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BOTANY

ГРИБКОВЫЕ ЗАБОЛЕВАНИЯ, НАБЛЮДАЕМЫЕ У ДРЕВЕСНЫХ РАСТЕНИЙ, ПРОИЗРАСТАЮЩИХ НА АПСШЕРОНСКОМ ПОЛУОСТРОВЕ, И ЧАСТОТА ИХ ВСТРЕЧАЕМОСТИ

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FUNGAL DISEASES OBSERVED IN WOODY PLANTS GROWING ON THE ABSHERON PENINSULA AND THEIR FREQUENCY OF OCCURRENCE

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Аннотация

В статье рассматриваются грибковые заболевания, которые часто встречаются у древесных растений, произрастающих на Апшеронском полуострове. Описаны основные виды грибов, поражающих растения данного региона, а также их признаки и симптомы. В работе приведена информация о факторах, способствующих развитию грибковых заболеваний, таких как климатические условия, особенности почвы и агротехнические мероприятия. Особое внимание уделено частоте встречаемости этих заболеваний в разных экосистемах Апшеронского полуострова. На основе проведенных наблюдений предлагаются рекомендации по профилактике и борьбе с грибковыми инфекциями для сохранения здоровья древесных растений в регионе.

Abstract

This article discusses fungal diseases commonly found in woody plants growing on the Absheron Peninsula. The main types of fungi affecting plants in this region, as well as their signs and symptoms, are described. The paper provides information on the factors contributing to the development of fungal diseases, such as climate conditions, soil characteristics, and agronomic practices. Special attention is given to the frequency of occurrence of these diseases in various ecosystems of the Absheron Peninsula. Based on the observations, recommendations for the prevention and control of fungal infections are proposed to maintain the health of woody plants in the region.

Ключевые слова: грибковые заболевания, древесные растения, Апшеронский полуостров, частота встречаемости, профилактика, агротехнические мероприятия, климатические условия, фауна почвы, болезни растений.

Keywords: fungal diseases, woody plants, Absheron Peninsula, frequency of occurrence, prevention, agronomic practices, climatic conditions, soil fauna, plant diseases.

Введение

Апшеронский полуостров, находящийся в умеренном климатическом поясе, обладает разнообразием экосистем, в которых растут различные виды древесных растений. Однако, как и в других регионах с похожими климатическими условиями, растения на Апшеронском полуострове подвержены различным грибковым заболеваниям, которые могут существенно повлиять на их здоровье и продуктивность. Грибковые инфекции представляют собой одну из основных причин ухудшения состояния древесных растений, что требует тщательного изучения и разработки эффективных методов борьбы с этими заболеваниями. Исследование проводилось

на базе различных экосистем Апшеронского полуострова. Для сбора данных были использованы методы полевых наблюдений, лабораторных анализов и идентификации грибов. В ходе исследования были зафиксированы наиболее часто встречаемые грибковые заболевания на древесных растениях, а также проведен анализ факторов, способствующих их развитию. На основании собранных данных, самые высокие показатели встречаемости грибковых заболеваний наблюдаются в районах с повышенной влажностью и близостью к водоёмам, где создаются идеальные условия для развития грибов. Мучнистая роса и серая гниль имеют наибольшую частоту встречаемости в весенний и осенний пери-

оды, когда погодные условия способствуют их распространению. Ниже приводятся наиболее распространенные типы болезней деревьев и кустарников найденные на деревьях и кустарниках Апшеронском полуострова.

Ржавчина. Болезни этого типа вызываются ржавчинными грибами. Поражены листья, хвоя и молодые побеги. На листьях и побегах лиственных пород были заметны ярко-желтые, оранжевые или коричнево-бурые, порошащие, многочисленные пустулы, часто покрывающие всю поверхность пораженных органов. Наиболее распространенными из деревьев ржавчина листьев тополя, ивы. У хвойных пород на хвое обнаружили мелкие цилиндрические пузырьки, заполненные желтой массой спор, или оранжево-красные восковидно-бархатистые подушечки. Поражение первого типа характерно для ржавчины хвои сосны, ели, пихты. Примером второго типа служит золотистая ржавчина ели. Ржавчина приводит к преждевременному опадению хвои и листьев, ослаблению молодых растений и снижению их декоративности.

Мучнистая роса характеризуется образованием на пораженных органах поверхностных белых, вначале паутинистых, позже уплотняющихся мучнистых листьев. Листья и молодые побеги имели вид как бы присыпанных мукой. Возбудителями этого типа болезней являются мучнисто-росяные грибы. Мучнистая роса поразила многие лиственные породы деревьев и кустарников. Изучено что, широко распространены мучнистая роса дуба, клена, боярышника, караганы и другие. Мучнистая роса привела к ослаблению молодых растений, значительно снижает декоративность деревьев и кустарников. Пораженные молодые побеги не успели одревеснеть и пострадали от раннеосенних заморозков.

Пятнистость проявлялся в образовании на листьях, плодах и семенах пятен различной формы, размера, цвета, структуры. Они вызываются грибам, бактериями и абиотическими факторами (нарушение баланса питательных веществ, промышленное загрязнение среды и др.). Чаще пятна появились на листьях и значительно реже на плодах и семенах. Наиболее широко распространены пятнистости грибного происхождения. Как правило, пятна грибного происхождения имеют четкие границы. Нередко пораженные участки ткани выпали, и образовали так называемую дырчатую пятнистость (сероватая пятнистость вяза), и бурая – косточковых пород. Среди грибных пятнистостей преобладают некротические, например: белая– листьев тополя, кремовая–липы, серая–крылаток ясеня, темно-бурая– крылаток клена. Значительно реже встречалась строматическая пятнистость, к которым относятся: черная – листьев вяза, ивы, клена; оранжевая–черемухи). Характерный признак грибных пятнистостей – спорошение возбудителей.

Бактериальные пятнистости проявили себя в образовании плоских, расплывчатых, как бы маслянистых, неправильной формы пятен сероватого, се-

рого, коричневого цвета. Как правило, они расположены по краю листовой пластинки. Пятнистостью листьев сопровождается бактериальный рак, бактериальный ожог и туберкулез тополя. Неинфекционные пятнистости образуются вследствие загрязнения воздуха промышленными эмиссиями или недостатка (избытка) некоторых элементов питания. Пятна плоские, разного размера, чаще угловатые или неправильной формы, от желтоватого до коричневого цвета, расположены между жилками или по краю листа. Пятнистости листьев приводят к ослаблению молодых растений, снижению декоративности.

Чернь. Этот тип болезней проявил себя в образовании на листьях или хвое поверхностных, черных, как бы сажистых налетов. Возбудителями черни являются сапротрофные грибы, которые питаются выделениями сосущих насекомых (тлей, щитовок) и различными поверхностными наносами, например, пылью. На лиственных породах возбудителями черни являются грибы *Fumago vagans*. Чернь нарушает процесс ассимиляции, затрудняет доступ воздуха и цвета к листьям и хвое, привел к значительной потере декоративности деревьев и кустарников.

Деформация – это радикальное изменение формы различных органов. Причиной деформации у древесных растений являются грибы, вирусы, бактерии и некоторые абиотические факторы. Проявил себя деформации очень разнообразны. Деформация плодов вызывается грибами, под воздействием которых плоды разрастаются и теряют свою естественную форму. Деформация листьев возникает при поражении грибами и вирусам, вызывающими неравномерный рост отдельных участков листьев, вследствие чего они становятся волнистыми, сморщенными или вздутыми. В некоторых случаях такой характер поражения называют курчавостью. Деформация грибного происхождения были найдены на листьях, вяза, клена татарского. Значительно реже было обнаружено деформация листьев, вызванная вирусами, например, на малине и хмеле. Причиной деформации листьев могут быть также пестициды в случае нарушения регламента их применения. При этом листья полностью утратили характерную для породы форму. Например, листья липы мелколистной стали удлиненными, разрезными, с сильно вытянутыми, нитчатым вершинами.

Парша. На листьях, побегах и плодах образовался бархатистый оливковый или зеленовато-бурый налет, представляющий собой мицелий со спороношением грибов-возбудителей. Характерный признак парши – почернение молодых побегов, которые часто загибаются в виде крючка. Широко распространены парша ивы, яблони, груши. Парша резко снизил урожай и качество плодов, привел к преждевременному листопаду и ослаблению деревьев, снизил декоративность древесных пород.

Вилт (увядание) характеризуется поражением сосудистой проводящей системы деревьев и проявляется в постепенном или очень быстром усыхании

кроны. Главным признаком этого типа болезней является потемнение сосудов, а нередко и заболонной древесины, которое заметно на поперечных срезах стволов и ветвей в виде темных колец, полуколец, отдельных точек и пятен разной формы. Вилт вызывается грибами и бактериями. Яркие примеры грибного увядания – голландская болезнь (графтиоз) ильмовых пород, сосудистый микоз дуба, вертициллезное увядание (вилт) клена. К сосудистым бактериозам древесных растений относится мокрый язвенно-сосудистый рак тополя, бактериальное увядание ивы. Сосудистые болезни вызвал массовое ослабление и быстрое усыхание деревьев в лесных и городских насаждениях, часто на больших площадях, способствовал развитию очагов стволовых вредителей.

Некроз коры – это отмирание наружных тканей стволов и ветвей, происходящее на отдельных участках или по окружности пораженных элементов кроны. В одних случаях пораженная кора отличается по цвету от здоровой, в других – ее окраска не меняется. Локальные некрозы часто ограничены валиками каллуса и трещинами. Некроз коры преимущественно вызывается грибами, реже – бактериями. В первом случае в отмирающей коре образовались характерные грибные структуры: конидиомы, плодовые тела, стромы. Примером некрозов грибного происхождения являются: туберкуляриевый и цитоспоровый – на лиственных породах, ценангиевый – на сосне и других хвойных породах. Бактериальные некрозы характеризуются образованием на коре вздутий и трещин, из которых вытекает прозрачная, темнеющая на воздухе жидкость. Из болезней этого типа наиболее часто встретились бактериальные некрозы тополя и бука. Некрозы привели к ослаблению и усыханию деревьев и кустарников, способствуют развитию очагов стволовых вредителей.

Рак. При поражении болезнями этого типа на стволах и ветвях, иногда на корнях, выявлены новообразования: ступенчатые и не ступенчатые раны, язвы с наплывами каллуса или смоляных желваков, гладкие или трещиноватые опухоли (наросты). Причинами раковых болезней могут быть поражение грибами, бактериями и воздействием низких температур. При раковых болезнях грибного происхождения в местах поражения развились конидиомы, плодовые тела, стромы. Грибами вызываются многие широко распространенные болезни: ступенчатый (обыкновенный) рак лиственных пород, черный рак тополя, смоляной рак (серянка) сосны и другие. Признаком бактериального рака часто служит вытекающая из трещин коры прозрачная, буряющая на воздухе жидкость. В некоторых случаях этот признак отсутствует. Наиболее распространенными нашлись: мокрый язвенно-сосудистый рак тополя, поперечный рак дуба, бугорчатый рак сосны. Резкое понижение температуры в зимний период приводит к образованию на стволах лиственных и хвойных пород продольных трещин (морозобоин), вытянутых по длине ствола до 1 м и более. Со временем трещины

превратились в типические раны. Болезнью чаще найдены в деревьях вяз, дуб, клен, липа, ель.

Раковые болезни приводят к ослаблению и постепенному усыханию деревьев и кустарников, способствуют заражению стволов гнилями, образованию бурелома и заселению деревьев стволовыми насекомыми.

Ведьмины метлы – это тесно скученные, многочисленные, тонкие, укороченные вертикальные побеги, образующиеся из спящих почек на небольшом отрезке ветви. Они имеют шаровидную или овальную форму. Причиной образования ведьминых метел на древесных растениях чаще являются грибы и вирусы, в более редких случаях – насекомые и различные абиотические факторы. Ведьмины метлы грибного происхождения часто встретились на березе, вишне, пихте.

Ожог характеризуется почернением или побурением пораженных очагов, которые принимают как бы обожженный вид. Испортились молодые побеги, цветки, кора стволов и ветвей. Причиной ожога грибы, бактерии и абиотические факторы (высокие температуры, действие пестицидов и другое). Из инфекционных болезней этого типа широко распространены в Апшероне: монилиальный ожог косточковых, семечковых, бактериальный ожог груши, сирени. Высокие температуры в летний период вызывают поражение тонкой гладкой коры стволов. Пораженная кора вздувается, покрывается трещинами, а позже отмирает и опадает. Ожоги коры могут быть следствием резких колебаний температуры в зимний или ранневесенний период. Неинфекционный ожог хвои и листьев нередко возникает вследствие нарушения регламента применения пестицидов. Ожог привёл к снижению урожайности плодовых культур, способствует проникновению в стволы возбудителей некрозно-раковых болезней, снижает декоративность деревьев и кустарников.

Гниль характеризуется разрушением тканей различных органов растений. У деревьев и кустарников гниению подверглись семена, плоды и древесина корней, стволов и ветвей. Болезни этого типа преимущественно вызываются грибами. Ткани больных семян и плодов размягчились и полностью разрушились.

Мумификация – это тип болезней, при которых пораженные органы пронизываются мицелием возбудителей (грибов) и превращаются в плотные черные образования – «мумии». Поражаются преимущественно плоды и семена, реже – другие мясистые части растений. Широко распространены болезнями этого типа являются: мумификация желудей дуба и семян березы, плодовая гниль (монилиоз) яблони и груши. Мумификация приводит к значительному снижению урожайности плодов и семян древесных пород.

Выводы

В ходе проведенных фитопатологических исследований на территории Апшеронского полуострова были выявлены различные грибковые заболевания, поражающие древесные растения. Обследования охватывали как парковые зоны, так и

природные лесные участки, а также декоративные посадки в городской среде. Анализ показал, что на частоту распространения заболеваний влияют такие факторы, как климатические условия региона, возраст деревьев, состояние почвы и уровень антропогенной нагрузки. Наибольшее количество пораженных деревьев было зафиксировано в зонах с пониженной аэрацией почвы и высоким уровнем загрязнения воздуха.

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COMPUTER SCIENCES

DASTURIY TIZIMLAR O'RTASIDA MA'LUMOT ALMASHINUVI USULLARINI TAHLIL QILISH

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ANALYSIS OF DATA EXCHANGE METHODS BETWEEN SOFTWARE SYSTEMS

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Annotatsiya

Maqolada turli dasturiy vositalarning o'zaro muvofiqlikda ishlashini ta'minalash, hamda ularning ma'lumotlar bazalaridagi ma'lumotlarni muntazam bir biri bilan muloqotini ta'minlashga qaratilgan arxitekturalar haqida so'z boradi. Qo'shimcha ravishda ushbu arxitekturalar uchun integratsiyani amalga oshirishda data mapping va mapping qilishning bir nechta turlari izoxlanib o'tilgan bo'lib, data mappingga misol tariqasida ikkita usul, ETL va ELT olinib har biri alohida taqqoslanib o'tilgan. Ularning har birini arxitekturasini qay tartibda tuzilganligi va ishlash prinsiplari yoritilgan va ularning har biri uchun turli xil foydalanilish holatlaridagi imkoniyatlari taqqoslanilib, tezlik, maxfiylik, katta va kichik hajmdagi ma'lumotlar bilan ishlash jarayonlaridagi vaziyatlari alohida yoritilib berilgan

Abstract

The article discusses architectures aimed at ensuring the interoperability of various software tools and the regular communication of data in their databases with each other. In addition, several types of data mapping and mapping are described for these architectures when implementing integration, and two methods, ETL and ELT, are taken as examples of data mapping, and each is compared separately. The architecture of each of them is explained and the principles of operation are explained, and the capabilities of each of them in different use cases are compared, and the speed, confidentiality, and situations in the processes of working with large and small amounts of data are separately highlighted.

Kalit so'zlar: Data mapping, data migration, data integration, data transformation, ma'lumotlar bazasi, ETL, ELT.

Keywords: Data mapping, data migration, data integration, data transformation, database, ETL, ELT.

Kirish.

Hozirgi texnologiyalar rivojlangan davrda ko'plab soxalar va tizimlarning elektronlashishi natijasida turli dasturiy ta'minot va vositalarning bir biri bilan o'zaro muvofiqlikda ishlashiga bo'lgan talab ham ancha ortdi. Shuningdek eski elektron tizimlarda, misol uchun eski monolit sistemalarda ishlab turgan dasturiy vositalarning ma'lumotlar bazalari ichida anchagina katta ma'lumotlar yig'ilib qolganini hisobga olsak, ulardan to'g'ri va qulay ravishda foydalanishni tashkil qilish ancha dolzarb masalalarga aylanishi turgan gap [6]. Chunki ularning ma'lumotlar bazalarida foydalanuvchilar va korxonalarning turli xil kerakli saqlanib qolgan katta hajmdagi ma'lumotlari bor. Agarda shu sistemaga mos yangi dasturiy tizim yaratilishi ko'zlanayotgan bo'lsa albatta buning uchun eski tizimdagi ma'lumotlardan

keng foydalanilish talab qilinadi. Nafaqat uni qurishda testlash, uni imkoniyatlarini o'lchash, balki keyinroq u ishga tushganda shu ma'lumotlarni migratsiya qilib yangi sistemada ham kerakli ma'lumotlardan keng foydalanishni joriy qilish ham ko'zda tutiladi [7] [8].

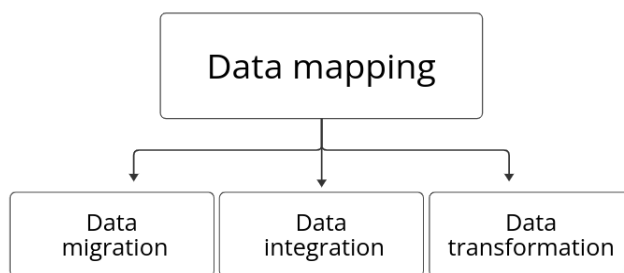
Bundan tashqari hozirgi kundagi ba'zi bir dasturiy sistemalariga e'tibor beradigan bo'lsak u bitta tizim bilan emas balki bir nechta tizimlar, bir nechta dasturiy vositalarning alohida ishlashi va umumiy bitta sistemani tashkil etishini ko'rishimiz mumkin [6]. Misol uchun hozirgi kunda katta biznes egalari o'zlarning shaxsiy elektron tijorat tizimi, elektron to'lov qilish dasturiy vositasi va shuningdek yana bir nechta shunga o'xshash sistemalariga egalik qilib o'zlarining mijozlari uchun qulaylik yaratish maqsadida bir nechta xizmat va

servislarni taklif etishmoqda. Barcha xizmatlarni o'zining umumiy sistemasi tizimiga moslab, ham o'zi uchun, ham xaridorlari uchun qulay bir sharoit yaratishni amalga oshirishmoqda. Albatta bunday tizimlarning alohida alohida bo'lib ishlashi va umumiy bitta sistemani tashkil etish jarayonini amalga oshirishda ulardagi ma'lumotlarning o'zaro muvofiqlikda ishlashi talab qilinadi va bu jarayonlarni amalga oshirilishi bir nechta algoritm va arxitekturalar asosida tasniflash mumkin. Ushbu maqolada ham shunga misol tariqasida ma'lumotlarning o'zaro muvofiqlikda ishlashni ta'minlashga yordam beruvchi algoritm arxitekturalari va ularning ishlash prinsiplari haqida bir nechta misollar va ular haqida izohlar berib o'tilgan.

Zamonaviy dasturlash tizimida bir sistemadan ikkinchi sistemaga ma'lumotlarni uzatish data mapping deb yuritiladi.

Data mapping - bu maydonlarni bir ma'lumotlar bazasidan ikkinchisiga moslashtirish jarayonidir. Bu ma'lumotlarni ko'chirish, ma'lumotlar integratsiyasi va boshqa ma'lumotlarni boshqarish vazifalarini osonlashtirish uchun birinchi qadamdir. Odatda Data mapping ko'plab ma'lumotlarni boshqarish jarayonlarining muhim qismidir. Agar ma'lumotlarning yo'nalishi biror bir jadval yoki qaysidir bir joyga aniq to'g'ri marshrutlanmagan bo'lsa, ma'lumotlar o'z manziliga o'tishi bilan ba'zi bir muammolarni tug'dirishi mumkin[6].

Data mapping asosan 3 xil holatlarda keng qo'llaniladi (1-rasm). Data mapping ma'lumotlarni ko'chirish (Data migration), integratsiyalash (Data integration) va o'zgartirish (Data transformation) da ma'lumotlardan maksimal darajada foydalanish uchun kalit hisoblanadi.



1-rasm. Data mapping turlari

Manbaa deb eski tizimdagi saqlanib turgan ma'lumotlar bazasidagi ma'lumotlarni hisoblasak, maqsad deb biz mapping qilmoqchi bolgan yangi tizimni izoxlaymiz

Data migration - bu bir martalik hodisa sifatida ma'lumotlarni bir tizimdan ikkinchisiga ko'chirish jarayoni hisoblanib, umuman olganda, bu vaqt o'tishi bilan o'zgarmaydigan ma'lumotlarni tashkil etadi. Migratsiyadan so'ng, maqsad ko'chirilgan ma'lumotlarning yangi manbai bo'lib qoladi va asl manbaa bekor qilinadi.

Data integration - bu ma'lumotlarni bir tizimdan ikkinchisiga muntazam ravishda ko'chirishning doimiy jarayoni hisoblanadi. Integratsiya ma'lum bir davrga moslashtirilib rejalashtirilgan bo'ladi. Ma'lumotlar o'zining manbaasida ham, mo'ljalida ham saqlanadi. Ma'lumotlar migratsiyasi kabi, integratsiya ham data mapping qilishni manbaa maydonlarini mo'ljal maydonlariga uzatishni amalga oshiradi va farqi bu muntazam davom etadi.

Data transformation - bu ma'lumotlarni manba formatidan mo'ljal formatiga aylantirish jarayoni

hisoblanadi. Bunga ma'lumotlar turlarini o'zgartirish, bo'sh (null) yoki takrorolanib qolgan ma'lumotlarni o'chirish, ma'lumotlarni yig'ish, ma'lumotlarni boyitish yoki boshqa o'zgartirishlar orqali ma'lumotlarni yangilash kiradi.

Bu jarayonlarni amalga oshirish uchun bir nechta arxitektura va vositalar bor bo'lib ularning har birini data mapping qilish jarayonidagi imkoniyatlari bilan birma bir quyida tanishtirilib o'tiladi.

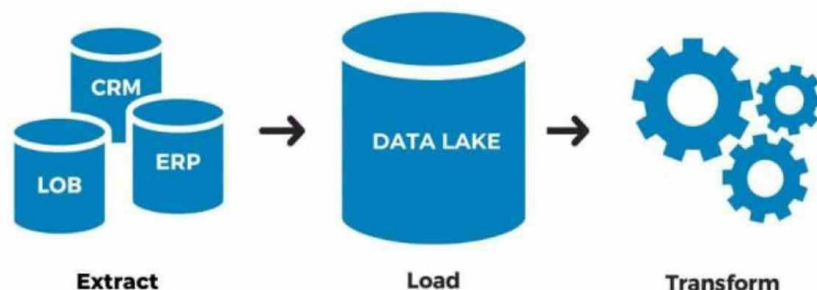
Ma'lumot almashinish usullari tahlili

ETL (Extract, Transform and Load) jarayoni - bu jarayon manbaadan mo'ljalga ma'lumotlarni olib o'tishda kerakli qolipga solishni ta'minlash vazifasini bajaradi va 3 xil bosqichda (2-rasm) o'tish bilan amalga oshiriladi yani dastlabki bosqichi ma'lumotlarni to'plash (Extract), ikkinchi bosqichda bu ma'lumotlarni kerakli qolipga yoki formatga solib tayyorlash (transform) va so'ngisi tayyor ma'lumotlarni ma'lumotlar bazasiga yuklash (Load) [1].



2-rasm. ETL usuli arxitektruasi

ETL usulining bosh asosiy maqsadi ma'lumotlarni olish, ularga kerakli o'zgartirishlarni kiritish, va ularni saqlab borish hisoblanadi. Bu usul ma'lumotlar tuzilmasi va ko'rinishi bo'yicha o'zgartirishlarni amalga oshirishda juda samarali bo'ladi [2] [4]. ETL usuli, katta miqdorda ma'lumotlarni olish va ularga kerakli o'zgartirishlarni amalga oshirish jarayonlarini avtomatlashtirishda yordam beradi.



3-rasm. ETL usuli arxitekturuasi

ETL-da, ma'lumotlar olinib, ularga transformatsiya amaliyoti qo'llanilganda, katta miqdordagi ma'lumotlarni o'zgartirish va ularda transformatsiya o'tkazish uchun kuchli resurslar talab etiladi. Buning natijasida, katta hajmdagi ma'lumotlar miqdori yuklanish va transformatsiya jarayonlarida yuqori tarmoq resurslariga zarur bo'lishi mumkin. Lekin ETL-da, ma'lumotlar biron bir formatda yoki xilma-xil formatlarda saqlanadi va ular ma'lumotlar bazasiga tez va muvaffaqiyatli yuklanadi. Keyin, ma'lumotlar bazasining tarmoq kuchiga ega bo'lgan imkoniyatlari yordamida transformatsiya amaliyotlari o'tkaziladi [1] [4].

Bu jarayonda, ma'lumotlar bazasiga yuklash jarayonlari odatda, ma'lumotlar bazasining tarmoq kuchiga ega bo'lgan yuqori ko'rsatkichli yordamchi vositalar orqali amalga oshiriladi. Ularning orasida, PostgreSQL DB Link yoki boshqa ma'lumotlar bazasining integratsiya interfeysi ishlatilishi mumkin. ETL ni qo'llash, ma'lumotlar bazasiga yuklash jarayonini ishlab chiqish va boshqarishda osonlikni ta'minlashi bilan ancha ommabop hisoblanadi.

ELT (Extract, Load and Transform) jarayoni - (Extract, Load, Transform) ma'lumotlar bazasi integratsiya jarayoni bo'yicha amalga oshirilgan metodologiya hisoblanadi. Bu jarayonlarning odatiy tartibi ETL bilan farq qiladi. ETL-da ma'lumotlar olinadi, keyin ular to'g'ri formatga olinib ma'lumotlar bazasiga yuklanadi, va keyin ma'lumotlar transformatsiya qilinadi (3-rasm). Biroq, ELT-da ma'lumotlar olinadi, keyin ularga ma'lumotlar bazasiga yuklash va so'ng ularda transformatsiya qilish o'tkaziladi [3] [5].

1-jadvalda bu ikkita usulning foydalanilish holatlari va qay holatlarda qaysi biri ancha foydali ekanligi tavsiflanib o'tilgan.

Ya'ni 1-jadvaldagi ma'lumotlarga nazar tashlaydigan bo'lsak u yerda turli xil foydalanilish holatida bu usullarning qo'llanilishi taqqoslangan va ularning har biridan foydalanilish holati bo'yicha quyida kengroq yoritib o'tilgan.

ETL:Tezlik - bunda dastlab ma'lumotlar yig'ilgandan keyin ular ustida transformatsiya ya'ni moslashtirish ishlari olib borilishi uchun biroz vaqt talab qilinadi va shu sababli vaqtdan biroz yutqazish mumkin.

Maxfiylik - ETL jarayoni ma'lumotlarni transformatsiya qilayotgan paytda, ularni ma'lum bir joyda saqlab turadi. Bu holatda, transformatsiya jarayonida ma'lumotlar xavfsiz joyda saqlanishi ta'minlanadi.

Xarajatlar - ma'lumotlar transformatsiya qilinyotgan paytda katta hajmli ma'lumotlarni o'zgartirish uchun kerak bo'lishi mumkin. Bu xarajatlar, masalan, qo'shimcha serverlar uchun litsenziya xarajatlari yoki yuqori samaradorlikka ega ta'minot xizmatlarining xarajatlari bo'lishi mumkin.

1-jadval.

ETL va ELT usullarining turli yo'nalishlardagi afzallik va kamchiliklari

Foydalanilishi holatlari	ETL	ELT
Tezlik	-	+
Maxfiylik	+	+
Xarajatlar kamligi	-	+
Katta hajmdagi ma'lumotlar bilan ishlashda	-	+
Kichik hajmdagi ma'lumotlar bilan ishlashda	+	-
Tajriba	+	-

Katta hajmdagi ma'lumotlar bilan ishlash - katta ma'lumotlar bilan ishlovchi jarayonlarda, ETL jarayoni tez ishlamaydi, chunki transformatsiya va yuklash bosqichlari katta hajmli ma'lumotlarning kafolatligini saqlash qo'shimcha vaqt talab etadi.

Kichik hajmli ma'lumotlar bilan ishlashda - ETL protsessi boshqa manbalardan olingan kichik ma'lumotlarni bir joyda birlashtirish va ularga o'zgartirishlar kiritish imkonini beradi. Bu, ma'lumotlarning qulaylik bilan ishlashni ta'minlab

ma'lumotlar bazasiga ma'lumotlarning kiritilishini ta'minlaydi.

Tajriba - ETL 20 va undan ko'p yildan beri mavjud va uning amaliyotlari va protokollari yaxshi ma'lum va hujjatlashtirilgan.

ELT:Tezlik - bu to'g'ridan to'g'ri ma'lumotlar bazasiga yozilishi sababli va u yerda kerakli datalarni transformatsiya qilishi shu yerni o'zida bajarilganligi uchun ETL dan ancha kamroq vaqt sarflaydi.

Maxfiylik - bu usulda, ma'lumotlar yuqori darajadagi ma'lumotlar bazasiga yuqori tezlik va osonlik bilan yuklanadi hamda keyinchalik transformatsiya qilish talab etilmaydi. Ma'lumotlar o'z asl holatida saqlanadi va ularni xavfsizlik nuqtai nazaridan o'zgartirish zarurati yo'q.

Xarajatlar - ma'lumotlar yuqori darajadagi maqsadiga to'g'ri yuklanishi jarayonida qo'shimcha serverlar uchun litsenziya xarajatlari yoki yuqori samaradorlikka ega ta'minot xizmatlarini xarajatlari muhim bo'lmaydi, chunki ma'lumotlar transformatsiya qilinmasdan yuklanadi.

Katta hajmli ma'lumotlar bilan ishlash - ELT transformatsiya bosqichini oxirida bo'lishi evaziga katta hajmdagi ma'lumotlarni to'g'ridan to'g'ri mo'ljalga yo'naltiradi va bu katta hajmli ma'lumotlarni dastlab mo'ljalga yo'naltirib keyin transformatsiyalash uncha qiyichilik tug'dirmaydi.

Kichik hajmdagi ma'lumotlar bilan ishlashda - ELTda, kichik ma'lumotlar yuqori darajadagi ma'lumotlar bazasiga o'zgartirishsiz yuklanadi. Bu esa, ma'lumotlarni optimallashtirish, boshqa manbalardan olingan ma'lumotlarni birlashtirish va

ularga o'zgartirishlar kiritish imkonini cheklashini ta'minlashni qiyinlashtiradi.

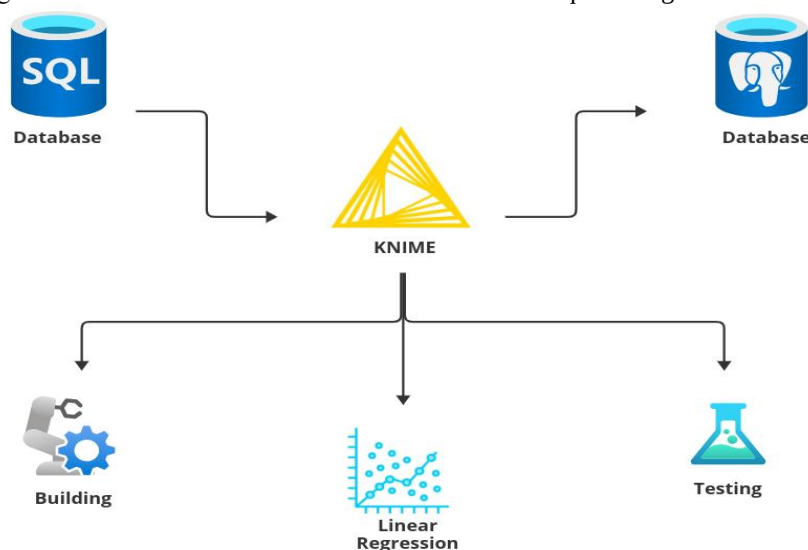
Tajriba - ELT ma'lumotlar integratsiyasining yangi shaklidir va hozirgacha o'zining qulay algoritmlari bilan ancha ommalasha olgan.

Ma'lumotlarni uzatishda ETL usulidan foydalanish

ETL usuli orqali ma'lumotlarni uzatishda ikkinchi ma'lumotlar bazasiga odatda ma'lumotlar filterlanib tayyor qolipga solinib yuboriladi. Tadqiqot ishimizda bizga berilgan muammolardan biri ham berilgan ma'lumotlar ya'ni datasetdan foydalanib ularning keyingi kuni uchun kuzatilishi mumkin bo'lgan bashorat natijalarini keyingi tizimga uzatishni tashkil etish hisoblanadi.

4-rasmda yuqorida aytgan tizimni amalga oshirishni rejalashtirgan arxitekturaning ko'rinishi tasvirlangan. Bunga ko'ra dastlab ma'lumotlar berilgan dataset orqali to'ldirilgan ma'lumotlar bazasidan olinadi va shu natijalar asosida KNIME dasturi chiziqli regressiya modellari orqali o'qitirilib uning modeli qurib olinadi va model asosida uning bashoratlash natijalari olinadi.

Olingan natijalarni uzatish KNIME tizimi orqali amalga oshiriladi. Bu yerda KNIME ma'lumotlarni olish, tahlil qilib modelini qurib olish va nihoyat kutilgan natijalarga erishilgach uni kerakli tizimga uzatish vazifasini bajaradi. Albatta, bu jarayon vaqtida bir nechta qadamlar va bir nechta vazifalar KNIME ni o'zida amalga oshiriladi va bu jarayonlarning umumiy yig'indisi ETL usulini tashkil qiladi bu to'liq sistema ETL usuli orqali amalga oshirilishini ta'minlab beradi.



4-rasm. ETL orqali ma'lumotlarni uzatishni amalga oshiriladigan sistema arxitekturalari.

Bu arxitekturada ETL usulidan foydalanishning asosiy maqsadi katta hajmdagi ma'lumotlarni olish va uni tahlil qilish va keyinchalik faqatgina tahlil qilingan natijalarnigina keyingi tizimga o'tkazishda bu usul ancha optimal hisoblanadi. Chunki keyingi tizimga katta hajmdagi ma'lumotlar emas, balki, kichik hajmdagi ma'lumotlarni uzatish amalga oshirilgani bois bu usul ELT susulidan ancha kam vaqt va resurs sarflaydi.

Xulosa

ETL va ELT algortimlari katta va kichik hajmdagi turli ma'lumotlar bilan ishlashda muhim ahamiyatga

ega. Bu usullar, ma'lumotlarni olish, transformatsiya qilish va yuklash jarayonlarida ishlatiladi. ETL usuli ma'lumotlarni olib, ularga transformatsiya qilish va so'ngra ma'lumotlar bazasiga yuklash bilan bog'liqdir, ELT esa ma'lumotlarni yuqori darajadagi ma'lumotlar bazasiga yuqori tezlikda yuklashda qo'llaniladi. Har ikki usul ham dasturiy ta'minotlarni tuzishda sodda va tushunarli bo'lgan ma'lumot tizimlarini qo'llanishini ta'minlaydi. Bu ikki usul katta miqdordagi ma'lumotlar bilan ishlashda tizimlarni integratsiya qilish va ma'lumotlar tahlili uchun keng imkoniyatlarni ta'minlaydi,

shuningdek bular dasturiy ta'minotlarni tuzishda o'rtacha darajada sodda va tushunarli bo'lgan ma'lumot tizimlarini qo'llashni ta'minlaydi va bular dasturlash va boshqarish jarayonlarini tez va samarali qilishga yordam beradi.

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EARTH SCIENCES

ИССЛЕДОВАНИЕ ПОЧВЕННЫХ ОСОБЕННОСТЕЙ С ПОМОЩЬЮ АЭРОКОСМИЧЕСКИХ ИЗОБРАЖЕНИЙ

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STUDY OF SOIL CHARACTERISTICS USING AEROSPACE IMAGES

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Аннотация

В работе рассмотрены вопросы обработки данных дистанционного зондирования сельскохозяйственных полей. На основе фрактальных методов обработки ИК и радиолокационных изображений показана возможность разделения разных типов почв.

Abstract

Work examines questions of processing of remote sensing of agricultural fields. Based on fractal processing methods of IR and radar image shows the possibility of separating the different types of soil.

Ключевые слова: почва, дистанционное зондирование, ИК и СВЧ данные, обработка данных, фракталы.

Keywords: soil, remote sensing, IR and microwave data, data processing, fractals.

Введение

Эффективное использование природных ресурсов и экологический мониторинг земной поверхности требуют разработки и введения в практику природопользования дистанционных методов определения характеристик почвенного и растительного покровов для нужд сельского хозяйства, изучения лесных массивов и бассейнов больших и малых рек, а также акваторий морей и океанов. Данные дистанционного зондирования служат основным источником информации при подготовке карт землепользования и топографических карт.

Актуальность решения этих задач не вызывает сомнения, так как традиционные контактные измерения не обеспечивают получение информации с достаточной детальностью в пространстве и времени и, кроме того, оказываются трудоемкими.

Решение всех указанных выше проблем невозможно без внедрения дистанционных методов исследования Земли, основанных на анализе структуры сигналов, сформированных в результате отражения или излучения электромагнитных волн природными образованиями, аппаратурой дистанционного зондирования, установленной на борту самолетов-лабораторий и космических платформ.

Дешифрирование аэрокосмических снимков проводят с использованием комплекса прямых и косвенных дешифровочных признаков. Прямые признаки (тон, структура, форма, тени и т.д.) непосредственно изображаются и воспринимаются со снимков при дешифрировании, а косвенные дают возможность установить зависимости между прямыми признаками и закономерностями культурных насаждений, почвенных характеристик и пр.

Космические снимки, имеющие большую обзорность и высокую оперативность, требуют применения автоматизированных методов обработки информации. Основными задачами автоматизированного дешифрирования аэрокосмических снимков являются распознавание объектов и определение их численных характеристик. В автоматизированных системах они решаются методами теории распознавания образов и статистической оценки параметров.

Перспективным путем повышения информативности полученных оптических, инфракрасных и радиолокационных аэрокосмических изображений является применение методов фрактальной топологии с использованием фрактальных моделей (Под ред. Пащенко Р.Э., 2006; Иванов и др., 2006, а также литература цитируемая там).

Цель наших исследований – с помощью фрактальных методов обработки аэрокосмической информации выявить возможность индикации гумуса в черноземах по материалам космической съемки.

Экспериментальные исследования и обработка результатов

Содержание гумуса в почвах по данным аэрофотосъемки основываются на связи оптических характеристик с содержанием гумуса в воздушно-сухих образцах (Михайлова, Орлов, 1985). Однако почти нет опыта индикации гумуса по данным космической съемки (Шатохин, Линдін, 2000).

Для демонстрации возможностей применения фрактальных методов обработки космических данных для решения вышеозначенных задач нами были использованы данные, полученные в ходе исследований, проведенных сотрудниками НЦ «Институт почвоведения и агрохимии» УААН (Шатохин, Линдін, 2000). В работе были использованы фондовые материалы института Укрземпроект: почвенный план и план землепользования (М1: 25000), а также архивные снимки спутника SPOT (HRV). Дешифрованы снимки с разрешающей способностью 20 м, которые были получены в многоспектральном режиме (видимый и ближний инфракрасный диапазона спектра), а именно по трем каналам: 1) 0,50-0,59 мкм; 2) 0,61-0,68 мкм; 3) 0,79-0,89 мкм. Во время съемки облачность 0%, поверхность почвы – воздушно-сухая (черный пар).

В работе проанализирован случай, когда в пределах одного поля (рис. 1), по данным крупномасштабных обследований, выделено 6 почвенных ареалов. В структуре почвенного покрова этого поля выделены такие черноземные почвы: 1-намытый среднесолонцеватый на лессовых породах; 2-обычный слабосмытый на лессовых породах; 3-обычный неглубокий на лессовых породах; 4-обычный на рыхлых песчаных породах слабосмытый; 5-обычный на рыхлых песчаных породах легкосуглинистых; 6-обычный на рыхлых песчаных породах супесчаный.

