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Conference schedule

Meet Link https://meet.google.com/iqz-qfun-yap

November 25, 2024

12:00 Eastern European Summer Time (EEST)

Time	Speaker	Title of Speech
12:00	Kathleen Aviso	MODELLING THE ECONOMIC IMPACT AND RIPPLE EFFECTS OF DISEASE OUTBREAKS
12:05	Chen Xiaogang	INTERSTITIAL WATER EXCHANGE PROCESSES IN MANGROVES AND SALT MARSH WETLANDS AND THEIR CARBON SINK POTENTIAL
12:12	Muhammet Mustafa Akkan	PRODUCTIVITY OF MARITIME TRANSPORTATION IN TURKEY
12:17	Macario Cordel II	BEAMFORMING POINTING ERROR OF A TRIAXIAL VELOCITY SENSOR UNDER GAIN UNCERTAINTIESBEAMFORMING POINTING ERROR OF A TRIAXIAL VELOCITY SENSOR UNDER GAIN UNCERTAINTIES
12:25	Bernardita Churchill	ENHANCING THE STUDY AND TEACHING OF PHILIPPINE HISTORY AND CULTURE: TOWARDS INCLUSIVITY AND TRUTH

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FACILITATING GLOBAL CLIMATE CHANGE EDUCATION: A VIRTUAL FUTURE CREATING WORKSHOP APPROACH

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This article explores the implementation of an online Future Creating Workshop (FCW) as a pivotal planning strategy for the Global Climate Change Education Initiative (GCCEI). The GCCEI, an Educational Action Research project, engages students aged 11–14 in examining the multifaceted impacts of climate change within their local communities and on a global scale. Through a detailed account of the FCW process, grounded in Critical Utopian Action Research, we discuss the challenges and successes encountered in launching this initiative amidst the pandemic. The article reflects on the implications of this approach for problem-based and multimodal learning, offering a model for educators and researchers to cultivate meaningful climate dialogue among students.

Introduction

Climate change represents a pressing global challenge, intersecting with critical issues such as public health, economics, and geopolitics. The Global Climate Change Education Initiative (GCCEI) aims to foster climate literacy and inspire youth to engage actively in addressing these challenges. Central to the GCCEI is the belief that young people can catalyze meaningful change through collaborative learning and dialogue.

However, the COVID-19 pandemic disrupted traditional educational models, necessitating innovative approaches to achieve GCCEI's objectives. We adopted a virtual Future Creating Workshop (FCW), a participatory planning method rooted in Critical Utopian Action Research, to navigate

these disruptions. This article examines how the FCW framework facilitated the co-creation of strategies for advancing climate education, its benefits in fostering multimodal learning, and its potential as a scalable model for global application.

Global Climate Change Education Initiative

The GCCEI is an Educational Action Research project designed to provide middle school students with the tools to explore the impact of climate change on weather patterns, health systems, cultural traditions, and political dynamics. By connecting students across international borders, the initiative fosters diverse perspectives and a shared sense of responsibility for global climate action.

Key to the GCCEI is its emphasis on inquiry-based learning, where students analyze local and global climate data, participate in collaborative projects, and propose solutions to climate-related challenges. This holistic approach aims to empower students with critical thinking skills, empathy, and agency in addressing the climate crisis.

The Future Creating Workshop (FCW) Framework

The Future Creating Workshop, originally developed by Robert Jungk, is a structured participatory method that facilitates collective envisioning and planning. The virtual adaptation of the FCW enabled participants to collaborate remotely, addressing the constraints posed by the pandemic. The workshop comprises three phases:

Critique Phase: Participants identify and analyze existing challenges in climate education.

Fantasy Phase: Creative brainstorming generates visions for ideal future scenarios in climate education.

Implementation Phase: Practical strategies and actionable steps are co-created to realize the envisioned futures.

Grounded in Critical Utopian Action Research, the FCW emphasizes democratic participation and transformative action. This aligns with GCCEI's commitment to empowering youth as co-creators of knowledge and solutions.

Methodology

Our online FCW was conducted with diverse participants, including students, educators, and climate advocates from multiple countries. The workshop utilized a multimodal approach, incorporating video conferencing, collaborative digital whiteboards, and breakout sessions to simulate the dynamics of an in-person workshop.

Participants were guided through structured activities designed to foster critical reflection, creative ideation, and collaborative planning. Data collection included recorded sessions, participant reflections, and observational notes, providing comprehensive insights into the workshop process and outcomes.

Challenges and Lessons Learned

The virtual FCW presented several challenges, including technical barriers, varying levels of digital literacy, and difficulties in sustaining engagement across time zones. Despite these obstacles, the workshop yielded valuable insights:

Increased Accessibility: The online format broadened participation, allowing individuals from remote areas to engage in the dialogue.

Enhanced Multimodal Learning: Combining visual, auditory, and interactive elements supported diverse learning preferences and facilitated deeper engagement.

Collaborative Problem-Solving: The structured phases of the FCW empowered participants to move from abstract discussions to concrete strategies for action.

Outcomes and Implications

The virtual FCW culminated in actionable strategies to enhance climate education, including:

Development of an international student exchange program focusing on climate research.

Creation of digital resources, such as interactive simulations and localized climate data visualizations.

Integration of climate education into broader curricula through interdisciplinary approaches.

These outcomes highlight the potential of FCW as a replicable model for fostering collaborative, problem-based learning in diverse educational contexts.

Reflections on Problem-Based and Multimodal Learning

The FCW approach aligns closely with principles of problem-based learning (PBL), where students engage with real-world challenges to develop critical thinking and problem-solving skills. The integration of multimodal tools further enriched the learning experience, enabling participants to communicate ideas, synthesize information, and co-create solutions effectively.

This approach underscores the importance of interactive and experiential learning in equipping students to navigate complex global issues like climate change. By combining critical reflection with creative action, the FCW fosters not only climate literacy but also a sense of agency and collaboration among students.

Conclusion and Recommendations

The virtual Future Creating Workshop demonstrates a promising approach to advancing global climate education in a rapidly changing world. By engaging students as active participants in the dialogue, this method supports the development of essential competencies for addressing the climate crisis.

Future research should explore long-term impacts of such workshops on student learning and community engagement. Investments in digital infrastructure, teacher training, and interdisciplinary curricula will be critical for scaling this model and ensuring its sustainability.

As educators and researchers, we must continue to innovate and collaborate, leveraging tools like FCW to prepare the next generation for the challenges and opportunities of a climate-affected world.

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PRIVATE INTERNATIONAL LAW AND SPACE VELOCITY: THE PROBLEM OF REGULATING PRIVATE LAW RELATIONS AT A DISTANCE OF LIGHT YEARS

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Novelty as an idea and additional information that raises additional questions. When you look at any object in the Universe, you do not see it as it is at the moment of observation. This concept may be perceived as futuristic, potentially by centuries or millennia, as evidenced by the mathematical Fourier series of the 18th century. This found its application and commercialisation in the 21st century in the technology of smartphone displays and tablets, among other devices. The speed of light, despite the fact that it is the highest (known to mankind today) speed at which any signal can propagate through the Universe, is still finite(?). No matter how close or far away an object is, you only see it as it was a certain amount of time ago: now when the object you see emitted (or reflected) light. The fact that light must travel from the object under study to the observer creates a gap in knowledge about that object that can only be filled by mental inference. Every observer in the Universe, unless they have spent a large amount of time travelling at close to the speed of light (or have been in an extremely strong gravitational field, such as a black hole event horizon), will perceive "right now" as the same moment in time relative to the Big Bang: 13.8 billion years have passed since that event. For closely spaced objects, the speed of light is large enough that the time difference between the source and the observer can be neglected in most cases. But the further we look, the

further back in time we go, and the closer to the moment of the Big Bang we look. This means that when a distant observer look at the Earth, he sees us as we were in the past. This is what someone looking at our planet could conclude:

1) from Voyager 1, the most distant human-made spacecraft from us today. Currently, Voyager 1 is 157.8 astronomic units (the distance from the Earth to the Sun) away from us – about 23.5 billion kilometers in more familiar terms. Launched in 1977, it took 45 years to reach its current location, which is already outside our solar system. It is one of only five spacecraft currently moving away from our solar system, and it will remain the furthest away for all time, unless we launch a new spacecraft that can overtake it. And yet, being so far away – farther than any planet, moon, asteroid or Kuiper belt object in our solar system – it sees planet Earth with a delay of less than a day. It sees us as we were just 21 hours and 46 minutes ago. An observer on the Moon sees us as we were ~1.25 seconds ago; an observer on Jupiter, now at the closest distance in 59 years, sees us as we were ~33 minutes ago; an observer on Pluto, now 5.1 billion km away, sees us as we were ~4 hours and 44 minutes ago.

From any place in or even near our solar system, the depth of the view into the past will be very small – especially if we think on a cosmic scale. Another way to look at it is that even one light year is a very, very long distance compared to the scale of our solar system; a distance that Voyager 1 will not cover in tens of thousands of years.

2) TOI700 is the first star system to discover an Earth-sized exoplanet in its habitable zone, located 101.6 light-years from Earth. When viewed from this world, the Earth looks like it did just after the end of 1920. It would take

more than 2 centuries for messages to be exchanged in both directions; no one would ever live to see a reply to a message sent by another person.[1]

In view of the above, the question arises as to what the starting point for the commencement of the limitation period in relation to a particular legal circumstance, transaction or contractual relationship is? The starting point of the transaction? Will such circumstances be subject to the jurisdiction of the Earth or colonies of Earthlings on other space objects closer to which the events with legal consequences occurred? Right now, for example, it is possible to use the Earth's space law conventions as a legal basis, but this area has prospects for development, as well as in relation to private international law: property rights, the right to choose the jurisdiction (lex loci), the location of property, which may affect the jurisdiction of choice of the law governing it. It is not known whether humanity will encounter alien civilizations that are like humanity on Earth and such civilizations may also have their own rules of law and what will be the source of private international law in this case. Should we be observed in 1920, for example, we would be able to ascertain the identity of the perpetrator, the location, the manner, and the time at which a criminal act was committed. However, this is a matter that falls within the purview of criminal lawyers.

However, assuming that humanity will be able to develop technologies for travelling to other galaxies, the question of the moment of reference of a transaction becomes interesting. In private international law, there is a concept of "place of performance" (locus regit actum), which determines which law applies to a particular transaction, such as a contract or

[1] National Geographic – Astronomers identify the stars where any aliens would have a view of Earth: https://www.nationalgeographic.com/science/article/astronomers-identify-the-stars-where-any-aliens-would-have-a-view-of-earth

agreement. As a rule, this law is determined depending on the place where the transaction was performed.

When it comes to space travel and activities in space, legal issues become somewhat more complex. There are documents that define the principles of state activity in space, such as the United Nations Outer Space Treaty (1967) and its additional protocols. However, these documents relate mainly to the legal regime of planetary bodies in the solar system, which are currently the objects of human exploration.

If bases or colonies are established on other planets or moons, the issues of law and the moment of reference of a transaction may become relevant. In such situations, the international community may need to develop new treaties and agreements to address the issue of the place of performance and the application of law in space. But it also raises the question of who says there will be law in space?

Another interesting point is what to consider as the point of time reference, the point of reference of a transaction or the place of jurisdiction of a transaction, or the place of choice of applicable law (lex loci) in private international law, which will happen when travelling at the speed of light in the future? Since, in theory, a person can be in two places at the same time when travelling at the speed of light.

During the Large Hadron Collider tests in Switzerland, a particle (and potentially, with the development of technology, a physical body) moving in a circle at almost the speed of light in one of the experiments was recorded simultaneously in two places, which also potentially raises the question of lex loci.[2]

[2] BBC Science News – CERN: particles travelling faster than the speed of light: http://surl.li/rpwvu

The speed of light in a vacuum is a constant value that we know quite accurately: for example, light travels at 299,792,458 meters per second.

According to Einstein's Special Theory of Relativity, nothing can move faster than light. Under normal conditions, light really does move instantly for us.

Until the twentieth century, the world was convinced that Isaac Newton's views on objects and gravity were correct. However, in the 1900s, none other than Albert Einstein changed the world forever.

Albert Einstein also suggested that there is no single standard reference frame. Everything is relative, even time (especially in the form in which people on Earth have decided and agreed to use it). Then he realized that the speed of light is constant and does not depend on the observer. Thus, if a person is moving at 50% of the speed of light in the same direction as the light, then a ray of light will look the same to him or her as it does to a person standing still.

When it comes to moving at almost the speed of light, say 90% of it, we will have interesting observations.

First of all, a person moving at this speed will feel time slowing down. Time will pass more slowly for them than for someone standing still. For example, if a person is moving at 90% of the speed of light, then when 10 minutes have passed for him, 20 minutes will have passed for a person standing still.

Of course, even with all the impracticalities and obstacles associated with travelling at the speed of light (or almost), it will undoubtedly be quite an adventure.[3]

[3] Discovery Science Living Planet – What happens when you travel at the speed of light: https://u.to/Tpd7IA

Physicists have shown that time works differently in quantum reality, and the past can be the future. For example, Isaac Newton believed in the existence of a "universal clock" that controls the life and death of everything in the universe. According to his theory of relativity, a person who reaches the speed of light will be able to stop the passage of "his" time. Albert Einstein went even further. He suggested that a person travelling faster than light would be able to turn back time.[4] The journey into the quantum world is best depicted, in my opinion, in Marvel's Ant-Man and the Wasp: Quantumania.[5]

Such a "game" with time is also officially confirmed by the biological state of astronauts who return from space travel biologically younger.[6] Also "game" with time and space is sown in films: Twin Peaks, Interstellar, Doctor Strange.

