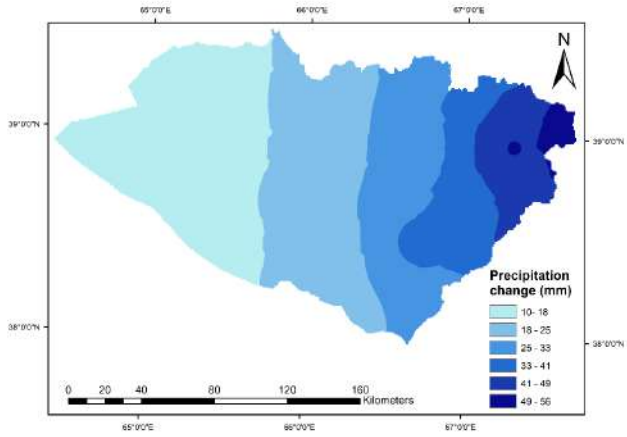

Fig. 3. Precipitation changes in Kashkadarya during 2010 (Source: Compiled by the authors)

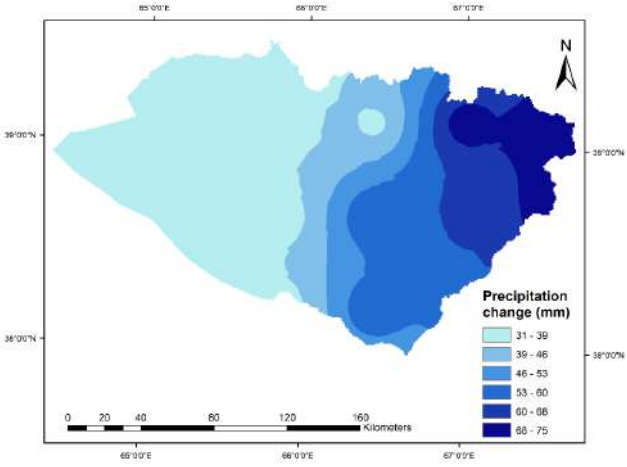

Fig. 4. Precipitation changes in Kashkadarya during 2010 (Source: Compiled by the authors)

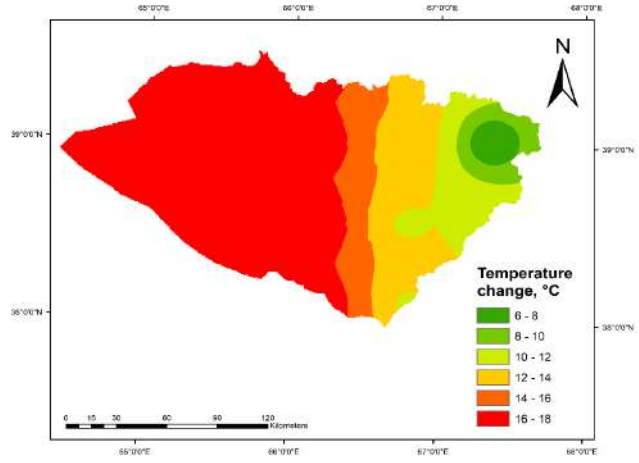

Fig. 5. Temperature change in Kashkadarya during 2000 (Compiled by the authors)

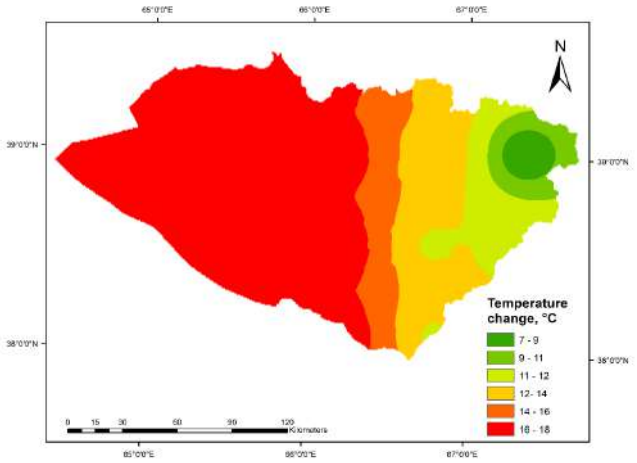

Fig. 6. Temperature change over Kashkadarya region in 2010 (Source: Compiled by authors)