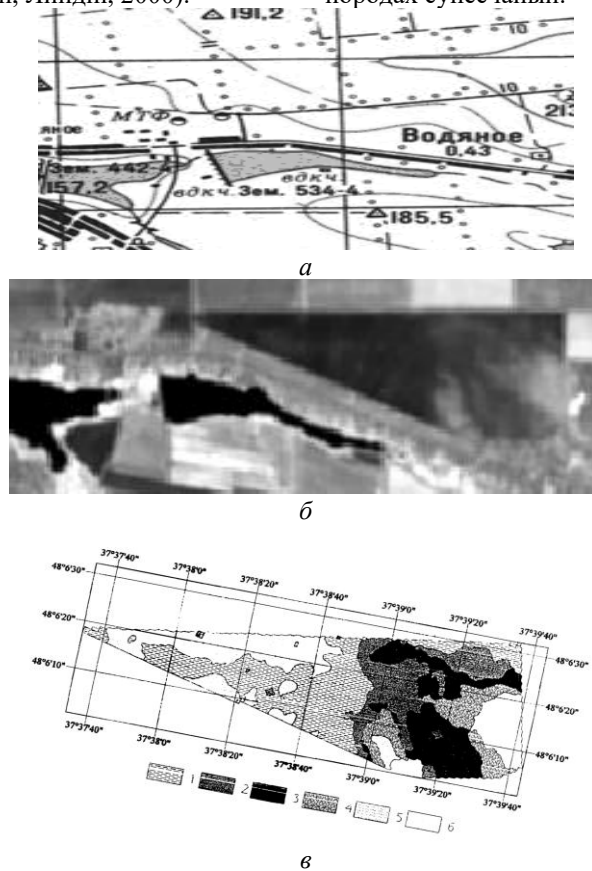


Рис.1. Исследуемое поле: географическая карта (а), космическое оптическое изображение (б), почвенные ареалы (в)

Вариаций шероховатости и поверхностной влажности по всей площади поля не наблюдается,

что подтверждается и синхронной съемкой, проведенной в миллиметровом диапазоне радиоволн (рис. 2) с борта самолета лаборатории ИЛ-18Д ИРЭ

им. А.Я. Усикова НАН Украины (под. ред. Конюхова и др., 2007). Данный вывод основывается на отсутствии обратного рассеяния по всей площади

тестового поля, а РБО в дальнейшем может быть использован как дополнительный инструмент оценки состояния сельскохозяйственных полей.

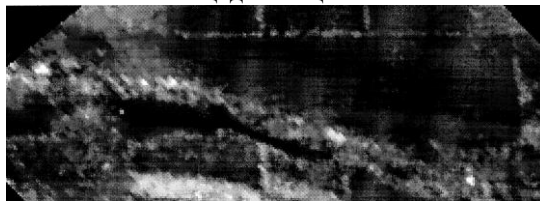


Рис. 2. Изображение тестового поля в миллиметровом диапазоне радиоволн

В пределах 6 контрастных по яркости изображения (рис. 1в) ареалов отобрано 24 почвенных образца, в которых определено содержание гумуса и гранулометрический состав. С помощью геоинформационной системы в тех же точках данного поля были считаны яркости космических изображений по всем трем каналам.

Установлена тесная связь между содержанием гумуса и физической глины, а также между гумусом и илистой фракцией. Яркость изображения в местах отбора образцов также тесно корректирует с гумусом, теснейшая связь в ближнем ИК - диапазоне. Достаточно тесно корректируют с яркостью отдельные фракции гранулометрического состава (Шатохин, Линдін, 2000).

Для выделения почвенных ареалов на изображении в ИК - диапазоне нами был использован аппарат фрактального анализа.

Достоверно установлено, что большое число процессов и явлений в физике и окружающей нас природе может быть представлено с использованием фрактальных моделей (Иванов и др., 2006, Пашенко Р.С., 2005). Фактически фракталы встречаются везде, где заканчиваются привычные правильные формы евклидовой геометрии.

Одним из перспективных путей повышения информативности аэрокосмических изображений является применение методов фрактальной топологии, основанной на том факте, что независимо от природы или метода построения, у всех фракталов есть ряд общих важных свойств: части фрактальных структур, в определенном смысле подобны всей структуре в целом, а степень изрезанности или

сложности фрактальных структур может быть описана неким характеристическим числом – фрактальной размерностью. Данное обстоятельство позволяет применить эти методы для дешифрирования радиолокационных изображений.

Использование фракталов для описания радиолокационных отражений от неровных структур, позволяет учитывать различные пространственные масштабы анализируемой поверхности. В (Иванов и др., 2006, Пашенко Р.С., 2005) представлены исследования фрактальных структур разнообразных поверхностей. Использование таких моделей предполагает учет парадигмы "топология зондируемого пространства - его фрактальная размерность

Для создания поля локальных фрактальных размерностей анализируемых изображений была разработана программа, которая позволяет выделять характерные кластеры фрактальных размерностей и отображать их определенным (в нашем случае - белым) цветом. Локальные фрактальные размерности строились для «окна» размером 8x8 пикселей с перекрытием 3 пикселя, т.е. использовалось «скользящее окно»

Программа строит гистограмму локальных фрактальных размерностей, для анализируемого ИК изображения (рис. 3), показанную на рис. 4, и позволяет произвольно выбирать диапазоны фрактальных размерностей, используемых при проведении сегментации изображений.

На гистограмме по оси X отложена величина фрактальной размерности D , а по оси Y относительная частота наличия фрактальной размерности f_D на анализируемом изображении.



Рис.3. Изображение тестового поля в ИК-диапазоне

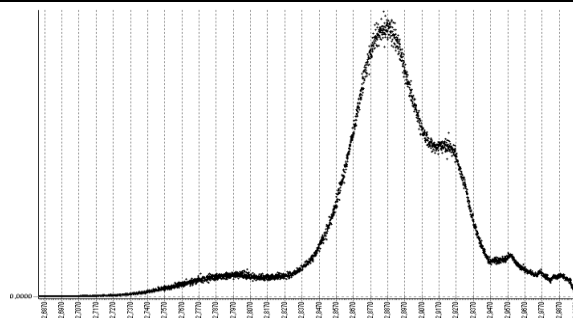


Рис. 4. Гистограмма локальных фрактальных размерностей

Как видно из рис. 4, гистограммы локальных фрактальных размерностей анализируемого изображения имеют ряд характерных особенностей. Локальная фрактальная размерность данного изображения рис. 3а изменяется от величины $D_a = 2,747$ до величины $D_a = 2,995$. Левая часть гистограмм плавно возрастает до величины $D_a = 2,83 - 2,89$, $D = 2,88 - 2,91$. Правая часть гистограмм характеризуется резким спадом с тремя ярко выраженными участками относительной частоты фрактальной размерности (2,92 - 2,953;

2,886 - 2,947, минимум относительной частоты достигается при $D = 2,995$).

Проведем анализ характерных особенностей гистограмм локальных фрактальных размерностей анализируемого изображения и построим селективные изображения соответствующих диапазонов изменения величины фрактальной размерности.

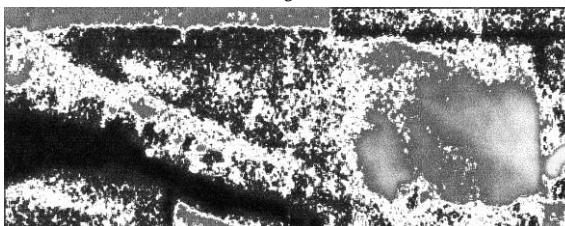
Селективные изображения для различных диапазонов значений фрактальной размерности показаны на рис. 5а-е.



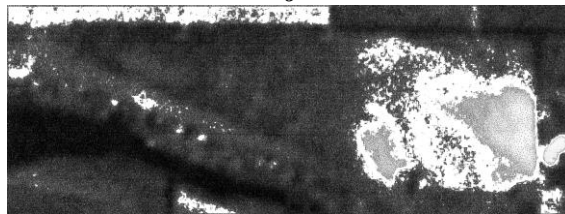
а



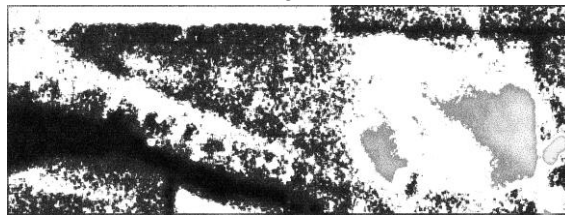
б



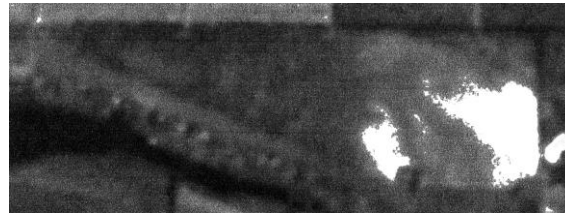
в



г



д



е

Рис. 5. Селективные изображения для различных диапазонов значений фрактальной размерности
а – $D=2.747-2.797$; б - $2.83-2.89$; в - $2.8847-2.9145$; г - $2.9203-2.953$; д - $2.8868-2.9474$; е - $2.94692-2.9951$

На селективных изображениях можно уверенно выделить водную поверхность (рис. 5а), намытые черноземные среднесолонцеватые почвы на лессовых породах и обычный чернозем на рыхлых песчаных легкосуглинистых и супесчаных породах (1+6+5, рис. 5б), намытый среднесолонцеватый чернозем на лессовых породах и на рыхлых песчаных породах легкосуглинистых (1+5, рис. 5в), чернозем обычный слабосмытый на лессовых породах и обычный неглубокий на лессовых породах (3+2, рис. 5г), обычные - слабосмытый на лессовых породах и неглубокий на лессовых породах и на рыхлых песчаных породах слабосмытый (2+3+4, рис. 5д), чернозем обычный на рыхлых песчаных породах супесчаный (рис. 5е).

Заключение

Показано, что в результате применения ИК и радиолокационной съемки, использования фрактального аппарата для тематической обработки полученных изображений, возникает хорошая перспектива мониторинга состояния почв для проведения широкомасштабного обследования гумусного состояния черноземов.

Для более детального разделения почвенных ареалов и уточнения их границ в дальнейших работах необходимо провести дополнительный анализ

различных селективных изображений на базе их математического сравнения.

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CURRENT STATUS OF ECO-VILLAGE DEVELOPMENT IN UKRAINE

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Ternopil, Ukraine*DOI: [10.5281/zenodo.15427537](https://doi.org/10.5281/zenodo.15427537)**Abstract**

The article reveals the current state of development of ecological settlements in Ukraine. The authors draw attention to the peculiarities of ecological settlements, their differences from other types of modern settlements. Ecological settlements are a fairly young phenomenon and originated as an echo of the «hippie» culture. At the same time, the popularity of this type of settlements in recent years is due to the desire of humanity to preserve the environment, to harmoniously combine human habitation in an ecologically clean environment. The authors draw attention to the special importance of ecological settlements in Ukraine during the war, as they became important centers of accommodation and shelter for internally displaced persons from combat zones.

Keywords: ecological settlement, settlement, ecotourism, rural green tourism, territory.

Introduction. Ecovillages are communities that strive for sustainable development, using ecological principles in their daily lives. They emerged as a response to the problems of the modern world, such as climate change, depletion of natural resources and social inequality. In Europe, ecovillages have become popular due to their ability to combine environmental, economic and social aspects.

Main text. The modern ecovillage movement in Ukraine began in the 1990s, when there was a need for alternative models of life that combine ecological principles and traditional methods of management. The most massive development of ecovillages is associated with the financial crisis of 2008, which forced people to look for new ways to ensure their well-being. At this time, the concept of «ancestral estate» also began to spread, which became the basis for the creation of many new communities.

Most ecovillages that emerged in Ukraine in the period after 2008 are actively developing today, using traditional methods of management and low-tech technologies. However, with the adoption of the concept of sustainable development, new communities began to emerge that focus on more modern technological approaches.

In September 2018, the public organization «Global Network of Eco-Settlements of Ukraine» (GEN Ukraine) was registered in Ukraine, uniting more than 40 communities. In the same year, the first catalog was published, containing the histories of 24 settlements and describing their management technologies. Today's version of the catalog includes more than 50 settlements, communities and projects in 19 regions, focusing on current initiatives [2].

Despite 10 years of war, communities that strive for an ecological and healthy lifestyle in harmony with

nature continue to develop in Ukraine. These communities exist both in large cities and in remote settlements, including eco-settlements, ancestral estates, art farms and spiritual communities. All of them are united by a common desire for sustainable development, biodiversity conservation and the maintenance of harmonious social relations.

In February 2022, Russia's full-scale invasion of Ukraine began, which posed new challenges for ecovillages. The NGO Global Ecovillage Network and the Public Organization Permaculture in Ukraine joined forces to create a map of locations in rural areas ready to receive people seeking shelter. In partnership with the Global Ecovillage Network Europe, a map of European eco-communities ready to receive Ukrainian refugees was created.

During the two years of the «Green Road of Eco-Settlements» existence, more than 60 locations in Ukraine have provided assistance to more than 3,000 internally displaced persons. Many people who moved to eco-settlements remain there to this day.

Eco-settlements not only provide shelter, but are also actively involved in humanitarian assistance. They:

- Provide shelter and humanitarian assistance to internally displaced persons.
- Help civilians in need and relatives of military personnel.
- Support military personnel in hospitals and at the front, providing humanitarian assistance, equipment, generators, and transportation.
- Organize the production of camouflage nets, trench candles, and prepare food for the Armed Forces of Ukraine.
- Develop programs of art, gardening, animal, and other types of therapy to restore psycho-emotional state.

Eco-settlements in Ukraine demonstrate resilience and adaptability in difficult conditions. They are becoming important centers of support and development, uniting people around the ideas of sustainable living and social responsibility. Despite the challenges facing the country, these communities continue to develop,

embodying the concept of harmony with nature and between people. In general, in Ukraine, as of the beginning of 2025, there are more than 50 eco-villages in 19 regions of Ukraine. The largest number of them is in Vinnytsia (8 settlements), Dnipropetrovsk (8 settlements) and Kharkiv (7 settlements) regions (Table 1).

Table 1

Ecovillages in the regions of Ukraine*

Region	Number of ecovillages	Name of ecovillages
Vinnytsia region	8	Salyntsi Bushanska Toloka Tverdunia Big Family Lyubodarovo Streams Cultural Projects Manor of Creativity
Volyn region	2	Dawn Jah Manor
Dnipropetrovsk region	8	Masters' Settlement Green Grove New Mayapur Hobbit Terra City of the Sun Andriivka Space of Samara Rassvet-Samara
Zhytomyr region	4	PRP Yemelyanivka Space of Love Academy Posolon PRP Kazkove
Zaporizhia region	1	Honchar's house
Ivano-Frankivsk region	3	ZIN SPACE Teplya Gora Living house
Kyiv region	4	Green Cliffs Bhakti Tirtha Dham Rodaria GlynoLend
Kirovohrad region	1	Light Forest
Lviv region	2	Honey Chest Authentic Home
Mykolaiv and Odesa regions	2	Bhumi Charitable Organization The House of the Sun
Poltava and Sumy regions	5	EcoUniverse Fairy Valley Baranivka Project «Garden Yeva» Svitankove
Ternopil and Khmelnytskyi regions	2	Settlement VeleSvit Podilska Etnokhata
Kharkiv region	2	Living House Voronya Slobidka Happy People Ozarenii Sviachene Buryakivsky Family Estate Kolo Lisu
Cherkasy region	3	Vrinda -Ashram Earth Creation Magical
Chernihiv region	2	PRP Blagodat Art Farmer Obirok

*Created by authors based on source [1]

The largest number of eco-villages is currently registered in Vinnytsia region. A vivid example of the unification of residents of one village into an ecological community can be seen in the example of the eco-village «Salyntsi» [1].

The eco-village «Salyntsi» began its existence in 2008, when a small initiative group decided to create a space for living in harmony with nature. Over time, they were joined by like-minded people who sought to equip their ancestral estate or young families who were looking for ecological alternatives to life in big cities.

The village of Salyntsi is located on several hills surrounded by ravines and overlooks the right bank of the Southern Bug River. This picturesque place impresses with its coniferous and oak forests that invite you to walk, pick mushrooms and berries. In the summer, residents enjoy swimming in the river, fishing and kayaking, overcoming numerous rapids.

The people of Salyntsi have a long history, dating back over three centuries. There is a legend about the «hot stone» - a rock on the river bank, on which the footprints of St. Mary remained. This story gives the place a special charm and significance.

Salyntsi is not just a settlement, but a community of like-minded people united by the idea of living in harmony with nature. The settlers learn to interact with the natural environment, try to understand the laws by which it exists, and not harm it with their actions. They strive to observe nature without interfering in its course of life.

The community is actively engaged in planting trees and shrubs, landscaping land, holding clean-up events, and prefers phosphate-free detergents. An important aspect of their activities is ecological communication with people around them, expressing their own opinions and accepting each other's positions.

Among the settlers are vegetarians and connoisseurs of yogic culture. The community includes teachers, alternative educators, a speech therapist, builders, a stove-maker, songwriters and needlewomen. They are engaged in vegetable gardening, beekeeping, gardening, have a plant nursery, and make jewelry, boxes and amulets from natural materials.

In «Salyntsy» children's and family camps «Free Space» are held, where participants can learn new skills, get acquainted with nature and develop creative abilities. There is also a bicycle workshop that promotes an active lifestyle.

The eco-village «Salyntsi» is a vivid example of how one can live in harmony with nature, supporting ecological principles and traditions. This is a place where people not only create comfortable living conditions, but also actively work to preserve the environment, forming a community in which mutual understanding and support reign.

In Ternopil region, there is currently only 1 eco-settlement - VeleSvit. In 2010, the history of this settlement began in the villages of Novosilka and Mali Borky, founded by the first settlers from different regions of Ukraine. This settlement arose as a spiritual community of people who sought to restore ancient Ukrainian Slavic traditions and live in harmony with

like-minded people, not far from the Slavic spiritual center in the village of Rashtivtsi.

During the 12 years of the settlement's existence, its number fluctuated. The events that took place in the spiritual center had a significant impact on the number of settlers: festivals, seminars, camps and spiritual training. This center attracted like-minded people and supporters of the Slavic tradition, but in 2014 it closed, which marked the beginning of a new stage for VeleSvit.

Over time, the settlement ceased to exist as a spiritual community and turned into a small community of three families who maintained friendly relations until April 2022. The difference in views and values made further relations impossible, but active members remained - the family of Velemyr and Svitlada Babich [1].

Due to the full-scale military aggression of the Russian Federation against Ukraine, the Babichs decided to use empty houses to provide shelter to internally displaced persons (IDPs). As a result, since the beginning of the war, nine families have received long-term shelter in four prepared houses, of which four families still live there. One of the IDP families even bought a house for permanent residence.

VeleSvit actively cares about the ecological use of the natural environment. Residents implement the principles of permaculture, organic farming, and ecological living in their homes. The settlement is located in a picturesque area among hills and fields, near the Medobory nature reserve, where wild animals such as wild boars, roe deer, foxes and hares live. The forest is rich in mushrooms, wild garlic and medicinal plants, and the Zbruch River flows through Medobory.

Medobory is also home to ancient temples of Slavic magi, the most famous of which is located on Mount Bogyt. This place is an important cultural heritage that reminds of the deep roots of Slavic tradition.

Today, VeleSvit is not just a settlement, but a center of support and interaction, where residents live in harmony with nature and with each other. Despite the changes that have occurred over the years of its existence, the community continues to develop, maintaining traditions and values that are important to its residents.

Conclusion. Ecovillages in Ukraine play an important role in the formation of a conscious society that strives for harmony with nature. They contribute to the preservation of ecology, implementing the principles of sustainable development, which helps to reduce the negative impact on the environment, preserve natural resources and biodiversity. Residents of such settlements have the opportunity to live a healthy life, consume environmentally friendly products, which has a positive effect on their physical and mental health. Ecological settlements form communities of like-minded people who support each other, exchange experience and knowledge, which contributes to the development of social responsibility and mutual assistance. They can become the basis for new forms of economic activity, such as organic farming, ecotourism, beekeeping and other environmentally friendly enterprises. This not only creates new jobs, but also increases interest in the

regions, which contributes to their development. In addition, ecological settlements become a platform for training and popularization of environmental knowledge, which is important for the formation of a new environmental consciousness among the population. Thus, ecological settlements in Ukraine not only contribute to the preservation of nature, but also have a positive impact on socio-economic development, forming new values and approaches to life in the modern world.

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ECONOMY

STATISTICAL ASSESSMENT OF THE IMPACT OF AGRICULTURAL SUBSIDIES ON FARMERS' INCOMES AND PRODUCTIVITY IN AZERBAIJAN

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Abstract

Although agricultural subsidies offer farmers short-term financial stability, they call into question their long-term output and environmental effect. The study findings indicate that direct income support subsidies can be more fair and focused. This strategy guarantees effective resource use and helps to environmental protection. Aiming to grow high-value and export-oriented agriculture, Azerbaijan's subsidy plan for 2025 gives tea plantations, vineyards, and crops cultivated with contemporary irrigation top priority. Simultaneously, enhancing systems and equipping farmers with information should also be given first importance. Therefore, agricultural subsidies ought to be included in not only economic but also social and environmental policies.

Keywords: Economic growth, statistical analysis, subsidy rates, agriculture.

INTRODUCTION

The main function of the agricultural sector is to meet the individual's food needs. The needs of society such as education, health and security can only be met after food needs are met. The agricultural sector has a strategic importance in meeting the basic food needs of man. This feature distinguishes it from other sectors. Since natural conditions affect the agricultural sector, the sector may need to be supported. For this reason, many countries promote the agricultural sector with various support instruments. Incentives are an important tool in tracking the development strategies of countries. Incentives can be very broad, covering all kinds of assistance to investors in the country, or they can be targeted at a specific target. There is a wide range of incentives in the regulatory framework, including direct investment grants and loans at preferential rates, tax holidays and reduced tax rates, subsidized infrastructure services, exemptions from environmental standards, electricity, water and transport services at below commercial prices. Although the concept of incentive corresponds to the meanings of motivation and encouragement, it is seen that concepts such as financial assistance, cheap loans, subsidies, state aid and support are also preferred in the literature. Its definition is as follows: "Material and/or non-material support, assistance and incentives by the people in various ways to ensure that certain economic activities develop more and faster than others". The main purpose of incentives is to ensure the use of existing resources of countries in areas that will play a leading role within the framework of macroeconomic policies. Most countries provide some type of agricultural subsidies. Subsidies may be linked to inputs and/or outcomes. Given that linking subsidies distort pricing and render the market non-competitive, the current trend is to decouple subsidies. Decoupled subsidies, by definition, should not influence farmers' immediate marginal production choices. In perfectly competitive marketplaces, there are no economies of scale, and producers exhibit risk neutrality. In actuality, these prerequisites are not met, and

hence, even detached subsidies may influence production decisions. In theory, there are four mechanisms through which coupled and decoupled subsidies can influence production:

- (i) by altering the relative prices of inputs and outputs,
- (ii) via an income effect affecting both on-farm and off-farm activities,
- (iii) through an income effect on investment choices,
- (iv) by impacting farm expansion and exit decisions.

All these effects may alter the technical and economic performance of the farms. In this context, a critical question is whether these effects are beneficial or detrimental to farm performance. Conventional economic theory and policy evaluation assert that agricultural subsidies distort incentives and diminish production. According to Garrone et al. (2018, p. 2), subsidies can diminish agricultural productivity due to the following reasons:

- Farmer investment decisions may be skewed towards less productive activities that receive subsidies;
- Farmers may excessively invest in subsidized inputs;
- Subsidies may diminish a farmer's motivation to implement cost-optimizing strategies;
- Subsidies may create soft budget constraints, resulting in inefficient resource utilization.

Nevertheless, recent investigations suggest that these assertions are not universally valid. According to Garrone et al. (2018), subsidies may augment agricultural productivity by alleviating farm limitations resulting from rural market flaws.

In the presence of inefficiencies in rural capital markets, subsidies may alleviate the financial limitations faced by farmers, either by directly enhancing their financial resources or indirectly by facilitating access to credit.

In the presence of imperfect insurance markets, subsidies can alleviate risk and stimulate investment in specific activities that the farmer might otherwise deem too dangerous. Empirical research also provide mixed evidence. The subsequent section of this study examines the findings of recent empirical studies about the impact of subsidies on agricultural efficiency and output. In the next stage of the study, the norms of subsidy rates in Azerbaijan for 2025, as well as the amount of currently arable land, the impact of subsidies on farmers' income, as well as their role in economic evaluation will be statistically compared.

LITERATURE REVIEW

The Green Revolution in wheat, maize, rice, and other types of staple crops has been primarily responsible for the remarkable increase that agriculture has seen all over the globe over the course of the previous half century and beyond. However, the trend in food costs has been growing lately (Kumbhakar, S. C., Lien, G., 2010). Because of expanding food production, prices declined until 2010, but they have been on an upward trend since then. Between the years 1961 and 2019, there was an increase in total factor productivity (TFP) in agricultural output. During the same time span, the pace of increase of inputs became increasingly less significant. In the next part, we will discuss the origin of this development in productivity, as well as convergence and location. Throughout the whole period from 1961 to 2019, developing nations were the pioneers in terms of production growth. Despite the fact that the pace of development for the developing world has slowed down in the recent decade (2010-2019) in comparison to the preceding decade, the growth of production continues to be 1.3 percentage points quicker than in developed nations. On the other hand, industrialized nations are also seeing an increasing trend in the expansion of agricultural output. Despite the fact that agriculture is responsible for the employment of a significant number of people in developing nations, automation has not yet happened at the same rate as it has in rich ones (Li, C., et.al., 2022). Mechanization was not the cause of the over three percent increase in production that developing nations saw in most decades; rather, it was the expansion of input usage (Mamun, A., 2024). China, Brazil, and India, along with some regions in Southeast Asia, have made significant strides in agricultural productivity during the 1990s. This is mostly because to the increased utilization of inputs and automation for agricultural purposes. The total factor productivity (TFP) is a measure of the combination of all elements, including land, labor, capital, and materials input. In the breakdown of agricultural expansion, total factor productivity (TFP) is the factor that accounts for the biggest percentage, followed by intensification of inputs, irrigation, and extension of land area. The total factor productivity (TFP) of high-income nations has been growing at a rate of around one percentage point up to the year 2010 (Figure 2). Since then, however, the pace of increase of total factor productivity (TFP) has slowed down: the average growth of TFP has decreased from 1.1% in the period 2001-2010 to 0.6% in 2014-2019. TFP growth in emerging nations is generally controlled by countries with lower and higher

middle incomes, notably China and Brazil, as well as countries in Southeast Asia, North Africa, and Latin America. Brazil and China are two examples of these countries. In both developed and emerging nations, high total factor productivity growth is accompanied by lower input growth. Particularly in the 1970s and 1980s, irrigation and fertilizer are considered to be the most important factors that contribute to growth that is driven by inputs. Beginning in the 1970s and continuing into the 1990s, developing nations made significant investments in irrigation systems in an attempt to provide food security for their expanding populations. nations, India is seen to exert a significant amount of pressure on local pricing, giving around US\$65 billion annually on average between the years 2014 and 2018. India's trade policy seems to be geared more toward satisfying the requirements of consumers than those of producers; as a result, it may be seen as a kind of taxes on farmers (Niftiyev, I., Ibadoghlu, G., 2023). On the other hand, China, which is classified as an upper-middle income nation, has recently transitioned from holding negative price support to holding positive territory (Laborde et al., 2021). At the international level, fiscal subsidies account for more than one-third of the overall assistance that is supplied. 38 percent of the overall subsidy amount, which is 242 billion dollars in the United States, is allocated to input subsidies, while another 30 percent is allocated to subsidies provided to farmers for elements of production, which include land, capital, and labor. It is thus the case that payments for inputs and elements of production combined account for 68% of subsidies. This reflects the efforts that governments make to maintain the productivity of the agricultural sector and to guarantee that everyone has access to food (Karamba, R. W., Winters, P. C., 2015). Especially noteworthy is the fact that nations with high incomes and upper-middle incomes give a significant amount of assistance for inputs, which is often unrestricted. Many nations, including those in Europe, China, and India, are among those that provide substantial subsidies for inputs and factors. The majority of nations that give output subsidies are those with high incomes or upper-middle incomes. Output subsidies account for fewer than 5% of the total (Van Berkum, S., 2017). Additionally, subsidies are distributed to farmers via methods that are disconnected. 2. Approximately one-third of all subsidies in the world are disconnected. This is a reflection of the reforms that have been implemented by a number of industrialized nations, such as the United States and the European Union, in order to move away from payments that are related to output. The goal of these reforms is to reduce market inefficiencies (Wang, S. W., et.al., 2019).

By intervening in the economic life of the country, using a wide variety of methods, the state provides visible support to certain economic entities, in many cases violating their right to make independent decisions (Huseynov, M., et.al., 2023). With the help of the subsidies received, other sectors of the economy manage to survive only from a financial point of view, regularly achieving negative or zero results. In this sense, subsidies raise a number of issues related to both their financial side and the criteria for selecting the lucky ones, as

well as their consequences. Subsidies located at the intersection of economic and political decisions also have social consequences, therefore, the use of this financial lever should be carried out with great caution. A subsidy is financial support provided free of charge and unilaterally, but in most cases conditionally and for a specific purpose (Мамедов, Н. Н. О., 2020). This implies, on the one hand, material need and demand for assistance, and, on the other hand, the presence of a material base and a willingness to provide support. We can say about a subsidy that the latter expresses the destructive activity of the authorities in the sense of the destruction of classical boundaries (Huseynov, M., et.al.,2024). The subsidy granted to an enterprise confirms the relativity of the distinction between the private and public sectors, national and personal interests. Moreover, subsidies distort the distinction between income and expenditure. Even if they are initially public expenditures, they are studied as community resources and in tax legislation they are treated as income of enterprises, for which a special regime should be applied to determine the taxable part or the basis for calculating VAT (Value Added Tax). In order to correctly analyze the impact of subsidies on the activities of economic entities, it is necessary to classify the latter. Thus, a distinction is made between production subsidies and investment subsidies. Production subsidies are intended to compensate for the shortage of certain products produced or to cover certain production costs. If such a subsidy is not allocated, they should partially or fully compensate for the total costs that the enterprise may incur. Subsidies for production include:

- Compensation for losses resulting from low sales prices;
- Amounts received from the state for the creation of new jobs;

- Subsidies aimed at covering production costs.

Investment subsidies are financial assistance that allows the purchase or construction of real estate, as well as long-term financing. These subsidies can partially or fully finance the costs, the main rule to be observed is that they are taken into account at the time of provision without expecting payment. As a financial note characterizing subsidies, we can say that they represent nothing more than relatively limited amounts, their expenditure will never be justified; they themselves offer solutions to the problem, which must be accepted primarily depending on strict economic criteria. Moreover, since subsidies are subject to taxation, they are less attractive to businesses than long-term, low-interest loans. In the financial practice of economic agents, investment subsidies represent part of the fixed assets on the liabilities side of the balance sheet (Hemming, D. J., et.al.,2018).

There have been many changes in agricultural support policies from the past to the present. The dynamics that have been effective in agricultural support policies to date and are thought to be effective in the future processes are; external dynamics, which are obligations and responsibilities formed by international organizations or institutions that are members, country communities, and internal dynamics arising from country conditions and society's needs (Gulaliyev, M. G., et.al.,2019). Among these reasons, membership conditions for the European Union, international organizations such as the World Trade Organization and the International Monetary Fund, bilateral agreements, some macroeconomic problems, climate changes, problems in agricultural structure, various changes in rural areas and environmental problems are some factors.

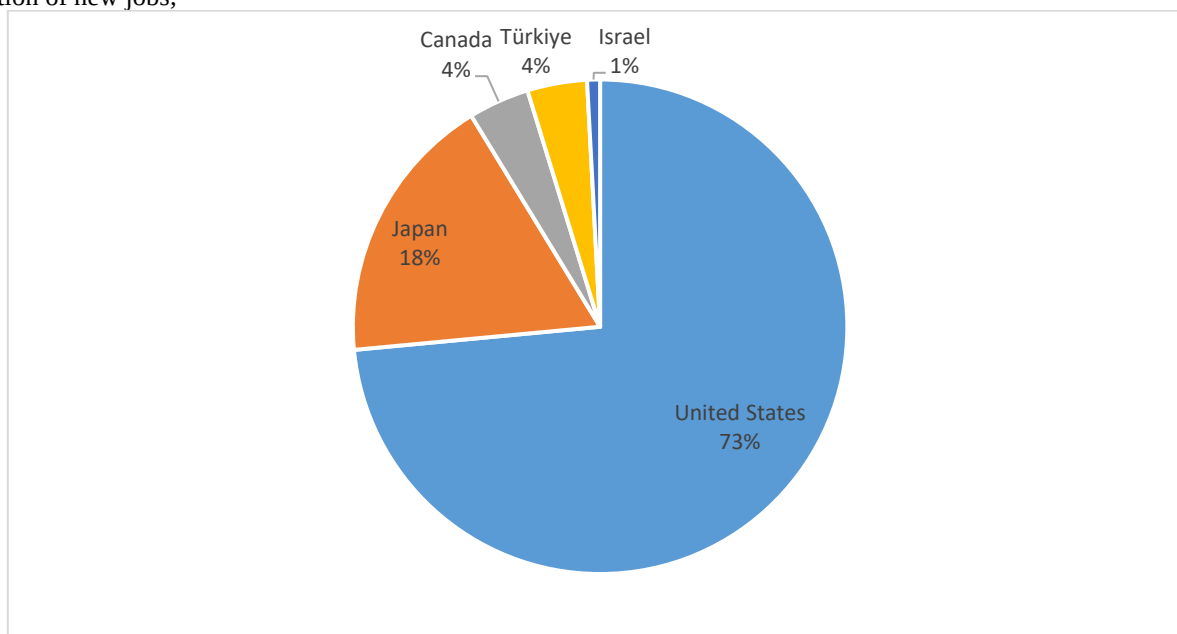


Fig 1. Subsidies for agriculture in various countries

Source: OECD

Today, agricultural supports consist of area-based agricultural support payments, difference payment supports, livestock support payments, agricultural insurance services, other agricultural support, compensatory

payments and payments for rural development (Hashimova, A. C., 2023). Agricultural supports made from the budget and continuing are as follows;

- **Area-based supports:** This support includes fuel and fertilizer support, organic livestock support, organic agriculture support, good agricultural practices support, hazelnut area-based income support, small family business support for plant production, soil analysis support, solid organic/organomineral fertilizer support.

- **Differential Payment Support:** Products such as seed cotton, olive oil, soy, safflower, sunflower oil, dry beans, canola, chickpeas, lentils, grain olives, oats, fresh tea, rye, wheat, barley, triticale, grain corn, and paddy are included in this support.

- **Livestock Support:** Breeding of animal breeds suitable for certain regions of the countries, improvement of hygiene conditions for production facilities, regulations made for animal health, establishment of animal markets and incentives for aquaculture products are included in this scope. Forage crops, beekeeping, breeding small cattle for breeding purposes, calves, milk, approved dairy farms, milk analysis, silkworms, animal disease compensation, aquaculture, traditional coastal fishing, processed aquaculture, large cattle fattening, vaccination, biological and biotechnical control, animal genetic resources, calf, buffalo, herd growth and renewal, feed, waste, ear tag application, etc. supports are included here.

- **Agricultural Insurance Support Services:** The aim is to put the insurance mechanism into effect to cover the risks that arise in the agricultural sector and become a threat.

- **Compensatory Payments:** Payments made for income loss resulting from the production of different products by changing the product grown in the event of excess supply of agricultural products; are within the scope of plant quarantine compensation, potato wart support, tea pruning compensation and expenses.

- **Agricultural Supports for Rural Development:** With a new approach in the 2000s, the rural development model began to be widely implemented based on a project aimed at strengthening the integration of agriculture and industry in rural areas. Because the nature of agricultural subsidies has changed, agricultural support tools have diversified, the functionality given to rural areas and agriculture has increased and institutionalization has occurred in regional policies. With agricultural support for rural development; the income of rural residents (Agyemang, S. A., et.al.,2022).

METHODOLOGY

This research work is carried out in Azerbaijan to assess the impact of agricultural subsidies on farmers' incomes and productivity using statistical data. During the research, data was obtained from the Ministry of Agriculture of the Republic of Azerbaijan and the State Statistical Committee of the Republic of Azerbaijan. Based on the information obtained, it was planned to determine the impact of subsidy rates on farmers' incomes and their role in regulating economic activity. The analysis period was planned between 2015-2023 and work was done in this direction.

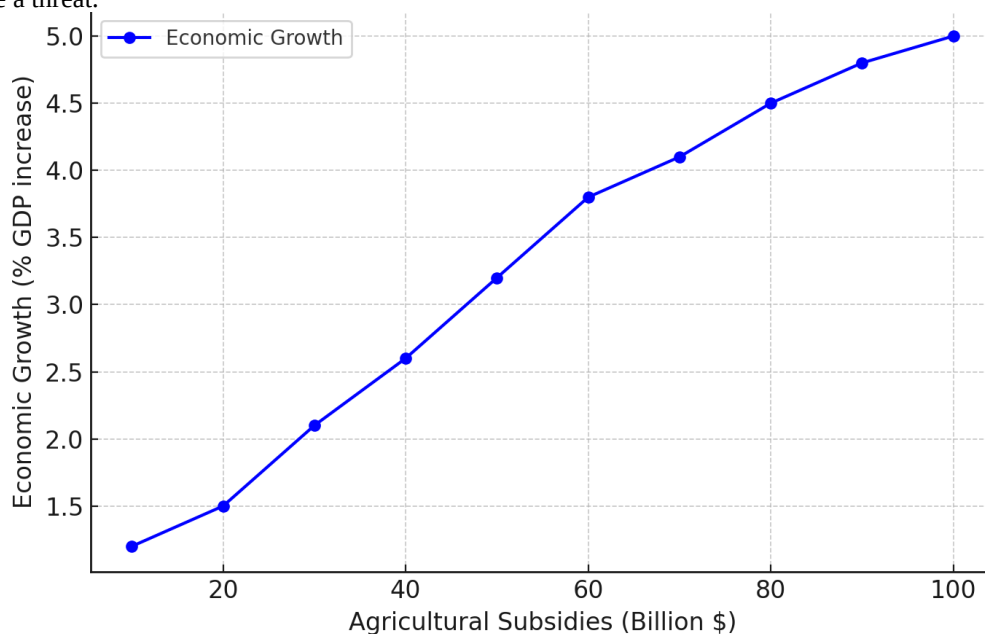


Fig 2. Trend between subsidies in agriculture and economic growth

Source: Prepared by the author himself as a result of research

The graph shows the relationship between agriculture and subsidy rates. When looking at the relationship between the variables, a direct proportionality is noted between economic growth and the effect on the amount

of subsidy. According to rough calculations, a subsidy of \$ 20 billion affects an estimated 1.5% of GDP growth.

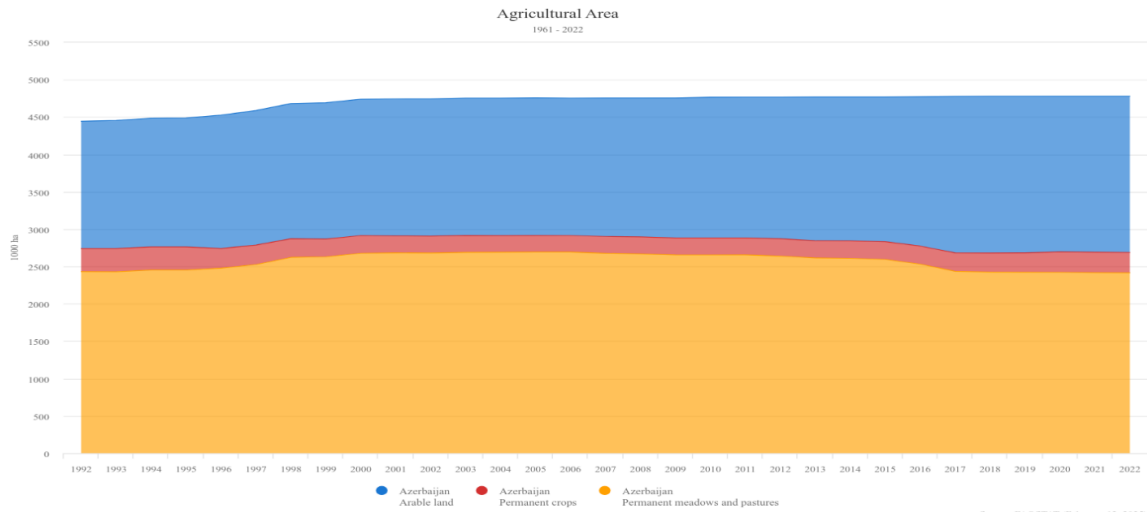


Fig 3. Agricultural lands of Azerbaijan

Source: <https://www.fao.org/faostat/en/#country/52>

The graph shows the dynamics of agricultural areas in Azerbaijan for the years 1992-2022. Arable land (blue) is shown, having the main share. In addition, the growth over the years demonstrates a stable increase.