The prospects for the development of the private international law aspect in space law are becoming increasingly relevant with the progress of space research and commercial space missions, as well as the development of celestial bodies (space objects). The more states and private companies engage in space activities, the more there is a need to develop appropriate legal mechanisms and regulatory frameworks to govern these relations.

"I think it would be best if the form of government on Mars was direct democracy. Everyone votes on every issue and that's how it works," Elon Musk. According to Musk, a colony on Mars is extremely important for the survival of humanity.

[4] New Science Voice – Фізики показали, що у квантовій реальності час працює інакше, а минуле може бути майбутнім. Як це можливо?: У квантовій механіці час може працювати не так, як ми звикли, і піти назад. (nv.ua)
[5] Marvel – Ant-Man and the Wasp: Quantumania: Ant-Man and The Wasp: Quantumania (Movie, 2023) | Cast, Characters, Credits, Release Date | Marvel
[6] Scott Kelly: 'I came back from space younger than my twin': Scott Kelly: 'I came back from space younger than my twin' | Space | The Guardian

"I think it is unlikely that we will ever have a world war again," the businessman said.[7]

Future human colonies on Mars present a unique situation that requires in-depth consideration of legal aspects, in particular private international law. As this is a new territory that is not part of any state, numerous questions arise regarding the legal status, rights and obligations of residents, property, conflicts and many other aspects.

Property and land rights: how to resolve the issue of land ownership on Mars? What legal mechanisms can be used to regulate the sale, transfer or inheritance of rights to real estate, mining on space objects (Moon, Mars, asteroids)?

Relations with the Earth: how will relations between Martian colonies and Earth-based states be regulated? What international documents can determine the status and legal regime of future Martian territories? Will the settlers from Earth to Mars in the future want an independent status for their territory?

In summary, the complexities inherent in regulating private law relations across vast distances of light years demand innovative legal solutions that reconcile the challenges posed by space velocity with the principles of fairness, predictability, and the rule of law. As humanity embarks on increasingly ambitious space exploration missions, traditional legal frameworks face unprecedented challenges in addressing the intricacies of private interactions in the extraterrestrial domain.

The intersection of private international law and space velocity gives rise to a myriad of complex issues, ranging from jurisdictional disputes to

[7] BBC News Ukraine – Musk: Mars colony should be created before the world war: Musk: Mars colony should be established before world war – BBC News Ukraine: https://u.to/V5Z7IA

the determination of applicable law and the establishment of effective enforcement and dispute resolution mechanisms. Traditional legal doctrines, rooted in territoriality and nationality, struggle to accommodate the borderless nature of space and the absence of a universally recognized authority in space law.

Jurisdictional challenges loom large in the regulation of private law relations in space. The absence of clear territorial boundaries and the multinational composition of space mission's complicate efforts to determine which state or international body has the authority to adjudicate disputes arising from space activities. Moreover, the transitory nature of space habitats further muddies the waters, raising questions about the applicability of traditional jurisdictional principles in the extraterrestrial context.

Similarly, the question of applicable law presents significant hurdles. While existing legal frameworks may offer some guidance, they often fail to account for the unique circumstances of space travel. Factors such as the multinational composition of space missions, the absence of clear legal frameworks for extraterrestrial activities, and the fluidity of space habitats make it difficult to establish clear rules governing private law relations in space.

Enforcement mechanisms and dispute resolution mechanisms pose further challenges. The remoteness of space missions and the vast distances involved render traditional enforcement mechanisms impractical. Moreover, the absence of a universally recognized authority to enforce judgments or arbitral awards complicates efforts to resolve disputes arising from space activities.

Addressing these challenges requires a holistic approach that draws upon insights from various disciplines, including law, astrophysics, engineering, economics, and sociology. Interdisciplinary collaboration is essential to develop effective legal regimes that balance the interests of stakeholders while promoting fairness, predictability, and the rule of law.

Furthermore, international cooperation is paramount to the development of coherent legal frameworks for regulating private law relations in space. By working together, nations and international organizations can establish common principles and norms that provide a foundation for the peaceful and sustainable exploration of outer space.

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ГУМАНІТАРНЕ РОЗМІНУВАННЯ В УКРАЇНІ: ГЛОБАЛЬНІ ВИКЛИКИ

Оксана Бойко, кандидат наук з державного управління, старший викладач кафедри інновацій, інформаційної діяльності в освіті та навчання за міжнародними проєктами, Інституту державного управління та наукових досліджень з цивільного захисту, Київ, Україна

Одним із наслідків триваючої вже майже три роки російсько-української війни є статус України як однієї з найбільш забруднених вибухонебезпечними предметами країн світу, що призвело до нових викликів та проблем, зокрема у сфері протимінної діяльності.

Так, станом на 1 січня 2024 р., за даними Національного органу з питань протимінної діяльності, що верифіковані в системі управління інформацією з протимінної діяльності (IMSMA), загальна площа територій, які зазнали безпосереднього впливу російської збройної агресії, становить майже 156 тис. кв. кілометрів. Водночас така оцінка не є остаточною, оскільки на території України тривають активні бойові дії [7].

Загальна ситуація, що склалася, негативно впливає на безпеку населення та його життєдіяльність, соціально-економічний розвиток регіонів та держави, що спричинило виникнення проблемних питань у сфері протимінної діяльності, інших сферах діяльності держави.

Повоєнна відбудова нашої країни потребуватиме повного очищення її території від вибухонебезпечних предметів.

Планом пріоритетних дій Уряду на 2024 рік передбачено: проведення гуманітарного розмінування деокупованих територій для

відновлення нормальних умов життєдіяльності населення та зменшення ризиків від вибухонебезпечних предметів; підвищення спроможностей піротехнічних підрозділів ДСНС; організацію вітчизняного виробництва спеціальної техніки та обладнання для гуманітарного розмінування; створення системи пріоритизації забруднених територій, що підлягають гуманітарному розмінуванню відповідно до їх економічної, соціальної, безпекової важливості; реалізацію експериментальних проектів щодо здійснення обов'язкової сертифікації механізованих засобів гуманітарного розмінування, пов'язаних з ними виробів, компонентів та обладнання і щодо сертифікації операторів протимінної діяльності та процесів протимінної діяльності [6].

Важливим стало схвалення в Україні Національної стратегії протимінної діяльності на період до 2033 року та затвердження операційного плану заходів з її реалізації у 2024-2026 роках. Ця Стратегія є довгостроковим програмним документом, що визначає проблеми, які становлять загрозу національній безпеці через забруднення вибухонебезпечними предметами територій України внаслідок російської збройної агресії, а також основні напрями і завдання державної політики у сфері протимінної діяльності та шляхи реалізації національних інтересів України у сфері протимінної діяльності, що визначаються відповідними стратегічними цілями [7].

В Україні також в стислі терміни створено організаційно-правові засади діяльності у сфері гуманітарного розмінування, які регламентують Закон України «Про протимінну діяльність в Україні», Порядок ведення обліку операторів протимінної діяльності, затверджений постановою Кабінету Міністрів України від 3 листопада

2021 року № 1150, постанова Кабінету Міністрів України від 11 серпня 2023 року № 1188 «Про внесення до деяких постанов Кабінету Міністрів України змін з питань протимінної діяльності», інші нормативно-правові документи.

Закон України «Про протимінну діяльність в Україні» визначає правові та організаційні засади здійснення протимінної діяльності та особливості державного регулювання у відповідній сфері. Розмінування (гуманітарне розмінування) – це комплекс заходів, які проводяться операторами протимінної діяльності з метою ліквідації небезпек, пов'язаних із вибухонебезпечними предметами, включаючи нетехнічне та технічне обстеження територій, складання карт, виявлення, знешкодження та (або) знищення вибухонебезпечних предметів, маркування, підготовку документації після розмінування, надання громадам інформації щодо протимінної діяльності та передачу очищеної території [3].

Протимінна діяльність – це заходи, що проводяться з метою забезпечення національної безпеки та спрямовані на зменшення соціального, економічного та екологічного впливу вибухонебезпечних предметів на життя та діяльність населення.

До проведення розмінування (гуманітарного розмінування) в Україні залучаються фахівці з розмінування операторів протимінної діяльності – уповноважених підрозділів центральних органів виконавчої влади, підприємств, установ та організацій незалежно від форми власності, у тому числі міжнародних та іноземних, що залучаються до проведення заходів у сфері протимінної діяльності.

Суб'єктами протимінної діяльності згідно чинного національного законодавства є: Національний орган з питань протимінної діяльності;

уповноважені органи виконавчої влади у сфері протимінної діяльності, місцеві державні адміністрації та органи місцевого самоврядування; центр протимінної діяльності та центр гуманітарного розмінування; оператори протимінної діяльності.

Кабінет Міністрів України у сфері протимінної діяльності забезпечує проведення державної політики у сфері протимінної діяльності, здійснює державне регулювання у цій сфері; забезпечує розроблення та виконання державних програм у сфері протимінної діяльності; координує діяльність міністерств, інших центральних органів виконавчої влади та державних органів, місцевих органів виконавчої влади та органів місцевого самоврядування підприємств та організацій незалежно від форми власності, що залучаються до проведення заходів у сфері протимінної діяльності.

Питання гуманітарного розмінування займають сьогодні чільне місце в порядку денному діяльності як центральних так і місцевих органів виконавчої влади, відмічається їх зростання з геометричною прогресією.

Так, на виконання статті 21 Закону України «Про протимінну діяльність в Україні» Кабінетом Міністрів України внесено зміни до положень про Міністерство оборони, Міністерство внутрішніх справ, Державну службу України з надзвичайних ситуацій, Міністерство охорони здоров'я, Міністерство освіти і науки, Міністерство закордонних справ, Міністерство у справах ветеранів, Міністерство з питань стратегічних галузей промисловості, Міністерство захисту довкілля та природних ресурсів, Міністерство аграрної політики та продовольства та Національну соціальну сервісну службу щодо покладання на них завдань участі у реалізації державної політики у

сфері протимінної діяльності в частині гуманітарного розмінування та виконанні міжнародних зобов'язань України з урахуванням національних інтересів у межах своїх повноважень та у взаємодії з Національним органом з питань протимінної діяльності, центром протимінної діяльності та центром гуманітарного розмінування.

Взаємодію центральних органів виконавчої влади з питань протимінної діяльності в частині гуманітарного розмінування забезпечує Міністерство економіки України, відповідно до покладених на нього завдань. В апараті Мінекономіки утворене та функціонує Управління з питань гуманітарного розмінування.

За інформацією Національного органу з питань протимінної діяльності від початку широкомасштабної збройної російської агресії державні оператори протимінної діяльності вже обстежили та розмінували 5308 км квадратних української території [5].

Піротехнічними підрозділами ДСНС лише впродовж 2023 року здійснено близько 40 тис. виїздів, виявлено та знешкоджено понад 153 тис. вибухонебезпечних предметів, обстежено та розміновано територію загальною площею понад 36 тис. га, з них 14 тис. 217,5 га акваторії водних об'єктів, у тому числі очищено за допомогою машин механізованого розмінування 511,2 га території. Основні зусилля було зосереджено на виконанні робіт із розмінування деокупованих територій Донецької, Київської, Миколаївської, Сумської, Харківської, Херсонської та Чернігівської областей. Всього на деокупованих територіях піротехнічними підрозділами ДСНС обстежено 424 км автодоріг, 4 тис. 459,8 км ліній електромереж, 22,8 км залізничних колій, 259,4 км газопроводів, 613 об'єктів та 5 тис. 307 домогосподарств. Реалізується План заходів із розмінування (гуманітарного

розмінування) земель сільськогосподарського призначення, який схвалено на засіданні Національного органу з протимінної діяльності. Планом визначено 1 тис. 409 ділянок загальною площею 470 тис. га на території Дніпропетровської, Запорізької, Київської, Миколаївської, Сумської, Харківської, Херсонської, Черкаської, Чернігівської областей. Координацію заходів Плану покладено на обласні військові адміністрації. На виконання Плану піротехнічними підрозділами ДСНС проведено нетехнічне обстеження понад 121 тис. 584 га, розміновано близько 7 тис. га земель сільськогосподарського призначення [2].

Подальшому вдосконаленню гуманітарного розмінування в Україні сприяє також міжнародне співробітництво, зокрема з питань формування ринку гуманітарного розмінування, технічного оснащення відповідних підрозділів та підготовки фахівців. Цьому сприяла проведена в 2023 році в Загребі (Республіка Хорватія) перша міжнародна донорська конференція з гуманітарного розмінування. І це не випадково, адже в Хорватії війна завершилася в 1995 році, а розмінування планується завершити 2026 року [4].

ДСНС у 2023 році від міжнародних партнерів отримано 30 машин механізованого розмінування, наразі працює на території України 31 машина механізованого розмінування (MineWolf MW-370, Armtrak 400, DOK-ING MV-10, DOK-ING MV-4, GCS-200, DIGGER, REVIVAL P) [2].

Перспективним також є подальше проведення наукових досліджень з питань гуманітарного розмінування, зокрема з метою їх практичного використання операторами протимінної діяльності, вдосконалення національного законодавства з цих питань.

Останнім часом наукові дослідження у сфері протимінної діяльності здійснили М. Артикула, Р. Беспалько, Є. Бірюков, Р. Валерко, Б. Ворович, А. Гаваза, Л. Герасимчук, М. Геращенко, В. Горбулін, С. Горєлишев, Т. Гуцул, О. Журахов, І. Заблодська, М. Іванець, І. Казімір, М. Козяр, І. Лаппо, В. Матухно, І. Ментус, К. Мирончук, С. Мосов, Д. Окіпняк, І. Пацева, С. Потеряйко, Є. Саприкін, Є. Стецюк, В. Ткач, І. Толкунов, М. Хобзей, О. Червотока, В. Ясько та інші.