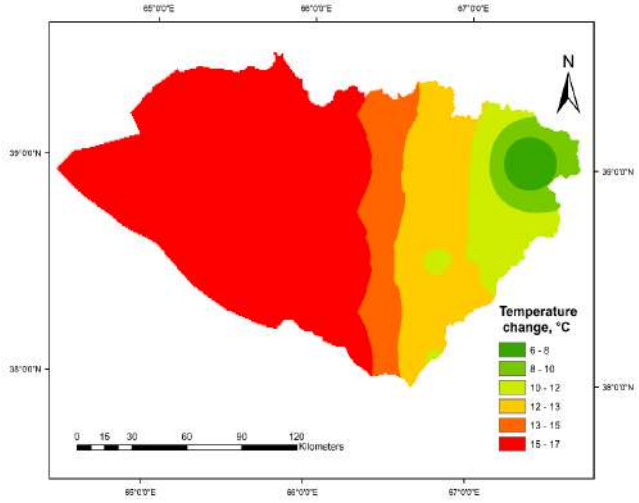

Fig. 7. Temperature change in Kashkadarya during 2020 (Source: Compiled by the authors)

4. Conclusions

The precipitation amount in Kashkadarya exhibited considerable variability, ranging from 140 to 628 mm in the year 2000. The highest precipitation of 628 mm was recorded in the mountainous northeastern part of Kashkadarya, including districts like Shakhrisabz and Kitab. In contrast, the lowest precipitation of 140 mm was observed in the flat areas, which are characterized as more arid desert regions with lower vegetation cover.

In the year 2020, there was a slight decrease in average temperatures compared to the previous two decades. Specifically, the temperature dropped by 1-2 °C in the mountainous areas, such as Shakhrisabz and Kitab districts. This suggests a possible cooling trend in the region during that particular year.

Last but not least, building resilience to climate change impacts is crucial. This involves implementing strategies such as developing climate-resilient infrastructure, implementing early warning systems for extreme weather events, improving water management, and enhancing disaster preparedness.

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УЎТ: 519 (79)

АВТОТРАНСПОРТ ВОСИТАЛАРИДАН ЧИҚАДИГАН ИФЛОСЛАНТИРУВЧИ МОДДАЛАРНИНГ МАНЗАРАЛИ ДАРАХТ БАРГЛАРИДАГИ ПИГМЕНТ МИҚДОРИГА ТАЪСИРИ

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Аннотация: *Дунёда атроф-муҳитни ифлосланишдан ҳимоя қилиш ҳамда экологик муаммоларни ҳал қилишга катта эътибор қаратилмоқда. Автотранспорт воситаларидан чиқадиган зарарли моддалар биринчи навбатда ўсимликларга катта зарар етказади. Дарахтларнинг барглари ўсимликларнинг асосий вегатив органларидан бири бўлиб, у фотосинтез, транспирация ва газ алмашув вазифаларини бажаради. Автотранспорт воситаларидан чиқадиган зарарли моддалар эса манзарали дарахт баргларига салбий таъсир кўрсатади. Ҳаводаги азот оксидларини ютган ўсимлик барглари ҳужайраларининг заҳарланиши туфайли нобуд бўла бошлайди. Дарахт баргларидаги пигментлар миқдори эса атроф-муҳитнинг ҳолатини белгиловчи ўзига хос индикатор вазифасини бажаради.*

Калит сўзлар: *ўсимликлар, атроф-муҳит, манзарали дарахт, пигмент миқдори, автотранспорт воситалари.*