The area of permanent crops (red) shows variability, having a small share. While these areas remained stable until 2013, a decrease is observed in the following years.

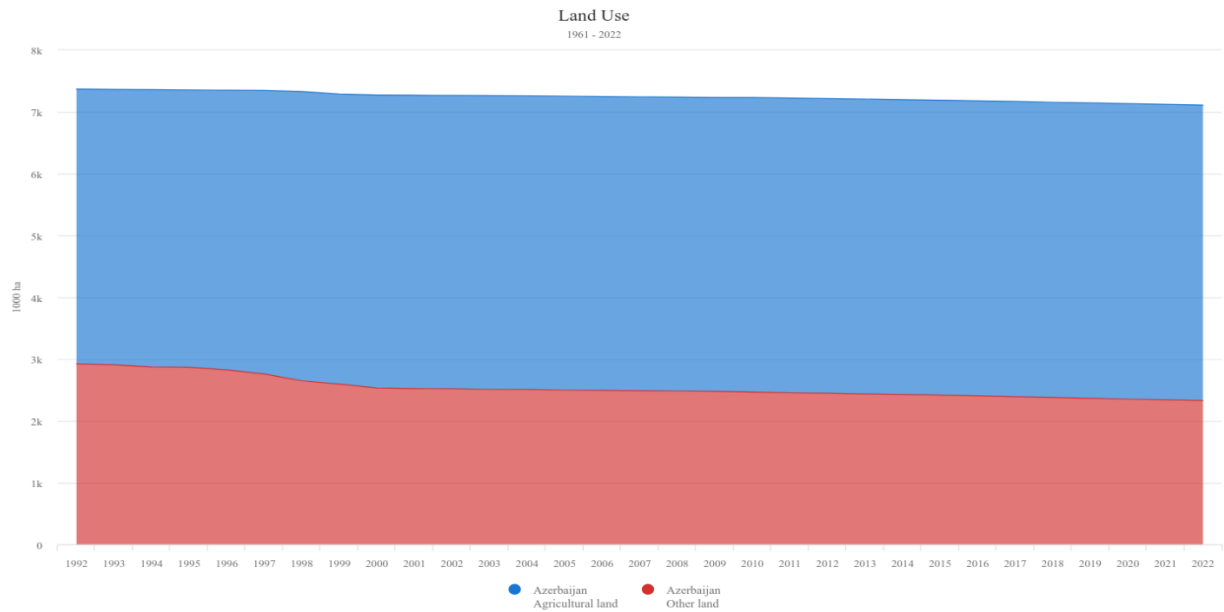


Fig 4. Land and other areas used for agriculture in Azerbaijan

Source: <https://www.fao.org/faostat/en/#country/52>

The graph represents the statistical distribution of land use in Azerbaijan for the years 1992-2022. The blue area reflects agricultural lands, and the red area reflects other lands. Since 1990, an increase in the volume

of usable land has been observed, providing evidence of Azerbaijan's agricultural potential.

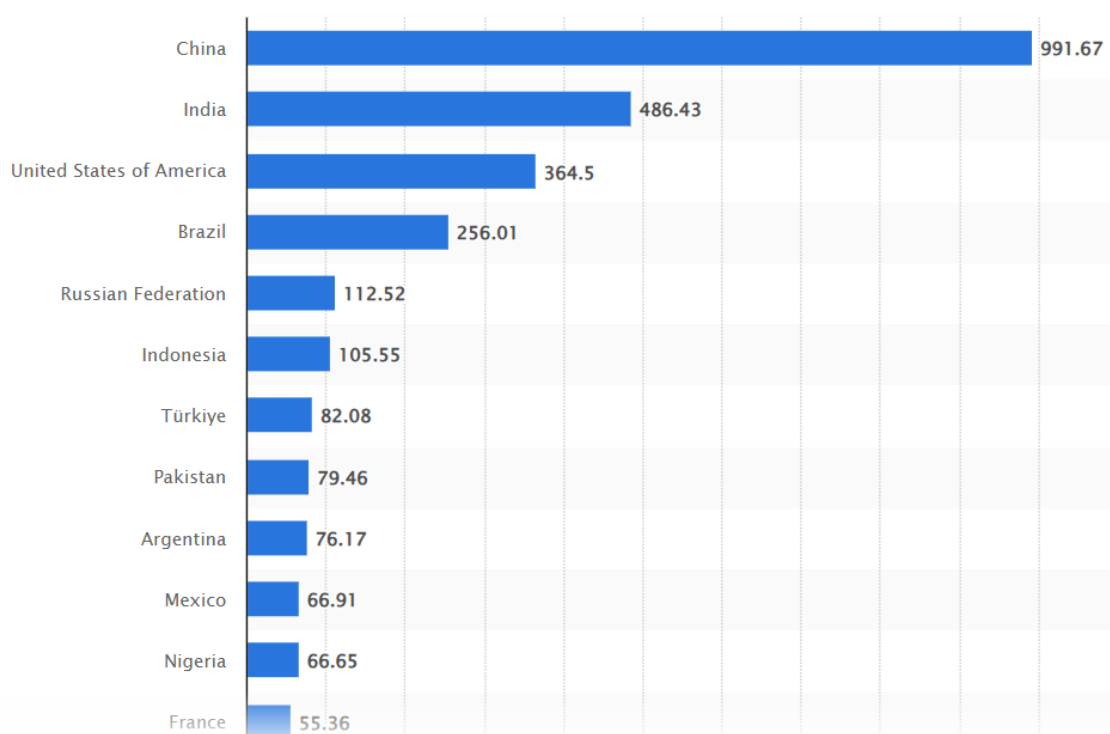


Fig 5. Value of global agricultural production by country in 2022 (in billion international US dollars)

Source: <https://www.statista.com/statistics/1332343/the-leading-producers-of-agricultural-goods-worldwide>

The graph shows the ranking of countries that provide the most subsidies to agriculture. China, which is in the leading position, is in the first place with \$991.67 billion in subsidies. This reflects the strategic importance the country attaches to agriculture and its policy aimed at food security. India, which is in second place, allocates a fairly high amount with \$486.43 billion. The United States is in the top three with \$364.5 billion in subsidies. Brazil (256.01 billion), Russia (112.52 billion) and Indonesia (105.55 billion) also attract attention with high subsidies. Turkey is in the middle with \$82.08 billion. Countries such as Pakistan, Argentina, Mexico and Nigeria also have subsidies ranging between \$55–80 billion. France, which is in the last place with \$55.36 billion in subsidies, although it is a notable level among European countries, is in a lower position on a global scale. These data show the role that subsidies play in national policies.

The figure (6) below lists the sowing coefficients for agricultural crops in Azerbaijan as well as the subsidy amounts. Soil fertility and the degree of subsidies directly influence the planting coefficient. Strategic and

high value-added items get the most subsidies. The distribution of 8,000 and 12,000 manat subsidies for tea gardens and vineyards, respectively, during 2024-2025 suggests that these sectors are given top priority.

These subsidy levels suggest that the state supports the growth of these goods and that it seeks to boost export potential. Relatively constant are the planting coefficients and subsidy levels for conventional grain crops rice, maize, millet, sorghum, cereals and legumes. The planting coefficient of maize and millet grown under contemporary irrigation systems, for instance, is 1.45 and the subsidy is 290 manat. This underlines the influence of irrigation on output and its importance in subsidy policy. Especially when irrigation systems are in place, vegetables, melons, and potatoes are also very subsidized. Replanting and regions without irrigation infrastructure have the lowest cropping rates and subsidies. This suggests that the state supports high-tech and intensive agriculture. The table generally indicates that subsidy programs are related to irrigation, the economic worth of the crop, and its strategic relevance.

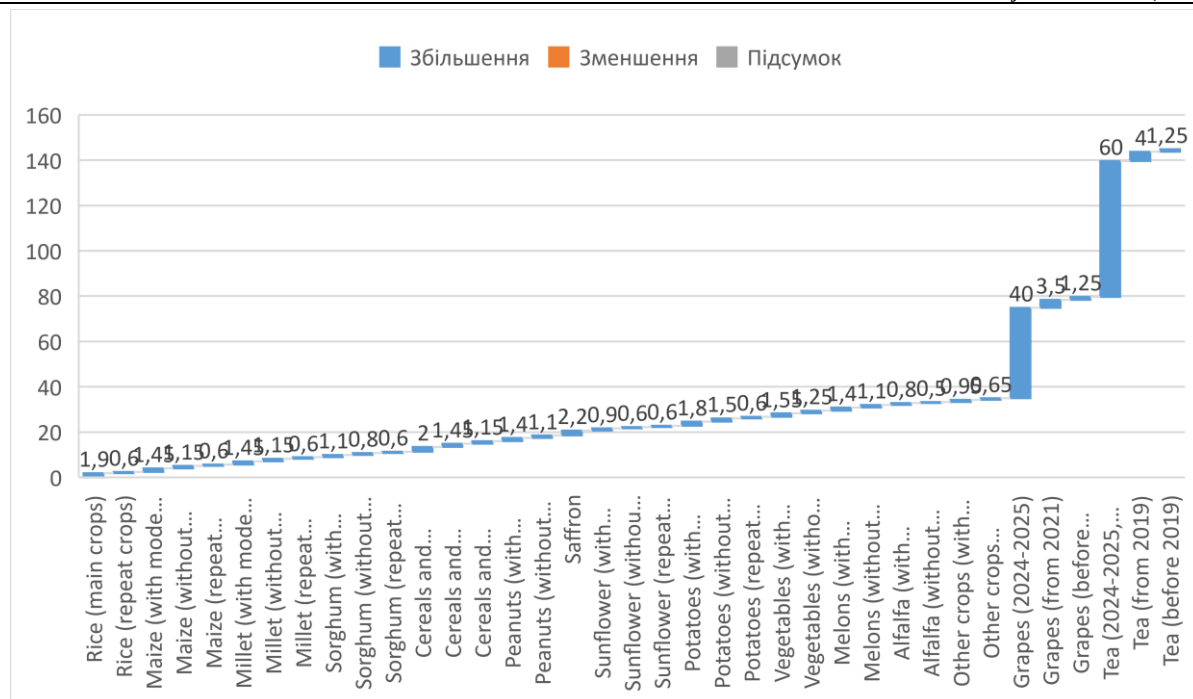


Fig 6. Subsidy rates in agriculture in Azerbaijan in 2025

Source: <https://www.agro.gov.az/az/news/020924?utm>

RESULT AND DISCUSSION

The findings have important implications for agricultural policy in Asia, India, Azerbaijan, the United States, Japan, and the world at large. While agricultural subsidies play an important role in supporting farmers and ensuring food security, their long-term impact on profitability and sustainability remains questionable (Agasalim, A. A., 2020). To address these challenges, policymakers need to adopt a more targeted, efficient, and sustainable approach to supporting agriculture. Subsidies for Direct Income Support One key recommendation is to gradually shift from input subsidies (such as fertilizer and electricity subsidies) to direct income support for farmers. Subsidies can encourage overuse of resources and lead to environmental degradation, while direct income support can provide a more stable and equitable form of support for farmers. This shift can also help reduce market distortions and improve the efficiency of resource allocation in the agricultural sector. Extension services can also play an important role in disseminating knowledge and technology to farmers, especially small-scale farmers, who have limited access to information and resources. The promotion of agri-environmental schemes and ecosystem services should also promote agri-environmental schemes and ecosystem services to promote more sustainable agricultural practices. These schemes can provide incentives for farmers to adopt practices such as conservation tillage, crop rotation and integrated pest management, which can help reduce environmental impacts and enhance biodiversity. Ecosystem services such as carbon sequestration and watershed protection can also provide additional income streams for farmers, while promoting environmental sustainability. Finally, attention should be paid to improving market access and value chain development for farmers, particularly small-scale farmers in developing countries. This could include investments in infrastructure such as roads and

storage facilities, as well as support for farmer organizations and cooperatives. Value chain development can also help improve the quality and traceability of agricultural products, increase farmers' incomes and contribute to rural development.

CONCLUSION

The research indicated that in the near term agricultural subsidies significantly help to raise farmers' incomes and guarantee food security. The effect of subsidies on economic efficiency and production in the long run is uncertain. Traditional subsidies, particularly subsidized fertilizers, can cause excessive use of energy and water resources, therefore harming the environment. Empirical studies reveal that the influence of subsidies on production choices is not only connected to price mechanisms but also to income effects, investment behaviors, and farmers' risk attitudes. This shows that subsidies have an indirect influence on technical as well as economic efficiency. The research, meanwhile, indicates that subsidies can be modernized that is, made more focused by means of ecosystem services in agriculture, technology distribution, and knowledge transfer. Direct income support in the form of subsidies can be more fair and sustainable. This approach lets farmers plan and carry out their economic activities free from market pressure. Azerbaijan's planned subsidy rates and various product type policies for 2025 reveal state interest in strategic items. This helps to increase the export potential of agriculture and produce items with significant added value. Therefore, from both economic and social points of view, subsidy policy should be balanced and in line with strategic objectives.

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PREDICTING EMERGING MARKET RETURNS WITH SIMPLE MACHINE LEARNING TECHNIQUES

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Abstract

This study applies simple machine learning techniques to predict Emerging Market (EM) equity returns. It examines excess returns for major EM indices versus relevant benchmarks. Predictor variables were drawn from the same security's historical excess returns. The intuition is that past performance can be predictive of future investment interest and that predictive relationship is unique for each security. Therefore, a variety of models need to be considered. A total of five models were applied: traditional logistic regressions, ridge, random forest, boosting and neural nets. The results indicate that newer machine learning-based predictive relationships, such as random forest, boosting, and neural nets, generate valuable out-of-sample results. In nearly all countries, there was a machine learning active strategy that delivered higher returns than a passive long strategy. The paper identifies avenues for further exploration of such investment strategies.

Keywords: emerging markets, machine learning, international investing, momentum.

The shift of investment flows from active managers to passive vehicles has turned into a deluge in recent years. This move has been driven by, among other things, low fees for passive vehicles and lackluster performance by active managers. However, most passive funds utilize a naïve long-only market capitalization based approach to investing and then optimize for the lowest possible trading cost. Emerging “smart-beta” products (e.g. Momentum or Value) are based on universal factors that have been back-tested excessively, with limited application of modern data mining techniques. New developments in machine learning allow for multiple levels of abstraction that supersede the complex regression modeling even from a few years ago, let alone beat subjective heuristics that active managers or passive index rules often rely on.

Using EM index excess returns

The focus on excess returns for emerging market indices is unique for four reasons.

Longer time horizons: Many large algorithmic firms focus on very high frequency trading (e.g. at the tick-level). The statistical relationships and proposed investment strategies are much longer term in nature. In other words, they are “playing” in a different world for even the same security.

Emerging Market coverage: EM tends to have less investment coverage given its smaller size, lower liquidity, political risks and difficulty marketing such funds to Western investors. In fact, emerging markets investing is still seen as a “boots-on-the-ground” endeavor, a self-fulfilling prophecy that means there is more to be explored quantitatively in this space.

Relative Returns: using excess returns for a security over its higher-level aggregate benchmark further narrows the scope of analysis. Such an approach seeks to derive information from the top-down country allocation approach that international investors implicitly use.

Indices: Using broad-based index returns instead of single stocks adds diversification. It also mitigates the potential for a machine learning's strategy's “edge” to be competed away soon. The overall equity market for a country or region has a plethora of participants with varied motivations, only some of whom will ever

invest based on an algorithm even if presented with a 99% accurate one. In other words, there are natural limits to arbitraging away such strategies at the total stock market level. In addition, index returns can also be replicated easily today using low-cost liquid ETFs or futures.

Using historical returns

This analysis is inspired from research by Krauss, Do, and Huck (2016), Takeuchi and Lee (2013), Moritz and Zimmerman (2014). All these studies apply machine learning techniques to individual stocks in either the S&P 500 or US CRSP database. In particular, they use various horizons of past daily performance to predict future returns, with an inherent emphasis on momentum philosophies. Asness, et al. (2014) lay out the basis for momentum's centuries-long performance as a source of sustainable and meaningful investment returns. Habauer, et al. (2023) have used machine learning models on individual EM stocks rather than indices to show the superior forecasting ability of machine learning relative to traditional linear models. As a variant to this, this paper analyzes excess returns for individual indices, rather than create a portfolio that requires daily rebalancing of individual stocks. With the growth of futures and liquid ETF vehicles aiming to replicate country stock indices, this index-based approach may be more practical and diversified for a broad array of financial practitioners.

Using monthly data

Although weekly data can greatly expand the number of observations, monthly data has a few advantages. Cross-country allocations are often driven by medium-term political and economic views. Reducing the frequency can remove noise associated with intra-month gyrations. Monthly data also reduces transaction costs from higher frequency trading. Finally, this approach aligns with the monthly rebalancing schedule followed by major ETFs.

Data extraction, cleanup and summary

The dataset is extracted from Thomson Datastream's MSCI database (Morgan Stanley Country Indices). These are indices that track the global equity market levels and are the most commonly-used benchmarks for index funds and institutions. The index levels

are extracted monthly and denominated in US dollars to provide a common standard. The indices used are calculated on a total return basis, i.e. dividend are included.

The MSCI World index is the developed country index, representing large and mid-cap equities that covering approximately 85% of the free float in each of the 23 constituent countries. The index tends to be very highly correlated with US S&P 500 index, not a surprise given the 73% weight to the US. The next largest countries are Japan and the UK at 5.2% and 3.6% respectively.

The MSCI Emerging Market index is made up of 24 emerging market nation indices, covering approximately 85% of the free float in each country again. This index represents 10% of global market capitalization, up from 1% in 1988 when it was launched. The index is heavily dominated by Asia. The top four countries - China, Taiwan, India and Korea - comprise around 75% of the index. While the index was launched in 1988, the larger countries in the current index were only added in the mid-to-late 1990s.

The definition of Emerging Market used here is based solely on western investor behavior and MSCI index rules. There are many dimensions across which it would be inappropriate to label these countries developing, e.g. China's share of global GDP/trade or Korea's per capita income.

Response and predictor variable creation

For clarity's sake, the model is applied solely to the aggregate Emerging Market index. First, a return stream is created for the excess return of emerging over developed markets. The next month's value of excess return is considered to be the response variable, transformed into a binomial i.e. if the excess return is greater than zero, the response variable is 1 and 0 otherwise.

The predictor variables are generated as trailing differences at various horizons. The study selects months 1 through 12, and then 6 months intervals out to 3 years for sensibilities sake, to get a total of 16 predictors.

To visualize this, say one is looking at the June 2015 datapoint. EM outperformed DM in the next month, July 2015, so the response value = 1. X_1 = 1-month (June 2015) return of EM less 1-month (June 2015) return of DM, X_2 = 2-month return of EM less 2-month return of DM, ...and so on until X_{16} = 3-year return of EM less 3-year return of DM, both ending June 30 2015.

This format can then be extended to each EM country relative to overall EM. For instance, Brazil's response variable will be 1 if Brazil's return is greater than EM the following month. And the predictor variables will be Brazil less EM returns at various horizons.

Splitting observations

Three methods for splitting data were considered (using a standard 75/25 split): Chronological, Random Sampling and Rolling Windows. The final choice was to use Chronological, but it is relevant to discuss the merits and concerns of each approach.

Chronological: The chronological split sets the train data from 1999 through mid-2019 and test data

from then until 2024 (roughly 5 years to capture a cycle). Inherently this means that one is making a prediction based on historical relationships. The advantage of chronological splitting is that it allows one to logically calculate hypothetical performance statistics for an investment strategy based on these results.

Random Sampling: One alternative was to use a random sample of monthly observations that ignored the chronological time nature. This would mean using future data points to predict past ones. Unintuitive as it sounds, this wouldn't be problematic because it identifies the predictive relationship of a security to its past return structure. It assumes that this relationship is independent of time. In fact, this would allow one to make a more "universal" or "evergreen" model for that specific security and not limit training (or testing) time period. One concern is that performance statistics from this would be erroneous. The performance statistics require a chronological time series and one cannot use the randomized serial numbers for that.

Rolling Windows: A rolling window would maintain chronological nature of the data. For instance, one could split data into 7.5 years training and the next 2.5 years test, repeatedly at intervals starting each calendar year. This would provide around 25 iterations of each model and 25 train/test errors, which could then be averaged to provide a final error estimate. The model's continuous updating will account for changing secular market regimes by basing predictions on the recent past. The challenge here is that more observations are needed and monthly numbers limit the scope for this. In addition, each time the model is losing data from old time periods that may have predictive power for the future.

Models

5 models were used. First, a **simple logistic regression** against all the variables. Second, a **ridge regression** to regularize the variables, i.e. shrink the size of the coefficients by adding a penalty for a higher number of variables introduced. The third model is a **random forest**, which breaks the data into trees along randomly selected variables (5 randomly selected out of the total 15), majority vote within any tree node (minimum node size is 10 observations), and repeats this 500 times by using bagging (resampling with replacement). The fourth model was **boosting**, which begins with a weak model and then iteratively estimates the remaining error to improve the model's predictive power. The starting weak model was a simple decision tree with 3 splits. For each security, it found the optimal number of iterations to fit the final boosting model. The model's target was set to minimize classification error. Finally, a **neural net** model was applied, that uses a sigmoid function repeatedly to estimate our response variable. This version uses 2 layers of 5 and 3 neurons for the neural net.

Results

The misclassification errors for the models over the test period are provided below. Misclassification error is the percentage of times the predicted performance (i.e. excess return > or < 0) does not match the actual result next month.

Exhibit 1: Results

	Simple Logistic	Ridge	Random Forest	Neural Net
EM*	62%	62%	59%	50%
Thailand	56%	59%	50%	53%
China	45%	62%	45%	52%
Korea	36%	50%	41%	41%
Taiwan	50%	42%	55%	62%
Malaysia	45%	44%	50%	39%
Thailand.1	56%	61%	50%	53%
India	50%	52%	47%	50%
Indonesia	58%	55%	55%	52%
SoAf	50%	45%	53%	48%
Poland	52%	50%	45%	48%
Brazil	50%	50%	36%	45%
Mexico	41%	47%	58%	48%
Chile	45%	47%	56%	45%
Turkey	47%	55%	59%	47%

*EM vs DM; Rest are Country vs EM

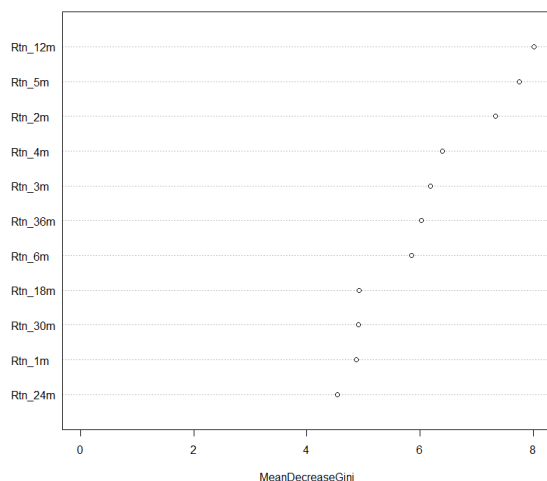
In general, the random neural net performs very well. Given the very low significance of individual variables in the regression approaches, we're more inclined to use either random forest or neural net. Random forests have very low training errors that could indicate overfitting due to the small number of observations. To mitigate this, the minimum nodesize was set to 10 versus the default 1 typically used for classifications.

The value in being able to run these alternative models against each security is that one does not need

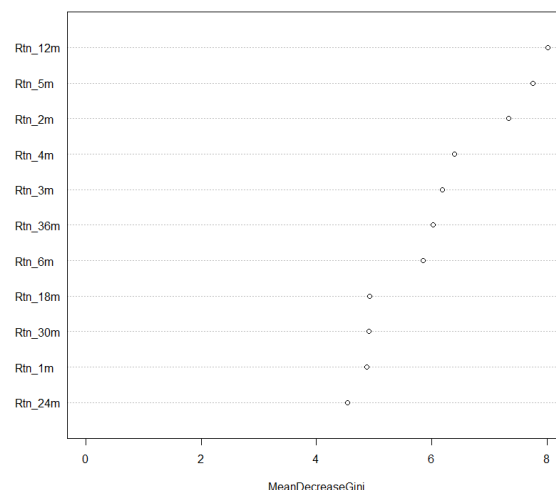
to pick a universal approach. For certain securities, neural net does a better job and for others, random forest (e.g. see Poland and Brazil). Moreover, even with the same model, e.g. random forest, the variables that are most important can vary by security. E.g. the charts below are variable importance plots from the random forest models for EM and Malaysia. The former is driven most by the 1-month return and the latter by the 2-year return.

Exhibit 2: Random Forest: Variable Importance Plots

Brazil
rf



Malaysia vs EM
rf



In comparison to human active management that finds it extremely difficult to beat naïve passive indices, our model errors less than 50% have the potential to be developed into powerful investing strategies. Of course, such potential is subject to the distribution of returns for a given security. Analysis and comments on that provided in the next section.

Investment Performance

Investment strategies were created based on all the models. The strategy goes long when the next month is

predicted to have positive excess returns and short otherwise. This is compared against performance of a passive strategy that stays long the security. In all these cases one is going long one security vs the other (i.e. these are all relative returns).

A summary performance table is below along with a chart for the EM vs DM performance (additional charts in appendix). On a country by country basis, no one model is robust across the countries. However, certain models jump out as generating very strong returns

for a given country, which ties back to a point in the previous section that each security is unique in its relationship to past returns. Therefore, model selection can be done on a security-by-security basis rather than to create universal market truths. For EM vs DM as a

whole, neutral net deliver top results. The only two countries where machine learning techniques do not generate a higher-value strategy vs passive long are Taiwan and India – notice that these 2 have also been outlier strong performers within the group.

Exhibit 3: Performance (Annualized, test period)

	Passive Long	Simple Logistic	Ridge	Random Forest	Neural Net
EM*	-8.6%	-9.0%	-12.3%	-8.0%	2.7%
Thailand	-7.4%	-8.4%	-7.4%	-1.9%	-1.3%
China	-4.2%	4.6%	-4.2%	-6.6%	-6.0%
Korea	-1.5%	12.1%	-0.4%	9.9%	8.7%
Taiwan	12.5%	2.9%	6.5%	-3.4%	-11.3%
Malaysia	-3.2%	-1.1%	1.7%	-0.8%	7.0%
India	8.5%	-2.6%	-3.1%	0.8%	-11.8%
Indonesia	-5.3%	-11.6%	-3.9%	-8.1%	0.9%
SoAf	-0.4%	-7.3%	-2.4%	-7.4%	1.0%
Poland	-3.7%	-1.4%	0.2%	4.9%	7.5%
Brazil	-7.1%	-0.8%	0.4%	26.9%	3.0%
Mexico	1.6%	10.7%	-6.0%	-16.2%	8.8%
Chile	-6.7%	6.6%	1.9%	-8.0%	3.8%
Turkey	1.8%	7.0%	1.8%	-19.4%	-7.5%

*EM vs DM; Rest are Country vs EM

Ignores transaction costs, which should be minimal given liquid ETFs and monthly rebalancing

	top model vs passive	top model
EM*	11%	nn
Thailand	6%	nn
China	9%	glm
Korea	14%	glm
Taiwan	-6%	ridge
Malaysia	10%	nn
India	-8%	rf
Indonesia	6%	nn
SoAf	1%	nn
Poland	11%	nn
Brazil	34%	nn
Mexico	9%	glm
Chile	13%	glm
Turkey	5%	glm

Exhibit 4: EM vs DM performance chart



Scaling

The models predict a probability for whether the next month's excess return is positive or not. A simplifying assumption was used here that if the predicted probability exceeded 50%, go long and otherwise go short. One approach to improve this could have been to scale the long/short positions based on the probability itself rather than using the arbitrary 50% threshold. Another option would be to choose a threshold based on risk tolerance. e.g. if one is more fearful of sharp negative moves, one would want to minimize false positives and maximize true negatives, so choose a threshold greater than 50%.

Taking a step back from the classification approach, one could also treat next month's returns as a continuous response and use a least square error loss function. Scaling of investments could then be done by standardizing (z-score) the mean square error for each observation.

Conclusion

This research can be used by investors to access superior returns that are difficult to arbitrage away, and a unique algorithmic strategy that adds to portfolio diversification. Index firms can use this to expand their product menu and cater to the nascent demand for machine learning based investment products. It could also be used by active managers as a trading indicator to supplement or diversify their own fundamentals-based research. Such diversification might be particularly val-

uable for emerging market funds. Individual quantitative investing enthusiasts can use this research as a stepping stone for further study and investing.

The results should provide more light on the predictive power of newer machine learning techniques. There are many avenues for further exploration: data frequency, replacing X_t s with different horizons/risk metrics, incorporating lasso, splitting, scaling, and extending this framework to other securities. In conclusion, if one believes that each security's relationship to its past returns is unique and relatively stable over large periods of time, there is no need to be straightjacketed by a one-size-fits-all factor model across those securities.

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LOGISTICS-BASED MANAGEMENT OF ENTERPRISE PRODUCT ASSORTMENT THROUGH VALUE CHAIN BUSINESS PROCESS ANALYSIS

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Abstract

Theoretical approaches to defining the content of product assortment management processes at the enterprise level have been generalized based on the analysis of the business process chain involved in new value creation. Recommendations are provided for assessing the feasibility of modifying the company's product assortment by identifying changes within the logistics chain of value-creating business processes.

Keywords: logistics, logistics management, product assortment, business process, value creation.

Introduction. The product assortment policy includes specific actions company management takes to meet the actual demand of target customer groups (market segments). These actions help form a product range that is both commercially effective and aligned with planned sales goals. Creating an optimal assortment of goods and services means organizing related business processes in the proper order and location. This is made possible by the stable work of the company's logistics system. The logistics system, in turn, covers the full cycle of creating new value – from finding ways to finance the business, buying necessary materials, transporting and storing them, processing them, storing and distributing the final products, selling them, receiving income, and paying back loans.

Literature Review. The theoretical and methodological foundations of logistics-based product assortment management have been explored by well-known economists such as Andrade R. [3], Camp R. [4], Guban A. [5], Hryhorak M. [1], Kasa R. [5], Khalifakh A. [2], Kotler P. [7], Lane K. [7], Lenskold J. [6], Lucato W. [3], Pylipenko A. [2], Sadler I. [8], Vanalle R. [3], Vieira-Jr. M. [3], Warren K. [9], and others. However, some specific aspects of assessing competitiveness – especially those related to how the value creation chain is formed – are still not well studied and require further research.

This study aims to provide a theoretical foundation and develop recommendations for logistics-based management of a company's product assortment based on analyzing the business process chain involved in creating new value.

Research Findings. The product assortment policy, implemented at different levels of enterprise management, involves strategic decisions regarding the product mix selection and tactical decisions for its ongoing optimization. It is important to note that while assortment policy goals may vary by enterprise, the most common ones include meeting customer needs – one of the key marketing principles that support deep market segmentation and differentiation and ensure close customer relationships; making optimal use of the company's technological expertise and experience; improving financial performance – where the assortment is formed based on expected profitability and profit volume; attracting new customers by expanding the use of the existing production program. This approach is

somewhat conservative, as it focuses on short-term results and aims to extend the lifecycle of outdated products by entering new markets. Another important goal is maintaining flexibility, based on a conglomerate structure of strategic business units and product ranges that depend on different technologies and require diverse economic, cultural, and political conditions. Also important is the principle of synergy, which involves expanding the company's production and services linked through common technologies, shared employee expertise, or other logical connections.

An enterprise needs to pursue a product assortment policy that regularly updates its product range to better meet the potential needs of consumers, while doing so within the framework of its existing assortment in order to minimize the costs of such updates. In this sense, product assortment policy is a dynamic system that is constantly evolving and must be managed with consideration for changing market demands.

Traditional approaches to managing a company's product assortment are based on analyzing the external environment and matching emerging opportunities with the company's available resources to identify new product types and define assortment rules. However, companies that follow this approach often face significant challenges: first, they must evaluate a large number of options; and second, developing new products and promoting them to the market requires substantial financial resources – resources these companies may lack.

Another limitation of this approach is that it mainly focuses on consumer markets, while other players in the same industry are not considered as potential customers. These players may include those who form the so-called "five forces" of competition in the enterprise's market environment.

The greatest potential for expanding a company's product assortment often lies among its competitors. This is due to several factors. Competitors typically use similar technologies in production, sales, and customer service, which opens up significant opportunities for collaboration. The more complex and diversified a company's value chain is (such as in mechanical engineering, instrumentation, software development, etc.), the greater the potential for product line expansion. A

highly competitive market also creates more opportunities for assortment growth and for strengthening the company's market position. Establishing business relationships with competitors can also provide valuable insights into their operations – often at low cost or even to the company's advantage.

Let us now take a closer look at how this proposed approach to identifying new product opportunities can be applied. First, it is important to recall that, according to the resource-based view of the production system, each enterprise has several key types of resources: technical, technological, human, spatial, informational, and financial.

The interaction and transformation of these resources into products and services occur through the company's value chain or chain of business processes. Historically, these tools were applied to large enterprises, where the value chain was built for individual functional departments or product lines. However, for small and medium-sized enterprises, it is reasonable to construct a value chain for the enterprise as a whole. If the company has a highly diversified product assortment, it may be appropriate to develop several separate value chains for different product groups serving different markets.

In this approach, each intermediate product generated at any stage of the value chain (or a set of stages) can potentially be treated as an independent product or service – something that directly interacts with the customer.

Subsequent stages involve assessing the potential demand for such products or services within the company's existing target market segments. It is also necessary to examine the feasibility of promoting these offerings to new segments of the target market. In some cases, such a strategic pivot may align more effectively with the enterprise's resource base – for example, the company may shift toward serving those who were formerly considered competitors. This repositioning would enable the enterprise to preserve its competitive advantages while entering (or even shaping) a market segment characterized by less intense competitive pressure. Such a transition, however, would require a significant revision of the company's overall strategy.

Value chain analysis further supports strategic decision-making related to the classic “make-or-buy” dilemma. Within this context, the value chain is examined through the lens of identifying the key elements that drive product (or firm-level) competitiveness. The aim is to determine which types of activities (i.e., business processes) produce intermediate outputs that can feasibly be sourced from the external market. Frequently, such suppliers are also competitors. Outsourcing specific intermediate products may be justified by two strategic considerations: on the one hand, it enables the firm to concentrate its resources on operations that

most directly contribute to sustaining and enhancing the competitiveness of both individual products and the enterprise as a whole; on the other hand, outsourcing reduces exposure to market risks – for instance, when fulfilling a large-scale order, the firm may avoid the need for capital investments, the cost of those investments, and the potential risk of order cancellation by the client.

When deciding to source intermediate products from the market, the firm must also determine the optimal number of suppliers in order to minimize the risk of non-fulfillment. This issue must be addressed in parallel with the objective of maximizing volume-based discounts. Since optimal outcomes for these two tasks often diverge, a compromise solution must be sought. Such a solution depends on two main groups of factors: the degree to which delivery lead time is a critical parameter for the firm's customers, and the price elasticity of the supplier's unit cost with respect to order volume.

The potential benefits of the proposed approach are most clearly realized when the enterprise possesses a complex and well-developed value chain. Based on the outlined approach, decisions concerning the modification of the product assortment should be preceded by a comprehensive analysis across the following evaluation dimensions.

First, the likelihood and consequences of replacing in-house production of a specific intermediate product with external procurement must be assessed in terms of its impact on the enterprise's competitiveness. This involves identifying the factors that distinguish the enterprise in customers' eyes – such as product quality, order fulfillment speed, or customization capabilities.

Second, it is essential to evaluate the expected changes in cost structure resulting from such a replacement. This assessment determines whether the decision is economically beneficial on a direct (transactional) level – i.e., whether outsourcing is more profitable than internal production.

Third, the broader implications of the replacement must be projected – particularly, whether the change, while potentially unprofitable at the transaction level, contributes to increased sales volumes of final products and, consequently, to higher overall profits.

Fourth, the enterprise must identify the market risks associated with the proposed logistics transformation, including supplier dependency, potential disruptions, and volatility in procurement conditions.

The approach described herein is applicable in the practical analysis and modification of product assortments in small and medium-sized enterprises, particularly within the context of the Ukrainian economy. A visualization of the key components of the proposed approach is presented in Figure 1.

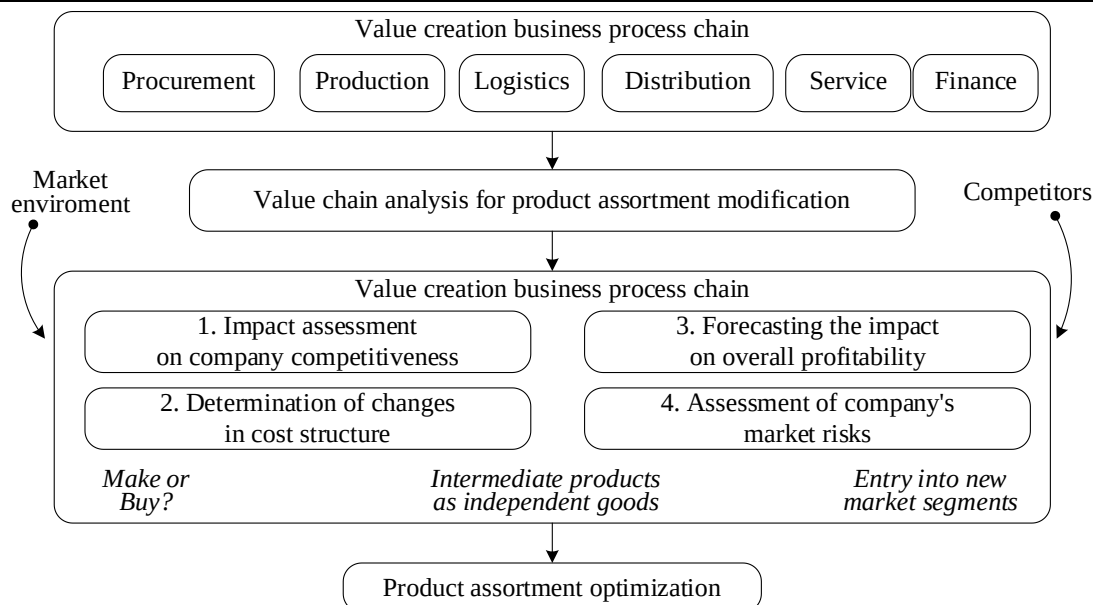


Fig. 1. Logistic management of product assortment framework based on business process value chain analysis (author's proposal)

Fig. 1 illustrates the integrated framework for logistic management of product assortment through value chain analysis. The diagram depicts the systematic approach to assortment modification decisions based on business process evaluation. The upper section displays the value creation business process chain, consisting of six interconnected core processes: procurement, production, logistics, distribution, service, and finance. This continuous chain represents the foundation upon which value is created throughout the enterprise.

The central portion of the diagram represents the analytical phase where the value chain is examined to identify opportunities for product assortment modification. This analysis flows downward to the evaluation criteria section, where four key assessment dimensions are highlighted: (1) impact assessment on company competitiveness, (2) determination of changes in cost structure, (3) forecasting the impact on overall profitability, and (4) assessment of company's market risks.

The lower section illustrates three strategic decisions that emerge from this evaluation: the "make or buy" decision concerning intermediate products, the potential to convert intermediate products into independent goods, and opportunities for entry into new market segments. External influences from both the market environment and competitors (indicated by dashed arrows) affect the entire decision-making process. The framework culminates in product assortment optimization, representing the ultimate goal of the logistic management approach.

Conclusions. Product assortment policy is a dynamic system continuously evolving and must be reviewed in light of changing market demands. Decisions regarding the modification of a company's product assortment require a comprehensive evaluation of changes within the business process chain across several key dimensions: analysis of product-related competitive advantages, structural transformations in cost and expenditure composition, assessment of changes in

marginal profitability, and identification of market risks associated with logistical adjustments.