Слід виокремити наукове дослідження В. Горбуліна «Світова глобальна проблема розмінування: український вектор». Ним проведено всебічний аналіз світової глобальної проблеми розмінування з проекцією на Україну. На системних засадах розглянуто наслідки і проблемні питання мінних війн для світу та України, проаналізовано розроблення засобів виявлення мін в інших країнах світу і ситуацію з розмінуванням українських територій [1].

Таким чином, вищенаведене свідчить про глобальність проблеми розмінування в України і необхідність застосування інноваційних підходів до її розв'язання; створення новітніх комплексів і засобів виявлення вибухонебезпечних предметів; сучасної системи підготовки фахівців для виконання робіт із гуманітарного розмінування; активізації міжнародного співробітництва у сфері протимінної діяльності та подальших наукових досліджень практичного спрямування; впровадження передового досвіду розмінування територій тощо.

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INNOVATION MARKETING IN THE SMART SOCIETY

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The advent of technology has ushered in a new era characterized by the emergence of SMART societies – environments that integrate digital technologies into everyday life. In such settings, innovation marketing plays a crucial role in meeting the evolving needs of consumers who demand tailored and efficient solutions. This paper explores the strategies employed in innovation marketing within SMART societies, analyzing how companies adapt their approaches to resonate with a tech-savvy audience. This study highlights key strategies such as co-creation with customers, the use of big data for personalized marketing, and a focus on sustainability. Furthermore, the challenges posed by rapid technological advancements and privacy concerns are discussed. The findings suggest that for businesses to thrive in a SMART society, they must embrace flexibility, prioritize consumer engagement, and uphold ethical marketing practices.

In recent years, the concept of SMART societies has gained significant traction, redefining how technology interacts with daily life. The term «SMART» encompasses a set of principles – Specific, Measurable, Achievable, Relevant, and Time-bound – that guide the development and implementation of technologies aimed at improving the quality of life for individuals and communities. These societies leverage advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI),

and big data to create interconnected systems that enhance efficiency, sustainability, and user experience.

As SMART technologies become increasingly integrated into various sectors, including healthcare, transportation, and urban planning, the role of innovation marketing has become more critical than ever. Marketing strategies must evolve to cater to a digitally empowered consumer base that not only seeks innovative products but also demands personalized experiences and transparency from brands. In this dynamic environment, traditional marketing approaches may no longer suffice, necessitating a shift toward innovative marketing strategies that align with the values and expectations of a SMART society.

This paper aims to investigate how companies adapt their marketing strategies for innovation in response to the unique challenges and opportunities presented by SMART societies, namely: to analyze key marketing strategies that effectively promote innovations in a technologically advanced environment; to identify the challenges faced by marketers in a SMART society, including data privacy concerns and the rapid pace of technological change; to examine real-world case studies of organizations successfully employing innovative marketing practices in SMART contexts.

The concept of a SMART society has evolved significantly over the past two decades, largely due to advancements in technology. SMART societies are characterized by their ability to utilize digital technologies to enhance quality of life, improve urban infrastructure, and create more efficient systems. According to, a SMART society employs technology to manage resources effectively and improve citizen engagement. This is achieved

through the integration of various technologies, including the Internet of Things (IoT), artificial intelligence (AI), and big data analytics [10].

IoT devices have revolutionized everyday life by enabling the interconnection of various objects, leading to increased efficiency and convenience. For example, smart home devices allow users to control lighting, heating, and security remotely, enhancing comfort and energy management [4]. As these devices proliferate, they generate vast amounts of data, which can be harnessed for innovative marketing strategies.

AI technologies play a critical role in processing large datasets and deriving actionable insights. Businesses utilize AI for predictive analytics, which helps in understanding consumer behavior and preferences [3]. The incorporation of AI into marketing strategies allows for more personalized consumer experiences, fostering deeper connections between brands and customers.

The rise of big data analytics enables organizations to gather, analyze, and leverage consumer data to inform marketing strategies. By understanding customer patterns and preferences, companies can tailor their products and marketing efforts to meet the specific needs of their target audience. This trend is particularly relevant in a SMART society, where consumers expect brands to be responsive and relevant.

The integration of these technologies into the fabric of society has profound implications for marketing. The shift towards a SMART society has redefined consumer expectations, with individuals increasingly seeking personalized and immediate solutions to their needs. This paradigm shift necessitates innovative marketing approaches that are agile, data-driven, and consumer-centric.

Innovation marketing refers to the strategies employed by companies to promote and deliver new products and services to the market. Unlike traditional marketing, which often focuses on promoting existing products, innovation marketing emphasizes the introduction of novel solutions that meet emerging consumer needs. According to, effective innovation marketing requires a deep understanding of market dynamics and consumer behavior [6].

As marketing strategies evolve in response to the characteristics of SMART societies, several key trends have emerged.

Consumers increasingly expect personalized experiences tailored to their preferences. Companies are leveraging data analytics to create targeted marketing campaigns that resonate with specific audience segments [1].

There is a growing emphasis on sustainability and corporate social responsibility in marketing efforts. Consumers are more inclined to support brands that demonstrate a commitment to environmental and social issues [7].

The rise of social media and digital platforms has transformed how brands interact with consumers. Companies are utilizing these channels to foster direct engagement, gather feedback, and build communities around their products [5].

The use of big data allows marketers to make informed decisions based on real-time insights. This data-driven approach enables companies to optimize their marketing strategies and improve overall effectiveness [2].

Many organizations successfully employed personalized marketing strategies that leverage big data analytics to tailor their offerings to individual consumer preferences. For instance, a leading e-commerce platform utilizes machine learning algorithms to analyze consumer

behavior, enabling the creation of highly personalized product recommendations. This approach not only enhances customer satisfaction but also increases conversion rates.

Companies such as LEGO have actively engaged their customers in the design process through platforms that allow users to submit ideas for new products. This strategy not only fosters consumer loyalty but also ensures that the final products align closely with market demands.

In a SMART society, sustainability is increasingly important to consumers. Brands that effectively communicate their commitment to sustainability and ethical practices often enjoy a competitive advantage. For example, a leading outdoor apparel company emphasizes its use of recycled materials and environmentally friendly production processes in its marketing campaigns, resonating with environmentally conscious consumers. The integration of digital marketing channels is crucial in a SMART society. Companies that leverage social media, mobile apps, and other digital platforms to engage with consumers in real time have reported higher levels of brand engagement. For instance, a global cosmetics brand uses social media influencers to promote new products, creating buzz and encouraging consumer interaction.

Successful organizations actively solicit and incorporate consumer feedback into their marketing strategies. Surveys, focus groups, and social media interactions are utilized to gather insights that inform product development and marketing campaigns. For example, a tech company frequently conducts user surveys to understand customer satisfaction and areas for improvement, allowing for agile responses to consumer needs. Many brands have focused on creating communities around their products [8-9].

This involves fostering interaction among consumers, allowing them to share experiences and ideas. For instance, a fitness brand has developed an online community where users can share workout routines and motivational stories, enhancing brand loyalty and customer retention. Providing valuable educational content has emerged as a prominent strategy for engaging consumers. Companies that produce informative content–such as tutorials, webinars, and blog posts–position themselves as industry leaders while building trust with their audience. For example, a health and wellness brand produces a series of video tutorials on healthy cooking, which not only promotes their products but also educates consumers on nutrition.

As companies increasingly rely on consumer data to inform their marketing strategies, concerns about data privacy have become paramount. Organizations face challenges in navigating privacy regulations while still gathering the insights needed for effective marketing. The implementation of stricter data protection laws, such as the General Data Protection Regulation (GDPR), has prompted companies to reevaluate their data collection and usage practices.

The fast pace of technological advancements poses a challenge for marketers to keep up with the latest tools and trends. Organizations must invest in continuous learning and adaptation to ensure that their marketing strategies remain relevant in the face of evolving technologies.

While innovation is essential, companies must also consider the preferences of consumers who may be more traditional in their values. Striking a balance between innovative practices and maintaining a sense of brand identity can be challenging, as companies seek to appeal to diverse audience segments.

In summary, the results of this study indicate that innovation marketing in SMART societies requires a multifaceted approach that emphasizes personalization, consumer engagement, and sustainability. However, organizations must also navigate challenges related to data privacy and technological change. The next section will discuss the implications of these findings and offer recommendations for businesses looking to enhance their innovation marketing strategies. The findings of this study highlight the transformative impact of SMART societies on innovation marketing strategies.

While this study provides valuable insights into innovation marketing in SMART societies, several areas warrant further exploration. Examining how marketing strategies evolve over time in response to technological advancements and changing consumer preferences could provide deeper insights into effective innovation marketing practices.

Investigating how different industries implement innovation marketing strategies in SMART societies could reveal unique challenges and best practices that are applicable across various sectors.

Further research could explore the implications of emerging technologies, such as blockchain or augmented reality, on innovation marketing strategies and consumer engagement in SMART societies.

In conclusion, the intersection of innovation marketing and SMART societies presents both opportunities and challenges for organizations. By embracing personalization, co-creation, sustainability, and digital engagement, companies can effectively navigate this dynamic landscape. However, they must also address the challenges of data privacy, rapid technological change, and the need to balance innovation with traditional values.

The exploration of innovation marketing within SMART societies reveals a complex landscape where technology and consumer expectations intersect. This study highlights the critical role that personalized, consumer-centric strategies play in effectively engaging today's tech-savvy audience. As organizations strive to adapt to the demands of SMART societies, several key conclusions emerge:

– in a world where consumers are inundated with choices, the ability to deliver personalized marketing experiences has become essential. Companies that leverage big data and analytics to tailor their offerings not only enhance customer satisfaction but also drive loyalty and retention. As consumers continue to expect tailored experiences, organizations must invest in the necessary infrastructure and capabilities to fulfill this demand;

– the practice of co-creating with consumers has proven to be a valuable strategy for innovation marketing. By involving customers in the product development process, companies can better align their offerings with market needs and foster a sense of community and brand loyalty. Organizations should seek to establish platforms that facilitate this co-creation process, encouraging feedback and collaboration;

– as awareness of environmental and social issues grows, consumers are increasingly drawn to brands that prioritize sustainability and ethical practices. Organizations must ensure that their marketing strategies reflect a genuine commitment to these values, as consumers are quick to discern superficial efforts. Transparency and accountability in sustainability practices are essential for building consumer trust;

– the importance of digital platforms in engaging consumers cannot be overstated. Organizations must develop a robust online presence and utilize social media to foster real-time interactions with their audience. This digital

engagement not only enhances brand visibility but also allows for immediate feedback, enabling organizations to adapt their strategies effectively;

– while the opportunities presented by innovation marketing in SMART societies are substantial, organizations must also confront the challenges of data privacy, rapid technological changes, and the need to balance innovation with traditional values. By adopting ethical marketing practices, fostering a culture of continuous learning, and understanding diverse consumer preferences, companies can navigate these challenges successfully.

In summary, innovation marketing in SMART societies represents a frontier for businesses seeking to thrive in an increasingly interconnected world. By embracing personalization, co-creation, sustainability, and digital engagement, organizations can create meaningful connections with consumers and drive their success in a rapidly evolving landscape.

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МІЖДИСЦИПЛІНАРНІ ПІДХОДИ ДО ВИВЧЕННЯ ІНОЗЕМНИХ МОВ

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Міждисциплінарне навчання набуває все більшого значення в освіті, долаючи розриви між традиційними галузями знань, збагачуючи результати навчання та сприяючи більш повному розумінню. Інтегруючи методи, інструменти та ідеї з різних дисциплін, міждисциплінарне навчання розвиває аналітичні, когнітивні та практичні навички студентів, дозволяючи їм вирішувати складні проблеми з різних точок зору. Такий підхід є особливо корисним у сучасному глобалізованому світі, де адаптивність і всебічна освітня база є запорукою успіху. В останні роки освітяни почали застосовувати міждисциплінарні методи для вивчення іноземних мов, створюючи нові ефективні способи взаємодії учнів з мовою, що виходять за рамки традиційних граматичних і словникових вправ **[5]**

У контексті вивчення іноземних мов міждисциплінарні підходи означають використання знань з таких галузей, як психологія, когнітивні науки, технології, культурологія і навіть фізичне виховання, щоб покращити залученість студентів та їхнє утримання в навчанні. Психологія, наприклад, пропонує цінну інформацію про збереження пам'яті, мотивацію та когнітивне навантаження, які відіграють вирішальну роль у вивченні мови. Методи когнітивної науки, такі як повторення через певні проміжки часу та активне пригадування, використовують ці психологічні знання для покращення запам'ятовування та вільного володіння мовою. Нейролінгвістика, підгалузь неврології, також робить свій внесок, вивчаючи, як мозок

обробляє мову, допомагаючи викладачам розробляти вправи, які стимулюють мовні центри в мозку, підтримуючи більш ефективне навчання.

Технології - ще один потужний компонент міждисциплінарної мовної освіти. Завдяки досягненням у галузі штучного інтелекту адаптивне програмне забезпечення для вивчення мов тепер забезпечує індивідуальний досвід, який підлаштовується під темп, рівень навичок та вподобання учня. Такі платформи, як Duolingo і Babbel, використовують моделі на основі штучного інтелекту для персоналізації контенту, а такі інструменти, як розпізнавання мовлення і віртуальна реальність, пропонують захоплюючий досвід, що імітує використання мови в реальному світі. Ці технологічні інновації уможливлюють рівень взаємодії та занурення, якого раніше було важко досягти в мовних класах, роблячи навчання більш захопливим і реалістичним.

Культурологія також відіграє важливу роль у міждисциплінарному вивченні мови. Мова тісно переплітається з культурою, і розуміння звичаїв, цінностей та історичного контексту носіїв мови може покращити розуміння та комунікативні навички. Інтегруючи культурологічні студії, студенти отримують повніше, автентичніше розуміння мови, виходячи за межі синтаксису та структури, щоб оцінити ідіоматичні вирази, гумор та соціальні норми.