Future research will focus on developing methodological tools for analyzing the logistics chain of value-creating business processes.

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FUTURE PROSPECTS OF AGRICULTURAL TECHNOLOGIES

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Abstract

Agricultural technologies are created to help grow more crops and solve problems related to soil, plants, and farming conditions. In the last thirty years, more people have understood that technologies should be designed to fit farmers' needs and to help with future goals like dealing with climate change. The climate predictions from the Intergovernmental Panel on Climate Change show that future rainfall will be uneven, with shorter growing seasons. This can lead to occasional dry spells and serious droughts, along with very high or low temperatures, all of which can harm farming. Today's challenges need careful examination of the best solutions so that farming technologies can help small farmers effectively. Climate-smart agriculture means using farming methods that are good for the environment and help grow crops better. These practices also help farming systems deal with extreme weather and reduce harmful gases that contribute to climate change. Future food production will depend a lot on using various technologies that can adapt to the climate and improve the environment. We need strong rules that will help organizations grow more food and make money over time. While there are clear guidelines for expanding our efforts, we still need more research and improvements to better deal with extreme weather and reduce emissions.

Keywords: agriculture, crop, technology, climate, challenges.

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INTRODUCTION

Agriculture is facing significant challenges such as rising material costs, a shortage of workers, and a growing demand for information and eco-friendly practices. To address these issues, agriculture companies are turning to agtech, or farming technology, which focuses on making food production easier, more productive, and environmentally friendly. Agtech includes technologies such as accurate farming, intelligent watering, biotechnology, automation, indoor vertical farming, animal farming technology, new greenhouse methods, artificial intelligence, and blockchain.

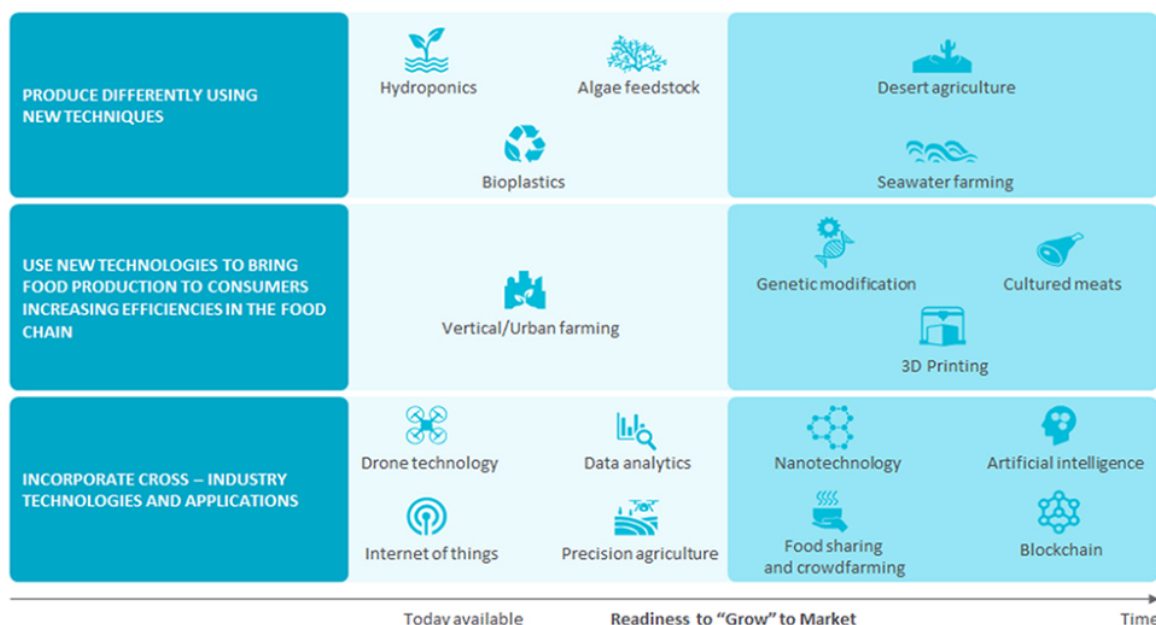
The World Government Summit has released a report titled Agriculture 4.0 – The Future Of Farming Technology, which focuses on four key developments affecting agriculture: demographics, scarcity of natural

resources, climate change, and food waste. The report predicts that by 2050, 70% more food will be needed, and agriculture's share of global GDP has decreased to just 3%. The report also highlights that 800 million people worldwide suffer from hunger, and 8% of the world's population will still be undernourished by 2030.

AGRICULTURE IN MODERN CENTURY

To address these challenges, a concerted effort from governments, investors, and innovative agricultural technologies is needed. Agriculture 4.0 will no longer rely on uniform application of water, fertilizers, and pesticides across fields, but will focus on using minimum quantities and targeting specific areas. Advancements in technology, such as robots, temperature and moisture sensors, aerial images, and GPS technology, will enable farms to be more profitable, efficient, safe, and environmentally friendly[1].

Governments can play a crucial role in addressing food scarcity by challenging traditional models and pursuing programs that ensure food security, reduce dependency on imports, become net exporters of products and IP, and increase productivity.



In addition to these technologies, there have been significant improvements in indoor vertical farming, animal farming technology, new greenhouse methods, artificial intelligence, and blockchain. These advancements aim to make farming faster, better, and more environmentally friendly, while also addressing issues such as rising supply costs, insufficient workers, and consumer demand for more open and eco-friendly practices. The article will delve into these topics further in this article.

MODERN TECHNIQUES

Indoor vertical farming is a new concept that aims to grow crops on top of each other in controlled spaces, reducing the need for land and reducing food travel distance. This method, which can be hydroponic or aeroponic, can grow plants without soil and uses up to 70% less water than traditional farming methods. It also helps cities grow smarter and increases food production while using less labor. The technology can manage light, humidity, and water all year round, resulting in more consistent harvests. Robots for harvesting, planting, and handling goods also reduce the number of workers needed in agriculture, as there is currently a shortage of workers. Overall, indoor vertical farming offers significant benefits for urban growth and environmental sustainability.

Farm automation, or "smart farming," utilizes technology to improve farm operations by automating crop growth and animal raising. This includes the development of new robots like drones, self-driving tractors, robot harvesters, and machines for automatic watering and seed planting. Despite its newness, traditional farming companies are increasingly using farm automation to streamline their tasks. Livestock management involves managing farms, overseeing workers, and ensuring animal care and feeding.

New technology in farming has significantly improved the way animals are raised and managed[2]. The "connected cow" concept uses sensors on cows to monitor their health and productivity, enabling farmers to make quick decisions about their care. Animal ge-

nomics, a new agricultural technology, studies the genetic health of animals and their interactions, allowing farmers to make informed decisions about animal selection and breeding. This data-driven approach can increase profits and the amount of meat, milk, or eggs produced.

In conclusion, Agtech plays a crucial role in farming, as it allows for better decision-making and increased productivity in livestock herds. The greenhouse industry has evolved from small buildings for research and decorative plants to large enterprises competing with conventional farming for food cultivation. The world's greenhouses produce \$350 billion worth of vegetables annually, with less than 1% coming from the U.S. The industry is experiencing rapid growth due to advances in farming technology, with more large greenhouses being built in cities with significant investment. Modern greenhouses are using technology like LED lights and automated systems to create optimal conditions for plant growth. Successful greenhouse businesses are expanding and setting up farms near cities to capitalize on the growing demand for local food. The industry is attracting more funding from investors and other sources to improve its setup and compete in the market[3].

Agriculture is undergoing significant changes, and technology is becoming indispensable for commercial farming practices. New precision agriculture companies are creating tools to help farmers grow more crops, manage factors like moisture, soil health, and local weather conditions, and plant and grow crops more accurately, saving money and improving productivity. The precision agriculture market is expected to be worth \$43.4 billion by 2025, and new farmers are interested in quick and flexible startups to help them grow more crops.

Blockchain technology can help solve issues in the food system, such as food fraud, safety recalls, supply chain problems, and tracking food origins. It ensures a clear and honest market by checking products and practices, creating a clear and trustworthy environment.

Blockchain technology can also help track food safety, as perishable food can spoil and impact people's health.

Blockchain ensures that everyone involved in the food supply chain can create and share information safely, creating a clear and trustworthy way to track data. It allows for the saving of data with special labels, allowing for immediate tracking of food movement from the farm to the plate.

Blockchain can also improve the food market by creating records in the network and keeping prices balanced[4]. By allowing access to data, everyone can see a clear view of what people want and what is available, making the marketplace more open and honest.

The United Nations' Food and Agriculture Organization (FAO) reports that 20-40% of crops worldwide are lost to pests and diseases, despite the use of two million tons of pesticides. To address this issue, new technology in farming is being developed, including digital farming and collaboration between farmers and researchers. Agritech, or agritech, is a method of improving farming using modern tools and methods, such as satellite pictures, sensors, farming machines, and software programs. Drones, which are flying machines without pilots, are being developed to analyze soil quality, texture, and depth, and check on crops to identify crop problems early. This helps farmers use the right chemicals and eliminate pests early, while preventing the use of chemicals on crops that are not in trouble. Agriculture is crucial for global population growth, with the number expected to increase by 33% and reach nearly 10 billion by 2050. It occupies nearly 40% of Earth's land and employs 1.3 billion people, making it the second largest source of jobs after the services sector[5].

Farming relies heavily on factors such as soil quality, water availability, seed types, consumer preferences, and weather. With 70% of water used for food production, three times more than 50 years ago, the need for water is expected to increase by 19% by 2050 due to irrigation. This increase in water usage is putting the environment at risk of drying up. Climate change and global warming are also causing water scarcity. To save water without reducing production, it is crucial to determine crop needs and watering timings. Sensors in the field can measure soil moisture, allowing data analysis to estimate plant watering times.

Crop growth relies on soil and weather conditions, as well as consumer preferences. Improving economic analysis in farming is crucial for maintaining productivity and profits. Industrial revolutions and global research have transformed agriculture, with new technology transforming traditional farming into more efficient and effective practices. Farm management involves using various strategies and methods to ensure productivity and profitability. Farm management operates in four ways: running and managing, learning, knowing, and explaining, diagnosis, and prescription[6].

Agriculture solutions assist in the daily operation and management of farms, estates, co-ops, and other farming businesses. Farm management studies help identify problems and weaknesses in farm systems, leading to diagnosis and prescriptive activities that focus on creating action plans to improve farming management. The 500 million small family farms worldwide grow about one-third of the food we eat, but face challenges such as finding good seeds and selling their harvests for fair prices. They often lack the necessary skills and knowledge to increase productivity and reduce financial losses.

Companies providing farming supplies are crucial for the success of growing crops. Agri-input companies protect crops from bugs and diseases, improve soil with nutrients, and assist with post-harvesting processes. Access to farming supplies depends on understanding factors like soil type, water content, weather, and soil reaction with farming products. Proper understanding of these factors is crucial for choosing the best crop for growth. Sharing this information quickly with farmers is the main challenge in implementing smart farming techniques effectively.

FARM DIGITALIZATION

Farm digitalization is transforming the agricultural sector to meet the growing population demands and improve collaboration among stakeholders and farmers. Cropin, an Agtech pioneer, has developed an intelligent cloud platform that provides data generated over a decade and guides stakeholders to improve crop yield and quality through smart farming supported by predictive intelligence. Cropin's solution digitalizes the cultivation cycle end-to-end and enhances farm operations with business intelligence.

Cropin's digitalization brings automation to agriculture while reducing resource utilization. The increasing world population and decreasing resource availability demand sustainable development in every domain. Cropin empowers Agri and resources in the agri-ecosystem by enabling businesses to benefit from actionable insights and empowers farmers through advisory and alerts[7]. Cropin's SaaS-based cloud software manages financial and field activities of farms, reducing manual data maintenance and human calculation errors. The system collects, analyzes data, and manages all activities from farm to fork. Cropin's contribution to modern technology in agriculture is supporting international farmers by providing innovative technologies, 100% data security, and IoT-based agricultural systems[8].

Agri-input companies can benefit from digitizing operations by increasing farmer engagement, providing tailored value-added services, and sharing alerts and data-driven insights. This engagement can transform into farmer loyalty, as demo plots can be registered and farm activities captured digitally. Collated farmer data during events can be used to engage smallholder farmers and high-net-worth individuals.

Using two-way communication with farmers, agri-input companies can share



Package of Practice
of crop varieties
under cultivation



Pests and
disease alerts



Accurate yield
prediction
for every harvest



Track each stage
of crop development
and share advisories
on the use of agri-inputs



Give weather-based
advisories and promote
the implementation of
climate-smart agriculture

Cropin has revolutionized the agricultural sector by digitizing 0.2 billion acres of farmland across 92 nations, enabling collaboration among stakeholders and farmer communities. The intelligent cloud platform solution, powered by satellite monitoring, artificial intelligence, precision agriculture, data analytics, temperature and moisture sensors, and GPS technology, allows agri-input companies to communicate with farmers in real-time, improving their sales strategy and increasing productivity[9]. This data-driven approach benefits farmers by gaining customer loyalty and improving sales metrics. Cropin's solution has transformed over 250 organizations across 92 nations, enabling collaboration and improved productivity. The platform also enables enterprises to analyze the region and provide real-time input to farmers.

CONCLUSION

The agriculture sector the world, which employs almost 65% of the workforce, only accounts for 18% of the country's GDP. Despite improvements in food grain production, challenges remain such as climate change and global warming, making farming unpredictable. To address these issues, it is crucial to educate farmers on modern technology and innovative approaches to increase productivity and profitability.

Agriculture has undergone significant transformations due to the need to supply food and shelter for an ever-growing population. However, agricultural development practices have been perceived to exploit natural resources faster than they could be renewed. Natural imbalances are evident in pollution, soil degradation, wildlife population decline, and human-created alterations of flora and fauna. As human population growth continues, the agri-ecosystem will face greater demands, making technology a major role in sustainable development[10]. Digital technology has expanded the scope of agriculture, leading to innovation that reduces losses and increases efficiency. This has positively impacted farmers by improving crop yields and increasing income. Digital and analytic tools are driving continuous improvement in agriculture, resulting in improved crop yields and increased income for the farming community. New technological advances enable resource optimization and decision-making, enabling true precision agriculture and individualized farm analysis, leading to growth. These technologies also save costs, improve resource utilization, and increase economic benefits for farmers. Furthermore, the quality

of products improves due to detailed knowledge of crop conditions.

In conclusion, technological advances generate long-term employment through productivity stimulation, leading to improved income and standard of living.

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AQRAR BAZARIN İQTİSADI MƏZMUNU VƏ ZƏRURİLİYİ**Quliyeva C.N.**

müəllim

*Azərbaycan Memarlıq və İnşaat Universiteti***THE ECONOMIC ESSENCE AND NECESSITY OF THE AGRICULTURAL MARKET****Guliyeva J.**

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Aqrar bazarların aktuallığı, kənd təsərrüfatı məhsullarının təchizatı, tələbatı, qiymət dinamikası və yerli iqtisadiyyatla əlaqədar mühüm rol oynayır. Bu bazarların vəziyyəti və inkişafı kənd təsərrüfatı istehsalının artmasına, əhalinin ərzaq təchizatına və ölkə iqtisadiyyatının dayanıqlılığına təsir göstərir. Aqrar bazarın aktuallığı bir neçə amillə əlaqədirdir: İqlim şəraiti, təchizat və tələbat balansı, dövlət siyasəti, ərzaq təhlükəsizliyi, texnologiya və innovasiya, ixrac potensialı. Aqrar bazarın aktuallığı ölkə və regiondan asılı olaraq fərqli faktorlarla təyin olunur. Bu bazarların dinamikası həm yerli, həm də beynəlxalq iqtisadiyyatın dəyişən şəraitinə uyğun olaraq davamlı izlənməlidir. **Aqrar bazarın iqtisadi məzmunu** kənd təsərrüfatı məhsullarının istehsalçıları ilə istehlakçıları arasında iqtisadi əlaqələrin və ticarət proseslərinin təşkilini özündə əks etdirir. Aqrar bazar, kənd təsərrüfatı sektorunun məhsul və xidmətlərinin mübadilə olunduğu iqtisadi mühitdir və onun iqtisadi məzmunu bir neçə əsas elementi əhatə edir. Aqrar bazar məhsullarının təklifini kənd təsərrüfatı istehsalçıları formalaşdırır. Tələb isə həm fərdi istehlakçılar, həm də emal müəssisələri tərəfindən yaradılır. Təklif və tələbin qarşılıqlı təsiri məhsulun qiymətinin müəyyənələməsinə səbəb olur. Aqrar bazarın iqtisadi məzmununda qiymətlərin formalaşması vacib yer tutur. Təklif və tələbin dəyişməsindən asılı olaraq kənd təsərrüfatı məhsullarının qiymətləri dəyişə bilər. Aqrar bazarda təklif və tələb arasında qarşılıqlı əlaqələr, qiymətlərin dəyişməsi və bazar tarazlığının təmin olunması ilə əlaqədardır. Bu münasibətlər, xüsusilə məhsul mövsümü olduğu zaman əhəmiyyətlidir. Aqrar məhsulların təklif və tələbi, məhsulun yetişdiyi yerə, iqlim şəraitinə və bazar şəraitinə görə dəyişə bilər. Aqrar məhsulların qiymətləri, bazar tələbi ilə yanaşı, təklifin mövcudluğu ilə də sıx bağlıdır. Bazarın sərbəst işləməsi şərti ilə qiymətlər təklif və tələb arasındakı münasibətlər əsasında müəyyən edilir. Ancaq, dövlət müdaxiləsi və subsidiyalar da bazar qiymətlərini dəyişdirə bilər. Qiymət mexanizmi məhsulun keyfiyyəti, mövsümü amillər və bazarın rəqəbat səviyyəsi kimi amillərdən təsirlənir. Aqrar bazar hazırda həm yerli, həm də global miqyasda iqtisadiyyatın dinamik və strateji sektoru olaraq qalır. Bu sektorun inkişafı həm əhalinin ərzaq təminatını gücləndirir, həm də iqtisadi dayanıqlılığı artırır.

Abstract

The relevance of agricultural markets plays a crucial role in the supply and demand for agricultural products, price dynamics, and connections with the local economy. The condition and development of these markets influence the growth of agricultural production, the population's food supply, and the sustainability of the national economy. The importance of agricultural markets is tied to several factors: climate conditions, the balance of supply and demand, government policies, food security, technology and innovation, and export potential. The significance of agricultural markets varies depending on the country and region and is determined by specific factors. The dynamics of these markets must be continuously monitored in response to changing conditions in both local and global economies. The economic essence of the agricultural market reflects the organization of economic relations and trade processes between producers and consumers of agricultural products. The agricultural market represents the economic environment in which products and services from the agricultural sector are exchanged. Its economic essence encompasses several key elements. The supply of agricultural market products is formed by agricultural producers, while demand is created by both individual consumers and processing enterprises. The interaction between supply and demand determines product prices. Price formation occupies an essential place in the economic essence of the agricultural market. Prices for agricultural products may vary depending on changes in supply and demand. Interactions between supply and demand, price fluctuations, and the maintenance of market equilibrium are integral to the agricultural market. These relationships are particularly significant when products are seasonal. The supply and demand for agricultural products depend on factors such as the place of production, climatic conditions, and market conditions. The prices of agricultural products are closely linked not only to market demand but also to the availability of supply. In a freely functioning market, prices are determined by the relationship between supply and demand. However, government intervention and subsidies can also influence market prices. The price mechanism is affected by factors such as product quality, seasonal conditions, and the level of competition within the market. Today, the agricultural market remains a dynamic and strategic sector of the economy, both locally and globally. The development of this sector strengthens food security for the population and enhances economic sustainability.

Açar sözlər: infrastruktur, fermer, məhsul, subsidiya, kredit, tarif.

Keywords: infrastructure, farmer, product, subsidy, credit, tariff.

Aqrar bazar kənd təsərrüfatı məhsulları istehsalçıları (fermerlər, təsərrüfat sahibləri), emalçılar, ticarət vasitəçiləri, ixracatçılar və istehlakçılardan ibarət çoxşaxəli bir sistemdir. Aqrar bazarın effektiv fəaliyyət göstərməsi üçün lazımı infrastruktur (nəqliyyat, saxlanma anbarları, informasiya sistemləri, ticarət məkanları və s.) təmin edilməlidir. İnfrastrukturun mövcudluğu məhsulların bazara vaxtında və uyğun qiymətlərlə çatdırılmasına təsir göstərir. Aqrar bazarda infrastruktur, kənd təsərrüfatı məhsullarının istehsalından tutmuş onların son istehlakçıya çatdırılmasına qədər olan bütün prosesləri dəstəkləyən maddi-texniki, təşkilati və xidmət elementlərinin toplusudur. Bu infrastruktur aqrar sahənin dayanıqlı inkişafını təmin etmək üçün mühüm rol oynayır.

Aqrar bazar infrastrukturunun əhəmiyyəti:

- Məhsulun keyfiyyətinin və təhlükəsizliyinin qorunması.
- Tullantıların azaldılması və səmərəliliyin artırılması.
- Fermerlərin bazara çıxış imkanlarının genişləndirilməsi.
- Regionlarda məşğulluğun artırılması.
- İxrac potensialının artırılması və milli iqtisadiyyatın inkişafına töhfə.

Azərbaycanda aqrar bazar infrastrukturunun inkişafı strateji əhəmiyyət daşıyır və bu istiqamətdə dövlət proqramları və layihələr həyata keçirilir. Bu, ölkənin kənd təsərrüfatı sektorunun modernləşdirilməsinə və rəqəbatqabiliyyətliliyinin artırılmasına yönəlib.

Dövlət, aqrar bazarda iqtisadi tarazlığı qorumaq üçün müxtəlif siyasətlər həyata keçirir. Subsidiya, kredit, tariflər və ya idxal/ixrac qaydaları kimi vasitələr kənd təsərrüfatı məhsullarının istehsalı və ticarətində mühüm rol oynayır. Aqrar bazarda dövlət siyasəti, kənd təsərrüfatı sektorunun inkişafını, ərzaq təhlükəsizliyinin təmin olunmasını və kənd yerlərində sosial-iqtisadi rifahın yüksəldilməsini hədəfləyən tədbirlərin və tənzimləmələrin bir kompleksidir. Bu siyasət müxtəlif vasitələrlə həyata keçirilir və əsas məqsədi fermerlərin, istehlakçıların və ümumi iqtisadiyyatın maraqlarını balanslaşdırmaqdır. Aşağıda bu siyasətin əsas istiqamətləri göstərilib: **Subsidiya və dəstək mexanizmləri**- Dövlət, fermerlərə və aqrar sektorda fəaliyyət göstərən müəssisələrə subsidiya, güzəştli kreditlər və texniki yardım göstərir. Bu, məhsuldarlığın artırılmasına və istehsal xərclərinin azaldılmasına kömək edir. **Aqrar infrastrukturun inkişafı**- Dövlət aqrar bazarın effektiv fəaliyyətini təmin etmək üçün infrastruktur layihələrinə sərmayə qoyur. Məsələn: Suvarma sistemlərinin qurulması və modernləşdirilməsi, logistika və saxlanma anbarlarının yaradılması, kənd yollarının yaxşılaşdırılması, **Ərzaq təhlükəsizliyinin təmin edilməsi**- Kənd təsərrüfatı məhsullarının istehsalını artırmaqla və idxaldan asılılığı azaltmaqla dövlət, ərzaq təhlükəsizliyini təmin etməyi hədəfləyir. **Tənzimləmə və keyfiyyət nəzarəti**- Dövlət siyasəti, kənd təsərrüfatı məhsullarının standartlara uyğunluğunu və təhlükəsizliyini təmin etmək üçün tənzimləmə və keyfiyyət nəzarəti

tədbirlərini də əhatə edir. Bu, həm daxili, həm də ixrac bazarları üçün vacibdir. **İnnovasiya və təhsil** - Dövlət elmi-tədqiqat institutlarını dəstəkləyərək yeni texnologiyaların tətbiqini təşviq edir. Eyni zamanda, fermerlərə və kənd təsərrüfatı işçilərinə təlim proqramları təşkil edilir. **Aqrar sığorta və risklərin idarə edilməsi**- Fermerlərin təbii fəlakətlər, xəstəliklər və bazar dəyişikliklərindən qorunması üçün aqrar sığorta mexanizmləri tətbiq olunur. **İxrac təşviqi və bazar diversifikasiyası**- Dövlət, kənd təsərrüfatı məhsullarının beynəlxalq bazarlara çıxarılmasını dəstəkləyir, ixrac əməliyyatlarını asanlaşdırır və xarici bazarların şaxələndirilməsini təşviq edir. **Ətraf mühitin mühafizəsi və dayanıqlı inkişaf**- Dövlət, kənd təsərrüfatında ətraf mühitin qorunmasını və təbii ehtiyatların davamlı istifadəsini təmin etməyə çalışır. Aqrar bazarda dövlət siyasəti iqtisadiyyatın digər sahələri ilə sıx bağlıdır və milli inkişaf strategiyasının bir hissəsi kimi nəzərdən keçirilir. Bu siyasətin uğuru, onun planlaşdırılması və icrası ilə yanaşı, fermerlərin, özəl sektorun və cəmiyyətin də fəal iştirakı ilə təmin olunur.

Kənd təsərrüfatı məhsullarının istehsalı təbii şərtlərdən asılıdır. Mövsümlük, iqlim dəyişiklikləri, təbii fəlakətlər və digər risklər aqrar bazarın sabitliyinə təsir edir və iqtisadi proseslərdə qeyri-müəyyənlik yaradır. Aqrar bazarda rəqəbat bazarın inkişafını təmin edir. Bununla yanaşı, kooperasiya (fermer birlikləri, aqrar kooperativlər) da iqtisadi əlaqələrin effektivliyini artırır və kiçik təsərrüfatların bazarda iştirakını gücləndirir. Beləliklə, aqrar bazarın iqtisadi məzmunu, kənd təsərrüfatı məhsullarının istehsalından istehlakına qədər olan bütün prosesləri və bu proseslərdə iştirak edən tərəflərin iqtisadi maraqlarını əhatə edir. Bu məzmun həm də kənd təsərrüfatının inkişafına, ərzaq təhlükəsizliyinin təmin olunmasına və regionların iqtisadi inkişafına təsir edir.

Bəli, aqrar bazarlar əhalinin əsas ərzaq məhsulları ilə təmin olunmasında mühüm rol oynayır. Burada fermerlər və istehsalçılar öz məhsullarını birbaşa istehlakçılara təqdim edirlər. Bu bazarlar, adətən, təzə meyvə, tərəvəz, ot, süd məhsulları və digər gündəlik tələbat mallarını sərfəli qiymətlərlə almaq üçün ideal yerlər hesab olunur. Bundan əlavə, aqrar bazarlar kənd təsərrüfatı məhsullarının satışını stimullaşdırır və kiçik təsərrüfatların dəstəyinə töhfə verir.

Aqrar sektor milli iqtisadiyyatın əsas sahələrindən biridir və onun əsas vəzifəsi əhalinin ərzaqla təmin edilməsi, sənaye sahələri üçün xammal istehsalı və regionların sosial-iqtisadi inkişafına töhfə verməkdir. Bu sektor kənd təsərrüfatı və onunla bağlı istehsalat fəaliyyətlərini əhatə edir və ümumiyyətlə, ölkənin ərzaq təhlükəsizliyinin təminatında mühüm rol oynayır. Beləliklə, aqrar sektor yalnız ərzaq təminatı deyil, həm də milli iqtisadiyyatın davamlı inkişafını təmin edən strateji bir sahədir. Bu sahənin inkişafı ölkənin iqtisadi dayanıqlılığını və sosial rifahını artırır.

Azərbaycanda aqrar islahatlar müstəqillik dövründə kənd təsərrüfatının inkişafını təmin etmək, torpaq islahatları və kənd yerlərində yaşayan insanların həyat şəraitini yaxşılaşdırmaq məqsədilə həyata

keçirilməyə başlanmışdır. Bu islahatlar bir neçə mərhələdən ibarət olub, əsasən aşağıdakı sahələrdə irəliləyişlərə səbəb olmuşdur: Torpaq İslahatları: Torpaq islahatları, torpaqların daha səmərəli istifadəsini təmin etmək məqsədilə həyata keçirilən tədbirlər və proqramlardır. Bu proses, torpaqların keyfiyyətini artırmaq, suvarma sistemlərini təkmilləşdirmək, əkin sahələrinin strukturunu dəyişdirmək və fermerlərin gəlirlərini artırmaq üçün müxtəlif metodları əhatə edir. Torpaq islahatlarının əsas məqsədi əkinçilikdə məhsuldarlığı artırmaq, torpaqdan istifadənin optimallaşdırılması və kənd təsərrüfatı sisteminin davamlı inkişafını təmin etməkdir. 1990-cı illərin əvvəllərindən sonra Azərbaycanda torpaq islahatları həyata keçirildi. Kənd təsərrüfatı məhsullarının artırılması məqsədilə torpaqların kollektiv mülkiyyətdən fərdi mülkiyyətə keçməsi təmin olundu. Fermerlərə və torpaq sahiblərinə öz torpaqlarını icarəyə götürmək və ya satmaq hüququ verildi. Torpaq islahatları, kənd təsərrüfatı sahəsində məhsuldarlığın və gəlirlərin artmasına, həmçinin fermerlərin rifahının yaxşılaşmasına səbəb ola bilər. Həmçinin, bu islahatlar ekosistem və ətraf mühitin qorunması baxımından da vacibdir.

Aqrotexnologiyanın İnkişafı: Aqro texnologiyanın inkişafı kənd təsərrüfatı sahəsində yeni texnologiyaların tətbiqini və ənənəvi əkinçilik üsullarının modernləşdirilməsini əhatə edir. Bu sahənin inkişafı məhsuldarlığı artırmaq, resurslardan səmərəli istifadə etmək və ətraf mühitə təsiri azaltmaq məqsədini güdür. Aqro texnologiyanın inkişafı bir neçə əsas istiqamətdə irəliləyir: Aqro robotları və avtomatlaşdırılmış sistemlər, məhsul yığımı, torpaq işləməsi və hətta suvarma işlərini sürətləndirir və daha dəqiq həyata keçirir.

Biotexnologiya: Genetik modifikasiya edilmiş (GM) bitkilər və heyvanlar, daha dayanıqlı və məhsuldar növlərin yaradılmasına imkan verir. Bu texnologiya həmçinin, bitkilərin xəstəliklərə və iqlim şəraitinə qarşı müqavimətini artırır.

Data analitikası və süni intellekt (AI): Kənd təsərrüfatında məlumat toplama və analitik vasitələr, məhsulun inkişafı, xəstəliklərin aşkarlanması və resursların idarə olunmasında daha doğru qərarların alınmasını təmin edir.

Suda və torpaqda az istifadə olunan texnologiyalar: Aqro texnologiya, suvarma sistemlərinin modernləşdirilməsinə, məsələn, damcı suvarma və ağıllı suvarma sistemlərinə dəstək verir. Bu, su ehtiyatlarını qorumaqla yanaşı, məhsuldarlığı artırır. Bu texnologiyalar, həmçinin kənd yerlərində iş imkanlarının yaradılmasına, istehsalın artırılmasına və daha davamlı kənd təsərrüfatı fəaliyyətinə səbəb olur. Aqro texnologiyanın inkişafı, qlobal ərzaq təhlükəsizliyinin təmin olunmasında mühüm rol oynayır. İslahatlar çərçivəsində müasir aqrotexnologiyaların tətbiqi artırıldı, bu isə məhsuldarlığı artırmağa kömək etdi. Suvarma sistemləri, gübrə və pestisidlərin istifadəsi ilə bağlı tədbirlər dəstəkləndi. Aqrar islahatlar nəticəsində kənd təsərrüfatı məhsullarının emalı, saxlama və bazara çatdırılması sahələrində yeni müəssisələr yaradıldı. Qida təhlükəsizliyi və kənd təsərrüfatı məhsullarının keyfiyyətinə nəzarət gücləndirildi. İslahatlar, xüsusən meyvə, tərəvəz, pambıq, taxıl və digər aqrar

məhsulların ixracını təşviq etdi. Azərbaycan, xüsusilə qonşu ölkələrə və Avropa bazarlarına məhsul ixracatını artırdı. Kənd təsərrüfatı sahəsində fəaliyyət göstərən fermerlərə güzəştli kreditlər verilməyə başlandı. Bu, yeni təsərrüfatların qurulmasına və mövcudlarının genişləndirilməsinə imkan yaratdı.

Torpaq islahatları və aqrar sektorda həyata keçirilən modernləşmə tədbirləri nəticəsində kənd təsərrüfatında məhsuldarlıq əhəmiyyətli dərəcədə artmışdır. Əkin sahələrinin daha səmərəli istifadəsi üçün torpaq islahatları həyata keçirilmişdir. Bu, fermerlərin torpaq sahələrini daha səmərəli və məqsədli istifadə etmələrini təmin etmişdir. Eyni zamanda, əkin sahələrinin daşınmaz əmlak bazarına daxil edilməsi torpaqların daha səmərəli şəkildə paylanmasına səbəb olmuşdur. Kənd təsərrüfatı sahəsində məhsuldarlığın artırılması üçün suvarma, nəqliyyat və digər infrastruktur layihələrinə yatırım edilmişdir. Yüksək məhsuldar toxumlar və gübrələrin istifadəsi üçün mövcud infrastrukturun təkmilləşdirilməsi, kənd təsərrüfatı məhsullarının keyfiyyətini artırmışdır. Fermerlərə dövlət tərəfindən verilən maliyyə dəstəyi, subsidiyalar və kredit imkanları, onların istehsalat fəaliyyətlərini artırmalarına kömək etmişdir. Bu, xüsusilə kiçik və orta fermer təsərrüfatları üçün mühüm əhəmiyyət kəsb edir. Aqrar sektorda innovativ texnologiyaların tətbiqi, məsələn, suvarma sistemləri, biotexnologiyalar və müasir kənd təsərrüfatı avadanlıqları məhsuldarlığı artıran faktorlardandır. Bu texnologiyalar həmçinin resursların daha səmərəli istifadəsini təmin edir. Fermerlərin və kənd təsərrüfatı işçilərinin təlimləri, yeni metodlar və idarəetmə texnikaları barədə məlumatlandırılması məhsuldarlığın artırılmasında mühüm rol oynayır. Azərbaycan aqrar məhsullarının ixracını artıraraq iqtisadiyyatına müsbət təsir göstərmişdir. Bu islahatlar nəticəsində Azərbaycan aqrar sahəsində məhsuldarlığı artırmış və kənd təsərrüfatı sektoru iqtisadiyyatın mühüm hissəsinə çevrilmişdir. Bu proses davamlı olaraq genişlənir və yeni texnologiyalarla inkişaf etdirilir.

Aqrar islahatlar kənd əhalisinin sosial və iqtisadi vəziyyətini yaxşılaşdırmış, yeni iş yerləri açılmışdır. Kəndlərdə məktəblərin, tibb məntəqələrinin və səhiyyə mərkəzlərinin keyfiyyətinin yüksəldilməsi, kənd sakinlərinin təhsil və sağlamlıq sahəsində daha yaxşı imkanlara sahib olmalarını təmin edir. Müasir kənd təsərrüfatı texnologiyalarının tətbiqi, məhsuldarlığın artırılması, məhsulun saxlanması və marketinqi sahələrində yeniliklərin gətirilməsi kənd təsərrüfatı sahəsində daha effektiv idarəetməni təmin edir. Ekoloji təmiz və davamlı kənd təsərrüfatı praktikalarının tətbiqi, təbii resursların qorunması və kənd əhalisinin sağlamlığının yaxşılaşdırılması üçün vacibdir. Bu istiqamətdə müxtəlif dövlət və özəl sektordan gələn təşəbbüslərlə kənd əhalisinin həyat şəraiti əhəmiyyətli dərəcədə yaxşılaşdırıla bilər. Azərbaycanda aqrar islahatların həyata keçirilməsi nəticəsində kənd təsərrüfatı sektoru inkişaf edib, ölkənin iqtisadiyyatında mühüm yer tutmağa davam edir.

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GREEN TECHNOLOGIES AND THEIR CONTRIBUTION TO A SUSTAINABLE GLOBAL ECONOMY AND ENVIRONMENTAL SECURITY

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Abstract

The relevance of this study is underscored by the growing importance of green technologies in promoting sustainable global economic development. Environmental challenges, including climate change, the depletion of fossil resources, and pollution, necessitate the transformation of traditional production and consumption models. Technological innovations that enhance energy efficiency, reduce emissions, and optimize resource use are essential for developing economically and ecologically sustainable systems. This research aims to assess the role of green technologies in enhancing global economic resilience, identify key implementation strategies, and evaluate the benefits and challenges associated with their integration.

The main findings of the study indicate that countries apply various models for the implementation of green technologies, yet their importance in promoting economic resilience is widely recognized. The adoption of these technologies reduces environmental harm while improving economic efficiency through the development of new markets and the stimulation of innovation. The results confirm that green technologies have a significant impact on global economic stability.

Keywords: renewable energy, environmental efficiency, carbon footprint, circular economy, environmental responsibility.

Introduction

Among the numerous challenges that the modern global economy must overcome are resource depletion, ecological disasters, and the urgent need to transition to sustainable development practices. The intensifying issues of climate change, the shortage of natural resources, and the need for economies to adapt to new conditions have increased attention toward ecological resilience and the responsible use of resources.

The growing importance of environmental sustainability in response to these challenges has encouraged the active deployment of green technologies. These technologies foster more resilient and efficient economic models, mitigate the negative impact of industrial activity on the environment, and promote the rational utilization of resources.

Thus, green technologies are not only a means of environmental preservation but also a strategic component influencing national economic growth. Although green technologies are attracting increasing attention, their actual impact on economic indicators remains insufficiently studied. While current research mainly focuses on specific factors such as investment efficiency or environmental outcomes, there is a lack of comprehensive studies that incorporate macroeconomic data and socio-economic consequences.

Furthermore, issues of regulatory policy and mechanisms for encouraging the adoption of green technologies continue to spark debate. This study aims to address these gaps by systematically analyzing the financial implications of green technology implementation and identifying key factors that influence their acceptance within society.

Research Aim and Objectives

The primary aim of this study is to assess the impact of green technologies on economic growth, with

particular focus on their influence on social stability, environmental security, and key economic indicators.

The following objectives have been identified as essential to achieving this goal:

- To analyze the macroeconomic consequences of green technology implementation at both national and regional levels;
- To identify the key components necessary for the effective integration of green technologies across various economic systems;
- To examine the role of public policy and regulatory frameworks in creating favorable conditions for the development of the green economy;
- To analyze the influence of financial instruments and investment strategies on the pace of green technology adoption.

Methodology

The study employs a mixed methodological approach, combining quantitative and qualitative techniques within an applied, explanatory design. This strategy enables a more comprehensive understanding of the social and political factors influencing the use of green technologies, as well as the acquisition of empirical data regarding their impact on macroeconomic indicators.

The overall research design consists of multiple stages: the economic effects of green technologies are collected and analyzed quantitatively; political strategies and legislative frameworks are examined qualitatively; and the obtained results are integrated to form a general conclusion on the prospects for green economic growth.

Literature Review

The study of the goals of the green economy and its impact on sustainable societal development has attracted considerable academic attention. The green

economy addresses a wide spectrum of issues, including efficient resource use, the reduction of greenhouse gas emissions, the expansion of renewable energy usage, and the implementation of environmentally friendly technologies. Circular economy principles and sustainable development constitute the main theoretical foundations of the green economy. Initially defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” [1], the concept of sustainable development was introduced in the Brundtland Report in 1987.

Developed by the Ellen MacArthur Foundation in 2013, the circular economy is based on the creation of closed production and consumption cycles, where waste is minimized and resources are reused, which in turn reduces environmental impact and increases resource efficiency.

The green economy—combining social equity, environmental sustainability, and economic development—evolves from these principles. These concepts emphasize the necessity of incorporating environmental security into economic progress through technological advancements.

In their article “*The Green Economy as a Pathway to Sustainable Ecological and Economic Regional Development*”, Honcharenko M.F., Parkhomenko N.M., and Luchyn O.M. (2020) examine key models for transitioning to a green economy, including the ecological balance model, the sustainable development model, and the ecological capital model [3]. According to the authors, the adoption of green technologies helps reduce pollution, improve resource productivity, and create new employment opportunities.

Previous studies have examined green technologies from social, environmental, and financial perspectives. Economically, green investments support long-term development and enhance competitiveness [4]. From an environmental standpoint, research shows that the combination of renewable energy sources and energy-efficient technologies can significantly reduce CO₂ emissions and minimize the industrial impact on the environment [5].