Завдяки міждисциплінарним методам студенти можуть взаємодіяти з мовою на різних рівнях, розвиваючи не лише мовні навички, але й когнітивну та культурну обізнаність. Такий комплексний підхід сприяє багатшому, ціліснішому вивченню мови, озброюючи учнів навичками, необхідними для орієнтації в складних

мультикультурних контекстах та ефективного використання мови в різних ситуаціях.

Сфери когнітивної науки та психології зробили значний внесок у розуміння того, як ми вивчаємо мови. Психологічні принципи, зокрема ті, що стосуються збереження пам'яті, когнітивного навантаження та мотивації, допомагають формувати ефективні практики вивчення мови. Наприклад, такі стратегії збереження пам'яті, як інтервал повторення, сприяють засвоєнню словникового запасу шляхом посилення контакту зі словами з плином часу, покращуючи довготривале запам'ятовування. Управління когнітивним навантаженням або обсягом розумових зусиль, які учень може витримати до того, як стане перевантаженим, має важливе значення для розробки мовних вправ, які є складними, але не розчаровують. Мотивація є ще одним критичним фактором; психологи визнають, що внутрішня мотивація (внутрішній інтерес і задоволення) може значно прискорити вивчення мови. Розуміння цих психологічних чинників дозволяє педагогам створювати привабливе та стійке навчальне середовище.

Теорії навчання — біхевіоризм, когнітивізм і конструктивізм — також впливають на мовну освіту. Біхевіоризм, зосереджений на формуванні звички через повторення та підкріплення, лежить в основі багатьох базових мовних вправ. Когнітивізм, зосереджений на психічних процесах, заохочує учнів активно працювати з мовою, встановлюючи зв'язки між новими та наявними знаннями. Конструктивізм, який наголошує на формуванні знань через досвід і контекст, підтримує стратегії мовного занурення, коли учні практикують навички мови в реальному світі. Разом ці теорії сприяють

створенню мовних програм, які стосуються різних стилів навчання та вподобань, забезпечуючи збалансований підхід, який підтримує всебічне засвоєння мови.

Нейролінгвістика, дослідження того, як мова репрезентується та обробляється в мозку, мала трансформаційний вплив на мовну освіту. Розуміючи, як мова функціонує неврологічно, педагоги можуть створювати навчальні дії, які стимулюють ділянки мозку, пов'язані з мовою. Наприклад, вправи, які залучають обидві півкулі, як-от поєднання мовних завдань із музикою, візуальними ефектами чи кінестетичною діяльністю, підтримують більш повне залучення мови та можуть покращити розуміння та запам'ятовування. Дослідження показують, що такі комплексні вправи допомагають активізувати зони як у лівій півкулі (структура мови та логіка), так і в правій півкулі (креативність і контекст), покращуючи як лінгвістичні, так і когнітивні навички..**[4]**

Культурологія має вирішальне значення для досягнення всебічної мовної освіти, оскільки мова глибоко пов'язана з цінностями, традиціями та світоглядом носіїв. Коли учні розуміють культурний контекст, вони отримують уявлення про мотивацію та значення, що стоять за виразами та ідіомами. Наприклад, розуміння культурної традиції чи свята може зробити певні фрази чи метафори зрозумілішими, додавши глибини до розуміння мови. Крім того, усвідомлення культурних нюансів, таких як відповідні способи привітання чи висловлення вдячності, допомагає учням більш ефективно орієнтуватися в розмові в реальному світі.

Порівняльні дослідження між культурами пропонують учням унікальний погляд на мовний контекст. Вивчаючи відмінності та

подібності, наприклад, через історичні контексти, літературу чи фольклор, студенти розвивають більш глибоке уявлення про тонкощі та унікальні аспекти мови. Наприклад, інтеграція навчального плану може включати вивчення літератури цільовою мовою або обговорення історичних подій для виявлення культурних цінностей, дозволяючи учням формувати мовні навички разом із культурним розумінням.

Соціальні науки, зокрема соціолінгвістика та антропологія, дають суттєве уявлення про те, як мова функціонує в суспільстві, пропонуючи цінний контекст для учнів. Соціолінгвістика, дослідження мови в її соціальному контексті, показує, як використання мови змінюється в різних регіонах, соціальних групах і ситуаціях. Для тих, хто вивчає мову, знайомство з діалектами, регіональними виразами та соціолектами — різними формами мови, що використовуються певними соціальними групами — розширює розуміння мовного розмаїття в реальному світі. Ці знання допомагають учням усвідомити, що мова не статична, а динамічна, змінюючись у різних контекстах. Наприклад, різниця між формальним і неформальним мовленням або сленгом, унікальним для певних вікових груп, ілюструє, як мова адаптується до ідентичності та потреб носіїв. Вивчаючи варіації мов, студенти набувають гнучкості у своїх навичках спілкування, допомагаючи їм орієнтуватися в різноманітних соціальних умовах і відповідно адаптувати використання мови.**[6]**

Антропологія також збагачує вивчення мови, досліджуючи, як мова вбудована в людські взаємодії та соціальні структури. Завдяки антропологічному розумінню студенти дізнаються, що мова – це не лише засіб спілкування, але й спосіб вираження ідентичності, соціальних відносин і культурних норм. Розуміння мови через

антропологію спонукає студентів розглянути, як цінності та звичаї формують мовні вирази. Практичні застосування, такі як рольові ігри, засновані на конкретних соціальних звичаях, дозволяють студентам практикувати мову в контексті. Наприклад, студенти можуть імітувати соціальні взаємодії, такі як сімейні збори, ділові зустрічі чи неформальні розмови, застосовуючи лінгвістичні та культурні знання для ефективного спілкування в певній соціальній структурі. Цей захоплюючий підхід допомагає учням зрозуміти культурні нюанси мови, сприяючи більш автентичному та культурно чутливому спілкуванню.

Міждисциплінарне проектне навчання пропонує практичні способи інтеграції багатьох аспектів вивчення мови. Проекти, які поєднують вивчення мови з культурними чи соціальними знаннями, поглиблюють залученість студентів і розуміння контексту. Наприклад, студенти можуть перекладати тексти, які мають культурне значення, або створювати двомовні презентації на тему, пов’язану з культурою цільової мови..**[1]** Такі проекти заохочують учнів заглиблюватися в культурні та соціальні аспекти мови, покращуючи їхнє розуміння та оцінку складності цільової мови.

Література та мистецтво також є потужними міждисциплінарними інструментами для мовного занурення. Аналізуючи тексти, фільми чи образотворче мистецтво, студенти можуть залучатися до мови на глибшому, деталізованішому рівні. Література пропонує багатий словниковий запас та ідіоматичні вирази, тоді як мистецтво розкриває культурний символізм та історичний контекст. Наприклад, читання роману цільовою мовою або вивчення культурно значущої картини дозволяє студентам інтерпретувати мову та культуру одночасно. **.[8]**

Цей комплексний підхід покращує як мовну, так і культурну грамотність, пропонуючи цілісне розуміння мови як втілення людського досвіду

Висновок

Міждисциплінарні підходи до вивчення мови об'єднують ідеї з таких галузей, як психологія, когнітивна наука, технології та соціальні науки, створюючи багату, багатогранну структуру для тих, хто навчається. Включаючи принципи збереження пам'яті, когнітивної активності, культурного розуміння та соціальної динаміки, цей підхід забезпечує більш ефективний і комплексний спосіб вивчення мов. Ознайомлення з різними дисциплінами дозволяє студентам оцінити контекстуальну та культурну глибину мови, покращуючи не лише їх вільне володіння, але й здатність до адаптації та культурну обізнаність.

Цей цілісний метод робить вивчення мови більш привабливим і релевантним для реальних ситуацій.[2] Наприклад, такі технології, як керовані штучним інтелектом мовні платформи, забезпечують персоналізовану практику, а соціолінгвістичні знання допомагають учням орієнтуватися в діалектах і регістрах, підвищуючи як компетентність, так і впевненість у спілкуванні.

У майбутньому міждисциплінарна мовна освіта може продовжувати розвиватися, охоплюючи нові галузі, такі як біоінформатика, що може сприяти нашому розумінню обробки мови та когнітивного навантаження. Крім того, прогрес у віртуальній реальності та доповненій реальності пропонує захоплюючий досвід, який може імітувати чуже середовище, дозволяючи учням практикувати мовні навички в автентичному середовищі. Інтегруючи такі інновації, міждисциплінарні підходи обіцяють зберегти мовну

освіту динамічною, адаптованою та глибоко пов’язаною з нашим постійно розширюваним розумінням як мови, так і навчання.

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ФОРМУВАННЯ МЕДІАЦІЙНИХ НАВИЧОК У КОНТЕКСТІ ПРОФЕСІЙНОЇ ПІДГОТОВКИ СОЦІАЛЬНИХ ПРАЦІВНИКІВ

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Медіація є важливим інструментом у професійній діяльності соціальних працівників, оскільки вона дозволяє ефективно вирішувати конфлікти, сприяючи досягненню взаєморозуміння між сторонами. Формування медіаційних навичок є невід'ємною частиною процесу підготовки майбутніх фахівців у сфері соціальної роботи. У статті розглядаються ключові аспекти медіації як частини професійної підготовки соціальних працівників та важливість її інтеграції в навчальні програми.

Медіація — це метод мирного вирішення конфліктів, який передбачає участь нейтрального посередника, що допомагає сторонам досягти взаємопов’язаного рішення [1]. Вона широко використовується в різних сферах соціальної роботи, від сімейних конфліктів до трудових суперечок. Медіація дозволяє уникнути ескалації конфліктів і створює можливість для конструктивного діалогу між сторонами. Для соціальних працівників медіація є не лише технікою вирішення суперечок, а й частиною загальної стратегії соціальної підтримки. Тому важливо забезпечити професійну підготовку фахівців з медіації, що дозволяє їм ефективно виконувати свою роль у складних ситуаціях.

Підготовка майбутніх соціальних працівників до медіації включає в себе кілька ключових етапів. Перш за все, це вивчення теоретичних основ медіації, включаючи принципи, методи та техніки вирішення конфліктів. Це дає студентам глибоке розуміння механізмів, за

допомогою яких можуть виникати конфлікти, а також дає можливість розвинути навички конструктивної комунікації.

Другим важливим аспектом є практична підготовка. Студенти повинні вміти застосовувати медіаційні навички в реальних умовах, що передбачає участь у спеціальних тренінгах, рольових іграх та симуляціях. Такі практичні заняття дозволяють студентам розвивати впевненість у своїх силах, покращувати комунікативні навички та здатність до неупередженого вирішення конфліктів.

Медіація має важливе значення для соціальних працівників, оскільки дозволяє створити більш здорове соціальне середовище, де проблеми вирішуються мирним шляхом. Вона допомагає зменшити рівень насильства, запобігає ескалації конфліктів і сприяє відновленню довіри між сторонами.

Соціальні працівники, які володіють медіаційними навичками, можуть ефективно допомагати людям у вирішенні особистих та соціальних конфліктів, тим самим сприяючи соціальній згуртованості та стабільності [2]. Це особливо важливо в умовах постійних соціальних та економічних змін, а також у ситуаціях, коли конфлікти можуть мати серйозні наслідки для окремих осіб або громад.

Незважаючи на численні переваги медіації, її інтеграція в навчання соціальних працівників не завжди є достатньо ефективною. Однією з основних проблем є відсутність єдиного стандарту підготовки медіаторів у сфері соціальної роботи. Для покращення цієї ситуації важливо розробити більш детальні навчальні програми та включати медіацію як обов'язковий елемент професійної підготовки.

Іншою проблемою є відсутність достатнього досвіду та кваліфікації серед викладачів медіації в багатьох навчальних закладах.

Тому важливо організувати курси підвищення кваліфікації для викладачів та створювати можливості для обміну досвідом між різними освітніми установами.

Як висновок, можна зазначити, що формування медіаційних навичок у майбутніх соціальних працівників є важливою складовою їх професійної підготовки. Медіація дозволяє ефективно вирішувати конфлікти, сприяє збереженню миру та стабільності в суспільстві. Для успішної інтеграції медіації в професійну підготовку соціальних працівників необхідно розробити комплексні навчальні програми, удосконалювати методику викладання та забезпечити належний рівень практичної підготовки.

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RESTORATION OF UKRAINE'S HUMAN RESOURCE POTENTIAL UNDER INTENSIFIED MIGRATION PROCESSES

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Over the past decade, Ukraine has experienced a significant reduction in its human resource potential. In 2013, according to the State Statistics

Service of Ukraine, the number of employed individuals was 19.3 million [1]. However, by 2023, estimates from the Ukrainian Institute for the Future indicated a decrease to 9 million [2]. This represents a loss of nearly half of the country's working-age population. Such a dramatic change carries profound economic and social implications. The decline in human resources adversely affects overall productivity, hinders economic growth, and limits the state's capacity to provide social guarantees. Addressing this issue is critical to ensuring sustainable development and social stability [3].

The primary driver of increased migration of Ukraine’s human resources since 2022 has been the full-scale invasion of independent Ukraine by the russian federation. Frequent and prolonged power outages in July 2024 became a significant catalyst for migration processes. Within just one month, over 160,000 people left the country in search of better living conditions abroad. Since the beginning of the year, the total number of citizens forced to leave their homes has reached 400,000 [4]. The dynamics of migrant numbers since the onset of the full-scale invasion are illustrated in Figure 1.