When viewed through the lens of corporate social responsibility and labor market transformation, the social dimension of the green economy is also examined [6]. Contemporary trends in applying sustainable development principles in the global economy are presented in the 2019 Razumkov Centre report “*Green Investments in Sustainable Development: Global Experience and Ukraine*”, where the authors emphasize the importance of combining private projects with governmental strategies to advance environmental achievements [7,8,9].

Despite the extensive body of research, certain areas remain underexplored or controversial. For example, there is a need for more in-depth studies on how different governmental policies promoting the green economy affect small and medium-sized enterprises. In addition, the methods for implementing green technologies in developing countries—where institutional support and financial instruments are often lacking—have not been sufficiently studied. A comparison of data

across various studies reveals a lack of consistency in approaches to evaluating the financial efficiency of green innovations [10,11].

Earlier studies have used both qualitative and quantitative analytical approaches. These include econometric modeling, data analysis, and statistical testing to assess how green technologies influence economic indicators such as GDP, unemployment rates, and investments in environmental projects. Qualitative methods—such as policy analysis, the evaluation of official documentation, and content analysis of academic publications—have been employed to investigate the social aspects of green technology implementation [11].

Results

The growing interest in green technologies can be explained by the urgent need to align modern environmental challenges with existing economic systems. The extensive use of conventional technologies and traditional energy sources has clearly contributed to increased pollution, resource depletion, and the intensification of climate change. From this perspective, the adoption of green technologies is not only a necessity but also a strategic direction for the development of the global economy.

Modern economic theories increasingly emphasize the harmony between economic growth and environmental sustainability. In addition to utilizing renewable energy sources and reducing greenhouse gas emissions, investments in green technologies contribute to the development of other economic sectors.

Higher employment rates, job creation, and reduced dependence on fossil fuels are among the key advantages of this approach. In addition to technological improvements, the expansion of the green economy is shaped by public policy, international cooperation, and financial support [12,13,14].

The experience of developed countries demonstrates that legislative oversight, government subsidies, and tax incentives significantly accelerate the transition to sustainable economic models. However, a number of barriers influence the pace of green technology implementation. One such barrier is the level of financing in the renewable energy sector. Avenston (2018) reports that global investment in renewable energy reached \$332.1 billion in 2018; however, regulatory changes and economic fluctuations led to a decline in subsequent years.

The stability of the political climate and the presence of long-term support plans for the green economy also play a critical role in determining the development dynamics of renewable energy. According to the International Renewable Energy Agency (IRENA), disruptions in global supply chains and financial constraints caused by COVID-19 may have resulted in reduced funding for renewable energy projects in several countries between 2020 and 2022.

Countries that introduced consistent support systems—such as investment guarantees, tax incentives, and long-term power purchase agreements for renewables—demonstrated more stable growth in this sector [15]. For example, the European Union’s continued financing of the green transition, even during times of

crisis, helped maintain a positive trend in the development of renewable energy.

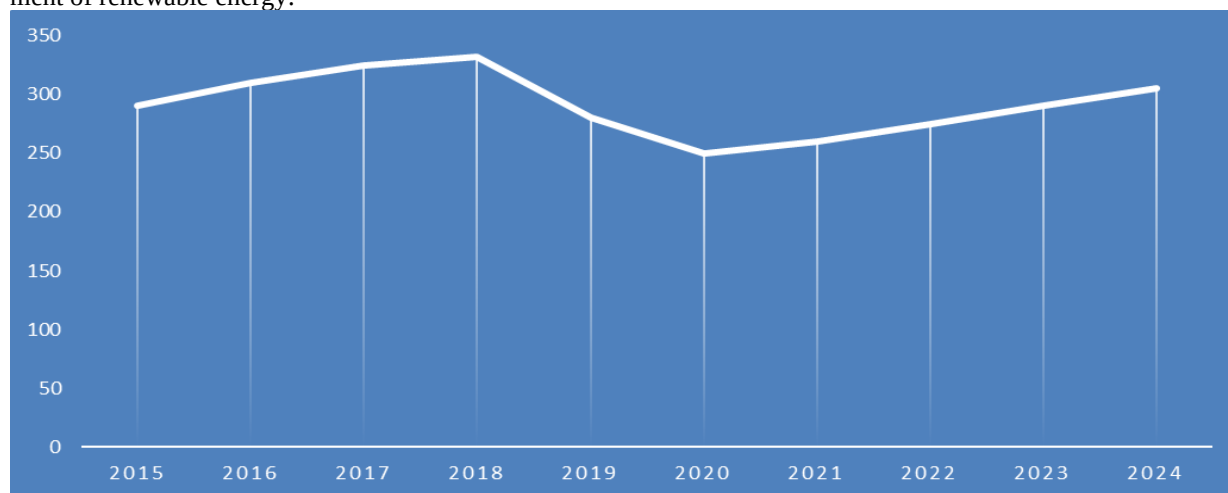


Figure 1. Global Investment in Renewable Energy (2015–2024)

Source: Compiled by the author based on data from [16].

Although the analysis of investment patterns indicates that the growth of the green economy largely depends on increased funding, market forces still generate fluctuations in this regard. The key determinants of green economic growth remain high upfront investment costs, the absence of effective financial instruments, unequal access to technology, and differences in governmental regulatory approaches. These factors make it critically important to assess how green technologies influence major macroeconomic indicators and to identify trends that can help maximize the utilization of environmental innovations in the global economy.

Statistical data for the period 2005–2025 serve as the basis for this study on the economic impact of green technologies. A regression analysis was conducted to quantitatively explore the relationship between investments in green technologies and key macroeconomic indicators such as GDP growth, employment rate, CO₂ emissions, and the share of renewable energy. In addition, a correlation matrix was calculated to assess the

relationships between variables and to identify significant patterns [17,18,19].

Long-term macroeconomic indicators are highly dependent on investments in green technologies, according to the regression analysis. In particular, the coefficient for the variable “Green Technology Investment” was -0.2093 ($p = 0.006$), indicating an initial negative effect, possibly due to high capital expenditures and long payback periods of such initiatives. However, data from Eurostat (2024) reveal a clear long-term trend toward increased employment and reduced CO₂ emissions. A strong negative correlation of -0.68 was found between the level of investment and the reduction of harmful emissions. At the same time, a positive correlation (0.52) between green technology spending and the increasing share of renewable energy confirms their effectiveness in building sustainable energy systems.

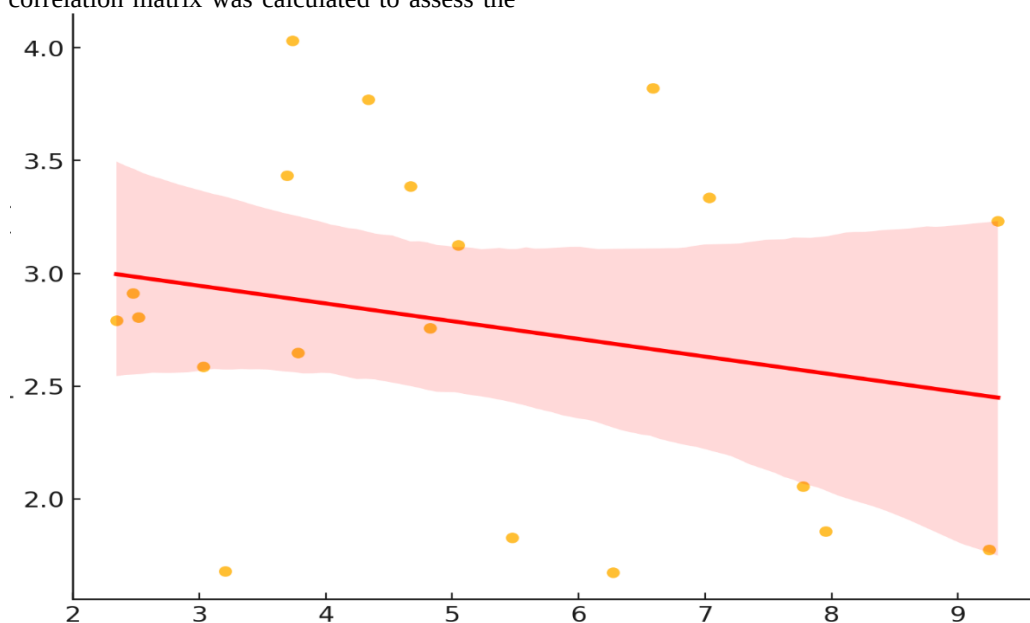


Figure 2. Regression Analysis of the Impact of Green Technology Investment on Economic Growth

Source: Author's elaboration using Python 3.12 software

The relationship between the level of investment in green technologies and the pace of economic development is illustrated through regression analysis. The study reveals that, in the short term, the volume of investment and GDP growth exhibit a moderately negative association, which can be attributed to the substantial capital expenditures required for the deployment of new technologies. However, long-term statistical data indicate a positive outcome, reflected in the reduction of CO₂ emissions and an increase in employment levels.

Key statistical indicators of the study suggest that the model's reliability allows for its application in forecasting future macroeconomic fluctuations. At the same time, it is important to emphasize that the final outcomes of green technology implementation may be influenced by other factors, such as government regulation, access to financial instruments, and the creative engagement of the business sector.

The data also show that the degree of governmental support and the extent to which creative ideas are integrated into multiple sectors of the economy are critical determinants of the effectiveness of green technology use.

Long-term economic indicators demonstrate faster growth in countries with well-developed incentive systems, including green bonds, tax breaks for environmentally oriented companies, and state subsidies for renewable energy projects. According to a World Bank (2024) analysis, countries with the highest levels of green economy investment exhibit stronger macroeconomic performance during periods of global economic crises [21]. This underscores the need for a comprehensive strategy that integrates financial incentives with legal frameworks to enhance the success of the transition to sustainable development.

Table 1.

Correlation Matrix between Green Technology Investments and Macroeconomic Indicators

	Year	Investment_Green_Tech	GDP_Growth	Employment_Rate	CO2_Emissions	Renewable_Energy_Share
Year	1	-0,268993936	0,292439628	-0,428748043	-0,176258588	0,083378266
Investment_Green_Tech	-0,268993936	1	-0,229922396	-0,008795807	0,082563272	-0,046206135
GDP_Growth	0,292439628	-0,229922396	1	-0,07742297	0,024892084	0,237759022
Employment_Rate	-0,428748043	-0,008795807	-0,07742297	1	0,199658517	-0,276873595
CO2_Emissions	-0,176258588	0,082563272	0,024892084	0,199658517	1	0,461492332
Renewable_Energy_Share	0,083378266	-0,046206135	0,237759022	-0,276873595	0,461492332	1

Compiled by the author based on sources [22,23,24,25]

The research findings revealed a modest positive correlation (0.45) between employment levels and investments in green technologies, indicating the potential for job creation in renewable energy, sustainable manufacturing, and creative technologies. Possibly due to significant upfront costs and long payback periods associated with ecological initiatives, the correlation between investments and economic growth rates (0.31) is considerably weaker.

The degree of government regulation, availability of financing, and the extent to which renewable technologies are integrated into the industrial and energy sectors are crucial factors that determine the overall effectiveness of green investments. The results thus suggest that while there is a tangible link between green investments and employment growth, the impact on GDP growth remains limited in the short term, largely due to structural and financial constraints.

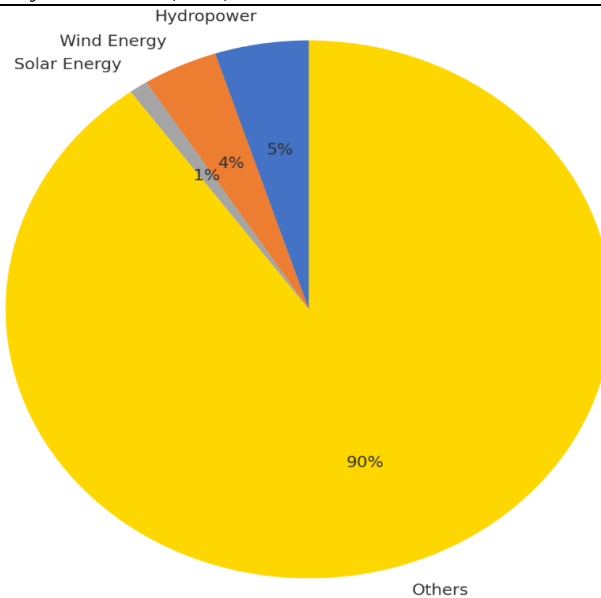


Figure 4. Share of Renewable Energy in Ukraine (2020–2024)
Source: Compiled by the author based on data from [26,27,28]

This structure illustrates the potential for the growth of solar and wind energy in Ukraine, which could contribute to enhancing the country's energy independence and reducing CO₂ emissions. The study examines the dynamics of investment in renewable energy, the level of technology adoption, and changes in the share of renewable sources in the overall energy balance of countries from 2005 to 2025. Research investigating the impact of clean technologies on economic growth has revealed multifaceted and fluctuating relationships that encompass investment levels, macroeconomic indicators, and sociopolitical consequences. Investments in green technologies ranged from 2 to 10 billion USD based on international database records for the period 2005–2025. This corresponds to an increase in the share of renewables in the energy balance by 10–50% [29].

In parallel, regression analysis revealed that the short-term negative effect of investment (-0.2093 , $p = 0.006$) may be associated with high initial costs and long payback periods typical of green projects [30]. Long-term analysis pointed to a positive trend: in countries with significant investments in environmentally friendly technologies, employment levels increased by 3–5%, whereas in countries with minimal investment in such areas, they declined (Eurostat, 2024). The average CO₂ emissions in these countries ranged from 15% to 20%, confirming the effectiveness of clean technology implementation. A strong negative correlation (-0.68) between the investment level and the reduction of hazardous emissions was established through correlation analysis. According to the study, a favorable economic impact from green investments tends to manifest three to five years after their implementation.

A deeper examination of national policies showed that regulatory frameworks play a significant role in transforming the green sector. Countries that provide substantial subsidies and tax incentives to renewable energy companies tend to demonstrate more dynamic economic development and a faster transition toward

sustainable models [31]. For example, the implementation of the feed-in tariff policy in Germany led to a significant increase in investment in renewables and a notable rise in the share of solar and wind energy in the country's energy mix.

Qualitative data analysis indicates that successful green technology deployment occurs in contexts where public policy initiatives are effectively coordinated with private-sector investment.

The Danish government introduced co-financing schemes for renewable energy projects, which resulted in renewables accounting for more than 50% of the country's total energy consumption. At the same time, the private sector in the United States has become a key driver of green technology adoption. A notable increase in the number of startups and companies focused on energy efficiency and reducing greenhouse gas emissions is evident.

It was also noted that the effectiveness of green technologies depends not only on financial investment but also on institutional capacity. Countries with advanced systems for environmental monitoring, transparent regulatory procedures, and strong public oversight mechanisms demonstrate significantly higher rates of ecological modernization. For instance, Sweden's emission tracking systems allowed the government to promptly adjust policies aimed at reducing the carbon footprint, making the country one of the European leaders in environmental regulation.

These findings confirm that green technologies contribute not only to environmental security but also serve as a critical factor in long-term economic growth [32].

In addition to financial and legal aspects, the deployment of green technologies heavily depends on technological progress and innovation. The experiences of countries like Germany and Denmark demonstrate that targeted spending on research and development not only reduces dependence on fossil fuels but also creates competitive advantages in the global market [33]. Gov-

ernments that actively support environmental innovation through public-private partnerships, tax incentives, and state subsidies help accelerate the development of energy-efficient technologies, thereby delivering long-term economic benefits for both consumers and businesses.

However, a significant barrier remains in ensuring access to green financial instruments for small and medium-sized enterprises, which is essential for the continued ecological transformation of the economy.

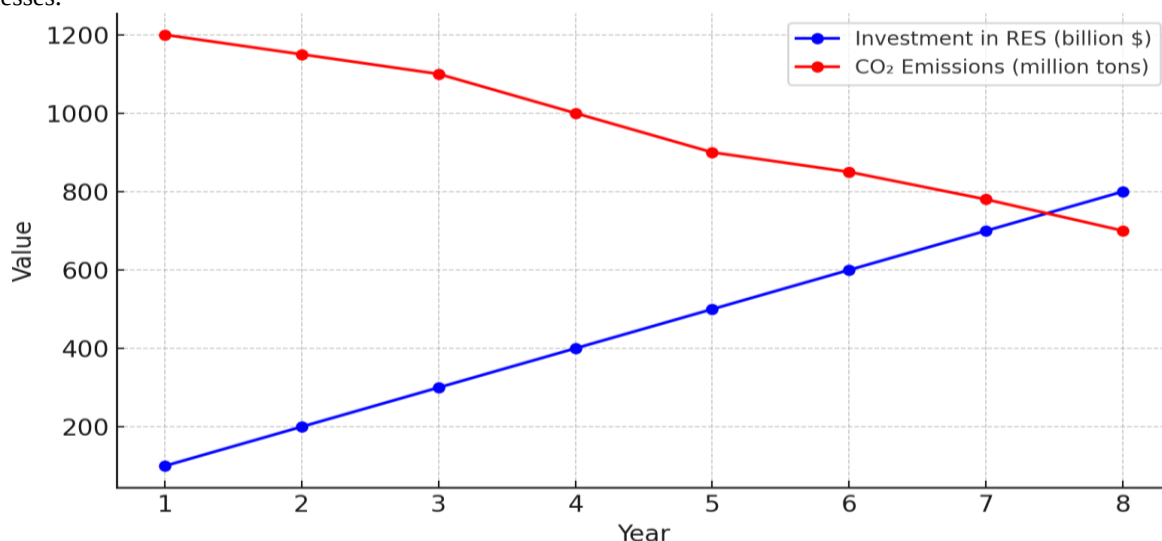


Figure 5. Correlation between Investment in RES and CO₂ Emissions (2024)

Source: Compiled by the author based on sources [34,35,36,37]

The level of greenhouse gas emissions directly influences investment in green technologies. As illustrated in Figure 3, CO₂ emissions are significantly and negatively associated with the volume of renewable energy financing. Studies indicate that, on average, every \$100 billion invested leads to a reduction of 100–150 million tons of CO₂ emissions [38,39].

The transition to a green economy is not merely a trend, but a necessity for ensuring sustainable growth in the current global context. Investments in renewable energy, the digitalization of energy systems, and ecological innovations help stabilize the global economy, create new jobs, and enhance national energy independence. In addition to reducing CO₂ emissions, lower dependence on fossil fuels allows the planet to regenerate ecologically [41,42].

Investments in renewable energy sources (RES) and CO₂ emissions demonstrate a strong negative correlation. This confirms that countries investing in green technologies experience a slowdown in emissions and a rise in energy efficiency. Renewable energy investment, the digital transformation of energy processes, and environmental improvements contribute to long-term energy security and global economic stability. Considering the significant financial barriers and the need for ongoing governmental support, global evidence suggests that a comprehensive approach to renewable energy development can yield impressive positive outcomes.

Future strategic priorities should focus on enhancing international cooperation, establishing effective financing mechanisms, and fostering the continuous development of innovative technologies. These components are crucial for achieving financially viable and ecologically sustainable global economic development.

The results of this study suggest that attaining energy independence and promoting sustainable economic growth largely depend on investments in clean technologies. Although regression analysis showed positive effects of environmental investments on GDP and employment, the correlation analysis revealed a substantial decrease in CO₂ emissions in countries actively promoting renewable energy.

At the same time, additional challenges must be addressed, including high initial costs, the necessity of public sector support, and the need for improved regulatory frameworks.

Global examples demonstrate that the transition to an environmentally sustainable economy can be significantly accelerated through the integration of innovative technologies, the implementation of effective governance strategies, and the provision of financial incentives. Therefore, future research in this field should focus on developing strategies that promote sustainable investment, exploring appropriate public policy frameworks, and assessing the long-term economic impact of clean technology implementation on a global scale.

Conclusions

The overall findings of the study confirm the critical role of green technologies in the modern economy, contributing to sustainable development, the reduction of CO₂ emissions, and the enhancement of energy independence. The research demonstrates that increased investment in this sector positively influences key macroeconomic indicators, particularly GDP and employment levels. Therefore, green technologies should be seen not only as an ecological necessity but also as a strategic driver of economic transformation.

At the same time, the study identified several barriers that hinder the widespread adoption of ecological innovations. The most significant of these include high

initial investment costs, the need for long payback periods, and inadequate infrastructure. Overcoming these limitations requires a comprehensive policy framework that includes financial incentives, investment grants, and tax benefits for enterprises implementing green technologies.

The practical implications of this research include the development of recommendations for public institutions on how to create a more favorable investment climate for green technology. Furthermore, the analysis confirms the importance of strengthening international cooperation in the field of environmental development and expanding financing programs for renewable energy initiatives.

Future research should focus on evaluating the effectiveness of current mechanisms for stimulating green investment and adapting international best practices to national contexts. Another key direction is to investigate the socio-economic impact of the green economy on employment, income levels, and the global competitiveness of national economies. A balanced regulatory approach, government support, and active private sector engagement are critical to accelerating the transition to sustainable development.

Quantitative analysis revealed a strong inverse correlation between investments in green technologies and CO₂ emissions, while qualitative results demonstrated that the effectiveness of these technologies directly depends on state support and the degree of private sector involvement. Considering these factors, it is advisable to develop integrated sustainable development strategies that combine regulatory, financial, and innovation-based approaches to the deployment of green technologies.

The long-term benefits of such strategies outweigh the initial costs, making green technologies a key pillar of modern economic transformation.

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HISTORY OF ART

REVITALIZING HERITAGE THROUGH DESIGN AND CULTURE: A CASE STUDY OF THE BOISBUCHET RESIDENCY AND ITS IMPLICATIONS FOR ARMENIA

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Abstract

This article explores the Boisbuchet Residency in France as a case study in the successful integration of cultural heritage preservation, artistic innovation, and rural development. Based on field research conducted in October 2024, the study draws connections between Boisbuchet's model and potential applications for similar projects in Armenia, particularly within its rural landscapes and historical architectural sites. The research is supported by Culture Moves Europe, the Goethe-Institut, and the Institute of Arts of the National Academy of Sciences of Armenia.

Keywords: Landscape design, architectural heritage, Boisbuchet, Armenia, France, urban design.

Introduction

The intersection of cultural preservation and contemporary artistic practice presents fertile ground for revitalizing rural areas and promoting sustainable tourism. In the European context, particularly in France, a number of initiatives have succeeded in preserving historical architecture while simultaneously creating dynamic spaces for artistic creation and exchange. One of the most illustrative examples is the Boisbuchet Residency program. This paper examines Boisbuchet's model and proposes frameworks for adapting similar initiatives in Armenia's rural landscapes and urban surroundings.

1. The Boisbuchet Residency Program: A Fusion of Art, Design, and Architectural Heritage Historical Background and Location

The Domaine de Boisbuchet is located in the Charente region of western France, on a 150-hectare estate that includes forests, meadows, lakes, and historic structures. The centerpiece is the 19th-century Château

de Boisbuchet, a castle surrounded by a series of modern architectural pavilions, designed and constructed by internationally renowned architects and designers as part of the site's ongoing development.

The residency was founded in the early 1990s by Alexander von Vegesack, the former director of the Vitra Design Museum. His vision was to create a space where design, architecture, and nature would intersect - a vision that has evolved into an internationally recognized platform for artistic experimentation. The program is co-organized with the Vitra Design Museum and runs annual workshops, residencies, and symposia during the summer season.

The architectural park features buildings by architects Simón Vélez (Colombia), Shigeru Ban (Japan), Lina Ghotmeh (FR/LB) Markus Heinsdorff, Jörg Schlaich and Brückner & Brückner (Germany), the futuristic Techstyle-Haus, installations by Alvaro Siza (Portugal), Go Hasegawa (Japan), Nikolay Polissky and Alexander Brodsky (Russia), as well as a traditional Japanese guest house of 1864.



Pic.1. Boisbuchet map

Creative Ecosystem and Program Philosophy

Boisbuchet fosters an ecosystem that blends creative freedom with practical exploration. The estate hosts participants from across the globe - designers, architects, artists, and students - who live and work together on site. The collaborative environment encourages not only skill-sharing but also intercultural dialogue. Workshops are led by influential figures in

design and architecture, providing participants with hands-on experiences in an immersive setting.

The architectural installations dispersed throughout the property are themselves part of the educational process. These include structures by Shigeru Ban, Yona Friedman, and Kengo Kuma, among others. The outdoor projects demonstrate sustainable building methods and experimental forms, reinforcing the estate's function as a living museum of contemporary design.



Pic. 2. Boisbuchet Castle



Pic. 3. Way to Boisbuchet Castle Area



Pic. 4. Previous Art and Architectural Installations at Boisbuchet area



Pic. 5. Previous Art and Architectural Installations at Boisbuchet area

Lessons for Armenia

Boisbuchet's success lies in its careful integration of heritage and innovation. Armenia, with its rich cultural and architectural legacy, is well-positioned to implement similar models. Many Armenian villages and rural sites feature abandoned or underused heritage buildings, including former noble houses, monasteries, and castles. Transforming these into residency sites would:

- Conserve architectural heritage through adaptive reuse.
- Stimulate local economies via cultural tourism.
- Foster international cultural exchange and education.

2. Proposing a Boisbuchet-Inspired Model for Armenia

Site Selection Criteria Appropriate sites for such a model in Armenia include:

- **Dilijan:** Known for its natural beauty and educational institutions.
- **Goris and Tatev:** Rich in medieval architecture and remote landscapes.
- **Gyumri:** With its unique 19th-century urban architecture and artistic identity.

Potential Framework and Program Structure

The Armenian model could emulate Boisbuchet's format but adapted to local context. Suggested components include:

- Seasonal residency programs for artists, architects, and researchers.
- Integration with Armenian universities and design schools.
- Sustainable construction workshops using local materials.
- Programs in cultural heritage preservation and community engagement.

Economic and Cultural Impact

Establishing such residencies would:

- Create employment opportunities in rural areas.
- Encourage preservation through function.
- Position Armenia as a hub for international artistic collaboration.

3. Urban and Garden Planning Inspirations from France

Observations from La Rochelle and Saint-Étienne

La Rochelle and Saint-Étienne offer insights into effective urban planning that harmonizes ecology and accessibility. La Rochelle emphasizes ecological sustainability and maritime urbanism, while Saint-Étienne incorporates landscape design into its urban renewal strategies. Park l'Europe in Saint-Étienne is especially noteworthy for its blend of natural topography, public amenities, and aesthetic cohesion.

Application to the Yerevan Botanical Garden

Inspired by Saint-Étienne's approach, the Yerevan Botanical Garden could be revitalized through:

- Zoning areas for educational, recreational, and ecological functions.
- Designing pathways and plantings to enhance visitor experience.
- Hosting cultural events and educational activities.

Cité du Design: A Model for Armenian Innovation Centers

Located in the former arms manufacturing site of Manufacture d'Armes in Saint-Étienne, the Cité du Design is an urban regeneration success story. It serves as a campus for design education, research, and innovation. Exhibitions, symposia, and public engagement initiatives place design at the center of social development.

Armenian Application: Creating a similar design center in Armenia would contribute to:

- The growth of the creative economy.
- Professional training in design and architecture.
- Public awareness of sustainable and inclusive urban solutions.

4. Cultural Heritage as a Platform for Sustainable Development

The Power of Adaptive Reuse

Boisbuchet exemplifies how cultural heritage can be reactivated through adaptive reuse. Rather than preserving buildings as static monuments, this approach gives them new life as active cultural hubs. This model aligns with UNESCO's view that culture is a driver of sustainable development (UNESCO, 2013).

Artist-Led Revitalization of Rural Sites

Empowering artists to lead the revitalization of heritage sites not only fosters innovation but also ensures community engagement. This aligns with participatory planning models where local populations are co-creators of cultural value (Landry, 2000).

Opportunities for Armenia

In Armenia, initiatives such as TUMO Studios already promote creative education and production. Ex-

panding these initiatives into rural contexts and anchoring them in heritage preservation would enhance regional balance in cultural investment.

Conclusion

The Boisbuchet Residency stands as a compelling case study in integrating historical preservation with contemporary cultural practice. Its success underscores the potential of combining natural landscapes, architectural heritage, and creative collaboration in rural revitalization efforts. For Armenia, which faces both the challenge of heritage conservation and rural depopulation, this model offers a strategic and inspiring solution.

By repurposing historical sites into artist residencies, Armenia can:

- Preserve its tangible and intangible cultural heritage.
- Promote sustainable rural development.
- Attract international attention and collaboration.

Incorporating urban planning strategies observed in La Rochelle and Saint-Étienne further strengthens Armenia's potential to develop inclusive and green public spaces. Finally, the establishment of a design innovation center akin to the Cité du Design would anchor Armenia's creative future in both historical consciousness and forward-thinking innovation.



Pic. 6. Previous Art Project at Boisbuchet area



Pic. 7. Previous Art Project at Boisbuchet area

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NEUROIMMUNOLOGY

СТРУКТУРНЫЕ ИЗМЕНЕНИЯ ЖЕЛЕЗ МОЧЕВОГО ПУЗЫРЯ КРЫС ПОСЛЕ ВОЗДЕЙСТВИЯ КРЕПКИХ СУЛЬФИДНЫХ БАЛЬНЕОЛОГИЧЕСКИХ ВАНН

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THE STRUCTURAL CHANGES OF THE RATS URINARY BLADDER GLANDS AFTER EXPOSURE TO STRONG SULFIDE BALNEOLOGICAL BATHS

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Аннотация

Изучали железы мочевого пузыря крыс в норме и после воздействия крепких сульфидных ванн. Работу выполняли на 60 половозрелых крыс-самцах 3-4 месячного возраста, массой тела к началу эксперимента 180-200 г (30 крыс - эксперимент, 30 - контроль). Срезы мочевого пузыря крыс толщиной 5-7 мкм окрашивали гематоксилин-эозином по Ван-Гизону. По данным исследования, воздействие крепких сульфидных ванн негативно влияет на структуры желез мочевого пузыря крыс – приводят к «структурной регрессии» желез стенки мочевого пузыря крыс. Уменьшается толщина и площадь начального отдела желез, количество начальных частей их. Начальные части или альвеолы желез подвергаются кистозным изменениям.

Abstract

Studied the rat's urinary bladder glands in the norm and after exposure to strong sulphide balneotherapy procedures. Experimentally-morphological work carried out on 60 (30 rats – experiment, 30 – control) genitally mature rats-males 3-4 monthly ages, weight of a body to the experiment 180-200 gr. The rats received strong sulfide baths. The cuts of urinary bladder in the thickness 5-7 microns painted by hematoxilin-eozin on Van Gizon. After influence of the strong sulphidic procedures is observed the “morphological regression” of glands of rat's urinary bladder. After the strong sulphidic baths of the rats decreases the thickness and the areas of initial (alveolus) departments, quantity of initial parts (alveolus). The initial parts (alveolus) undergo cystoids changes.

Ключевые слова: морфология, эксперимент, железы, мочевой пузырь.

Keywords: morphology, experiment, glands, urinary bladder.

Введение. Имеются многочисленные работы по морфологическим особенностям и изменчивостям желез полых внутренних органов у человека и в эксперименте, и после различных бальнеовоздействий [1-7]. По данным литературных источников, железы как морфологические индикаторы динамично реагируют на любые экзогенные воздействия и подвергаются структурным изменениям. Надо добавить, что последние годы применение физиотерапевтических подходов в клинике при профилактике и лечении хронических и острых заболеваний внутренних органов, в том числе мочевого пузыря постоянно нарастает [9]. Поэтому существенное значение имеет изучение структурных характеристик желез мочевого пузыря после бальнеовоздействий различного минерального состава [8].

Цель исследования. Целью исследования является изучение структурных характеристик и закономерностей морфогенеза желез мочевого пузыря в эксперименте при действии сульфидных бальнеопроцедур.

Материал и методы исследования. Работа выполнена на 90 половозрелых беспородных крыс-самцах 3-4 месячного возраста, массой тела к

началу эксперимента 180-200 г (30 крыс - эксперимент, 30 - контроль). Поскольку минеральные и органические бальнеопроцедуры эффективны в непосредственной близости от источника, эксперимент проводили в этой зоне. Мы провели структурный анализ железистого аппарата крыс в норме, а также изменения после курсового воздействия крепких сульфидных ванн с высококонцентрированной сероводородно-хлоридо-натриевой водой из источника «Шихова» (Азербайджан). Все процедуры проводили по схемам, принятым в современной бальнеокуртологии. Температура воды в каждой серии эксперимента – 36-37,5°C, по 14 ванн, через день и продолжительность курса в каждой серии 28 дней (концентрация сероводорода – 300 мг/л; продолжительность воздействия 1-й ванны 2 минуты, 2-й – 4 минуты, остальных – по 6 минут). В каждой серии задействовали по 20 крыс. Крыс кормили стандартизованным кормом, при свободном доступе к питьевой воде. Мочевой пузырь подвергали гистологической обработке после вскрытия крыс. Срезы толщиной 5-7 мкм окрашивали гематоксилин-эозином по ван Гизону.

При изучении микропрепаратов анализировали толщину и площадь начальных отделов. Линейные размеры определяли с помощью окулярной

сетки, планиметрические (площадь) – окулярной сеткой. Под толщиной этих структур понимали разницу между их наименее и наиболее удаленными зонами от покровного эпителия. Изучали также площадь начальной части желез на срезе. Соответствующие микроскопические измерения проводились в пяти случайно выбранных зонах с вычислением среднего значения для каждого микропрепарата. При изучении микропрепаратов при биометрии (толщины начальных отделов желез и др.) использовали ЭВМ IBM 486 SX33 с помощью пакета прикладных программ «Морфолог», работая в среде Windows.

РЕЗУЛЬТАТЫ ИССЛЕДОВАНИЯ. В слизистой оболочке в норме на протяжении всего мочевого пузыря определяются начальные отделы, которые имеют четкие контуры. Начальные части обычно округлые. В результате действия крепких сульфидных ванн определяются существенные изменения желез стенки мочевого пузыря крыс. Значительная часть начальных частей кистозно расширена, сохранившиеся начальные части на срезе различной формы, деформированы. Эпителий слизистой оболочки частично десквамирован. В слизистой оболочке мочевого пузыря после курса крепких сульфидных ванн наблюдается картина стаза (рис.1).

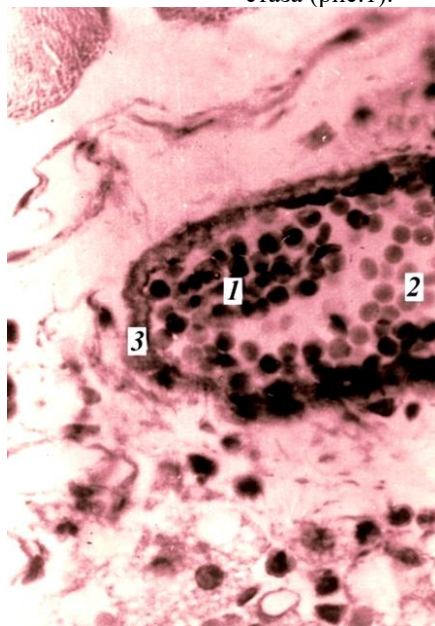


Рис.1. Стаз в венуле слизистой оболочки мочевого пузыря крысы после курсового воздействия крепких сульфидных ванн. Микропрепарат. Средняя треть. 1- клетки лимфоидного ряда в просвете венулы; 2- эритроциты в венуле; 3-стенка венулы. Окраска гематоксилином-эозином. Ув. 450х.

Мы провели комплексное морфометрическое исследование различных размерных показателей желез стенки мочевого пузыря крыс, на которых

были оказаны общепринятые бальнеовоздействия сульфидных ванн.

Таблица 1.

Толщина начального отдела желез мочевого пузыря у крыс после курсового действия сульфидных бальнеопроцедур ($\bar{X} \pm Sx$, min-max; мкм)

Тип бальнеовоздействий	n	Толщина начального отдела, отдел мочевого пузыря			
		Верхняя треть	Средняя треть	Нижняя треть	В целом органе
Сульфидные ванны	10	4,5 $\pm$ 0,5 5,3-13,2	10,0 $\pm$ 0,3 9,2-14,6	11,8 $\pm$ 0,5 10,4-18,6	8,8 $\pm$ 0,2 6,2-9,3
Контроль	10	10,0 $\pm$ 1,5 6,0-19,6	13,4 $\pm$ 0,6 12,5-18,2	14,4 $\pm$ 0,9 10,7-19,5	12,6 $\pm$ 1,1 9,2-19,2

Примечание:

1. n – число наблюдений;
2. $\bar{X} \pm Sx$ – среднеарифметическая показатель;
3. «min-max» – границы индивидуальной изменчивости.

Толщина начального отдела желез при воздействии крепких сульфидных ванн в стенках верхней трети мочевого пузыря меньше в 2,2 раза ($p < 0,05$), в средней трети органа – в 1,3 раза ($p < 0,05$), в нижней трети – в 1,2 раза ($p < 0,05$), а у органа в целом – в 1,4 раза ($p < 0,05$), чем контрольные показатели

(таблица 1). Индивидуальные минимальные и максимальные показатели толщины начального отдела желез на протяжении всей стенки мочевого пузыря у крыс при курсовом воздействии этих ванн меньше данных у крыс соответствующих контрольных групп. Морфологические данные по этому вопросу о площади начального отдела желез на срезе

отражены в табл. 2. Площадь начального отдела желез на срезе при действии крепких сульфидных ванн в стенках верхней трети мочевого пузыря в 1,6 раза меньше ($p < 0,05$), средней трети органа в 1,4 раза меньше ($p < 0,05$), нижней трети в 1,4 раза меньше ($p < 0,05$), у органа в целом в 1,5 раза

меньше ($p < 0,05$) контрольных показателей. Индивидуальные минимальные и максимальные показатели площади начального отдела желез на срезе на протяжении всей стенки мочевого пузыря у крыс при курсовом воздействии крепких сульфидных ванн меньше данных у крыс контрольных групп.

Таблица 2

Площадь начального отдела желез мочевого пузыря у крыс при курсовом действии крепких сульфидных бальнеопроцедур ($\bar{X} \pm Sx, \min\text{-}\max, 10^{-4} \text{ мм}^2$)

Тип бальнеовоздействий	n	Площадь начального отдела, отдел мочевого пузыря			
		Верхняя треть	Средняя треть	Нижняя треть	В целом органе
Сульфидные ванны	10	57,0 $\pm$ 1,9	64,5 $\pm$ 2,0	68,1 $\pm$ 1,0	63,2 $\pm$ 1,5
		39,1-69,5	37,5-70,5	55,5-72,5	46,5-70,0
Контроль	10	89,9 $\pm$ 6,4	92,4 $\pm$ 5,8	94,1 $\pm$ 5,2	92,1 $\pm$ 6,9
		65,2-123,2	63,7-116,2	77,7-125,5	65,8-119,2

Примечание:

1. n – число наблюдений;
2. $\bar{X} \pm Sx$ – среднеарифметическая показатель;
3. «min-max» – границы индивидуальной изменчивости;
4. 10^{-4} мм^2 – показатель площади.

Данные исследования об особенностях количества начальных частей, образующих начальный отдел желез на срезе представлены в таблице 3. Данный показатель при воздействии крепких сульфидных ванн меньше в стенках верхней трети мочевого пузыря в 1,8 раза ($p < 0,05$), в средней трети органа – в 1,3 раза ($p < 0,05$), в нижней трети – в 1,3

раза ($p < 0,05$), у органа в целом – в 1,4 раза ($p < 0,05$) контрольных показателей. Индивидуальные минимальные и максимальные показатели числа начальных частей на протяжении всей стенки мочевого пузыря у крыс при курсовом воздействии крепких сульфидных ванн меньше данных у крыс соответствующих контрольных групп.

Таблица 3

Количество начальных частей у начального отдела (на продольном срезе) желез мочевого пузыря у крыс после курсового воздействия различных бальнеопроцедур ($\bar{X} \pm Sx, \min\text{-}\max$)

Тип бальнеовоздействий	n	Число начальных частей отдела, отдел мочевого пузыря			
		Верхняя треть	Средняя треть	Нижняя треть	В целом органе
Сульфидные ванны	10	6,4 $\pm$ 0,5	10,5 $\pm$ 0,7	12,4 $\pm$ 0,8	9,7 $\pm$ 0,6
		4-10	7-17	8-19	7-16
Контроль	10	11,3 $\pm$ 1,4	14,0 $\pm$ 0,9	16,3 $\pm$ 1,1	13,9 $\pm$ 0,8
		7-19	11-19	12-22	10-17

Примечание:

1. n – число наблюдений;
2. $\bar{X} \pm Sx$ – среднеарифметический показатель;
3. «min-max» – границы индивидуальной изменчивости.