These indicators are confirmed by the macroeconomic and monetary review of the National Bank of Ukraine for September 2024. The document, based on data from the UN, presents a comparison of migration dynamics: as of August 19, 2024, the number of Ukrainians registered as migrants in various countries worldwide stood at 6.739 million. In comparison, the previous month this figure was 6.58 million. Thus, the monthly increase amounted to 160,000 people, which is one of the highest migration rates in 2024 [5].

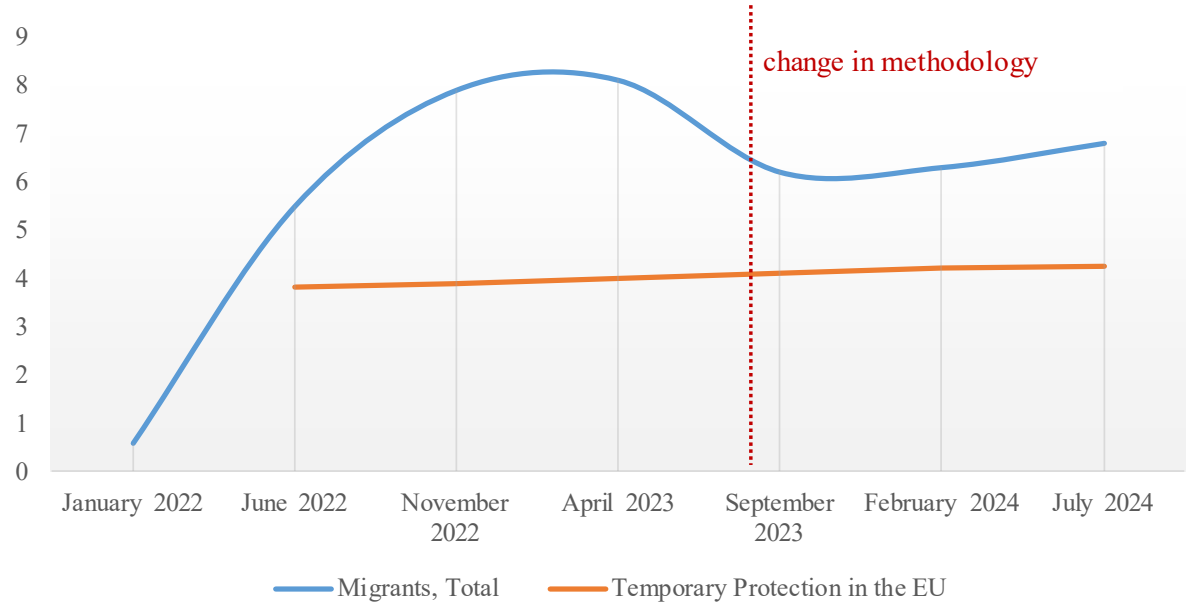

Figure. 1. Number of migrants since the beginning of the full-scale invasion, million people

*Compiled by the author based on [5, 6]

The growth of migration flows has multifaceted causes. The deterioration of living conditions due to frequent power supply disruptions increases the overall stress level among the population, complicates business operations, reduces labor productivity, and negatively affects access to basic services. Combined with military threats, socio-economic instability, and uncertainty regarding the country's recovery prospects, this creates a favorable environment for the growth of emigration sentiments.

The scale of this phenomenon draws particular attention, as the significant outflow of the population, primarily of working age, will have long-term consequences for Ukraine's economy. Furthermore, according to research, around 70% of refugees hold higher education degrees, which significantly exceeds the corresponding indicator among labor migrants before the war, as well as among the working population within the country. The high educational level of displaced individuals contributes to their quick

adaptation and integration into the societies of host countries, as already demonstrated by the experience of the first year of the war. Many countries hosting Ukrainian refugees are actively interested in their long-term integration, creating appropriate socio-economic conditions. This, in turn, may reduce the likelihood of these citizens returning to Ukraine even after the war ends. It could lead to a prolonged labor shortage, particularly concerning specialists needed for post-war reconstruction processes and economic recovery. This trend poses a threat to socio-economic development and could significantly slow down recovery efforts. The loss of human capital, reduced domestic demand, and potential losses of intellectual capital may substantially affect the pace of post-war state recovery.

To mitigate the effects of mass migration, a comprehensive strategy must be developed. This strategy should include measures to improve infrastructure, ensure stable energy supply, create conditions for entrepreneurship and investment development, as well as expand support programs for the population. It is especially important to stimulate the return of citizens who temporarily left abroad through the implementation of reintegration programs and involving the Ukrainian diaspora in the country's recovery process.

Thus, the mass migration of human capital, driven by challenging socio-economic and energy conditions, is not only a demographic challenge but also a critical factor that affects the state's ability to recover quickly and effectively.

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ENHANCING THE STUDY AND TEACHING OF PHILIPPINE HISTORY AND CULTURE: TOWARDS INCLUSIVITY AND TRUTH

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The study and teaching of Philippine history require urgent revision to counter historical revisionism and provide a comprehensive narrative of the nation's past. This includes a critical reevaluation of controversial periods such as the Martial Law years (1972–1986) and the integration of historically marginalized communities, particularly the Muslim and Indigenous Peoples (IPs). This article emphasizes the need to "enhance" history education in both

basic and higher education, fostering an inclusive history that reflects the multicultural and multi-ethnic nature of Philippine society.

Introduction

The teaching of Philippine history has long been criticized for its lack of inclusivity and a narrow focus on dominant narratives. Recent attempts at historical revisionism, particularly concerning the Martial Law period under Ferdinand Marcos, underscore the urgency of revisiting and enhancing history education. Furthermore, the marginalization of Muslims and Indigenous Peoples in mainstream history curricula perpetuates an incomplete understanding of the nation's heritage and diversity.

This article examines the need for a restructured approach to history education that addresses these gaps, aiming to create an inclusive and truthful representation of Philippine history.

Revisiting Philippine History: Countering Historical Revisionism

The Martial Law era (1972–1986) remains a contentious period in Philippine history. While it is remembered by many as a time of authoritarian rule, human rights abuses, and economic decline, efforts to "sanitize" this era have gained traction in public discourse. These attempts at revisionism distort historical facts, mislead younger generations, and hinder the pursuit of historical justice.

To counteract these trends, educators must ensure that history teaching is grounded in verified sources, critical analysis, and diverse perspectives. The integration of primary documents, survivor testimonies, and scholarly analyses into the curriculum can provide students with a nuanced understanding of this critical period.

Towards an Inclusive History: Recognizing Marginalized Communities

The dominant narrative of Philippine history often centers on the experiences of Christian lowland Filipinos, neglecting the rich histories and cultures of Muslim and Indigenous Peoples. This omission reinforces stereotypes, perpetuates discrimination, and alienates these communities from the broader national identity.

The History of Muslim Filipinos

Muslim Filipinos have played a significant role in resisting colonial rule and preserving their cultural heritage. From the establishment of the Sultanates of Sulu and Maguindanao to their struggles against Spanish, American, and post-independence governments, their history is marked by resilience and resistance. Including these narratives in history curricula fosters understanding and appreciation of their contributions to the nation.

The History of Indigenous Peoples (IPs)

The Indigenous Peoples of the Philippines, comprising diverse ethno-linguistic groups, possess unique traditions, governance systems, and worldviews. Their histories often highlight their relationship with the environment, struggles for ancestral land rights, and resistance to assimilation. Recognizing these contributions enriches the national narrative and promotes cultural pride.

Enhancing the Study and Teaching of Philippine History

To create an inclusive and accurate history, several key actions are necessary:

Curriculum Reforms

Integrate the histories of Muslims and IPs into all levels of education, emphasizing their cultural and historical significance.

Ensure that critical periods like Martial Law are taught with comprehensive and factual resources.

Teacher Training

Provide educators with specialized training to teach sensitive and complex historical topics effectively.

Develop resources that equip teachers to handle diverse perspectives and foster critical thinking among students.

Use of Multimodal Resources

Incorporate multimedia tools, such as documentaries, oral histories, and digital archives, to engage students and present diverse viewpoints.

Leverage technology to make historical materials accessible to a wider audience.

Community Collaboration

Engage with Muslim and Indigenous communities to co-create historical materials that authentically represent their experiences and voices.

Encourage partnerships between schools, local historians, and cultural organizations.

Critical Thinking and Historical Analysis

Promote activities that encourage students to analyze sources, question biases, and draw their conclusions about historical events.

Use project-based learning to deepen understanding of historical complexities.

The Role of Inclusive History in Nation-Building

An inclusive history fosters national unity by acknowledging the diverse experiences and contributions of all Filipinos. It challenges monolithic narratives and empowers marginalized communities by validating their stories. This approach not only enriches historical understanding but also promotes empathy, respect, and social cohesion.

Conclusion

Revisiting and enhancing the teaching of Philippine history is a vital step toward truth and inclusivity. By addressing the distortions of historical revisionism and integrating the narratives of marginalized communities, educators can cultivate a generation of informed and critical thinkers. This effort requires the collaboration of educators, policymakers, historians, and communities to ensure that Philippine history reflects the nation's rich diversity and complex past.

An inclusive history is not just a reflection of the past—it is a foundation for a just and united future.

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IMPLEMENTATION OF PUBLIC-PRIVATE PARTNERSHIP PROJECTS

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Great infrastructure projects with state participation will involve a high frequency of innovative developments and will require significant financial, material and human resources, which come from both the side of the state and business. At the same time, such projects carry a high degree of uncertainty and cumulative risks associated with current events of geopolitical instability and economic and social changes that are constantly changing. It is a current practice, both domestically and abroad, that great infrastructure projects are held in high regard by the community at all stages of their implementation. In this case, changes in the settings of the parameters can cause a negative reaction from the population, which can lead to high financial and reputational losses for all participants in the public-private partnership.

The revelation of low-level problems in the sphere of preparation and implementation of large infrastructure projects makes it particularly important to theoretically, methodologically and instrumentally support the complex of management actions related to these are implemented at different levels of the government administration system. At its core, the development and thorough development of essential analysis tools, assessment and risk management of public-private partnerships to implement large infrastructure projects is one of the key tasks of current risk management, This is the basis of the long-term government's trade and the domestic business.

The results of the investigation were followed by an addition that expands the characteristics of the daily risks management process within the framework of a public-private partnership based on the appearance of five key elements that are located in the middle of the steady management cycle risks within the project implementation stages. The development of the skin from the heel of the key elements may result from the overall goals and objectives of the implemented DPP project, with the regulation of the particularities of the interaction between the participants of the public-private partnership at various stages of implementation of the DPP project. The element "Socio-economic effects" is the basis for the implementation of the great infrastructure DPP project through its interaction with the interests of the state, the population, improved quality of life and well-being partnership in general, which represents the key objectives of the DPP project. "Socio-economic effects" form the basis of negotiations between the upcoming participants of the power-private partnership regarding the government's vision of funding, various subsidies and benefits for DPP projects.

Based on the results of the assessment and assessment of warehouse socio-economic effects, the initiators of the DPP project must proceed to the conclusion that the DPP project cannot ensure the achievement of national goals or the low influx on The socio-economic development of marriage and the parameters of the DPP project may be changed. Such elements as "Form of DPP" and "Organizational and management model" for the correctness of their choice, even at the initial stage. The interconnections between these elements are revealed in the fact that the form of the DPP project is the basis for the organizational and management model that is being fragmented. At this stage, a clear model of managing the DPP project at various stages of its

implementation is emerging, which allows us to later identify the weaknesses of the participants (incompetence, marriage, etc.), What allows me to reduce the risks of the DPP project by replacing participants or adjusting their activities. The element "Risks Matrix" is the result of structuring the DPP project and identifying risks at the advanced stages.

The risk matrix is the basis for negotiations between the key participants in the power-private partnership to develop a solution to a fair distribution of risks and areas of responsibility within the framework of the DPP project. The significance of this element is due to the fact that the factors not represented in the matrix will not be included in the basis of future contractual and other legally executed documents, which may become the subject of superfluous discrepancies, as a result of which money will be spent on the DPP project. The terms of its implementation may vary greatly. The element "Control and visibility system" provides the robot with a clear-cut control and visibility system based on information support, as well as a new function of predictive identification of parameters for the DPP project in the form of tasks value (including illegal activities of participants). This allows for preventive measures to be taken in order to eliminate the occurrence of damage, ensuring the minimization or exclusion of possible risks for the participants of the public-private partnership. Taken together, these elements form a comprehensive statement about the basis of mutual cooperation within the framework of a public-private partnership, which allows the management of the organization and government authorities to implement the implementation of DPP projects from the given level of effectiveness and satisfaction of interests of all participants.

The choice of the form of implementation of DPP projects depends on the parameters of the projects, participants, financing schemes, as well as the

availability of the legal and regulatory framework. However, neither in domestic nor in foreign practice there is no single approved version of the DPP forms, so when choosing the DPP form for planned projects, you must comply with the validity of the legal and regulatory framework of Ukraine. In this case, the country gives priority to DPP projects with a high rate of receipt of budgetary funding. Based on the analysis of world data and the original Ukrainian practice of implementing large, capitalist, infrastructure DPP projects, a summary has been compiled about those with the shortest form of implementation of great infrastructure projects with sovereign participation, the concession form of the DPP is based on the Build-Operate-Transfer principle ("Business - Operation/Management - Transfer").

The concession form makes it possible to ensure the receipt of financing for projects from different sources, to minimize pressure on the public partner and to provide different financial guarantees for the participants of the DPP, equitably distributing the benefits vestments between them. When implementing DPP projects under the concession form, the key participants are: a public partner in the grantor's individual and a private partner (a representative or a group of representatives of the private sector) in the concessionaire's individual.

Projects for the development of high-speed highways (hereinafter referred to as VSHM), and great infrastructure projects, between which a specialized transport infrastructure is created and modernized, where a dry goods warehouse develops a speed of over 200 km/year. For the state, as a potential public partner, the effects of large infrastructure projects are one of the key arguments for praising the decision to participate in such projects, as well as the negotiated supply associated with the supply of various

instruments. government support for projects in the form of subsidies, grants, tax benefits, etc.

It is indicated that for the country, the socio-economic effects of large infrastructure DPP projects are also a tool for returning investment for the comprehensive development of the economy of the regions along the VSM route. the economy of the region as a whole. The most important characteristic of warehouse socio-economic effects for a public partner is their effectiveness, which is reflected in GDP growth and an increase in budget revenues. For a private partner, an analysis of socio-economic effects is necessary to determine government support for the DPP project. Whose researched social and economic effects from the implementation of high-speed highway projects are organized and grouped in five groups emanating from them Priorities for the development of partnership and business environment: - effects of investment capital, which are characterized by guilt and increased demand for materials, equipment and services necessary for the implementation of the project that launches The reaction of growth in various sectors of the economy; - direct effects that arise at the stage of operation, as a result of the government activity of the ruler and operator of the created infrastructure; - agglomeration effects that are formed in a fraction of a time at a dose between two large populated areas, for which the economical integration of territories is promoted, which unites, stimulates development business and will be guaranteed a reduction in costs and increased income for market participants; - effects of saving an hour in travel, meaning the extra hour spent on the road, which allows you to spend it on the job, allowing you to work, which results in increased productivity; - the effects of reducing accidents on highways, which are indicated by reducing the number of accidents on the roads, which supports

the level of income of the population, allowing it not to be reduced through time-inconsistency. When the country's security budget receives a stable increase in tax revenues, the risk for the country to pay compensation to the population under the DPP is reduced.

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DEVELOPING VISUALIZATION AND CREATIVE SKILLS IN PHYSICS EDUCATION: FROM CONCEPTUAL MAPPING TO VIRTUAL SIMULATIONS

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Creative and visualization skills are essential for understanding the abstract concepts inherent in physics. This paper examines the role of conceptual tools such as mind maps, virtual simulations, and thought experiments in fostering these skills among students. Special attention is given to the use of digital technologies and augmented reality (AR) for enhancing visualization in physics education. Additionally, the paper explores innovative assessment methods, including scenario-based tasks and project-based learning, that measure and encourage creativity. Results

indicate that integrating creative approaches and visualization tools leads to improved academic performance and deeper comprehension of complex physics phenomena.

Keywords: visualization, creative thinking, mind maps, virtual simulations, augmented reality, physics education, innovative assessment.

1. Introduction

The advancement of science education requires methods that go beyond traditional approaches to engage students' creativity and visualization abilities. Physics, as a highly conceptual field, often challenges students to understand phenomena that are not directly observable. Modern pedagogical tools, including mind maps, thought experiments, and virtual reality technologies, offer novel ways to address this challenge. This paper explores how such methods not only develop students' visualization and imaginative thinking but also provide measurable improvements in their learning outcomes.

2. Enhancing Conceptual Understanding in Physics

2.1 The Role of Visualization in Physics

Cognitive psychology highlights the critical role of visual and spatial thinking in grasping abstract concepts. Tools like augmented reality and virtual simulations enable students to interact with models of electromagnetic waves, quantum states, and relativistic phenomena, thereby enhancing their cognitive engagement.

2.2 Integrating Creative Pedagogy

Creative tasks such as generating scenarios or designing experiments encourage students to explore and connect concepts in new ways. For example, mind maps can illustrate relationships between wave properties

and optical phenomena, while thought experiments can help conceptualize challenging topics like time dilation.

3. Digital Tools for Visualization and Creativity

3.1 Virtual Simulations in Physics Education

Virtual simulations allow students to visualize and manipulate complex systems in a controlled environment. For example, platforms like PhET Interactive Simulations enable exploration of phenomena like electric circuits and wave propagation, fostering both understanding and curiosity.

3.2 Augmented Reality in Learning

AR applications provide interactive 3D models that help students comprehend physical systems. For instance, AR apps can display magnetic fields around current-carrying wires or simulate planetary orbits, offering a dynamic alternative to static textbook diagrams.

4. Assessment of Creative Thinking in Physics

To evaluate the impact of visualization and creative pedagogy, innovative assessment methods are required. Scenario-based tests, project-based learning, and diagrammatic reasoning tasks provide insights into students' ability to creatively solve problems and conceptualize abstract ideas.

5. Recommendations for Educators

Physics educators are encouraged to integrate tools like mind maps, thought experiments, and digital simulations into their curricula. Additionally, designing tasks that challenge students to create visual or conceptual models of physics phenomena can foster both creativity and deeper understanding.

6. Conclusion

Visualization and creative thinking are indispensable for success in physics education. This study underscores the importance of integrating conceptual and digital tools to enhance these skills. By fostering students' ability to visualize and creatively approach problems, educators can significantly improve their learning outcomes and engagement in physics.

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Formal Sciences

- Mathematics
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BEAMFORMING POINTING ERROR OF A TRIAXIAL VELOCITY SENSOR UNDER GAIN UNCERTAINTIESBEAMFORMING POINTING ERROR OF A TRIAXIAL VELOCITY SENSOR UNDER GAIN UNCERTAINTIES

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A triaxial velocity sensor consists of three uniaxial velocity sensors, nominally identical, orthogonally oriented, and co-centered at a point in space. This system measures the acoustic particle velocity vector, offering two-dimensional spatial directivity despite its compact size. Existing analyses of its beam-pattern assume ideal gain uniformity across the sensors. However, practical deviations due to gain uncertainties can shift the beam-pattern's peak direction. This paper models such uncertainties stochastically, deriving the statistical mean and variance of these deviations. Analytical results are validated using Monte Carlo simulations.

Triaxial velocity sensors are extensively used for measuring acoustic particle velocity vectors due to their compact and efficient design. Each sensor component captures one Cartesian component of the velocity, enabling azimuth-elevation directivity. However, real-world manufacturing and deployment introduce gain uncertainties among the three uniaxial sensors. This paper investigates the statistical effects of such gain uncertainties on the spatial matched filter beam-pattern's peak direction.

Theoretical Model

Ideal Array Manifold

The ideal mathematical model of a triaxial velocity sensor's array manifold is:

$$\mathbf{a}(\theta,\phi)=\begin{bmatrix}\sin(\theta)\cos(\phi)\\ \sin(\theta)\sin(\phi)\\ \cos(\theta)\end{bmatrix},$$

where $\theta \in [0,\pi)$ is the polar angle measured from the z-axis, and $\phi \in [0,2\pi)$ is the azimuth angle measured from the x-axis. Each component corresponds to the uniaxial velocity sensor's orientation along the x, y, and z axes, respectively.

The array manifold remains independent of frequency and emitter-sensor distance due to the collocation of the uniaxial sensors. This independence is advantageous for broad-frequency acoustic events.

Array Manifold Under Gain Uncertainties

Practical gain uncertainties are modeled stochastically. The actual array manifold becomes:

$$\tilde{\mathbf{a}}(\theta,\phi)=\begin{bmatrix}g_x\\ g_y\\ g_z\end{bmatrix}\odot \mathbf{a}(\theta,\phi),$$

where g_x, g_y, and g_z are independent Gaussian random variables with mean 1 and variance σ_g^2. The symbol $\odot$ represents the Hadamard (element-wise) product.

Statistical Analysis of Beamforming Pointing Error

Given gain uncertainties, the beam-pattern□s peak direction deviates from the nominal look direction (θ_L,ϕ_L). The derived expressions for the statistical mean and variance of the deviation are as follows.

For the azimuth direction:

$$\text{Bias:}\quad \mathbb{E}[\phi_P-\phi_L]=f_1(\sigma_g),$$
$$\text{Variance:}\quad \mathrm{Var}(\phi_P)=f_2(\sigma_g),$$

where f_1 and f_2 are derived functions of σ_g.

For the polar direction:

$$\text{Bias:} \quad \mathbb{E}[\theta_P - \theta_L] = f_3(\sigma_g),$$
$$\text{Variance:} \quad \text{Var}(\theta_P) = f_4(\sigma_g).$$

Monte Carlo Simulations

Monte Carlo simulations validate the derived biases and variances. Each trial involves:

Sampling g_x, g_y, and g_z from the specified Gaussian distribution.

Computing the biased beam-pattern peak (θ_P, ϕ_P).

Comparing results across multiple trials to verify analytical expressions.

The following scenarios were analyzed:

Look direction: $(\theta_L, \phi_L) = (40°, 30°)$.

Look direction: $(\theta_L, \phi_L) = (30°, 50°)$.

Look direction: $(\theta_L, \phi_L) = (70°, 20°)$.

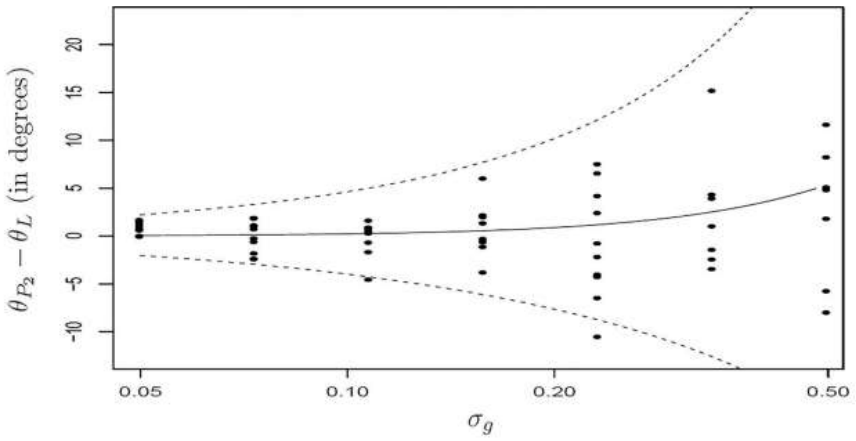

FIG. 10. Monte Carlo simulations verify the analysis on the *polar* pointing error $\theta_{P_2} - \theta_L$. Most Monte Carlo trials lie within the bias of Eq. (16) ± one standard deviation of Eq. (17). Here, the nominal azimuth-polar look direction is $\theta_L = 70°$ and $\phi_L = 20°$.

Results

Figures demonstrate that biases and variances from Monte Carlo simulations align closely with analytical predictions. The deviation grows with increasing σ_g, but remains within predictable bounds.

Conclusion

This study derived and verified the statistical biases and variances in the beam-pattern□s peak direction due to gain uncertainties in triaxial

velocity sensors. Future work will extend the analysis to include correlated gain errors and non-Gaussian models.

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ЕКСТРУДУВАННЯ КОРМОВИХ СУМІШЕЙ З ПІДВИЩЕНИМ ВМІСТОМ ЛІПІДІВ

Кожевнікова М., асистент кафедри технології зберігання і переробки зерна Національного університету харчових технологій, Київ, Україна; Янюк Т., канд. техн. наук, доцент кафедри технології зберігання і переробки зерна Національного університету харчових технологій, Київ, Україна

Процес екструдування – це спосіб обробки сировини, в процесі якого підготовлений продукт або збалансована кормова суміш, під впливом теплової дії перетворюється в пористий продукт. За рахунок високої температури 110-180 °С та перепаду тиску при переході з однієї зони екструдера в другу відбувається "вибух", збільшується об’єм, загальна площа поверхня продукту, що робить його більш доступним для впливу ферментів та підвищує засвоюваність [2].

У процесі екструдування крохмаль розпадається на прості цукри, шкідлива мікрофлора знезаражується, а вітаміни і амінокислоти, що містяться в злаках, завдяки короткочасності процесу зберігаються практично повністю. Крім того, на процес екструдування практично не впливають такі фактори як вологість перероблюваного продукту та наявність інших культур та насіння. Завдяки застосування процесу екструдування для обробки кормових сумішей маємо можливість виключити процес сушіння і сортування, і як результат отримати високоякісний корм відповідно до заданого рецепту [1,3].

Єдина вимога до сировини при екструдуванні, це відсутність смітної та іншої органічної домішки.

Для оцінки якості одержаної кормової суміші до екструдування та після попередньо суміш зволожили до 18 %. Результати досліджень показників якості показали порівняльну характеристику фізико-хімічного складу до та після екструдування досліджуваної кормової суміші, до складу якої входить насіння 45% соняшнику : 25% льону : 30% кукурудзи. Оскільки, перед екструдування суміш попередньо зволожили, масова частка вологи 18 %, то після екструдування вологість продукту становила 12,5%.

Об'ємна маса характеризує щільність продукту і є важливим фізичним показником. Об'ємна маса суміші до екструдування становила 621,3 кг/м3 після 545,8 кг/м3, що пояснюється утворенням пористої структури кормової суміші.

Аналіз даних показує, що в процесі екструдування супроводжується втрати сирого протеїну. До екструдування він становив 11,4 % після 10,5 %, що пояснюється денатурацією білку. В результаті часткового розпаду сирого жиру на жирні кислоти його кількість також зменшилась з 5,85 % до 5,45 %. Це можна пояснити тим, що в процесі екструдування під дією високої температури відбувається утворення комплексних сполук з білком та вуглеводами, що перешкоджає повному виділенню жиру з дослідних зразків, тому що жир знаходиться у зв’язаній формі Натомість перетравний протеїн підвищився за рахунок розщеплення білку до амінокислот.

За рахунок екструдування кормової суміші продукт набуває високої поживності і може бути незамінним у складі раціоні сільськогосподарських тварин, світської птиці та риби.

Спеціальна обробка кормових сумішей за допомогою екструдера дозволяє знизити навантаження на роботу шлунка тварин та зменшити витрати енергії тварини на перероблення корму.