Данные по вопросу об особенностях площади начальной части (на срезе) показывают (таблице 4), что после воздействия крепких сульфидных ванн в стенках всех третей и у органа в целом этот показатель почти в 1,2 раза меньше ($p > 0,05$) контрольных

показателей. Индивидуальные минимальные и максимальные показатели площади начальной части на протяжении всей стенки мочевого пузыря у крыс тоже меньше данных у крыс соответствующих контрольных групп.

Таблица 4

Площадь начальной части (на продольном срезе) желез мочевого пузыря у крыс после курсового воздействия крепких сульфидных бальнеопроцедур ($X \pm Sx$, min-max, 10^{-4} мм^2)

Тип бальнеовоздействий	n	Площадь начальной части, отдел мочевого пузыря			
		Верхняя треть	Средняя треть	Нижняя треть	В целом органе
Сульфидные ванны	10	$3,2 \pm 0,1$	$3,2 \pm 0,1$	$3,6 \pm 0,1$	$3,3 \pm 0,1$
		3,0-5,0	3,0-5,0	3,0-5,2	3,0-5,0
Контроль	10	$3,9 \pm 0,3$	$4,0 \pm 0,3$	$4,3 \pm 0,3$	$4,1 \pm 0,3$
		3,6-6,7	3,6-6,6	3,7-6,8	3,6-6,6

Примечание:

1. n – число наблюдений;
2. $X \pm Sx$ – среднеарифметический показатель;
3. «min-max» – границы индивидуальной изменчивости;
4. 10^{-4} мм^2 – показатель площади.

ОБСУЖДЕНИЕ РЕЗУЛЬТАТОВ ИССЛЕДОВАНИЯ.

Мы изучили морфологическую изменчивость желез стенки мочевого пузыря у крыс при крепких сульфидных бальнеовоздействиях, учитывая, что эти образования целесообразно рассматривать в качестве морфологических индикаторов, поскольку эти структуры динамично реагируют на любые экзогенные воздействия [9,10]. По нашим данным, размерно-количественные показатели желез стенки мочевого пузыря при курсовом действии этих ванн уменьшаются. По сравнению с контролем, наблюдается уменьшение толщины и площади начального отдела желез, количества и площади начальных частей в его составе. Выявленные признаки доказывают негативную эффективность и опасность курсового действия сульфидных ванн на примере слизистой оболочки мочевого пузыря и соответствуют данным авторов [8,9], изучивших влияние этих же ванн на структуры гортани и трахеи крыс. Данные воды могут оказывать определенное влияние по отношению к железистым структурам, учитывая их богатый микроэлементный состав и участвующий в антиоксидантной системе [4,6,7]. Известно, что органические ванны эффективны при лечении и профилактике больных нозологий широкого спектра [1,4-6]. Напротив, настораживают результаты нашего исследования о влиянии курса крепких сульфидных ванн на структурные характеристики желез мочевого пузыря крыс. По сравнению с контролем уменьшается морфологические показатели желез. Наблюдается кистозные изменения многих начальных частей. Наблюдается также картина стаза в слизистой оболочке мочевого пузыря, отсутствующая у крыс контрольной группы. Выявленные нами структурные изменения железистого аппарата мочевого пузыря приводят к снижению его секреторной активности, следовательно, как мы показали, к частичной десквамации покровного эпителия, его механическому повреждению любыми инородными субстанциями, содержащимися в моче (микроконкрементами, «мочевым песком»).

ВЫВОДЫ. Таким образом, в результате проведенных экспериментально-морфологических исследований железы мочевого пузыря крыс рассмат-

ривались как биомаркеры эффективности бальнеовоздействий. Практически важные результаты были получены при изучении действия крепких сульфидных ванн (их негативный эффект). Воздействие крепких сульфидных ванн и их последствие настораживает, требует дополнительного исследования, вероятного пересмотра имеющихся в бальнеопрактике клинических рекомендаций.

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EFFECTIVE WAYS TO USE MOBILE APPLICATIONS IN TEACHING THE KAZAKH LANGUAGE**Shadiyeva N.***A.K. Kussayinov Eurasian humanities institute, associate Professor of the Department of Kazakh language and Literature, candidate of Pedagogical Sciences*ORCID ID: <https://orcid.org/0000-0002-9315-0280>DOI: [10.5281/zenodo.15427624](https://doi.org/10.5281/zenodo.15427624)**Abstract**

This article discusses the methods of teaching the Kazakh language and modern applications that can be used in it. Currently, the use of modern technologies in the education system is one of the main tasks of teachers. It is obvious that the generation of students who are born and raised in a digital society will be more productive to educate in accordance with their own perception. The use of modern applications in the methods of teaching the Kazakh language will undoubtedly help students learn the beautiful and mysterious world of the Kazakh language. The article describes mobile applications that are widely used in the educational methodology today, gives various information related to their application: their features, functions are identified, and their effectiveness in education is considered. Training programs on mobile devices, classes on mobile applications have become the main way to gain knowledge and improve professional qualifications, attracting students and helping the teacher. It also refers to the research and opinions of well-known scientists on the methodology of teaching the Kazakh language in general. The advantages and disadvantages of mobile learning are listed, and various aspects of the use of information and communication technologies are noted. It is obvious that the role of interactive systems of work performed using computer information technologies in high-quality education and the development of cognitive interest is still being studied and filled. The purpose of applying world experience in the field of education in the education system of universities is to motivate students, to assimilate the knowledge provided by effective methods. This article is recommended for practical use by teachers of higher educational institutions.

Keywords: Kazakh language, teaching methods, mobile applications, mobile devices, ICT, Language Teaching, innovative technologies, modern methods.

Among many different applications, let's focus on the Google Classroom platform, which is considered suitable for teaching the Kazakh language.

Classroom is a free service for educational institutions and any non-profit institutions. It is also available to any person who has an account in the Google system. With the help of Classroom, today the relationship between teacher and student has reached a new level, not limited to the framework of the audience. Classroom is also suitable for saving valuable resources, such as time, or other physical resources. With its help, it becomes possible to develop a whole course, give tasks, establish communication and systematize the work. The advantages of working with Classroom are as follows:

The use is very simple. Teachers themselves can list their students for a specific course or provide registration codes as course listeners. It's a few minutes of work.

Efficiency in saving time. Working in an online format allows the teacher to send, check and evaluate tasks using a single platform, which means that the amount of time spent on each of the specified stages of the training system is reduced.

Convenience in the systematization of materials. Students can fully control which tasks have been submitted or not through the task page, and the available material is automatically uploaded to their Google Drive folder.

The Classroom app has a direct language feature. With the help of it, the teacher can draw a task, send an announcement and start the analysis. And students have

the opportunity to exchange materials and answer questions in the course feed.

How safe is this app? The Classroom app does not contain ads, and materials and student data are not used for marketing purposes.

The teacher will be able to publish videos and photos to the Classroom by allowing the camera in the Classroom app. You can attach photo and video materials stored on the device to the attachment by allowing storage. In order to be able to select an account in the process of working with this application, you must be allowed to use the account. These applications have made a great contribution to facilitate the learning process during the quarantine declared in the world due to the pandemic.

In the course of teaching the Kazakh language, the development of a culture of logical thinking of students is also an issue that is taken into account. What elements of logic should be introduced in the course of teaching the Kazakh language? How to combine the methods used in teaching elements of logic with the methods of teaching the Kazakh language? Mastering the content of logical knowledge that is considered necessary in the course of teaching the Kazakh language, it considers the ways of consistency, consistency of thinking in reading, the structure of reasoning and the ability to reason and reason by mastering it. So that the learning process does not turn into a purely linguistic education, it must be continuously monitored. Problems in teaching such a language can be included in the tasks in the appendix, taking into account the teacher. Tasks for the development of logic can be built into the Kahoot application. This application is also one of the

applications that has shown positive results in methodological practice in higher education institutions. How do we use the Kahoot app? Kahoot is an application based on online quiz tests and Q & A to make the lesson fun, lively and effective. An indispensable tool for mastering a new topic, consolidating knowledge and conducting surveys, creating a logical game in a few minutes or choosing the necessary one from a large number of ready-made products.

This application is well recognized by both teachers and students, school teachers and students and is used today even in the course of classes based on the traditional education system. And in the period of distance learning, this service has become the most effective tool for the teacher. Functions such as fixing the lesson in the form of a question and answer using Kahoot after changing the lesson from a regular format to a new one and explaining a new topic are available to any teacher. In addition, through the analysis of the presented materials, it becomes possible to form the competence of critical thinking. For example, in the process of mastering new materials, students may continue to nod their heads on the other side of the screen. If you take a short dynamic test at such a time, their interest in the topic will awaken, and they will begin to actively engage in the lesson. By taking a test, it is possible to determine whether students have fully mastered the material given by the teacher five minutes ago. Obviously, the fact that the correct answer is colored green also contributes to the fact that this answer is stored in the student's memory. Since the rating of players is visible during each game, this action motivates the participants of the knowledge contest: each participant will be motivated to answer the next question as correctly as possible and score good points. Complementing the order of classes conducted with Kahoot or expanding or transforming its use in accordance with the topic of the lesson is a process that takes place in accordance with the motivation, imagination and general worldview of the teacher. In the process of working on a complex topic that requires in-depth explanation, the gaps in the student's knowledge are filled in with the help of tests. There is also the possibility of organizing a video conference through Kahoot and sending tasks in a game format for independent execution within the framework of a distance learning system [1]. Thus, it is known as the most suitable application for summarizing the knowledge gained by the student from materials corresponding to the last topics, organizing questions and answers in the course of explaining new material. In order to identify positive changes in the development of knowledge of each student, it is necessary to use the analytics of the conclusion of the game. By independently compiling tests, students will deepen their knowledge, and passive students will be interested in the subject. With the help of this application, they have team game opportunities aimed at Building Group Partnership skills in themselves. To compile games and tasks in the Kahoot application, you need to familiarize yourself in detail with all the necessary mechanisms. You can choose a language and put some pleasant melody in the background, which will affect the mood of

the players during the quiz. You can write a topic, a description of the lesson, hang a picture, and, if necessary, put a link to one roller on YouTube. The main thing is not to forget to register them all in the game in advance so that the course of the game is available to all participants. The application has a writing bar at the top of the page and a picture hanger function on the side to enter the teacher's questions and answers. The possibility of limiting the time allotted for the student's response is also provided. At the end of the game or question and Answer Session, you can download the result on the electronic scoreboard, view and discuss the student's result.

Learning only achieves its goal when the learner is more motivated to learn. The activation of learning motivation belongs to the teacher's share. The formation of motivation in teaching depends on the experience and knowledge of the teacher [2].

The means that awaken motivation in the course of the educational process are new technical training tools. Professional qualifications oblige the teacher to use video films, television, audio recordings or the capabilities offered on various devices, such as computers and smartphones, in the learning process.

O. V. Kanarskaya: "innovative education in the Urok in the Russian language is the beginning of a new understanding in modern conditions for the resolution of humanization of education, the transition to formalism, authoritarian style, increasing the quality of education, the need to expand its creative potential, factual, innovative training – the result is a change of style in society, style of presentation of knowledge and understanding of their meaning"—as the definition of modern teaching suggests, in innovative lessons, along with the content of the lesson, with the maximum use of visuals, video, video-audio tools, computers, electronic textbooks, one lesson should be completely different from another [3]. Innovative training of the teacher should allow the learner to independently solve tasks, problems, in accordance with didactic conditions.

As for innovative teaching methods, we recommend using mobile applications again. This is the Socrative component. According to the technical support capabilities of the teacher, this application can also be used on a computer. In addition to traditional methods of mastering the Kazakh language, it is becoming a requirement for modern students to present lessons in an innovative way. You can check the words and actions contained in these materials using this application, showing films in the Kazakh language or listening to Kazakh songs as an audition task. For example, the teacher compiles questions on the same movie, song, or Socrative, which can compete students: whoever is the first to answer correctly, the teacher automatically rewards the participant on the screen. If you want to limit the time of completion of the task, the participant who quickly found the correct answer will be given additional points, and the participant's interest will increase with various motivational emoticons. Unfortunately, such effective applications are not often used by teachers in their classes. In Socratic, the teacher can create other quizzes for their students and choose standard quizzes during the lesson. The ability to answer these

quiz questions is also provided by students independently or anonymously, and this requirement is chosen by the teacher independently. As soon as students begin to complete tasks, answer statistics will appear on the teacher's screen. Based on the quiz answers of the participants, the teacher can analyze how much they have mastered the material, assess their level of knowledge, and contribute to updating, improving the curriculum. To compose the quiz, you need to have a teacher-specific version of this application on your mobile device.

In addition, the application offers many test options, such as:

- in the format of a question that defines right-wrong

- questions with multiple answer options;

- open questions [4].

As a teacher, our main activity is to teach the language. And our goal in education is general practical education and upbringing. In accordance with this goal of education, the content, methodology and means of training are selected. Teaching is a process aimed at achieving the highest level of educational and cognitive activity of the learner, the assimilation of the given knowledge. In this process, both the learner and the teaching party participate, on the basis of joint actions of the two, the learner receives or complements the knowledge, and the teaching party forms its methodological knowledge in depth.

Methodological science studies the laws of teaching. Teaching methodology studies the content, purpose, task, method of training, as well as methods of teaching and upbringing. The method, on the other hand, considers the relationship between the activities of the teacher and the student, who aims to acquire knowledge. A. N. Shchukin defined: "the concept of a method is a set of techniques and approaches to solving reality in a theoretical and practical way on the way to the implementation of a particular task." In order to organize the educational process in a rational way, the teacher should effectively use the following basic complex methods: the transformation of educational and cognitive activity, the method of developing motivation in education, the method of control, which increases the effectiveness of training, etc.

Effective learning tools are used not only to evaluate knowledge, but also apply as a learning strategy, frequently use tasks for evaluation and control, in order to reduce psychological pressure by allowing students to correct mistakes made during the task. It is better to use various individual strategies of control and evaluation methods, such as: clickers, cards, bingo, sticker reflection, movement test.

One of the applications that can be used in the methodology of teaching Kazakh language is the word-wall application. With the help of interactive exercises, you can work out grammar, vocabulary, reading, listening tasks. Features such as copying tasks from different templates to paper or quickly switching to the next type of task are the main features of this application. You can use the Learningapps app to relax when complex topics come side by side or recur and students get tired or become less interested. The Learningapps app is a

resource for fixing and working out the material provided using the game. Using this app, you can compose various games, quizzes, crosswords, puzzles according to the student's level of language proficiency. It has a gallery of interactive tasks created at the initiative of users. The teacher can select the material he needs, edit, correct, update or supplement it in accordance with the topic of the lesson or his own style of education. It is clear that among the exercises grouped by the names of academic disciplines, it is not difficult to find material related to the relevant discipline.

Each teacher has their own style of teaching, and it is recommended to use various applications to form the teacher's own style. Teachers who intend to use this application during the lesson before using the application first LearningApps.org the next step is to develop training models that meet the topic, purpose and objectives of the lesson, and at the end you can save them, update them as needed and make changes. The exercises section contains a set of exercises such as "all exercises", "new exercises", "my classes", "my workouts". Each teacher has their own style of teaching, and it is recommended to use various applications to form the teacher's own style. Teachers who intend to use this application during the lesson before using the application first LearningApps.org the next step is to develop training models that meet the topic, purpose and objectives of the lesson, and at the end you can save them, update them as needed and make changes.

Literacy is of particular importance in the formation of speech activity. The main task is to give priority to pronunciation tasks and form the student's skills of competent speech, the ability to correctly express the game. In addition to public speaking and rehearsing, you can use a mobile device to instruct you to prepare additional tasks and require them to be submitted in audio or video format [6].

Among the applications, we can also use the Quizlet application, which is designed to effectively learn educational materials through easy-to-use methods of teaching the Kazakh language. Each teacher develops their own module using electronic cards. In order to memorize phrases and analyze their structure, you can also resort to the help of Quizlet functions. In addition, when time is limited or there is a need to exchange views, cards prepared by other users come to the rescue. According to statistics, the effectiveness of this application in education, which has more than 60 million users, can be traced through such functions?

- putting the necessary material on the card and training with it;

- checking a student's memory through a subscription action;

- motivation by organizing the qualifying game and winning

- formation of correct oral delivery of texts;

- application of the mentioned application as preparation for an important exam, control work;

Quizlet provides a reason for fast memorization and assimilation of material, and the free use of the functions provided by the platform in teaching any subject is a great help to the general educational community [7].

«...Remembering the words of K.D. Ushinsky» every teacher should take part in the technologization of the learning process. The best experience will certainly show the best results.

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SPEAKING COMPETENCE IN AN ESP CONTEXT (A CASE STUDY OF ENGINEERING STUDENTS)

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Abstract

Speaking, apart from having the status of being the primary means of communication in general, it is one of the main mediums of communication in a foreign language class and at the same time, one of the key components of a foreign language syllabus. For most students, it is regarded as a skill that does not require much prior preparation, however, when taking tests, the speaking section is the one that causes the most anxiety. Learning a language does not necessarily mean speaking it. Learners need to be taught the right techniques and apply the useful strategies to be used while speaking and this is done by bearing in mind the aim one wants to achieve (narrate, summarize, give instructions, express viewpoints, justify opinions etc.) and the assessment criteria and the positive outcome of speaking. A considerable number of activities in textbooks are oriented towards speaking. To ESP students, in our case, engineering students, part of the speaking preparation, the one closely related to the lexicon, is covered with the introduction of the field-related terminology. Still, there are other aspects that need to be considered and developed by the students. Most of the lesson time is spent on talking, held either between the teacher and the student or among students. In the ESP textbooks used in our University, a considerable number of the activities are oriented towards oral communication with the aim of equipping future professionals with the right speaking skills for effective interaction with other coworkers. A high-frequency practice during the lesson is one appropriate approach, the positive results of which are obvious the moment 'the message' is fully conveyed and there is linguistic interaction.

Keywords: speaking, teaching, ESP, techniques, assessment.

Objective

This paper aims to pinpoint the Speaking activities in ESP classes as the ones that require a particular approach, specific techniques and lots of practice for the students to fully have a good command of it. Speaking is a dominant activity during a foreign language class and one of the four skills learners will have to be evaluated either for the final evaluation of the syllabus or for international exams of English. In this study, we will give an overview of the current situation of Speaking Skills in an ESP context and also reach conclusions on some strategies we believe might be useful to our learners to develop good speaking skills and build confidence in this life-long needed skill.

Methodology

For the conduct of this study, the approach used is the observational one, which is done in our English classes with the engineering students at the Polytechnic University of Tirana. The observation is also based on our experience as Speaking Examiners of English. Discussions are held with students, mini-surveys are done as well as analysis of the textbooks in order for us to have a full and clear picture of the obstacles they face.

Introduction

Speaking skills are vital to a good understanding of a foreign language and communication among people. It is a skill developed during a person's study cycle and a skill useful in one's career throughout the entire life. According to Srinivas Rao, P. (2019), Brown and

Yule (1983) described speaking as the skill students will be judged upon most in real-life situations. He highlights the importance of speaking by stating that 'the one who has good talent in speaking can conquer the entire world.

Shehu I. (2024) estimates presentation skills, a speaking activity, as one key competence and a huge asset the learner should possess and be well-rounded during one's studies.

Burns, A. (2019) concludes that the main aim of speaking tasks is to help students develop the fluency of natives, where meaning is communicated with few hesitations.

Thornbury, S (2005) specifically states that learning a language does not necessarily mean speaking that language. This fully supports our idea of first making students aware of the importance of acquiring such skills.

From an overview of the units in some of the Engineering textbooks used at our University, almost every unit starts with a warm-up activity, which is a discussion of a couple of questions through which learners start activating language and through which their interest is sparked. It constitutes 33% of the activities per unit, with another exercise in which students are asked to act out and simulate real-life and career-specific situations. Employing these guided speaking exercises, they are asked to practice useful language/phrases and sample language taught earlier in the

unit, practice the branch-related terminology and at the same time, recall other general speaking conventions and grammar rules which are not peculiar to language for specific purposes only, but general language too. It is inevitable to correct other speaking components such as pronunciation, stress, intonation and the register. This approach fully aligns with the communicative output (Ramadhani, P:2017) used in teaching Speaking skills.

Analysis

Regarding lexicon, unlike other EFL learners who struggle with limited vocabulary, our ESP students do not struggle much due to the high exposure to terminology in the textbooks used, specifically tailored for engineers. By applying the content-oriented method, the teacher encourages the learner to put into practice pre-taught vocabulary.

Via grammar, the learner is able to put words together and accurately use them. Grammar together with vocabulary is the first criterion assessed in a speaking activity and in the case of ESP students, basic grammar knowledge is required and taken for granted.

Pronunciation, the ability of the user to clearly produce sounds, is one of the Speaking Criteria in which learners get the highest points. Researchers of the Albanian language attribute this gifted skill of our learners to the relatively great number of phones (36 phonemes – 29 consonants and 7 vowels) in Albanian language, similarity in phonetic systems and probably the geographical position believed to influence linguistic sounds.

Speaking is regarded as the most active and spontaneous skill and it involves interaction. The reflection of this is seen in dialogues and discussions held in class, simulating real-life interaction. In the case of role-play, they push learners into creatively reacting to a situation, thus developing fluency, which is a key feature of natives. Interaction is one fundamental component of Speaking and requires learners to actively participate in listening and speaking. Pair work or group work are very useful activities that lead to interaction.

Elaborating on the ability to respond and be able to talk about any subject, is another skill strongly practised by the teachers, who time after time require learners to come up with an idea and a response, even when they have the least knowledge on the topic.

We believe that the cultural element in speaking is to a certain degree missing in the engineering textbooks, being of a technical character. However, culture can never be separated from language. As Sozen, P.H. (2016) puts it, it is inescapable to see culture, language and communication as a whole. Learning and practicing one language is equivalent to learning the culture of the place it is spoken. It is to be said that such elements are used to a large extent in EFL classes. Nevertheless, introduction to cultural elements in ESP class is done by the lecturer, and indirectly by the set phrases taught and used in conversations which in ESP might be informal or formal. Understanding cultural differences is essential in achieving effective communication and it

greatly impacts how a message is received and this applies in the ESP context as well.

Speaking is a spontaneous process and this characteristic is directly attributed to the fear of the learner to express oneself in a foreign language. As the saying goes, practice makes perfect, and this fully aligns with the case of teaching speaking in an ESL/EFL context. One way to best fight anxiety and build confidence in a foreign language learner is to give corrective, formative and encouraging feedback that motivates the student.

Recommendations

It is up to the lecturer to select from the various techniques to apply in teaching speaking. Among the most effective and commonly used techniques in teaching Speaking skills is to encourage learners to actively ask and answer questions, introduce and share ideas, engage in role-playing activities, give presentations, interpret images, tell stories, etc. Regardless of the strategies, speaking skills of ESP students have to be developed as they constitute the most frequent activity that learners will always be assessed and that will always play a part in a person's success in life. During the speaking process, learners may guess, interact with the interlocutor in English even by paraphrasing (not switching to Albanian), and dare to express ideas regardless of the fear of making mistakes.

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PHILOLOGY

TRACING THE EVOLUTION OF TRANSLATION FROM ANCIENT TEXTS TO MODERN THEORY

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Abstract

The history of translation stretches back to the earliest moments of written human communication. While translation is often viewed today as a technical or literary endeavor, in ancient times it held profound religious, political, and cultural implications. The early practices of translation in ancient civilizations were not merely linguistic exercises; they were acts of power, preservation, and transmission. Translation during the medieval and Renaissance periods was more than a linguistic necessity; it was a conduit for cultural, scientific, philosophical, and religious transformation. As societies evolved and came into contact through conquest, trade, and religious expansion, translation emerged as a key mechanism for the transmission of knowledge across cultural and linguistic boundaries. These periods witnessed a shift from translation as mere conversion of language to translation as a complex cultural act, embedding meaning within historical, ideological, and epistemological contexts. The modern era, roughly from the 17th century onward, witnessed not only the acceleration of translation as a professional and scholarly practice but also the emergence of translation as a theoretical discipline in its own right. Unlike earlier periods where translation was often subordinated to religious or literary imperatives, the modern era saw the formulation of abstract principles, frameworks, and debates that would define the study of translation. Intellectuals began to explore the nature of equivalence, the role of the translator, and the political, cultural, and ethical dimensions of cross-linguistic mediation.

Keywords: Translation History, Cultural Transmission, Translation Theories, Interlingual Communication, Translation Practices.

Introduction

The relevance of the topic lies in its ability to illuminate the pivotal role translation has played in shaping human civilization, intellectual development, and cross-cultural interaction. From its origins in the preservation and dissemination of religious, legal, and scientific knowledge in ancient societies, to its formalization as a theoretical discipline in the modern era, translation has continuously functioned as a bridge between languages, worldviews, and epistemologies. Understanding the historical trajectory of translation enables scholars to contextualize contemporary debates surrounding fidelity, equivalence, and translator agency within a broader continuum of evolving norms and expectations. Moreover, in an increasingly globalized and multilingual world, where translation governs the flow of information, literature, diplomacy, and digital communication, examining its historical foundations offers critical insight into how translation both reflects and constructs cultural identities. This topic is therefore not only relevant to linguistic and literary scholarship but also to fields such as philosophy, sociology, postcolonial studies, and digital humanities.

The study adopts a historical-descriptive research method, drawing on a combination of secondary sources from translation studies, linguistics, and intellectual history to trace the evolution of translation practices and theoretical developments across different time periods. The method involves systematically analyzing key historical milestones, influential figures, and theoretical paradigms by examining academic books, peer-reviewed articles, and critical essays. Through a diachronic approach, the study contextualizes translation

within its broader cultural, philosophical, and political settings, allowing for a nuanced understanding of how the role and perception of translation have changed over time. This qualitative approach ensures a comprehensive and interpretive synthesis of diverse historical trajectories, contributing to the broader discourse in translation theory and cultural studies.

The study is based on an extensive review of scholarly literature, including classical texts by John Dryden, Friedrich Schleiermacher, and Eugene Nida, which laid the foundation for modern translation theory. It also incorporates contemporary works by Lawrence Venuti, Susan Bassnett, and André Lefevere to examine the cultural and ideological dimensions of translation. Historical materials such as the Septuagint, the Rosetta Stone, and medieval Arabic-Latin translations are referenced to illustrate the practical contexts of translation across different civilizations.

Early Translation Practices in Ancient Civilizations

The earliest recorded instances of translation can be traced back to ancient Mesopotamia, where Sumerian and Akkadian languages coexisted in a diglossic environment. Scribes routinely translated Sumerian religious, legal, and literary texts into Akkadian, creating bilingual tablets that have survived into the present day. These translations were often word-for-word and focused on maintaining fidelity to sacred or legal content. The practice of interlinear glosses—where one line of Sumerian text was followed by a corresponding Akkadian line—reveals not only a pedagogical function for scribes-in-training but also a growing awareness of the

complexities of semantic equivalence between languages. Such practices were instrumental in the preservation and continuation of Sumerian cultural heritage long after the spoken use of the language had declined. Moreover, the presence of bilingual inscriptions in other language pairs, such as Akkadian-Hittite, suggests that translation in Mesopotamia was also a diplomatic necessity in maintaining communication between regional powers [2, p. 14-19].

Ancient Egypt, while linguistically more insular due to its geographic and political centrality, nevertheless developed translation practices in response to both internal diversity and external contacts. One of the most important artifacts for understanding early translation in Egypt is the Rosetta Stone (196 BCE), a trilingual decree inscribed in Egyptian hieroglyphs, Demotic script, and Ancient Greek. This inscription illustrates both the multicultural environment of Ptolemaic Egypt and the necessity of translating state decrees for multiple audiences—native Egyptian priesthods and the Greek ruling class. Translation in Egypt often served religious functions, especially in the transmission of mythological and theological texts across dialects and time periods. The translation of Egyptian religious texts into Greek, particularly during the Hellenistic era, introduced Egyptian cosmology and ritual practice to the broader Greco-Roman world, shaping later mystical and syncretic philosophies [4].

The ancient Greeks had a complicated relationship with translation, often viewing Greek language and culture as superior to those of “barbarian” others. However, as Greek contact with the Near East increased, translation became essential, particularly in the realm of science, philosophy, and religion. The most significant example is the translation of Hebrew scriptures into Greek—the Septuagint—in the 3rd century BCE in Alexandria. This translation, sponsored by the Hellenistic rulers and conducted by Jewish scholars, aimed to make Jewish religious texts accessible to Greek-speaking Jews and, indirectly, to the broader Greek world. The Septuagint marked a turning point in the history of translation, as it introduced debates about literalism versus paraphrastic translation strategies. While the translators aimed to remain faithful to the Hebrew original, they also adapted idioms and concepts to align with Hellenistic cultural expectations. The legacy of the Septuagint would later influence early Christian translations and theological interpretations [2, p. 22-29].

Greek philosophers, notably Plato and Aristotle, also indirectly engaged in translation-like practices when interpreting Egyptian and Babylonian ideas through a Hellenic lens. Although these were not formal translations, they represent a form of cultural translation that shaped the reception and transformation of non-Greek knowledge.

The Roman Empire, with its vast linguistic diversity, institutionalized translation practices for governance, military, and legal administration. Latin became the dominant language of law and imperial communication, but interpreters and translators (*interpretes*) were employed across the empire to mediate between Latin and local languages, such as Gaulish, Berber, Aramaic, and Greek. Roman writers such as Cicero and

Horace wrote extensively about translation, debating whether it should be “word-for-word” (*verbum pro verbo*) or convey the spirit of the original. Cicero’s famous distinction between the *interpretes* (literal translator) and the *orator* (rhetorical translator) reflects a growing theoretical awareness of translation as a creative and interpretive act. Roman translation practices also extended to literary works. Greek tragedies, epics, and philosophical treatises were translated into Latin and adapted to Roman values and social norms. These translations, often free in form, served to Romanize Greek culture and assert the intellectual legitimacy of the Roman world [4, p. 18-22].

For early Jewish and Christian communities, translation was not only a cultural or practical endeavor but a sacred mission. Beyond the Septuagint, other key translation efforts included Aramaic Targums—interpretive translations of the Hebrew Bible—and the Peshitta, a Syriac version of biblical texts. These translations were essential for communities that no longer spoke Hebrew fluently but wished to access religious teachings. Later, in the 4th century CE, Jerome’s Latin Vulgate would become the most influential biblical translation in the Western world. Commissioned by the Church, Jerome sought to combine fidelity to the Hebrew and Greek originals with stylistic elegance in Latin. His work illustrates an evolving philosophy of translation that balanced accuracy, clarity, and doctrinal orthodoxy [4, p. 23-27].

The Medieval and Renaissance Periods: Translation as Cultural Transmission

One of the most remarkable episodes in the history of translation occurred between the 8th and 10th centuries in the Islamic world, particularly in the Abbasid Caliphate centered in Baghdad. The Graeco-Arabic translation movement, spearheaded by scholars like Hunayn ibn Ishaq, Thabit ibn Qurra, and Al-Kindi, focused on translating Greek scientific, philosophical, and medical texts—especially those of Aristotle, Galen, and Hippocrates—into Arabic. The Bayt al-Hikma (House of Wisdom) functioned as both a library and translation academy, sponsored by the caliphs, and exemplified institutional support for intellectual inquiry. These translations were not merely mechanical conversions; they were sophisticated acts of interpretation. Greek philosophical terms had no direct equivalents in Arabic, and translators frequently developed new vocabulary or explanatory glosses to communicate complex ideas. The translations were often accompanied by commentaries that integrated Greek philosophy with Islamic thought, leading to the rise of a distinctly Islamic philosophical tradition (*falsafa*). This process of cultural transmission was reciprocal: while Greek knowledge was preserved and expanded upon in the Islamic world, it was also transformed in the context of Islamic theology, metaphysics, and logic [8].

As Europe emerged from the so-called “Dark Ages,” it encountered a cultural and intellectual revival largely driven by contact with the Islamic world, especially in Spain and Sicily. The Toledo School of Translators, active in the 12th and 13th centuries, was instrumental in retranslating Arabic scientific and philosophical texts—many of which were themselves translations

of Greek originals—into Latin. This included not only the works of Aristotle but also the commentaries of Averroes (Ibn Rushd) and Avicenna (Ibn Sina), whose interpretations heavily influenced scholastic thought in medieval Europe [3].

Key figures such as Gerard of Cremona, Michael Scot, and Adelard of Bath undertook translation projects that reshaped European intellectual life. For instance, Gerard of Cremona translated over 70 works, including Ptolemy's *Almagest* and Avicenna's *Canon of Medicine*. These texts revolutionized the medieval European curriculum and laid the groundwork for the development of universities and the eventual rise of the scientific method.

Translation in this period served not only to import foreign knowledge but also to legitimize it within a Christian intellectual framework. Latin translators often adapted texts to align with theological orthodoxy, sometimes omitting or modifying elements that contradicted Christian doctrine. Nevertheless, the influx of Arabic knowledge facilitated the flourishing of Scholasticism, a movement characterized by the synthesis of faith and reason, which reached its pinnacle in the works of Thomas Aquinas.

The Renaissance period, beginning in the 14th century, marked a shift in translation philosophy, particularly with the rise of humanism, which emphasized returning to classical sources in their original languages and promoting eloquence and moral clarity. Unlike their medieval predecessors, Renaissance translators were less concerned with religious orthodoxy and more focused on stylistic fidelity and rhetorical elegance. This period saw a re-engagement with original Greek and Latin texts, bypassing earlier Arabic intermediaries, and a renewed interest in the accurate rendering of classical literature and philosophy [9, p. 71-81].

Key humanist translators such as Leonardo Bruni, Erasmus of Rotterdam, and Marsilio Ficino played pivotal roles. Bruni's Latin translations of Plato emphasized Ciceronian style and clarity, while Ficino's translations of Platonic dialogues and Neoplatonic texts laid the foundation for Renaissance Neoplatonism. Erasmus, known for his *Novum Instrumentum omne*—a new Latin translation of the New Testament—challenged the authority of the Vulgate and initiated debates about textual integrity and doctrinal interpretation.

Equally transformative was the emergence of translations into vernacular languages, which expanded access to classical and sacred texts. Dante's *Divine Comedy*, although an original composition, exemplified the prestige of the vernacular. Later, Martin Luther's German translation of the Bible (1522–1534) played a decisive role in the Protestant Reformation, fostering both religious decentralization and linguistic standardization. In England, William Tyndale's translation of the New Testament (1526) contributed to the evolution of English prose and laid the groundwork for the King James Bible.

Translation thus became a tool of both linguistic innovation and political contestation, as the authority of Latin was increasingly challenged by vernacular literacy and nationalist sentiments. The Renaissance translator was no longer a mere conduit but a cultural agent,

shaping the reception of texts in accordance with new values of individualism, textual criticism, and artistic integrity [7].

The Rise of Translation Theory in the Modern Era

The Enlightenment era brought a rational and systematic spirit to the study of language and translation. Influenced by classical ideals of clarity and order, many theorists in the 17th and 18th centuries emphasized fidelity, accuracy, and readability. Thinkers like John Dryden in England proposed categories of translation—metaphrase, paraphrase, and imitation—that shaped early taxonomies of translation strategies. Dryden advocated for a balance between literal translation and stylistic elegance, a view echoed by Alexander Fraser Tytler, whose *Essay on the Principles of Translation* (1791) remains one of the first systematic works in the field. Tytler insisted on three main principles: accuracy, clarity, and preserving the style and spirit of the original.

However, the Romantic movement in the late 18th and early 19th centuries initiated a shift from rationalist ideals to a focus on the individual genius and the organic unity of texts. German philosophers and poets—particularly Friedrich Schleiermacher—argued for the creative, subjective role of the translator. Schleiermacher's 1813 lecture *On the Different Methods of Translating* made a crucial distinction: the translator could either “bring the reader to the author” or “bring the author to the reader.” This binary anticipates later debates about foreignization versus domestication—key concepts in 20th-century translation theory [11].

The 20th century saw a proliferation of theoretical approaches to translation, influenced by developments in linguistics, philosophy, and literary theory. Early in the century, translation was often treated as a subset of comparative literature or applied linguistics. However, with the rise of structuralism, scholars began to treat language as a system of signs governed by internal rules. This shift laid the groundwork for more formalist approaches to translation. A pivotal figure during this time was Eugene Nida, whose work in Bible translation led to the formulation of the concepts of formal equivalence (word-for-word) and dynamic equivalence (meaning-for-meaning). Nida's *Toward a Science of Translating* (1964) sought to make translation systematic and scientific, bridging linguistics with anthropology and communication theory. His approach was particularly influential in missionary and international development contexts, where conveying intended meaning was prioritized over linguistic fidelity [10].

Meanwhile, in the Soviet Union, Roman Jakobson introduced semiotic distinctions in translation: intralingual (within the same language), interlingual (between languages), and intersemiotic (between sign systems). Jakobson's insights were critical in positioning translation as more than mere linguistic substitution—it was a semiotic and interpretive act.

By the 1980s and 1990s, the “cultural turn” in translation studies expanded the scope of the field beyond linguistic equivalence to encompass ideology, power, and representation. Influenced by poststructuralism, deconstruction, and feminist theory, translation

theorists began to question assumptions of neutrality and transparency. Lawrence Venuti emerged as a leading voice during this period. In *The Translator's Invisibility* (1995), Venuti critiqued the Anglo-American tradition of fluent translation that erased the foreignness of the original text. He championed foreignization as a strategy to resist cultural homogenization and make visible the act of translation itself. Venuti's emphasis on the ethics and politics of translation marked a significant departure from earlier models that focused primarily on fidelity or equivalence [12]. Simultaneously, Gideon Toury and Itamar Even-Zohar contributed to the development of Descriptive Translation Studies (DTS) and Polysystem Theory. Rather than prescribing ideal translations, DTS aimed to describe actual translation practices across time and cultures. Toury introduced the concept of translation norms, arguing that translation is governed by cultural and institutional expectations that vary historically and geographically. Susan Bassnett, André Lefevere, and others further explored how translations are embedded in systems of patronage, ideology, and cultural exchange. Their work highlighted that translation is not a passive or derivative activity but a form of cultural production that shapes literary canons and sociopolitical discourse [1].

In the 21st century, translation theory continues to evolve, responding to the challenges of globalization, digital communication, and social justice. The role of the translator is increasingly viewed as interventionist, with scholars emphasizing issues such as translator agency, postcolonial resistance, and gender representation. Postcolonial translation studies, led by figures like Tejaswini Niranjana, argue that colonial translation was complicit in the imposition of Western epistemologies. Translating non-Western texts into European languages often entailed cultural erasure and reinterpretation to fit imperial narratives. Thus, translation becomes a site of epistemic violence—but also resistance—when reclaimed by postcolonial authors and translators. In parallel, feminist theorists such as Luise von Flotow have examined how gendered language and patriarchal ideologies influence translation. They advocate for feminist translation strategies that foreground issues of voice, visibility, and authorship in translating texts written by and about women [3].

Technological advances have also transformed the field. With the rise of machine translation, computer-assisted translation (CAT) tools, and neural networks, the boundary between human and machine translators has blurred. While these tools increase efficiency, they also raise ethical and epistemological questions about creativity, responsibility, and the limits of artificial intelligence in interpreting meaning. Moreover, the globalization of literature and information flows has intensified debates around cultural appropriation, untranslatability, and the politics of access. Translation in the digital age is not only faster but also more visible, participatory, and contested, involving crowdsourced platforms, fan translations, and multilingual digital activism.

Conclusion

The translation practices of ancient civilizations laid the foundation for the theoretical and practical developments in later periods. From the bilingual tablets of Mesopotamia to the rhetorical choices of Roman scholars and the theological dilemmas of biblical translators, early translation was deeply embedded in the cultural, political, and religious structures of its time. Far from being a neutral or mechanical process, translation in antiquity was a powerful instrument of continuity, conversion, and cultural exchange. Understanding these early practices allows us to appreciate the historical depth and complexity of translation as both an intellectual and social activity.

In both the medieval and Renaissance periods, translation was central to the transmission of knowledge, belief systems, and cultural values across space and time. Whether through the preservation and adaptation of classical thought in the Islamic world, the revitalization of learning in medieval Europe, or the stylistic and ideological innovations of the Renaissance, translation functioned as a bridge between civilizations. It enabled the reinterpretation of ancient wisdom in new cultural and linguistic contexts, spurred theological and scientific debate, and contributed to the shaping of modern European identities. The legacy of these translation efforts is not merely historical; it continues to inform contemporary understandings of intercultural dialogue, intellectual heritage, and the power of language to shape human thought.

The rise of translation theory in the modern era reflects the growing recognition of translation as a complex, multifaceted, and deeply cultural activity. From early Enlightenment principles of clarity and faithfulness to Romantic conceptions of the translator as creator, and from structuralist models to poststructuralist critiques, translation theory has undergone numerous paradigm shifts. In the contemporary world, translation is situated at the crossroads of ethics, identity, and technology, making it a vital tool for negotiating meaning in an increasingly interconnected and multilingual world. As the field continues to expand across disciplines, translation theory not only helps us understand how texts travel across languages but also how cultures, ideologies, and power structures are reproduced and reimaged in the process.

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MYTHOPOETIC STRUCTURES AND THE SYMBOLISM OF URBAN SPACE IN KAZAKH LITERATURE

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Abstract

In literary discourse, the city is conceived not only as a topographical space but also as a semiotic system that represents the cultural, historical and mental codes of a given era. In the Kazakh literary tradition, the urban chronotope is often linked to a crisis of identity and the loss of cultural continuity, standing in contrast to archaic models of nomadic culture. A comparative analysis with global literary traditions makes it possible to identify specific modes of representing urban reality, shaped by chronotopes, mythopoetic motifs and symbolic codes.

Keywords: Chronotope, Kazakh Literature, Mythopoetics, Urban Symbolism, Comparative Literary.

In recent decades, the city has become an increasingly prominent subject of literary inquiry – not merely as a backdrop for action, but as a complex symbolic construct that reflects shifts in collective consciousness, cultural codes and identity. Approaches rooted in postclassical narratology, literary urban studies and mythopoetic criticism view the city as an artistic reality shaped by chronotopic structures, symbolic systems and cultural archetypes. The concept of the chronotope, introduced by Mikhail Bakhtin, provides a theoretical and methodological framework for examining the interplay of time and space within literary texts [1]. Within the urban context, the chronotope takes on particular resonance, as the city encapsulates a wide range of conflicting meanings – from the promise of civilizational progress to the experience of social alienation.

In Kazakh literature, which occupies a unique position at the crossroads of nomadic and sedentary civilizations, the theme of urbanization takes on particular significance. The city is often juxtaposed with the steppe, a traditional locus of cultural memory and ethnic identity and emerges as a space of rupture, transformation and the search for a new sense of self. Analyzing the representation of the city in the works of Kazakh writers reveals the nationally specific features of the urban chronotope, along with its symbolic and mythopoetic patterns. The transition from a nomadic paradigm to an industrial and urban model of existence is accompanied by a shift in values, where urban reality becomes a locus of internal conflict, existential crisis and the erosion of traditional reference points.

This article aims to explore the artistic strategies used to represent the city in Kazakh literature, in comparison with global literary traditions. The study is grounded in the principles of chronotopic analysis as formulated by Mikhail Bakhtin, and also draws on elements of the comparative-typological approach.

In the works of Kazakh authors from the late 20th to the early 21st century, the urban space is frequently marked by a sense of emptiness, spiritual disorientation, and cultural marginalization. In contrast, since the 19th century, Western European and Russian literatures have often portrayed the city as an autonomous cultural subject. St. Petersburg in the writings of N. Gogol and F. Dostoevsky, Dublin in the work of James Joyce and Berlin in Alfred Döblin's

prose are not merely settings, but richly layered chronotopes, where every element of the urban environment reflects the inner state of the character and the philosophical structure of the narrative. In this sense, the city chronotope in Kazakh literature takes on the features of a heterotopic space (in Michel Foucault's terms) [2], where multiple temporal and axiological layers intersect. This framework positions the Kazakh city as a space of identity transformation and the reassembly of cultural experience.

In literature, urban space is often subject to mythologization, undergoing a transformation from a geographical entity into a symbolic field imbued with archetypes, cultural codes and collective representations. A mythopoetic approach makes it possible to uncover hidden layers of meaning within the text, where the city functions as a mediator between the real and the sacred, the profane and the transcendent. The nature of myth, its relationship to folklore, as well as questions of semantics and poetics, have been extensively explored in the works of O. Freidenberg [3], A. Losev [4], F. Kessidi [5], Ya. Golosovker [6] and others. In mythological analysis, key analytical categories include mythological thinking, mythological time, and mythological space. As a mode of artistic engagement with reality, mythopoetics involves the use of archaic imagery, symbolic motifs and structures of the collective unconscious. Within this framework, the city is no longer perceived as a purely physical space; it becomes a stage for ancient narrative patterns – of trial, initiation, exile return.

In Kazakh literature, the urban myth is most often associated with the motifs of loss and search. The city appears as a hostile territory in which the familiar structures of clan-based life are eroded and traditional reference points lose their stability. Yet archetypal structures persist, albeit in transformed forms: the protagonist's journey through the city frequently resembles a rite of initiation, passing through stages of crisis, alienation and eventual rebirth within a new social reality. In the novels of Oralkhan Bokeev, urban imagery is often associated with coldness, mechanization and the loss of emotional warmth – resonating with the mythological image of the labyrinth, a symbol of entanglement, trial and inner transformation. Urban spaces in Oralkhan Bokeev's work lose their familiar clarity: streets, squares and

buildings are transformed into enclosed traps, symbolic mazes in which the protagonist must find a new path to the self.

In world literature, the mythopoetic perspective on the city is vividly represented in the novels of Franz Kafka ("The Trial", "The Castle"), where the urban environment functions as a faceless and hostile world, evoking the archetype of the hero's journey through a chaotic realm. In Orhan Pamuk's "Istanbul: Memories and the City" ("İstanbul: Hatıralar ve Şehir"), the mythopoetics of the urban space is shaped around the image of lost grandeur and the experience of cultural decadence – corresponding to the universal mythological narrative of decline and nostalgia for a "golden age".

A distinctive feature of the Kazakh variant of urban mythopoetics lies in the presence of dual memory embedded in the image of the city: on the one hand, the memory of the nomadic civilization with its principles of free movement and open spaces; on the other, the new urban reality characterized by rigid structures and socio-cultural hierarchies. This duality gives rise to a specific synthesis of archaic and modernist elements in the literary representation of the city. Analyzing this feature necessitates recourse to Claude Lévi-Strauss's semantic model, in which the concept of binary oppositions plays a central role – representing the fundamental contradictions of human consciousness, the resolution of which is one of the key functions of mythological thinking [7].

The mythopoetics of the city in Kazakh literature reveals a profound connection with national mentality, manifested in the acute perception of a cultural identity crisis and the attempt to interpret urban space through archetypal structures. This tendency is especially evident in the works of M. Magauin, D. Isabekov and R. Seisenbaev, where the image of the city is portrayed as a site of internal rupture between traditional (nomadic) and modern (urban) modes of consciousness. In the novellas of Dulat Isabekov, for instance, the urban environment often serves as a space of alienation, evoking existential anxiety and a longing for the lost harmony encoded in the mythopoetic image of the steppe.

The ideas of Sigmund Freud and Carl Gustav Jung, which had a significant impact on the development of Western myth criticism, gave rise to the archetypal school, within which myth is understood as an expression of the unconscious structures of the human psyche. According to the psychoanalytic approach, the origins of mythological thinking are rooted in pre-rational forms of world perception: for Freud, myth arises from repressed and tabooed complexes, whereas for Jung, it emerges from universal archetypes that constitute the "collective unconscious." Within this paradigm, the mythological interpretation of space – including urban space – is viewed as a projection of deep psychological patterns onto external reality.

In the context of Kazakh literature, this mode of interpretation brings archetypal images such as home, native land (Atameken), the sacred center and the boundary into focus – serving as symbolic lenses

through which the city is perceived as a new, unnatural and psychologically "other" space. As V. Khalizev notes, myth can be understood either as a form of "primitive thinking" or as an artistic expression of emotional and subconscious human responses to the phenomena of the surrounding world [8]. Within the Kazakh narrative tradition, this perspective allows urban mythopoetics to be interpreted as a form of internal dialogue between cultural memory and contemporary experience.

In Kazakh literature, the mythopoetic engagement with urban space gains particular relevance within the context of postcolonial and post-Soviet experience. The city is often portrayed as a "foreign" or "othered" world, generating existential anxiety and spiritual fragmentation. In a number of works, there is a discernible tendency toward the syncretic fusion of the urban chronotope with archaic myths and symbols – such as the image of the labyrinth, the motif of metaphysical wandering, and the figure of the sacred center. This poetic strategy allows the city to be "anchored" to a national mythologeme, despite its visual and cultural otherness.

Mukhtar Auezov's epic novel "The Path of Abai" (Abai Zholy) serves as a vivid example of how Kazakh literature explores urban space through the lens of mythopoetics. In this work, the city – particularly in the context of Abai's life – emerges as a complex and multilayered space where traditional values intersect with new social realities. As the novel's central figure, Abai experiences existential anxiety triggered by the profound transformations taking place in society. For him, the city becomes not only a place of residence but also a symbol of cultural confrontation. It represents an "alien" world in which traditional norms and customs begin to lose their authority. This gives rise to an inner conflict, as the protagonist struggles to preserve his identity amid the forces of rapid change.

In "The Path of Abai", one can trace the use of mythopoetic imagery. For example, the motif of metaphysical wandering reflects Abai's search not only for his place in society but also for a deeper understanding of the meaning of life. The labyrinth of urban existence symbolizes the complexity and confusion inherent in the interaction between the old and the new. The figure of the sacred center may be associated with Abai himself, portrayed as a spiritual leader and bearer of national culture, who seeks to find a balance between tradition and modernity.

Thus, the epic novel "The Path of Abai" illustrates a syncretic fusion of the urban chronotope with archaic myths and symbols. This allows the reader to perceive the city not merely as a physical space, but as a site of spiritual quest and cultural transformation. M. Auezov constructs a multilayered narrative that sheds light on the complex processes of identity formation within the context of urbanization and the postcolonial experience of the Kazakh people.

In world literature, the mythopoetics of the city has a much longer tradition – ranging from the myth of cursed Babylon, seen as a symbol of human hubris and divine punishment, to the modernist concept of the "lost paradise" in 20th-century urban dystopias. The

city may function both as a locus of divine revelation (Jerusalem) and as a space of sacred decay (Sodom and Gomorrah). These opposing archetypes are actively employed in literary texts, shaping stable symbolic models for interpreting the urban environment. From this perspective, the mythopoetic dimension of the city serves as a universal mechanism for literary engagement with urbanization. However, in Kazakh literature, it acquires an additional layer of significance – as a means of reconstructing national consciousness in a post-traditional era. The mythologization of the city becomes not only a vessel of cultural memory but also a tool for artistic adaptation to a new socio-cultural reality.

The symbolism of the city in literary texts functions as a distinct mode of modeling social and cultural reality. Urban elements such as streets, houses, squares, bridges and skyscrapers acquire semiotic significance that transcends their literal description. Through these symbols, authors convey the inner states of their characters, as well as the social processes and cultural conflicts of their time.

In Kazakh literature, the symbolism of the city reflects the tension between traditional ways of life and the challenges of modernization. The image of the city is often imbued with ambivalent connotations: it may be perceived as a space of opportunity, social mobility and progress, yet at the same time as a site of alienation, loneliness and spiritual emptiness. For instance, in the works of M. Makatayev and A. Nurpeisov, the city symbolizes not only the alluring mirage of a new lifestyle, but also the risk of losing national distinctiveness.

Certain elements of urban symbolism in Kazakh literature are directly linked to traditional conceptions of space. For instance, the street is often perceived as an analogue of the steppe road – a path leading to self-discovery; however, within the urban context, this path becomes convoluted and anxiety-ridden. The house, traditionally associated with clan-based values and familial continuity, is transformed in the city into an impersonal architectural structure, devoid of its former sacred significance.

Similar symbolic models can be found in world literature, particularly in the works of G. Flaubert, J. Joyce and A. Camus, where the city is depicted as a metaphor for existential isolation, the struggle for identity and the search for meaning in a fragmented world. In “Ulysses” by James Joyce, for example, Dublin functions not only as a geographical setting but also as a mental labyrinth that mirrors the contradictions of modernity.

Unlike European traditions, the symbolism of the city in Kazakh literature maintains a closer connection to collective memory and the sacred perception of space. Even amid urbanization, the Kazakh cultural model strives to preserve value orientations rooted in the traditions of nomadic civilization: reverence for nature, the importance of kinship and the symbolic richness of the road as a metaphor for destiny. In this context, urban symbolism becomes a vital tool for representing the transitional state of culture – a kind of

code that encodes both the fears and the hopes of society during a time of change.

The symbolic dimension of the urban environment in literature is an integral component of the artistic world of the text. The city, as a symbolic construct, encodes multiple layers of meaning related to human existence, social dynamics and metaphysical quest. In this context, each element of the urban landscape – street, square, bridge, tower, underground space – becomes a semiotic carrier of specific cultural, philosophical, or mythological significance.

In Kazakh literature, the symbolism of the city often reflects the traumatic experience of modernization and urbanization, accompanied by the loss of traditional values. Urban landscapes are portrayed as chaotic spaces, devoid of harmony and internal logic, where familiar social ties and norms are dismantled. The image of the city is frequently associated with fragmentation, spiritual emptiness and the loss of both personal and collective identity. Notably, in the works of Kazakh writers, cities are often not given detailed or specific characteristics; instead, they appear as generalized, depersonalized spaces symbolizing broader processes of cultural erosion and social atomization.

In world literature, the symbolism of the city exhibits greater variability. The city may represent both the dynamics of progress and freedom – as seen, for example, in 20th-century American literature – and experiences of alienation and spiritual catastrophe. Urban architectural forms become metaphors for the inner states of characters: the bridge as a symbol of transition, the underground as a space of subconscious fear.

In both cultural contexts – Kazakh and global – the symbolism of the city serves as a means of interpreting the anthropological crisis of modernity. However, in Kazakh literature, this symbolism is closely intertwined with themes of national identity, memory of the nomadic civilization and attempts to synthesize traditional and modern worldviews.

Thus, the symbolism of the city in literary texts serves not only as a means of organizing spatial narrative structures, but also as a tool for the deeper interpretation of cultural, historical and existential processes that shape the fate of both the individual and society.

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ISSUES OF TEACHING AZERBAIJAN MORPHOLOGY

Hasanova S.*Doctor of philological sciences, professor**Nakhchivan State University**Nakhchivan Teachers' Institute**Nakhchivan, Azerbaijan**UOT 81:37.016**<https://orcid.org/0009-0002-9996-6229>*DOI: [10.5281/zenodo.15427661](https://doi.org/10.5281/zenodo.15427661)**Abstract**

Fresh Currently, national education in Azerbaijan is in a stage of development that is in line with human values and gives importance to these values. The rise of our language to such a stage requires great attention and responsibility from scientists and educators. There are a number of problems in curricula and textbooks that cause concern. It is the duty and responsibility of each of us to be very careful in modern science and education. Problems in the fields of science should also be approached from this perspective, and shortcomings in this aspect should be eliminated. The article highlights the problems related to the teaching of the morphology of the Azerbaijani language.

Keywords: science, language, teaching, problem, method.

INTRODUCTION

Teaching sciences justifies their deeper and more detailed study. From this point of view, teaching the Azerbaijani language is an interesting and relevant process. In teaching the Azerbaijani language, practical language materials should be followed more closely, and their problematic aspects should be revealed. In this sense, the issues of teaching morphology attract attention. Although the concepts of parts of speech, and morphological concepts in general, have been studied and analyzed to some extent in Azerbaijani linguistics, it is necessary to conduct a number of studies related to that area of grammar. Thus, researchers who deal with grammar have mainly focused on theoretical issues. However, problematic issues arise more often during teaching. In this sense, teaching the morphology of the Azerbaijani language is one of the interesting and relevant topics.

METHOD. The study used the linguistic analysis method to analyze some morphological facts in the study of the modern Azerbaijani language, the descriptive method to present linguistic facts, and the comparative method to analyze theoretical ideas on the topic.

DISCUSSION

Teaching grammar is one of the important, interesting and necessary issues of the pedagogical process. Since, on the one hand, it ensures the high development of grammatical thinking skills, on the other hand, it allows our speech to adapt to the norms of the literary language and strengthen these norms. "A person who is unable to correctly case a word and correctly change the verb according to tense, undoubtedly cannot acquire normal language habits, since he cannot even observe ordinary grammatical norms in his speech" (Baliyev (2003), p. 275).

A number of problems are revealed in the grammar of the Azerbaijani language, which should be clarified in the teaching process. There are some issues that need to be identified in the teaching of morphological topics, which should be given special attention in the pedagogical process. It is known that the alphabet of parts of speech begins with a noun. Therefore, initially,

the solution of problematic issues should begin with its teaching. "...If nouns, or rather, objective beings, phenomena, ideas about being, and the imaginary concepts they express, did not exist, there would be no qualities, signs, quantities and actions inherent in them. Therefore, the teaching of nouns takes the first place in teaching parts of speech, and in grammar lessons, the teaching of parts of speech begins with a noun" (Jafarov (1962), p. 6).

One of the points that causes confusion in the teaching of nouns is related to their case category. A number of ideas have been put forward regarding the case category in our historical and contemporary grammar. Finally, it was accepted that there are six cases in nouns, and it was shown that two of them have two forms (definite and indefinite).

It is known that a large group of words in the language - except for verbs, the remaining main parts of speech adopt the morphological features of a number of categories (case, belonging, quantity, information), that is, become nouns. In this sense, one of the main parts of speech that attracts attention is the adverb. It is known that not all adverbs, for example, adverbs of quantity and manner, are cased. However, adverbs of time and place are cased. For example:

Don't put off today's work until tomorrow.

Strange sounds are coming from below.

There is darkness ahead, etc.

When adverbs of time accept the case markers of the noun, the feature of uncertainty also manifests itself in the case of direction:

Fidan entered, etc.

The above-mentioned facts show that the noun has not only possessive and active cases, but also two types of direction cases (definite and indefinite). During the teaching of morphology in higher education institutions, drawing students' attention to the aforementioned issues contributes to the development of science, increases interest in it, and also provides students with relevant, original, and research-worthy topics for their scientific work.

Experience shows that one of the issues that creates confusion in the teaching process is the failure to distinguish between nouns denoting place and adverbs of place. As a result, nouns are sometimes attributed to adverbs of place. "In academic grammar, there are more unscientific facts about nouns that are attributed to adverbs of place, and all this seriously harms the teaching process" (Aliyev(2006), p.19).

It is even more regrettable that ideas that do not fit into scientific logic are put forward about adverbs. For example, how can one accept the idea that adverbs denoting place are considered nouns: "Words such as forward, backward, right, left, down, and outside are nouns denoting direction that are not reflected in grammar books" (Aliyev (2006), p. 19). This raises the following question: If the language units in question are nouns, what are adverbs of place? Maybe there is no adverb of place at all in our language? In our opinion, the reason for this confusion is the inability to distinguish between nouns denoting place and adverbs.

In some scientific literature, we come across facts of mixing nouns and adverbs (Huseynzadeh (2004), p. 145). They claim that an adverb becomes a noun when it accepts the case of the noun. However, these ideas cannot be justified. If we approach them from a logical point of view, these considerations have no scientific basis. Regardless of whether the noun accepts the morphological sign of the case category or not, adverbs of place are always adverbs and they should be taught as adverbs. That is, they carry the concept of an adverb both when accepting the directional suffix and without that case suffix.

Thus, it is worth talking about the case of indefinite directionality. We cannot ignore the ambiguity that manifests itself both in the adverb of place and in the interrogative pronoun "where?". Because in language, not only facts related to several parts of speech, but even signs are of great importance and meaning. From this point of view, every fact in the language has its essence and is worthy of scientific and theoretical ideas.

Studies show that the adverb has been in the center of attention of scientific and theoretical thought at different times (and now) as one of the linguistic units that causes controversial points among the main parts of speech. Especially when it comes to adverbial suffixes, it has caused more controversy: "Although the suffixes in adverbs resemble case suffixes, it is not correct to consider them as true case suffixes. They must be suffixes of a different nature" (Jafarov S. (1962), p. 33). It is difficult to agree with this opinion. Because a number of adverbs can be cased, and this is one of the natural processes in the language. However, one thing we can agree on regarding the suffix -da is that it is not always used as a case suffix, but also serves to form adverbs.

By the way, we should note that currently the concept of uncertainty in the Azerbaijani language has expanded significantly and can now be spoken of as a category. This issue, which manifests itself in grammar – both in morphology (indefinite possessive case, indefinite active case, indefinite directional case, indefinite quantifiers, indefinite pronouns) and syntax (indefinite person sentences, etc.), has already become a category.

There are also problems that attract attention in the teaching of adjectives. One of them is the degrees of the adjective. In linguistic literature, the degree sign is noted as the main feature that distinguishes adjectives from other parts of speech, and its relevance is shown only in relation to adjectives. However, modern linguistic facts show that the morphological features of the degree are also used in other parts of speech. Therefore, the concept of degree cannot be limited to adjectives alone, its scope is wider, and there is a need to accept the degree as a category and include it in the list of grammatical categories, which is also confirmed by the facts in the language.

One of the morphological features that form adjectives is the suffix -k⁴, which is written in four ways. According to scientific literature, this suffix creates adjectives from adverbs of time. However, the parts of speech to which this suffix is attached cannot be limited to adverbs.

Unfortunately, in some scientific-methodological literature there are also unscientific opinions about the suffix in question. Thus, it is also attached to adjectives and demonstrative pronouns. Thus, it is claimed that this suffix has three variants (Aliyev (2006), p. 39). The suffix -ki does not have three variants (there are no three-variant, i.e. three-way suffixes in the Azerbaijani language, suffixes are divided into three types according to their spelling:

1. Suffixes written in one way.
2. Suffixes written in two ways.
3. Suffixes written in four ways).

It is known that suffixes express different meanings (name, attribute) from a semantic point of view. It both expresses possession and belonging by joining nouns and pronouns, and it also creates adjectives by joining various parts of speech, mainly adverbs of time, and in both cases it is written in four ways.

In addition, we encounter a number of other unscientific ideas, which, if we rely on them, will not lead to the correct result in the teaching process. For example, such an idea attracts attention that "...it is illogical to claim that a case suffix is attached to a word twice" (Aliyev (2006), p. 39). However, although this "does not fit into logic", it is consistent with linguistic facts. We must not forget that there are exceptions in language and that every fact is important. Let us not forget that "...a linguistic fact is more reliable than any historical document" (Guliyeva, Hajiyevev (2006), p. 160). Yes, a noun can be in one case and a verb in the same tense. However, linguistic facts show that two case suffixes can be used in one word. This happens when a lexical suffix is necessarily present between two case suffixes. That is, two case suffixes cannot be used together, they can be used in separate places in the word. For example:

I bought my book, I forgot to buy yours.

Here, the word yours has two case suffixes:

1. Possessive case (-in).
2. Active case (-i).

If these are not case category suffixes, then what are they? If a case suffix is followed by a lexical suffix, this does not mean that they should be taken in the same

composition. Therefore, a grammatical sign and a lexical sign should not be considered the same suffix.

By the way, when teaching case suffixes, and suffixes in general, it is necessary to pay attention to whether they are stressed or not (Stress is one of the difficult topics in linguistics, and its teaching cannot be limited to phonetics alone). It is known that in all literature on stress, ideas have been formed and have already been fixed that case suffixes of nouns accept stress. However, there are also points where case suffixes do not accept stress. For example, if the case suffix is preceded by a lexical suffix -gil, which is written in a certain way, then the case suffix cannot accept stress. Because the suffix -gil itself does not accept stress, and does not leave the stress to the suffixes that follow it. As you can see, there are many confusing issues in the language (which even confuse experts), and when discussing them in the teaching process, one should be based on facts and try to draw the correct conclusion from these facts.

Teaching numbers is also an interesting pedagogical process. Linguistic literature shows that numbers do not participate in word formation, in fact, they participate, but are not active. Numbers are not formed from other parts of speech, they are formed by themselves. However, a number of parts of speech are formed from numbers (for example, nouns (union), adjectives (thirty), verbs (to unite), etc.). It is known that ordinal numbers are formed with the suffix -inci, -inci, -unci, -unci. This suffix is also added to the interrogative pronoun "how many?"

The Azerbaijani language plays an important role in all public events of the independent Republic of Azerbaijan. Using this language, it is possible to make speeches from high podiums and exchange ideas with listeners. Currently, the state pays great attention to the development of the Azerbaijani language in our country, and many official documents are signed in this area. "The first decade of the 21st century is characterized as a period of radical changes in the Azerbaijani education system. It can be said without exaggeration that a new era begins in this process for teaching the native language" (Nabiyeva (2010), p. 7). The Azerbaijani language has a communicative purpose. From this point of view, its teaching should always be kept in mind.

By the way, when teaching case suffixes, and suffixes in general, it is necessary to pay attention to their stress (Stress is one of the difficult topics in linguistics, and its teaching cannot be limited to phonetics alone). It is known that in all literature on stress, ideas have been formed and have already been established that case suffixes of nouns accept stress. However, there are also points where case suffixes do not accept stress. For example, if the case suffix is preceded by a lexical suffix -gil, written in a certain order, the case suffix cannot accept stress. Because the suffix -gil itself does not accept stress, it does not leave the stress to the suffixes that follow it. As you can see, there are many issues in the language that cause confusion (even confuse experts), and when discussing them in the teaching process, it is necessary to try to draw the correct conclusions from these facts, based on facts.

Teaching numbers is also an interesting pedagogical process. Linguistic literature shows that numbers do not participate in word formation, in fact, they participate, but are not active. Numbers are mainly formed from the numbers themselves, not from other parts of speech. However, a number of parts of speech (some nouns, adjectives and verbs) are formed from numbers. It is known that ordinal numbers are formed with the suffixes -inchi, -inchi, -unci, -unci. This suffix is also added to the interrogative pronoun "neçe?" and forms a new word. It is necessary to touch upon such subtle issues during teaching.

The pronoun has a unique role and position as a controversial, comprehensive lexical-grammatical unit among the main parts of speech. The lack of a specific object has formed hesitant ideas about the pronoun in linguistics. The expressions "empty word", "mysterious word" have arisen regarding the pronoun, and in some cases it has been considered an auxiliary part of speech. Interestingly, confused ideas about the pronoun still persist, and scientific and theoretical ideas on the subject in linguistic literature do not coincide. In modern grammar books, especially in secondary school textbooks, it is possible to find a large number of confusing considerations on the subject of the pronoun. This also affects the teaching process.

The pronoun is a part of speech with great functions in the language and has many syntactic tasks. Its responsible and careful teaching helps to solve a number of morphological and syntactic issues. Since the pronoun replaces all the main parts of speech, its teaching allows for the expansion and deepening of knowledge about various parts of speech. "The pronouns of the Azerbaijani language can play a certain role in clarifying many issues in linguistics" (Nabiyeva (2010), p. 121). Since the pronoun can be used in place of all members of the sentence, its syntactic significance is also great. In modern linguistic literature, the pronoun is also evaluated as a factor that forms the text. "The pronoun, which becomes actual from independent parts of speech, plays an important role in the creation of relevant texts" (Abdullayev (1998), p. 129).

When teaching pronouns, attention should be paid primarily to the following issues:

1. The multiple functions of pronouns;
2. The lack of a specific subject compared to other main parts of speech;
3. The fact that pronouns are functional grammatical units in our language;
4. The fact that the pronoun answers the question of the part of speech in which it is used, etc.

The facts obtained as a result of experience show that pronouns are more conservative compared to other main parts of speech and have their own unique characteristics. One of the Azerbaijani grammarians, H. Mirzazadeh, also confirms this idea: "The pronouns existing in the Azerbaijani language have not undergone any serious changes during their development, and have remained stable in terms of meaning and function" (Abdullayev (1998), p. 104). Indeed, when comparing both historical and contemporary linguistic facts, it becomes clear that the changes related to pronouns have occurred in a formal (external) sense, and they have not

been subject to changes in terms of content (internal). Formal changes are phonetic changes. Considering the importance of a masculine sign in a language, it is necessary to take phonetic facts seriously during teaching. In this sense, it is also necessary to pay attention to its sound structure when teaching pronouns. Thus, the sound structure of pronouns used in our language, on the one hand, serves to determine the phonetic aspects reflecting the development of the period to which they belong, and on the other hand, it helps to teach grammatical units perfectly. From this we can conclude that treating the sound aspect of any morphological unit as a mere external form during teaching prevents its correct teaching as a whole.

In teaching grammar, the issue of the pronoun playing a very important role in speech should not be forgotten. Because in the speech process, the meaning of the pronoun in texts on various topics significantly affects the coherence of sentences and texts: "The meaning of the pronoun is often revealed by the content of the sentence preceding it. The fact that one of the sentences in the text begins with a pronoun is a fact that proves that it is more closely related to the sentences preceding it" (Abdullayev (1998), p. 132).

In teaching pronouns as a morphological unit, it is necessary to pay special attention to the fact that they are not subject to external interference and retain their nationality. The description and internal features of the pronoun, which is an ancient and national part of speech, are facts that show the strength of the genetic connection of Turkic languages. The pronoun is a language unit that has an important position in Turkic languages, including the Azerbaijani language, with its semantic, grammatical, and stylistic features. In this regard, there are wide opportunities for its high-quality teaching. Teaching pronouns in connection with specific language facts leads to useful results. On the one hand, this ensures the comprehensive mastery of the pronoun, and on the other hand, it justifies the formation of connections with other parts of speech.

Various methods can be used in teaching personal pronouns. Special attention should be paid to the first person pronouns (me, we) in the singular and plural. The difference that arises when these pronouns are used with case suffixes of nouns can be evaluated as one of their special features.

Teaching grammar is such an interesting and responsible process that the information provided on any issue must be confirmed by factual materials. Only then can we talk about the quality of teaching. If an opinion has ever been expressed or written about any linguistic fact, it would not be right to accept it as a standard. The most correct and accurate opinion about the language is the facts. In this regard, it is possible to find the necessary amount of material in the "Azerbaijani language" textbooks.

One of the issues that attracts attention in teaching pronouns is the consideration of local and dialectal features. Thus, depending on the regions, sometimes the pronouns "elə", "belə" are pronounced as "bəylə", "öylə" and this also affects the writing process. Since demonstrative pronouns are very functional lexical-

grammatical units for our grammar, special attention should be paid to them in the teaching process.

The Azerbaijani language has already entered a new stage of development, gaining unique qualities and enriching itself in terms of literary language norms. It is known that, in accordance with the development characteristics of society, processes of enrichment and change also occur in the language. In the Middle Ages, a number of common Turkic words entered the lexical-grammatical norms of our language, strengthened and gained an active position, and over time, these words became "Azerbaijanized" in terms of phonetics. However, at the beginning of the 20th century, in connection with the spread of Turkic ideas, the idea of a "common Turkic language" was formed, and the Azerbaijani language was based on the norms of the Turkish language for a while. Demonstrative pronouns are one of the lexical-grammatical examples that confirm this fact among the main parts of speech - the fact that the morphological norms of the Azerbaijani language gave way to the norms of the Turkish language. That is, although some pronouns were subject to archaism until that period, they were reactivated at the beginning of the 20th century and were selected for their frequency of use in our literary language for a while. This idea can be said about the pronouns "öylə", "böylə". Although these pronouns remained as a fact of speech after the second half of the 20th century, they have become completely archaic for the literary language. However, this obsolescence is not limited to the phonetic norm. The pronouns "öylə", "böylə" have given way to the pronouns "elə", "belə" with the same content and have disappeared from our writing. These pronouns remain as a fact of the norm in modern Turkish, while biism lives in our language only as an example of dialect and accent. Therefore, it is necessary to approach this issue sensitively in the teaching of grammar, especially pronouns.

The issues related to interrogative pronouns, which are one of the linguistic facts that attract attention in the teaching of pronouns, are also interesting. The number of pronouns in our language, as is known, is not limited. Because each part of speech has at least three (more in adverbs) questions, and pronouns used in place of these parts of speech acquire numerous stylistic moments. In the Azerbaijani language, there are wide opportunities for pronouns to be used frequently and in various positions. When teaching interrogative pronouns, some question words, for example, the pronoun "hachan?", should be taken into account. This pronoun is currently used less in our literary language than the interrogative pronoun "ne zaman?". However, until the second half of the 20th century, the interrogative pronoun "hachan?" was more active. Since this pronoun is a literary linguistic fact and occupies a certain place in the texts in textbooks, it cannot be left out of teaching.

In the process of teaching pronouns, one should not forget about the types of structures. The importance of this issue is, on the one hand, the lack of a clear idea about the structure of the pronoun. According to the greatest scholar of Azerbaijani morphology, Mukhtar

Huseynzade, the pronoun has two types of structure (10, 123):

1. Simple pronouns
2. Compound pronouns

Thus, experience and research on the teaching process show that when teaching pronouns, it is necessary to pay attention to the following issues:

1. It is necessary to refer to materials related to pronouns in "Azerbaijani language" textbooks and confirm and reinforce theoretical information with specific language facts. Because if any idea about the language is not proven, it loses its scientific significance. In this regard, it is important to confirm theoretical linguistic ideas with actual materials.

2. When teaching grammatical topics, especially pronouns, attention should be paid to the extent to which they are used in the language. Because pronouns are interesting and rich lexical-grammatical units that confirm the national essence of the Azerbaijani language. In addition, pronouns are among the most frequently used words in our language.

3. During teaching, the issue of which part of speech pronouns are used should not be ignored. In this sense, pronouns should be divided into different groups and taught.

4. When teaching pronouns of the Azerbaijani language, dialect facts related to the topic should also be taken into account.

Experience shows that taking the above into account when teaching pronouns has a positive impact on the quality of the lesson and the ability of learners to absorb information.

It is also necessary to be careful when teaching the pronoun "some". Because this pronoun is a somewhat controversial pronoun. Although it is given among indefinite pronouns in a number of linguistic literatures, these ideas cannot be considered logically correct. In all secondary and higher school grammars, it is indicated that indefinite pronouns are used instead of nouns. Since the pronoun "some" does not have such a position, it cannot be attributed to indefinite pronouns; if it is considered an indefinite pronoun, then the definition given to these pronouns should be changed. In fact, the pronoun "some" has an explanatory feature. From this point of view, it should be included in definite pronouns. However, it should not be forgotten that an indefinite pronoun is also formed on the basis of this pronoun. This happens when it accepts plural and possessive suffixes. It is necessary to take into account the difference in meaning between these words. Thus, the pronoun "some" usually has a determinative feature, and when it accepts plural and possessive suffixes, it has an indefinite feature.

During teaching, one can also encounter confusing moments related to verbs. This especially applies to the infinitive form of the verb. In the Azerbaijani language, there are words with the same composition that are used as both nouns and infinitives. Therefore, they are sometimes confused with nouns.

The confusion of the infinitive with the noun is due to the fact that both of them denote the name. The infinitive denotes the name of the action, and the noun

denotes the name of concrete entities and abstract concepts. Therefore, according to its grammatical meaning, naming is a property that belongs not only to nouns, but also to the infinitive. In fact, the infinitive is a "timeless verb".

Due to its naming property (the name of the action), the infinitive has a common property with the noun and, although it is formed from the verb, it answers the questions of the noun. Therefore, the infinitive cannot bear all the properties of the verb and the noun. It cannot bear the properties of the time category, which is the most basic and important category of the verb, that is, in this respect it is far from the verb. The infinitive cannot take all personal suffixes like a noun (the infinitive only takes the third person ending), does not take plural endings, and cannot be used as a determiner in a sentence.

In this regard, teaching the infinitive requires special attention. Proper linguistic analysis of words that are used as both nouns and infinitives can eliminate the difficulty.

In teaching the Azerbaijani language, practical language materials should be monitored more, their problematic aspects should be revealed. In this sense, the issues of teaching parts of speech attract attention. Although the concepts of parts of speech, and morphological concepts in general, have been studied and analyzed to some extent in Azerbaijani linguistics, it is necessary to conduct a number of studies related to that area of grammar. Thus, researchers who discuss grammar have mainly focused on theoretical issues, while practical work can identify problems more quickly. "Most of the difficulties in the teaching process are related to problems in textbooks. The content of textbooks written long ago sometimes does not meet the requirements of the modern era, and it is sometimes difficult to find sufficient material in them to solve problematic issues. Therefore, there is a need to rework the morphology of the Azerbaijani language by preserving the valuable scientific-theoretical ideas of the past and adding innovations based on factual materials related to the development of science" (Hasanova (2017). p. 16)

CONCLUSION

Experience and research show that in any science, problematic issues arise more often in the teaching process. As in various fields of Azerbaijani linguistics, there are a number of problematic issues in the morphology section, which complicate the teaching of the subject during teaching. Therefore, problems should be taken into account in the explanation of any topic related to the subject and solved in the teaching process. In language issues, the idea of "it's like this in the book" is not the main thing, only the language facts themselves are the main thing. Different linguists can approach these facts from different perspectives and put forward correct and interesting ideas. These ideas generally play a big role in theory. However, language facts are more interesting and convincing not only with their external signs, but also with their levels and shades of meaning. Sometimes a word enters a group as a part of speech, that is, it carries the characteristics of a certain part of speech and is called by its own name. However, when used - within a sentence, different characteristics

arise from that part of speech. This applies more to the adjective-adverb and number-adverb zones.

The Azerbaijani language stands out among the Turkic languages and the world languages in general for its richness and tendency to metaphor, which manifests itself in both theoretical and practical issues. We cannot deny the presence of words in this language that are used as several parts of speech. This is actually one of the qualitative features of the Azerbaijani language. However, such words (in fact, different opinions about words) cause a number of confusions in the teaching process. Such words can be found both among the main and auxiliary parts of speech. Therefore, it is necessary to pay special attention to them in the teaching process and use more optimal teaching options. In this regard, comparisons are of great importance.

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PHYSICS

РОЗРАХУНОК ПРОЦЕСУ РОЗШИРЕННЯ ПОТОКУ РОБОЧОГО ТІЛА В СОПЛІ РІДКОФАЗНОГО ЯДЕРНОГО РАКЕТНОГО ДВИГУНА

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CALCULATION OF THE EXPANSION PROCESS OF THE FLOW OF WORKING BODY IN THE NOZZLE OF A LIQUID-PHASE NUCLEAR ROCKET ENGINE

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Анотація

У роботі проведено розрахунок параметрів потоку робочого тіла (водню) у вхідному, критичному та вихідному перерізах сопла рідкофазного ядерного ракетного двигуна. Запропоновано метод розрахунку питомого імпульсу тяги рідкофазного ядерного ракетного двигуна з врахуванням втрат на розсіювання, тертя та зміну питомої ентальпії робочого тіла внаслідок неадіабатності. Розраховане значення питомого імпульсу тяги рідкофазного ядерного ракетного двигуна є більшим 9500 м/с, що значно перевищує характеристики хімічних ракетних двигунів. Оцінка розрахованих термогазодинамічних параметрів розширення робочого тіла підтвердила високу ефективність рідкофазного ядерного ракетного двигуна та можливість його застосування в космічних місіях.

Abstract

In this work, flow parameters of the working body (hydrogen) were calculated at the inlet, throat, and exit sections of the liquid-phase nuclear rocket engine nozzle. A method was proposed for determining the specific impulse of thrust while accounting for losses due to scattering, friction, and variations in the specific enthalpy of the working body caused by non-adiabatic effects. The calculated specific impulse exceeded 9500 m/s, significantly surpassing the performance of chemical rocket engines. The evaluation of the thermogasdynamic parameters of the working body expansion confirmed the high efficiency of the liquid-phase nuclear rocket engine and its feasibility for space missions.

Ключові слова: ядерний ракетний двигун, сопло, ізоентропійне розширення, питомий імпульс тяги, питома ентальпія робочого тіла, математичне моделювання.

Keywords: nuclear rocket engine, nozzle, isentropic expansion, thrust specific impulse, specific enthalpy of the working body, mathematical modeling.

Постановка проблеми в загальному вигляді. Становлення і розвиток космічної галузі на сьогодні є ключовим чинником розвитку науки, технологій, економіки та міжнародного співробітництва. Дослідження космосу сприяють створенню нових функціональних матеріалів, інновацій у сфері енергетики та транспорту, а також розширенню знань про Всесвіт та, відповідно, формуванню сучасної наукової картини світу. На даний час єдиним засобом виведення корисного навантаження на навколоземну орбіту залишаються ракети з рідинними або твердопаливними двигунами. Однак хімічні ракетні двигуни, які забезпечують ці польоти, вже наблизилися до свого теоретичного максимуму ефективності [1]. Одним із перспективних рішень для розширення можливостей дослідження

космосу є застосування ядерних ракетних двигунів, які здатні забезпечити порівняну з хімічними ракетними двигунами тягу, але з набагато вищим питомим імпульсом [2, 3].