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SUSTAINABLE DEVELOPMENT OF METALLURGY: RESOURCE ASPECT

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Numerous scientific studies show that, as a rule, those industrial systems that most fully and effectively use the available resource potential of the territory are more sustainable than systems that use only a part of the resources. The most complete use of the resource potential of metallurgy allows solving the problem of functional redundancy of production components within the regional system, making it possible to compensate for the lack of other components. However, the study of the issues of managing the sustainable development of metallurgy allows us to draw a conclusion about the insufficient methodological elaboration of the issues of

forming the organizational and economic mechanism of resource support for this process.

Most studies of the prospects for the development of metallurgical complexes are considered from the point of view of increasing the efficiency of the use of resources already involved in production processes. Much less attention is paid to the possibilities of additional involvement in these processes of existing, available, but currently unused resources of the territory. At the same time, emphasis is often placed on natural and energy resources with insufficient attention to other components of the resource base of metallurgy. Thus, there was an obvious gap in scientific knowledge in the field of research into the prospects of increasing the sustainability of metallurgy development, taking into account the fullest use of its resource potential. Resource support for the sustainable development of metallurgy is largely related to the existing socio-economic conditions and institutions.

Therefore, public administration bodies should be more sensitive to existing challenges and threats, and tools related to the formation and development of market initiatives, as well as tools of state regulation, must be built into the organizational and economic mechanism of resource provision for the sustainable development of metallurgy. When considering sustainability within the framework of an adaptive approach, the following signs of sustainable development of metallurgy are highlighted: maximum full use of the available resource base to achieve the strategic goals of its socio-economic development; the maximum possible effectiveness of realizing the resource potential of metallurgy; the ability to expand the volume of resources involved in metallurgical production processes; the ability to implement the functions described above during a strategically significant period.

The mentioned features made it possible to define the stability of metallurgy as the ability of this socio-economic system to function effectively in a competitive environment, that is, to ensure stable development close to the long-term trend, using the available resources of the territory as fully as possible. The study of the factors of resource provision for the sustainable development of metallurgy was carried out from two main positions: from the point of view of the presence of conditions for the sustainable development of metallurgy, as well as the occurrence of possible causes of destabilization of the environmental characteristics of functioning (external factors); from the point of view of the internal capabilities of metallurgy to adapt or limit the effect of destabilizing influences taking into account the rational use of the existing resource base of development (internal factors).

Based on the understanding of the environment as a source of possible destabilizing influences, the dissertation identifies two groups of external threats to the effective implementation of the resource potential of the sustainable development of metallurgy, according to which it is proposed to carry out a typology of external factors. The first group of threats includes destabilizing factors of the competitive environment caused by objective changes in market relations. The second group of threats consists of changes in the conditions of economic activity, carried out by non-market methods, usually in the form of political decisions.

Considering that realizing the resource potential of the sustainable development of metallurgy is completely possible only in the conditions of a stable market environment, such a typology allows to identify risk factors (challenges) of resource provision for the sustainable development of metallurgy, as well as to determine the main directions of achieving the

continuity of reproduction of the resource potential of metallurgy in modern conditions. uncertainty and high degree of variability of the market environment. In order to study the internal possibilities of metallurgy to adapt to the changing conditions of the external environment or to limit the effect of destabilizing influences, it is suggested to take into account that the continuous process of reproduction of the resource base is a sign of the sustainable functioning of metallurgy.

Within the framework of the resource concept, a methodological basis was formed for the development of an organizational and management mechanism for the development of metallurgy, which includes the following provisions: sustainable development of metallurgy is ensured on the basis of available unique resources and abilities that allow to receive long-term rent on the balanced market; competitive advantages of metallurgy are provided within the framework of the administrative system, i.e. its sustainable development is the result of managerial activity; ensuring the sustainable development of metallurgy; competitive advantages are the basis of ensuring the stability of metallurgy on foreign and domestic markets. It is justified that the emerging organizational and management mechanism should be aimed at ensuring the most complete and effective involvement of the available resource potential of metallurgy for the effective implementation of its production capabilities.

It is shown that, depending on the regional policy being carried out, the development of metallurgy can proceed by achieving full employment of the population with the maximum use of production factors - tactical management, or by expanding production capabilities due to the elimination of disparities in the use of production factors and the

involvement of latent resource potential in industrial development potential - strategic management.

Energy, material and technical and labor resources, the replenishment and preparation of which require investment investments, were classified as system resources. This allocation of the components of the resource base of metallurgy development made it possible to focus on the endogenous factors of sustainable development, that is, on the available internal reserves, the use of which will ensure the effective use of the available resource potential of the territory. At the same time, it was assumed that the effectiveness of such involvement would not be lower than the actual values of the indicators of the efficiency of the use of production factors.

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КІБЕРДИПЛОМАТІЯ В СУЧАСНІЙ СИСТЕМІ МІЖНАРОДНИХ ВІДНОСИН

Наталія Бєлоусова, кандидат політичних наук, кандидат фізико-математичних наук, доцент кафедри міжнародної інформації Навчально-наукового інституту міжнародних відносин Київського національного університету імені Тараса Шевченка; Максим Музика, аспірант 1-го курсу кафедри міжнародної інформації Навчально-наукового інституту міжнародних відносин Київського національного університету імені Тараса Шевченка

Кібердипломатія - це використання дипломатичних інструментів і дипломатичного процесу взаємодії для вирішення питань, що виникають у міжнародному та національному кіберпросторі [1]. Кібердипломатія має стати новим інструментом, призначеним для розробки універсального підходу задля запобігання кіберконфліктам у міжнародних відносинах, зміцненні довіри між країнами та забезпеченні інформаційної безпеки [3]. Визначення поняття «кібердипломатія» включає в себе використання дипломатичних методів для аналізу та управління проблемами кіберпростору [2]. Деякі дослідники наголошують на тому, що кібердипломатія включає в себе і кібербезпеку та все що з цим пов’язано, а одна з основних проблем кібербезпеки є виявлення та протидія кібератакам. Іншим аспектом кібердипломатії є децентралізація та право на кіберпростір, включно з управлінням Інтернетом, свободу думки та конфіденційність. Кібердипломатія спрямована на досягнення балансу між правами людини і національною безпекою в кіберпросторі [3].

Спорідненим терміном є цифрова дипломатія, яка визначається як «використання сайтів соціальних мереж з метою сприяння діалогу з

онлайн-публікою» [2, с.332]. Дослідники уточнюють різницю між кібер- та цифровою дипломатією, пояснюючи, що цифрова дипломатія стосується використання цифрових інструментів і технік дипломатії [1], підтримки дипломатичних ініціатив та спрощення процесу комунікації за допомогою віртуальних ресурсів. Прикладом може бути ініціатива зі створення віртуальних посольств та спрощення консульських послуг для громадян держав, що користуються інтернетом [4] .

Кібердипломатія базується на вимірюванні м'якої сили і є ефективною практикою зменшення невизначеності та усунення ризиків та потенційних конфліктів, що виникають у кіберпросторі. Ключовими елементами кібердипломатії є підвищення кіберпотенціалу, зміцнення довіри, дотримання і розвиток кібернорм. Організація безпеки у кіберпросторі відрізняється від традиційних безпекових заходів, адже важче запобігти проникнення до кіберпростору, встановити наміри та масштаби завданих збитків. Дуже важливим є створення та прийняття міжнародних стандартів з протидії кібервикликам, де задля розбудови міжнародних норм з управління та захисту кіберпростору і будуть залучені кібердипломати для відстоювання національних інтересів. Традиційні дипломатичні навички, такі як здатність визначати наміри противника набуватимуть все більшого значення.

Сьогодні підхід до управління кіберпростором окремих країн та організацій демонструє, як єдність поглядів так і їх розрізненість. Виникає необхідність ведення перемовин з потенційними конкурентами задля вироблення спільного бачення. Саме дипломати

встановлюватимуть міжнародні норми поведінки, засновані на передовій практиці, які розвиватимуть геополітику кіберпростору.

Однією з провідних країн в кібердипломатії та організації кіберпростору є Естонія, яка постійно співпрацює з міжнародними організаціями такими як ООН та НАТО. Ще в 2008 році в Талліні був відкритий Об'єднаний центр передових технологій з кібероборонни НАТО для навчання, досліджень та обміну ми з кіберзахисту. Цей центр надає консультації, організовує зустрічі та створює екосистему співпраці як для країн-членів, так і для країн, що не входять до НАТО. Україна приєдналася до цього центру в Талліні 16 травня 2023 року [4].

Як наголошує CyberPeace Institute кіберзагрози особливо актуалізуються в контексті міжнародних збройних конфліктів. Вплив кіберзагроз поширюється не тільки на країни, залучені в конфлікт, але і на решту світу. Війна росії проти України дуже добре це демонструє. За підрахунками CyberPeace Institute, з січня 2022 року по грудень 2023-го кількість кібератак на цивільні об'єкти в світі, пов'язаних тільки з цією війною, досягла 3255. Це були кібератаки на енергетику, ЗМІ, уряд, телекомунікації, транспорт та фінансові структури. Як наслідок постраждали більше 30 країн, включаючи ЄС, США, Канаду, Австралію і Казахстан [5].

Для успішної реалізації кібердипломатії в Україні вже зроблені певні кроки. Насамперед, це наявність визначення поняття «кіберпростір» у законодавстві України: середовище (віртуальний простір), що надає можливості для здійснення комунікацій та/або реалізації суспільних відносин, утворене в результаті функціонування сумісних (з'єднаних) комунікаційних систем та забезпечення електронних комунікацій з використанням мережі Інтернет та/або

інших глобальних мереж передачі даних [6]. Необхідну правову базу доповнює прийнята в 2021 році Стратегія інформаційної безпеки, Стратегія кібербезпеки, Стратегія публічної дипломатії МЗС України на 2021–2025 рр., а також інші нормативно-правові акти [7]. Ґрунтуючись на цих документах Міністерство закордонних справ України почало розробку Стратегії кібердипломатії в Україні. Виокремлено підрозділ з кібердипломатії в структурі профільного Міністерства, ведеться підготовка кадрів, розбудова інфраструктури, а також цифровізація діяльності дипломатичної служби [8].

Наступним важливим кроком стала Розробка проєкту змін до Закону України «Про дипломатичну службу». Цим законопроектом передбачено надати повноваження щодо просування та захисту національних інтересів у кіберпросторі – кібердипломатам. Законодавці визначають поняття кібердипломатії, як комплекс дій та стратегій, спрямованих на просування та захист національних інтересів та реалізацію зовнішньополітичних цілей України в сфері міжнародних відносин в кіберпросторі, а також прав та інтересів громадян і юридичних осіб України за кордоном з урахуванням сучасних потреб [9].

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PRODUCTIVITY OF MARITIME TRANSPORTATION IN TURKEY

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Maritime transport plays a pivotal role in international trade, facilitating the movement of goods across global markets. It is the backbone of international commerce, handling the majority of trade volumes due to its cost-effectiveness and efficiency. For countries like Turkey, with a strategic geographical position, enhancing maritime transport capabilities is crucial for economic growth. This thesis aims to analyze the factors affecting the performance of maritime transport in Turkey, using data from various sources and applying statistical models to provide insights and recommendations for improvement.

Chapter 1: The Role of Maritime Transport in Global Trade

Maritime transport has been integral to global trade for centuries. It connects continents and enables the efficient movement of large volumes of goods. In 2019, over 11 billion tons of cargo were transported via sea, highlighting its dominance in international trade. Compared to road, rail, and air transport, maritime transport offers unparalleled capacity and cost benefits, making it the preferred mode for long-distance and bulk shipments.

Chapter 2: Turkey’s Geographical and Strategic Position

Turkey's unique geographical position at the crossroads of Europe and Asia, and its proximity to the Middle East, provides significant advantages for maritime transport. The country’s extensive coastline and strategic ports serve as vital hubs for international trade routes. The Turkish Straits, including the Bosporus and Dardanelles, are critical passageways for maritime traffic, enhancing Turkey's role in global trade.

Chapter 3: Factors Affecting Maritime Transport Performance

The performance of maritime transport is influenced by several factors, including infrastructure quality, technological advancements, and regulatory frameworks. Efficient port facilities, modern ships, and advanced logistics systems are essential for optimizing maritime transport operations. Additionally, government policies and international regulations play a significant role in shaping the maritime transport landscape.

Chapter 4: Methodology and Data Analysis

This study utilizes data from the United Nations Conference on Trade and Development (UNCTAD) and Turkey's Ministry of Transportation and Infrastructure. The generalized linear model method and Poisson distribution are applied to analyze the data, providing a robust statistical framework to identify and weight the factors affecting maritime transport performance in Turkey.

Chapter 5: Current State of Maritime Transport in Turkey

Maritime transport is crucial for Turkey's foreign trade, with a significant portion of exports and imports being conducted via sea. The use of containers has become increasingly prevalent, improving the efficiency of cargo handling and transport. Despite some fluctuations, the overall trend indicates a positive growth trajectory in maritime transport volumes.

Chapter 6: Comparative Analysis with Other Transport Modes

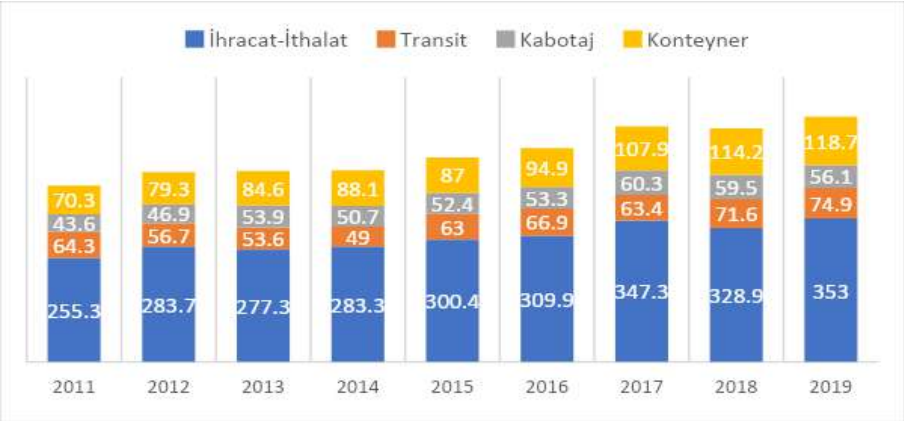

Figure 1. Annual Change in Cargo Handled in Our Ports (Million Tons)

While maritime transport is the most cost-effective and efficient mode for large-scale and long-distance shipments, other transport modes like road, rail, and air have their own advantages. This chapter compares these modes, highlighting the unique benefits and limitations of each. Maritime transport stands out for its ability to handle bulk cargo and its lower cost per ton-mile compared to other modes.