Теоретичні й експериментальні дослідження, спрямовані на покращення робочих характеристик ядерних ракетних двигунів є складним і великим за обсягом науково-технічним напрямком. Відповідно, в даній роботі ставилася задача провести розрахунки параметрів потоку робочого тіла в соплі ядерного ракетного двигуна малої тяги, призначеного для використання як розгінного двигуна космічних зондів. Застосування такого двигуна може суттєво скоротити час польоту зонду до визначеного пункту, а в перспективі модернізований варіант такого ядерного ракетного двигуна

може бути використаний для створення пілотованого космічного корабля для польотів на великі відстані в межах Сонячної системи.

Аналіз останніх досліджень і публікацій. У науково-технічній літературі існує ряд робіт, присвячених дослідженню та покращенню характеристик ядерних ракетних двигунів. Зокрема, у проєкті “Space Nuclear Propulsion for Human Mars Exploration” [4] окреслено основні технічні й програмні складнощі та ризики, що можуть виникнути під час розробки космічного ядерного двигуна. Представлено ключові етапи й дорожня карта розробки та демонстрації ефективних ядерних теплових і ядерних електричних силових установок, а також визначено завдання, що можуть бути реалізовані завдяки успішному розвитку зазначених технологій. У роботі [5] під час розрахунку параметрів сопла хімічного ракетного двигуна, його форми, ізоляції та механізму охолодження було доведено доцільність врахування температури, тиску і швидкості потоку газу в кожній секції сопла під час виконання зазначеного розрахунку. Автором роботи [6] розроблено конструкцію сопла твердопаливного ракетного двигуна та в подальшому заплановано експериментальну перевірку теоретичних передбачень. У роботі [7] розглянуто дві основні конфігурації сопла твердопаливного ракетного двигуна: контурну і конічну. Описано переваги і недоліки сопел зазначеної конфігурації. Також відзначено, що розробка параметрів сопла ракетного двигуна є складним, мультидисциплінарним процесом.

Таким чином, з огляду науково-технічної літератури можна зробити висновок про те, що процес розширення потоку газу в соплі ядерного ракетного двигуна недостатньо вивчений і потребує подальших теоретичних і експериментальних досліджень.

Мета статті. Враховуючи вищезазначене, мета статті полягає у розрахунку параметрів потоку робочого тіла під час розширення в соплі рідкофазного ядерного ракетного двигуна.

Виклад основного матеріалу дослідження. Ядерний ракетний двигун – це підвид теплового ракетного двигуна, в якому камерою нагріву робочого тіла є ядерний реактор. Рідке робоче тіло з баків літального апарату подається за допомогою відцентрового насоса спочатку в систему охолодження двигуна, а потім у ядерний реактор, де нагрівається до температури 2500-3500 К. Розігріте робоче тіло витікає через сопло, створюючи тягу.

Ядерний ракетний двигун має ряд переваг у порівнянні з хімічним ракетним двигуном, а саме:

- можливість використовувати як робоче тіло низькомолекулярні гази (водень), що дозволяє досягти значень питомого імпульсу у 2-3,5 рази вищих, ніж у хімічних ракетних двигунах;
- відсутність поділу палива на пальне та окисник, що спрощує конструкцію паливних баків і знижує масу ракети;
- теоретично вища надійність у порівнянні з хімічними ракетними двигунами, оскільки робоче тіло не зазнає хімічних перетворень;

- можливість використовувати як паливо практично будь-які легкі гази (хоча водень забезпечує найбільший питомий імпульс, застосування інших газів також допускається), що надає ядерному ракетному двигуну значну перевагу перед хімічним у контексті вибору двигуна для міжпланетних апаратів, які повертаються на Землю.

Ядерний ракетний двигун складається з системи подачі робочого тіла, ядерного реактора, сопла.

Система подачі палива включає відцентровий насос для подачі рідкого водню та турбіну, що приводить його в дію. Спочатку рідкий водень подається в кожух охолодження сопла, де випаровується та надходить у кожух охолодження керувальних барабанів ядерного реактора. Далі водень розділяється на кілька потоків, проходячи через канали охолодження сповільнювача нейтронів та технологічних каналів, де його температура підвищується до 700-1100 К. Після цього водень спрямовується на турбіну, де виконує механічну роботу, і потрапляє у технологічні канали реактора. Нагрітий до 3100-3300 К водень витікає через сопло, створюючи тягу.

Ядерний реактор містить сповільнювач нейтронів, оточений керувальними барабанами. Барабани мають дві сторони: одна виготовлена з матеріалу, що поглинає нейтрони (карбід бору), а інша – з матеріалу, який є хорошим відбивачем нейтронів (берилій). Управління реактивністю реактора здійснюється шляхом обертання барабанів. У поперечному перерізі сповільнювач умовно поділений на квадратні осередки. Кожний осередок містить один технологічний канал, оточений сповільнювачем. Чим більше осередків, тим менша частка сповільнювача, однак для досягнення критичності такий реактор матиме більшу масу порівняно з реактором, що містить менше осередків.

Технологічний канал – це труба з подвійними стінками, між якими циркулює потік водню, що виконує функцію охолоджувача. У середині каналу розташований пучок з 37 тепловиділяючих елементів (ТВЕЛів). ТВЕЛ – це герметичний циліндр із хвилястими краями, заповнений рідким ядерним паливом. Зовнішній середній радіус ТВЕЛа – 5,65 мм; товщина стінки – 0,5 мм; хвилястість країв використовується для зменшення теплового навантаження, частота хвиль – 12, амплітуда – 1,8 мм. ТВЕЛі закріплені з кожного боку реактора, дистанційні решітки відсутні. Кожен ТВЕЛ має компенсатор тиску, який забезпечує подачу гелію для підтримки внутрішнього тиску близького до тиску потоку газу, що омиває паливні елементи. Відношення висоти до діаметра ядерного реактора вибрано рівним 1,6. Це зумовлено необхідністю збільшити час перебування водню в активній зоні реактора для його ефективного нагріву.

Сопло складається з: звуженої частини, критичного перерізу (де потік газу досягає локальної швидкості звуку), розширювальної частини. Коефіцієнт розширення сопла $\bar{F}_e$ досить високий (300), що дозволяє отримати питомий імпульс

близько 10000 м/с. Принципова схема ядерного ракетного двигуна представлена на рис. 1.

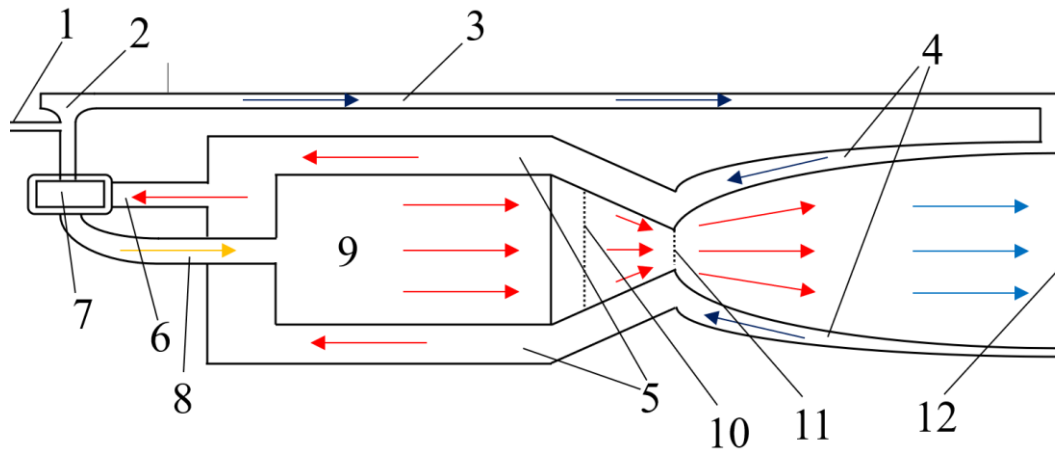


Рисунок 1. Принципова схема ядерного ракетного двигуна

1 – трубопровід робочого тіла з баку літального апарату; 2 – відцентровий насос подачі робочого тіла; 3 – трубопровід подачі робочого тіла до системи охолодження двигуна; 4 – тракт охолодження сопла; 5 – тракт охолодження ядерного реактору; 6 – трубопровід подачі нагрітого робочого тіла на турбіну; 7 – газова турбіна; 8 – магістраль подачі робочого тіла в реактор; 9 – ядерний реактор; 10 – вхідний переріз сопла; 11 – критичний переріз сопла; 12 – вихідний переріз сопла.

Метод розрахунку питомого імпульсу тяги включає визначення втрат питомого імпульсу на етапі розрахунку швидкості течії потоку газу у вихідному перерізі сопла. Такий підхід до розрахунку забезпечує узгодженість із рівнянням нерозривності потоку, що підвищує точність отриманих результатів і зводить похибки до мінімуму.

Ідеальна швидкість потоку газу у соплі визначається з рівняння збереження енергії [8, с. 86]:

$$v_{i.id} = \sqrt{2(i_r - i_i)}, \quad (1)$$

де i_r – питома ентальпія на виході з реактора;

i_i – питома ентальпія потоку газу в i – му перерізі сопла.

Ентальпію та ентропію атомарного або молекулярного водню представлено як функції температури та виражено поліномами [9].

Дійсний процес розширення і течії газу в соплі відрізняється від ідеального наявністю втрат. Суть розробленого методу розрахунку полягає в представленні втрат питомого імпульсу тяги як втрат швидкості течії потоку газу. Вираз для знаходження дійсного значення швидкості течії потоку газу у вихідному перерізі сопла має вигляд:

$$v_e = (1 - \xi_{fr} - \xi_s) \sqrt{2(i_r - i_e - \delta I_e - Q_n)}, \quad (2)$$

де ξ_{fr} – втрати на тертя;

ξ_s – втрати на розсіювання;

i_e – питома ентальпія робочого тіла на виході сопла;

$\delta I_e + Q_n$ – зміна ентальпії робочого тіла внаслідок неадіабатності.

Головною характеристикою ракетного двигуна є створюваний ним питомий імпульс, який розраховується за формулою:

$$I = v_e + F_e \frac{p_e - p}{\dot{m}}, \quad (3)$$

де F_e – площа вихідного перерізу сопла;

p_e і p – тиск у вихідному перерізі сопла та тиск середовища роботи двигуна відповідно;

$\dot{m}$ – секундна масова витрата робочого тіла.

Для вакууму $p = 0$. В розглядуваному випадку, розрахунок буде проводитися лише для питомого імпульсу, що створюється у вакуумі.

Під час розрахунку процесу розширення робочого тіла було прийнято припущення, що стосуються відхилення реальних характеристик потоку газу від ідеальних:

- втрати не спричиняють зміну рівноважного складу суміші;
- у кожній точці вибраного поперечного перерізу сопла потік газу є однорідним за своїм складом і має однакову температуру і тиск;
- процес розширення вважається ізоентропійним ($s = s_i = \text{const}$); ізоентропійне розширення характеризує показник n [10, с. 69, 70].

Під час проведення розрахунку розширення газу в соплі достатньо виконати розрахунок для трьох перерізів – вхідного, критичного та вихідного. На вході в сопло параметри потоку газу можна вважати рівними параметрам потоку газу на виході з реактору.

В критичному перерізі сопла відомо, що швидкість потоку, яку можна розрахувати за формулою (2) дорівнює локальній швидкості звуку ($M = 1$) [8, с. 87].

Для подальших розрахунків розширення газу в соплі та втрат питомого імпульсу необхідно визначити значення показників розширення для різних інтервалах тисків. Формула для визначення показника розширення в інтервалі від тиску на вході в сопло p_0 до тиску p_i має вигляд [8, с. 90]:

$$n_i = \frac{\ln \frac{p_0}{p_i}}{\ln \frac{p_0 \mu_o T_i}{p_i \mu_i T_o}} \quad (4)$$

де μ – молярна маса потоку газу у відповідному перерізі сопла;

T – температура потоку газу у відповідному перерізі сопла.

З урахування умови ізоентропійного розширення, система рівнянь для критичного перерізу сопла набуває вигляду [8, 52]:

$$\begin{cases} \sqrt{\frac{n_{crit} R T_{crit}}{\mu_{crit}}} = v_{crit} \\ \frac{1}{\dot{m}} \sum_{i=1}^n v_i \left[S_i(T_{crit}) + R \ln \frac{p_{std}}{p_{crit}} \right] = s_{crit} = s_0 \\ p_{crit} = \frac{p_0}{e^{\frac{n_{crit} \ln \frac{p_0 \mu_o T_{crit}}{p_{crit} \mu_{crit} T_o}}}} \end{cases} \quad (5)$$

де R – універсальна газова стала;

p_{std} – стандартний тиск;

$n = 2$ – оскільки відбувається дисоціація молекулярного водню, потік газу містить два компоненти: молекулярний і атомарний водень, які володіють різними термодинамічними властивостями.

Система рівнянь (2) розв'язується методом послідовних ітерацій з використанням програми, написаної мовою C++.

Витратний комплекс характеризує питомий імпульс, створюваний без сопла. Ця величина розраховується за формулою [8, с. 126]:

$$\beta = \frac{F_{crit} p_0}{\dot{m}} \quad (6)$$

де F_{crit} – площа критичного перерізу сопла;

$\dot{m}$ – секундна масова витрата робочого тіла.

Розрахунок параметрів газу у вихідному перерізі сопла зручно проводити для заданого значення температури. Так як даний двигун призначається для роботи у вакуумі, температура у вихідному перерізі сопла становить $T_e = 300$ К. Таке значення температури є компромісом між ефективністю і габаритами сопла, так як розширення до менших значень температури призвело б до суттєвого збільшення розмірів сопла.

Система рівнянь для вихідного перерізу сопла має вигляд [8, с. 52, 90]:

$$\begin{cases} s_e = s_0 = \frac{1}{\dot{m}} \sum_{i=1}^n v_i \left[S_i(T_e, p_{std}) + R \ln \frac{p_{std}}{p_e} \right] \\ p_e = \frac{p_0}{e^{\frac{n_e \ln \frac{p_0 \mu_o T_e}{p_e \mu_e T_o}}}} \\ F_e = \frac{\dot{m}}{v_e \rho_e} \\ \bar{F}_e = \frac{F_e}{F_{crit}} \end{cases} \quad (7)$$

Записавши системи рівнянь для визначення параметрів потоку газу в трьох перерізах сопла (вихідному, критичному і вихідному) можна визначити втрати питомого імпульсу.

Втрати питомого імпульсу зумовлюється різними за своєю природою явищами [8, с. 153]. Визначальні з них утворюють величину, що називається втратами питомого імпульсу ξ . У процесі розширення газу вектор швидкості потоку не паралельний осі сопла, тиск і число Маха можуть сильно відрізнятися в різних точках перерізу [8, с. 153]. Течія в'язкого і теплопровідного потоку неминуче призводить до виникнення діючої в протилежному напрямку до сили тяги сили тертя, внаслідок чого, дійсна швидкість витікання газу виявляється нижчою за ідеальну, отриману з рівняння збереження енергії.

Втрати на розсіювання визначаються за апроксимуючою формулою [8, с. 174]:

$$\xi_s = A_s \frac{e^{n_1 \left(1 - \frac{\bar{r}_e}{\bar{r}_1}\right)} - 1}{e^{n_1 - 1}} \quad (8)$$

де:

$$n_1 = 1,45 * \bar{r}_1^{-0,25} - 0,005 * \bar{r}_1,$$

$$A_s = 1,52 * [0,1 + e^{-30 * (n-1)}], \quad \bar{r}_e = \frac{d_e}{d_{crit}},$$

$$\bar{r}_1 = 1 + \frac{\bar{r}_e - 1}{Z} \quad \text{— емпіричні параметри;}$$

n – показник ізоентропи в інтервалі від тиску на вході в сопло p_0 до тиску у вихідному перерізі сопла p_e .

Точність цього виразу (8) при $n = 1,1 \div 1,25$, $Z = 0,4 \div 1,0$, $\frac{p_e}{p_0} = 2 \div 10000$ становить 5-10% [8, с. 174]. У першому наближенні можна прийняти $Z = 0,8 - 0,9$.

Для розрахунку втрат на тертя необхідно ввести два безрозмірні параметри – фактор теплообміну T_w (відношення температури внутрішньої стінки сопла до температури потоку газу) і число Рейнольдса Re_w [8, с. 177]:

$$Re_w = \frac{v_e \rho_0 L_n}{\eta(T_{wall})} \quad (9)$$

де v_e – швидкість потоку газу у вихідному перерізі сопла;

ρ_0 – густина потоку газу на вході в сопло;

L_n – довжина сопла;

$\eta(T_{wall})$ – динамічна в'язкість за температури стінки сопла T_{wall} .

Останній параметр варіюється по довжині сопла і досягає максимуму в районі критичного перерізу. Таким чином, з метою спрощення, розрахунок η_{wall} проводиться за температури стінки в критичному перерізі. Число Рейнольдса розроблюваного двигуна знаходиться в межах $10^8 < Re_w < 10^{11}$, що характеризує потік як турбулентний. У такому випадку, визначальними факторами втрат питомого імпульсу тяги внаслідок

тертя є показник ізоентропи розширення n , фактор теплообміну T_w і число Маха на зрізі сопла M_e [8, с. 177].

$$\xi_{fr} = \left[\frac{10^8}{Re_w} \right]^{0,2} 8 \left(\frac{2,62}{T_w^{1/3} n^2} - 1 \right) \frac{\sqrt{\bar{r}_e} - 1}{10^3} Z^{0,1} (0,3 + 0,035 e^{3Z^3}) \quad (10)$$

Точність апроксимації ξ_{fr} за цією формулою при $n = 1,1 \div 1,25$, $Z = 0,4 \div 1,0$ $T_w = 0,1 - 0,9$ становить 5-10% [8, с. 178].

Оскільки потік охолоджуючого сопла водню спрямовується в реактор, а не відразу в сопло, характер охолодження можна вважати незалежним. Таким чином, частина тепла передається охолоджувачу. Зміну питомої ентальпії робочого тіла можна описати співвідношенням [8, с. 226]:

$$\Delta i_Q = i_0 - (i_e + \delta i_e) - Q_n, \quad (11)$$

де i_0 , i_e — значення питомої ентальпії робочого тіла на вході та на виході сопла під час адіабатного розширення;

δi_e — зміна питомої ентальпії на виході з сопла внаслідок відведення тепла Q_n на ділянці сопла.

Визначити δi_e і Q_n можна за співвідношеннями [8, с. 226]:

$$\delta i_e = -T_e \int_{T_0}^{T_e} \frac{dQ_n}{T} \quad (12)$$

$$Q_n = \int_{T_0}^{T_e} dQ_n \quad (13)$$

Обчислити δi_e і Q_n можна, використовуючи як незалежну змінну відносну площу перерізу сопла (співвідношення площі вибраного перерізу до критичного [8, с. 226]). Тоді:

$$\delta i_e = -T_e \int_{T_0}^{T_e} \frac{dQ_n}{T} = -\frac{\beta}{p_0} \int_{\bar{F}_0}^{\bar{F}_e} \frac{qd\bar{F}}{T \sin \theta} \quad (14)$$

$$-T_e \int_{T_0}^{T_e} \frac{dQ_n}{T} = -0,55B \frac{q_{crit} T_e \beta}{p_0 T_0} \left[\frac{\ln \frac{2}{n+1} - \ln \bar{F}_0^2}{\sin \theta_0} + \frac{(n+1)(\bar{F}_e^{n-0,9} - 1)}{(n-1) \sin \theta_e} \right] \quad (20)$$

$$\int_{T_0}^{T_e} dQ_n = 1,1B \frac{q_{crit} \beta}{p_0} \left[\frac{1 - \bar{F}_0^{0,1}}{\sin \theta_0} + \frac{\bar{F}_e^{0,1} - 1}{\sin \theta_e} \right] \quad (21)$$

В таблиці 1 наведені результати розрахунку параметрів потоку робочого тіла у вхідному, критичному та вихідних перерізах сопла рідкофазного ядерного ракетного двигуна. Витратний комплекс

Втрати на тертя можна розрахувати за наближеною формулою [8, с. 178]:

$$Q_n = \int_{T_0}^{T_e} dQ_n = \frac{\beta}{p_0} \int_{\bar{F}_0}^{\bar{F}_e} \frac{qd\bar{F}}{\sin \theta} \quad (15)$$

де $\bar{F}_0$ — співвідношення площі вхідного перерізу сопла до площі критичного перерізу (ступінь звуження сопла);

$\bar{F}_e$ — ступінь розширення сопла (відношення площі вихідного перерізу до площі критичного перерізу);

θ — кут нахилу стінки сопла;

q — густина поверхневого теплового потоку.

Густина поверхневого теплового потоку газу і температуру газу можна представити у вигляді простих функцій відносної площі сопла [8, с. 226]. Для докритичної частини сопла:

$$q = 1,1 * q_{crit} \bar{F}^{-0,9}, \quad (16)$$

$$T = T_0 \left[\frac{2}{n+1} + \frac{\bar{F}^2 - 1}{\bar{F}^2} \left(\frac{n-1}{n+1} \right) \right] \quad (17)$$

Для закритичної частини сопла:

$$q = 1,1 * q_{crit} \bar{F}^{-0,9}, \quad (18)$$

$$T = T_0 \frac{2}{n+1} \bar{F}^{1-n} \quad (19)$$

де q_{crit} — густина поверхневого теплового потоку в критичному перерізі.

Кут нахилу стінки сопла можна апроксимувати, уявляючи сопло конічним з введенням коефіцієнту B [8, с. 226]. В подальшому, розрахувати значення інтегралів можна за формулами [8, с. 227]:

вказується лише для критичного перерізу, питомий імпульс — лише для вихідного.

Таблиця 1

Результати розрахунку параметрів потоку робочого тіла в соплі

Фізична величина	Вхід в сопло	Критичний переріз	Вихідний переріз
Тиск p , кПа	4581081,387	2861081,094	603,922
Температура T , К	3073,900	2867,000	300
Молярна маса μ , г/моль	1,987	2,017	2,017
Швидкість v , м/с	326,661	3795,308	9502,750
Число Маха M	0,080	1	7,338
Питомий імпульс у вакуумі I_p , м/с	-	-	9632,974
Витратний комплекс β , м/с	-	4989,276	-
Показник ізоентропи розширення n	-	1,218	1,355
Питома теплоємність c_p , Дж/(кг·К)	18513,393	18248,787	14312,744
Динамічна в'язкість η , Па·с·10 ⁴	0,526	0,503	0,163
Теплопровідність λ , Вт/(м·К)	0,751	0,710	0,166

Як виявилось, розраховане значення питомого імпульсу тяги рідкофазного ядерного ракетного двигуна є більшим 9500 м/с, що значно перевищує характеристики хімічних ракетних двигунів. Таким чином, отримані результати підтверджують перспективність використання рідкофазного ядерного ракетного двигуна для майбутніх космічних місій. Вдосконалення математичних моделей та методів розрахунку параметрів потоку робочого тіла під час розширення в соплі зазначеного двигуна дозволить значно розширити можливості проектування та оптимізації ядерних ракетних двигунів.

Висновки і перспективи подальших досліджень. У роботі проведено розрахунок параметрів потоку робочого тіла (водню) у вхідному, критичному та вихідному перерізах сопла рідкофазного ядерного ракетного двигуна. Встановлено, що раціональний вибір геометричних характеристик сопла та параметрів газового потоку дозволяє забезпечити оптимальні режими роботи двигуна, зменшуючи втрати енергії та підвищуючи ефективність перетворення теплової енергії в кінетичну.

Розроблено метод розрахунку питомого імпульсу тяги рідкофазного ядерного ракетного двигуна з врахуванням втрат на розсіювання, тертя та зміну питомої ентальпії робочого тіла внаслідок неадіабатності. Суть методу полягає в представленні втрат питомого імпульсу як втрат швидкості течії потоку газу у вихідному перерізі сопла. Розраховане значення питомого імпульсу тяги рідкофазного ядерного ракетного двигуна перевищує 9500 м/с. Таким чином, навіть з використанням сучасних конструкційних матеріалів існує можливість досягати значення питомого імпульсу тяги, що значно перевищує характеристики хімічних ракетних двигунів. Оцінка термогазодинамічних параметрів розширення робочого тіла підтвердила високу ефективність рідкофазного ядерного ракетного

двигуна та можливість його застосування в космічних місіях.

У подальшому запропонований метод розрахунку параметрів потоку робочого тіла під час розширення в соплі ядерного ракетного двигуна планується адаптувати для двигуна, який здатний використовувати різні типи робочого тіла (аміак, гідразин, монометилгідразин, метан) без змін в конструкції. Крім того, важливим аспектом є розгляд питань довговічності конструкційних матеріалів у жорстких умовах експлуатації, що включає вплив нейтронного випромінювання і високих температур.

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PSYCHOLOGY

PSYCHOLOGICAL AND PEDAGOGICAL EXAMINATION OF THE ADAPTATION OF STUDENTS WITH SPECIAL EDUCATIONAL NEEDS TO STUDY AT THE UNIVERSITY

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Abstract

This paper presents the results of a psychological and pedagogical examination of the adaptation processes of students with special educational needs (SEN) in higher education settings. The study explores the key challenges faced by these students during their transition to university life, including academic, social, emotional, and environmental factors influencing their adaptation. It also examines the effectiveness of existing support systems and inclusive educational practices implemented by universities. The findings highlight the necessity of a comprehensive, individualized approach to supporting students with SEN, emphasizing the role of psychological and pedagogical interventions in fostering successful integration and academic achievement. Recommendations are provided for enhancing adaptive capacity and promoting an inclusive educational environment at the university level.

Keywords: Psychological adaptation, pedagogical support special educational needs inclusive education, higher education, student adaptation, educational environment, individualized learning, support services, academic inclusion, social integration, mental health, education accessibility in higher education, learning difficulties, adaptive strategies, educational diagnostics, emotional well-being, teaching method, psycho-pedagogical assessment, university inclusion practices.

In the context of modern educational policy focused on the principles of inclusion, ensuring equal access to quality higher education for all categories of students, including students with special educational needs (SPE), becomes a priority. The university environment, as a complex socio-cultural and academic context, requires students to be highly independent, adaptable and ready to interact. For students with OOP, the adaptation process may be accompanied by a number of difficulties due to both individual psychophysiological characteristics and the insufficient readiness of educational institutions to meet their needs. But to assess the conditions, factors and mechanisms of adaptation of students with OOP, to identify barriers and potential resources for successful integration into the educational environment of the university. The lack of a systematic approach to conducting such an examination complicates the development of effective models of support and support, which negatively affects the academic performance, the level of socialization and professional self-identification of this category of students.

The purpose of the study:

To identify and substantiate the psychological and pedagogical conditions that contribute to the successful adaptation of students with special educational needs to studying at the university, through the examination of the adaptation process and the development of recommendations for its optimization. Thus, the need to develop and test scientifically based approaches to the psychological and pedagogical examination of the adaptation process of students with special educational needs determines the high degree of relevance of this study. Its results can contribute to the formation of an inclusive university environment and improve the quality of the educational process. The problem of optimizing socio-psychological adaptation taking into account individual indicators and the entire process is expressed in the development of models of adaptation strategies

to life, educational situations, including through the optimization, expansion and creation of a truly unified educational environment. Integration, complementarity and constructive dialogue between different types of organizations - general and additional education by their teachers will compensate for the shortcomings, fill the gaps at the expense of unique resources, accumulated potential and ensure the success of the younger generation in society. Russian social psychology [1–3] considers adaptation in an active adaptive-transformative context associated with constant orientation in new conditions of life, the formation of optimal ways of action in the presence of expressed motives for achievement. Socio-psychological adaptation of students, from our point of view, is the process and result of the coordination of their individual capabilities and states with the surrounding world, adaptation to a dynamically changing environment and conditions life, the structure of relations in "child-child" and "child-adult" communities. At the same time, the knowledge-oriented paradigm, which continues to de facto dominate in most higher institutions, is a serious deterrent to the success of the global process of socialization of the individual. In this regard, it is the institutions of additional education for students with their personal-activity, experience-transforming component that seem to be a unique educational environment for successful socio-psychological adaptation [4]. Initial originality, variable opportunities for the productive development of students of all ages due to specific forms of organization, synthesis of types of activity,

Theoretical analysis of the problem

The study of social adaptation in the context of educational environments has "tightened" aspects that were not previously included in its functionality, such as social success, social competencies and competence, social and educational risks. The field of forecasting possible risks of socialization of a student is in demand

today not only from the standpoint of their ascertainment, systematization, but also socio-psychological adaptation of the student to their objective and subjective existence. In terms of the degree of impact on this process, the risks of the micro-society – family environment, university, religious, public organizations, subcultures, the risk of information desocialization – are in the lead. The risk factors of the educational organization itself are especially highlighted: the presence of an unfavorable psychological climate of the student's existence, the authoritarian style of interaction in the system "adult (teacher) - student (pupil, pupil)", the dominance (and not parity) of education over upbringing, etc.

The risk intensity of socio-psychological adaptation is quite high, and not only in the "crisis" periods of the development of the student's personality, but also in connection with the polyfunctionality of the adaptation process itself, which involves the inclusion in multi-age, polylog, gender-role communication, relationships, connections through the mastery of various social roles and behavior models. There was a redistribution of priorities and types of activity: educational and cognitive (really informational and reproducing) activity, as the analysis of the university situation shows, practically pushed aside other types - artistic, creative, sports, labor, play. Social activity has practically come to naught, value-oriented activity and free communication are poorly represented. At the same time, the importance of activities related to the use of new sources of information, primarily the Internet, has increased significantly.

Along with the change in the correlations between the types of activity, there is a reorientation of its forms. Collective activities, which provide an opportunity for interpersonal communication, role behavior (as a way of forming social experience and social adaptation), are replaced by activities aimed at the implementation of exclusively individual plans and capabilities of the student. The presence of one or another factor of socio-pedagogical risk is a probability, but not the obligatory, of maladaptation, including socio-psychological. Any risk performs both stimulating and protective functions. And if the first can be constructive and destructive, the second is based on recognizing the reality of these risks and preparing for them. There is a development of strategies for behavior in situations due to uncertainty, which is directly related to socio-psychological adaptation as the ability to change oneself depending on the dynamics of social conditions or the environment of organizational conditions and influences that ensure cognitive, emotional, communicative and in general subjective-personal development of the individual on the basis of his age characteristics and taking into account the goals of society [5]. Any educational environment has certain quantitative and qualitative parameters: among them is breadth as a kind of structural and substantive characteristic, with the help of which it is possible to find out which subjects, processes and phenomena are included in it [6]. And at the same time, this environment begins where the meeting (meeting) of the forming and the forming takes place: where they jointly begin to design and build it – both as a subject and as a

resource for joint activity, where certain connections and relationships begin to be built between individual institutions, programs, subjects of education, educational activities [7].

The educational environment is understood today as a system of pedagogical, psychological and organizational conditions and influences that ensure the cognitive, emotional, communicative and in general subjective-personal development of the individual on the basis of his age characteristics and taking into account the goals of society [5]. Any educational environment has certain quantitative and qualitative parameters: among them is breadth as a kind of structural and substantive characteristic, with the help of which it is possible to find out which subjects, processes and phenomena are included in it [6]. And at the same time, this environment begins where the meeting (meeting) of the forming and the forming takes place: where they jointly begin to design and build it – both as a subject and as a resource for joint activity, where certain connections and relationships begin to be built between individual institutions, programs, subjects of education, educational activities [7].

Of course, socio-psychological adaptation in the educational environment of a particular type (kind) of an educational institution is specific. Institutions of additional education for students have special opportunities "aimed at the formation and development of students' creative abilities, meeting their individual needs for intellectual, moral and physical improvement, forming a culture of a healthy and safe lifestyle, strengthening health, as well as organizing their free time" [8]. UDOs provide their students with access to a wide range of cultural values that are not covered in mainstream education and are not represented in student programs. They not only concretize, expand, deepen the knowledge obtained at universities, but also provide an opportunity to gain practical experience in their implementation, create conditions for the social and cultural development of the individual. Additional education of students ensures their adaptation to life in society, professional orientation, as well as the identification and support of students who have shown outstanding abilities [8].

Socio-pedagogical adaptation in the institution of additional education of students is the process of activating the mechanisms for the formation of communicative skills, organizational skills and self-determination, self-realization of students, teaching socially significant affairs, the ability to positively transform social action [9]. It is in them, in contrast to the main general educational organizations, that there is a real opportunity to include the student in the most diverse range of activities. The educational process in the UDOD, its main directions provide the possibility of a smooth transition, change of activities, their complementarity, mutual enrichment [10]. The choice of the leading type of activity here remains with the student. "Trying" himself in all types of activity, the student not only develops comprehensively, communicates, expresses himself, but also forms his own social experience as an experience of activity, thus minimizing the risks of maladaptation. Adaptation of students at the university

is a process that can last throughout the student's education. Even if the subject has successfully adapted to the study group, the adaptation process does not end, every semester new disciplines appear and some teachers replace others, each teacher sets his own rules and has his own teaching style. Unsuccessful adaptation to the style of a teacher, difficulties in mastering a particular academic discipline or problems in the formation of a skill in one of the educational activities can affect the general adaptation at the university even by last year. The sad result of such a breakdown can be the failure to graduate from an educational institution or a decrease in the general psychological health of a person. Consequently, the adaptation of students to studying at a university presupposes the presence of many features in their behavior and activities. T. D. Dubovitskaya and A. V. Krylova propose to consider as such: satisfactory psychological and physical state of the student in educational and non-academic situations at the university; acceptance of social expectations and requirements imposed on him, as well as the compliance of his behavior with these expectations and requirements; the ability to give the desired direction to what is happening at the university and use the available conditions for the successful implementation of their educational and personal aspirations and goals [7].

126 A productive way of diagnosing adaptation can be considered the following methods:

developed on the model of adaptation criteria by A. A. Rean. He singles out two main criteria of adaptation: external and internal. The first is a reflection of the concept of "adaptation" and is understood as the achievement of the desired compliance with the requirements of the environment. It is described in terms of efficiency, competence, success, objective well-being. Adaptation according to the external criterion is associated with the so-called "cost of adaptation" - the amount of internal psychological resources spent on adaptation to the environment. It increases when the orientation to the external criterion prevails in the process of adaptation and the internal needs of the individual are ignored. The internal criterion is a reflection of the feeling of satisfaction, comfort, and general mental state. It is associated with a preference for saving internal energy resources, the absence of tension and anxiety, and an orientation towards changing oneself, one's own system of motives and values to reduce contradictions with the external environment. Signs of adaptation according to the internal criterion are low success, sometimes even deviant behavior, but against the background of a positive tone of individual mood. Coordination of external and internal criteria - the requirements of the environment and individual needs - is the main task of the adaptation process. In this context, only a result that meets the requirements of two criteria can be considered optimal adaptation, but such systemic adaptation presupposes high success, which is accompanied by a subjective sense of satisfaction. It is closely related to the concept of self-realization. It is the inner potential of the individual that determines the possibilities of self-realization and, accordingly, the highest form of adaptation [8].

Systemic adaptation involves high success, which is accompanied by a subjective sense of satisfaction. It is closely related to the concept of self-realization. It is the finding of a socially approved, productive and socially useful way of actualizing and expressing the inner potential of the individual that determines the possibilities of self-realization and, accordingly, the highest form of adaptation [8]. On the basis of this model, we can talk about the types of adaptation. The questionnaire "Adaptive Behavior Strategies" (TSA) by N. N. Melnikova is a diagnostic tool that allows you to determine the type of adaptation, or rather, adaptive strategies, the combination of which in individual behavior characterizes the style of adaptation of the individual. The author proceeds from three grounds that are essential for the interaction of the individual and the social environment in the process of adaptation: 1) the direction of the changes taking place (the environment changes - the individual himself changes), 2) contact - avoidance, 3) activity - passivity of the individual. As a result, the author describes eight behavioral strategies, each of which can be successful in certain situations and circumstances [9]. At the same time, the choice of the preferred strategy is always determined by individual and personal characteristics. Thus, the view of adaptation should be at least two-sided, i.e., the personal constructs that ensure adaptation processes and the environmental conditions that determine the configuration, type, or style of adaptation are considered, in both cases the evaluative aspect, i.e., the "cost of adaptation," should be taken into account. When assessing adaptation, the researcher has the right to ask the question about the quality of the environment, about whether the adaptive or transformative aspects of adaptation should prevail in each specific case. Sampling, methods and methods of research The purpose of the empirical study was to identify significant links between the content components of adaptation and other characteristics of the personality. Senior students of the Faculty of Psychological, Pedagogical and Special Education of Saratov State University took part in the study. The sample size was 130 people, the study was conducted individually. To diagnose the adaptation process, a variety of methods are used, focused both on specific areas of human functioning and on a wide range of socio-psychological factors. We judged the adaptation processes by choosing the following parameters: the student's adaptation to the study group and educational activity (diagnosed according to the method of T. D. Dubovitskaya and A. V. Krylova) [7], social adaptability, self-acceptance, acceptance of others, dominance, etc. (which are the scales of the methodology for diagnosing socio-psychological adaptation by C. Rogers and R. Diamond) [10], as well as the tendency of students to a particular strategy of adaptive behavior (determined by ASP-2 method by N. N. Melnikova) [9]. Diagnostic tools included: the methods "Level of Subjective Control" [13], "Personal Differential" [11], "Style of Self-Realization of Behavior" (SSP-98) by V. I. Morosanova and E. M. Konozy [12], assessment of the level of alexithymia [3], 5-factor personality questionnaire by R. McCrae and P. Costa [13]. To identify the factors

of good or insufficient adaptation of students to the educational environment of the university and their mutual influence in our study, we used correlation analysis. With high indicators of socio-psychological adaptability, flexibility and good self-regulation skills are manifested, a person is aware of what is happening in his emotional sphere, and can formulate and express what is happening in his inner world, describe and share both negative and positive experiences. Personality activity is also found as a factor contributing to adaptation. Emotionally stable and positive students who are able to cope with difficulties and insist on their own are able not only to ensure their own successful adaptation, but will also strive to support and encourage the people around them. It can be assumed that the predominance of adapted students in the study group will contribute to the speedy adaptation of maladapted students, provided that the team is cohesive and friendly. Disadaptation is associated with alexithymia and an actively avoidant, self-directed behavior strategy ("snail strategy"), which tears the subject away from reality, destroys ties with others and leads to the impossibility of obtaining resources from the outside. Assistance to such students should be focused on including them in safe and productive forms of interaction, both in and out of school situations, and on developing their emotional intelligence, from the skills of recognizing and describing emotional states to managing emotions. Various means can serve to establish and maintain contact with reality: for example, individual close attention to the student on the part of the teaching staff and personnel who provide educational work at the university, the provision of individual psychological assistance, the creation of psychological support groups for students with learning difficulties, as well as the use of various trainings and other active socio-psychological training that increase group cohesion of the student collective. The implementation of these measures will lead to an increase in the comfort of the educational environment and will contribute to the maximum disclosure and development of the potential of the younger generation of professionals. In our opinion, the material and personnel potential of the university should be directed to ensure and support these measures.

Findings:

Adaptation of students with special educational needs to the conditions of higher education is a multi-level and complex process that includes psychological, pedagogical, social and organizational aspects. As an example, psychological and pedagogical expertise as a method of scientific analysis makes it possible to identify both the individual characteristics of the adaptation of students with educational programs and systemic barriers that affect the success of their inclusion in the educational process. Further, the results of the examination show that the main difficulties in adaptation are associated with the insufficient preparation of the university's educational environment for inclusive education, the lack of special conditions, as well as the lack of a sufficient level of inclusive competence among teachers and students. The most significant factors for the successful adaptation of students with OOP are: the

availability of the educational environment, the availability of individual support, psychological support, as well as the active involvement of students in academic and extracurricular activities. The development and implementation of psychological and pedagogical recommendations aimed at creating an inclusive educational environment and supporting students with special educational programs contribute to increasing the effectiveness of their adaptation to studying at the university. The results obtained can be used in the development of programs for professional training and advanced training of teaching staff, in the design of adapted educational routes and the creation of mechanisms for supporting students with PLO in the higher education system.

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