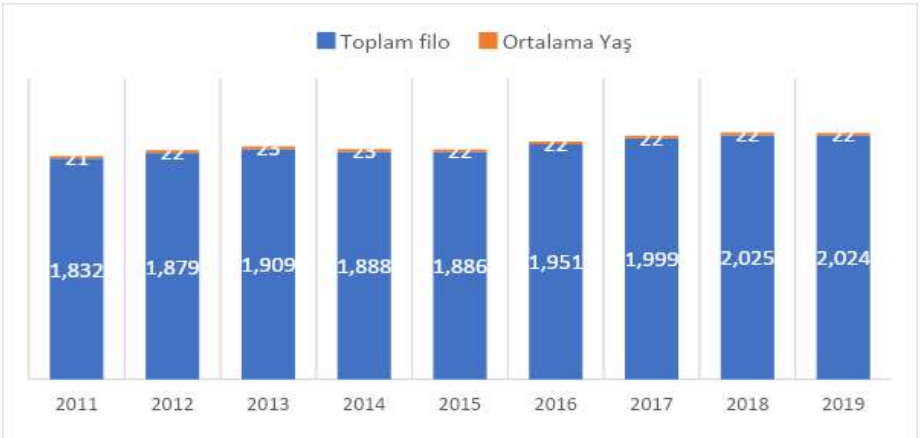

Figure 2. Annual Development of Turkish Merchant Fleet Number and Average Age

Chapter 7: Policy Implications and Recommendations

To enhance the performance of maritime transport, strategic policies are needed. Investments in port infrastructure, adoption of advanced technologies, and streamlined regulatory frameworks are essential for

optimizing operations. This chapter provides policy recommendations aimed at improving Turkey's maritime transport capabilities and addressing existing challenges.

Chapter 8: Economic Impact and Future Prospects

Improving maritime transport infrastructure and policies can significantly boost Turkey's economy. Enhanced efficiency in maritime operations leads to reduced costs, increased trade volumes, and greater economic growth. This chapter explores the long-term economic benefits and future prospects for Turkey's maritime transport sector, emphasizing the importance of continued investment and development.

Maritime transportation has an important place in both international trade and economic development of Turkey. For this reason, it is essential for our country to carry out studies to increase the performance of the relevant transportation mode. As seen in Table 6, the cargo transported by container and container port efficiency also have a high impact on performance. In this context, making our ports more suitable for container transportation and modernizing them with systems that will facilitate the handling of various cargoes can increase the performance even further.

When we look at the data on our country's trade fleet and the number of ships traded in ports between the years covered by the study, it can be stated that it followed a decreasing trend. Based on the findings obtained in the study, the effect of these two variables on performance is neutral. In this regard, improving our country's commercial fleet both numerically and qualitatively seems to be an important necessity in order to increase its share in maritime transportation.

Conclusion

The analysis underscores the critical role of maritime transport in Turkey's economic development. By addressing the factors affecting performance and implementing strategic policies, Turkey can enhance its maritime transport capabilities, driving economic growth and strengthening its position in global trade. Future research should focus on emerging trends and technological advancements to ensure sustainable growth in the maritime transport sector.

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ENVIRONMENTAL TRANSFORMATION: A CASE STUDY IN CHINA BASED ON FUTURE DEVELOPMENT SCENARIOS CHINA

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The rapid urbanization and industrialization witnessed globally have led to significant environmental challenges, particularly in resource-exhausted cities. These urban areas face unique ecological and economic difficulties due to their depleted natural resources. Effective land use strategies are crucial for these cities as they attempt to transition towards sustainable development. This article explores the environmental

transformation of Shizuishan City, China, using a multi-objective optimization model to predict land use changes under various future development scenarios. The "vigor-organization-resilience" assessment framework is utilized to evaluate the ecosystem health conditions in each scenario, providing insights into the potential outcomes of different ecological transformation modes.

Resource-exhausted cities are urban areas that have heavily relied on natural resource extraction for economic development. As these resources become depleted, these cities are left with environmental degradation, economic decline, and social challenges. Shizuishan City, located in an ecologically fragile area of China, serves as a representative case study for this research. The city has historically depended on coal mining, which has led to significant ecological damage and necessitates urgent ecological transformation.

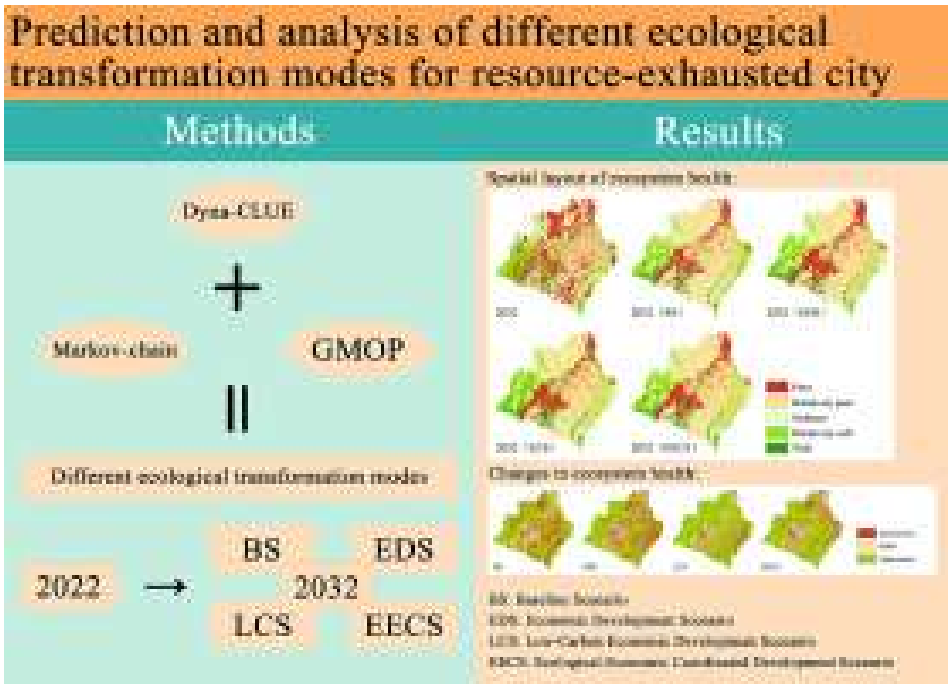

Figure 1. Prediction and analysis of different ecological transformation modes for resource-exhausted city

Methodology

To assess the potential ecological outcomes of different land use strategies, a multi-objective optimization model was constructed. This model considers various development scenarios, each representing a distinct ecological transformation mode:

1. Low-Carbon Economic Development Scenario
2. Ecological-Economic Coordinated Development Scenario
3. Baseline Scenario
4. Economic Development Scenario

The "vigor-organization-resilience" assessment framework evaluates the ecosystem health under each scenario, focusing on three dimensions:

1. Vigor: Measures the productivity and vitality of the ecosystem.
2. Organization: Assesses the structural complexity and stability of the ecosystem.
3. Resilience: Evaluates the ecosystem's ability to recover from disturbances.

Results

The study's findings reveal significant differences in the ecological health outcomes of the various development scenarios:

1. Ranking of Ecological Health Levels:
   - Low-Carbon Economic Development Scenario: 0.302
   - Ecological-Economic Coordinated Development Scenario: 0.291
   - Baseline Scenario: 0.290
   - Economic Development Scenario: 0.281
   - 2022 Baseline: 0.248
2. Improvement in Ecosystem Health:

- All four future development scenarios showed improved ecosystem health levels compared to 2022, with improvement areas accounting for over 60% of the city.

- The Low-Carbon Economic Development Scenario exhibited the most substantial improvement, with 75.81% of the area showing enhanced ecological health.

3. Dominant Dimension Influencing Ecological Health:

- Ecological system vitality was identified as the primary factor influencing the region's ecological health, highlighting the importance of maintaining and enhancing ecosystem productivity and vigor.

The study emphasizes the critical need for ecological transformation in resource-exhausted cities like Shizuishan. The findings suggest that a low-carbon economic development approach offers the most significant ecological benefits, promoting both environmental sustainability and economic growth. This scenario supports the transition to renewable energy sources, efficient resource use, and reduced greenhouse gas emissions, contributing to improved ecosystem health and resilience.

The ecological-economic coordinated development scenario also shows promise, balancing economic growth with ecological preservation. This approach encourages sustainable land use practices, integrated ecosystem management, and the development of green infrastructure.

The baseline scenario represents a continuation of current practices, providing a reference point for assessing the impact of more proactive ecological strategies. Although it shows some improvement, it is less effective than the other scenarios in enhancing ecosystem health.

The economic development scenario, while promoting economic growth, is the least effective in terms of ecological health improvement. This

scenario may lead to further environmental degradation if not carefully managed, underscoring the importance of integrating ecological considerations into economic planning.

Policy Implications and Recommendations

The study's results have several policy implications for resource-exhausted cities seeking ecological transformation:

1. Promotion of Low-Carbon Development:

- Policymakers should prioritize low-carbon economic development strategies, supporting renewable energy projects, energy efficiency measures, and carbon reduction initiatives.

2. Integrated Ecological and Economic Planning:

- An integrated approach to ecological and economic planning is essential. Policies should encourage sustainable land use, ecosystem restoration, and the development of green infrastructure.

3. Monitoring and Assessment:

- Regular monitoring and assessment of ecosystem health are crucial for evaluating the effectiveness of ecological transformation strategies. The "vigor-organization-resilience" framework provides a comprehensive tool for this purpose.

4. Public Engagement and Education:

- Engaging the public and raising awareness about the importance of ecological health and sustainable development can foster community support for ecological transformation initiatives.

Conclusion

The environmental transformation of resource-exhausted cities is a complex and urgent challenge. This case study of Shizuishan City demonstrates the potential benefits of adopting different ecological

transformation modes. The low-carbon economic development scenario, in particular, offers significant ecological and economic advantages, underscoring the importance of integrating sustainable practices into urban planning. By adopting proactive and integrated strategies, resource-exhausted cities can transition towards a more sustainable and resilient future.

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ADVANCES IN THE RESEARCH ON HYDROCARBON SYNTHESIS FROM DISSOLVED CO2 AND H2 UNDER HYDROTHERMAL CONDITIONS

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The reaction between CO_2 and H_2 under hydrothermal conditions to form alkanes provides an abiotic pathway for converting CO_2 into organic

matter. This research is significant for understanding the abiotic origins of hydrocarbons in oil and gas and the origins of life in hydrothermal vents. Studies have shown that favorable thermodynamic conditions (temperature, pressure) and suitable catalysts are essential for the reaction between CO_2 and H_2 to form alkanes under hydrothermal conditions. While chromite has been shown to catalyze the formation of CH_4, C_2H_6, and C_3H_8, it remains unclear whether natural mineral catalysts exist that can facilitate the formation of longer-chain alkanes such as C_4H_{10}. Magnetite containing one or more transition metals might be worth investigating. Further research is needed to elucidate the reaction mechanisms and establish C and H isotope signatures, which could help distinguish abiotic hydrocarbons from those derived from organic matter under hydrothermal conditions.

CO_2 is typically converted into organic matter through photosynthesis in plants and subsequently into hydrocarbons through thermal decomposition or microbial degradation. In 1923, Fischer and Tropsch discovered that syngas (CO + H_2) could react to produce liquid hydrocarbons under the catalysis of transition metals. Subsequent research has shown that gaseous CO_2 and H_2 can also react to produce hydrocarbons under similar catalytic conditions.

In geological environments, H_2 can be produced from the alteration of rocks containing reduced iron, while seawater, carbonates, and magmatic degassing can supply CO_2. Thus, it is possible for CO_2 and H_2 to react to form hydrocarbons under hydrothermal conditions. Methane (CH_4), ethane (C_2H_6), and propane (C_3H_8) found in hydrothermal vents have been attributed to reactions between dissolved CO_2 and H_2. The main questions that arise are whether hydrocarbons can form under these conditions, what

types of hydrocarbons are produced, what the reaction mechanisms are, and how to identify hydrocarbons produced by this process.

This paper reviews the progress in research on the formation of hydrocarbons from CO_2 and H_2 under hydrothermal conditions, summarizes the catalytic effects of natural minerals, and explores reaction mechanisms and hydrocarbon identification criteria. It also highlights the importance of finding natural mineral catalysts for the formation of longer-chain hydrocarbons and establishing comprehensive C and H isotope signatures.

Basis for Hydrocarbon Formation under Hydrothermal Conditions

Under certain temperature and pressure conditions, it is thermodynamically feasible for CO_2 and H_2 to react to form hydrocarbons and other organic compounds. Higher H_2 activity favors the formation of alkanes. The general reaction for the formation of alkanes from dissolved CO_2 and H_2 can be expressed as:

$$CO_2,aq + \left(3 + \frac{1}{n}\right) H_2,aq = \frac{1}{n} C_n H_{2n+2},aq + 2H_2O$$

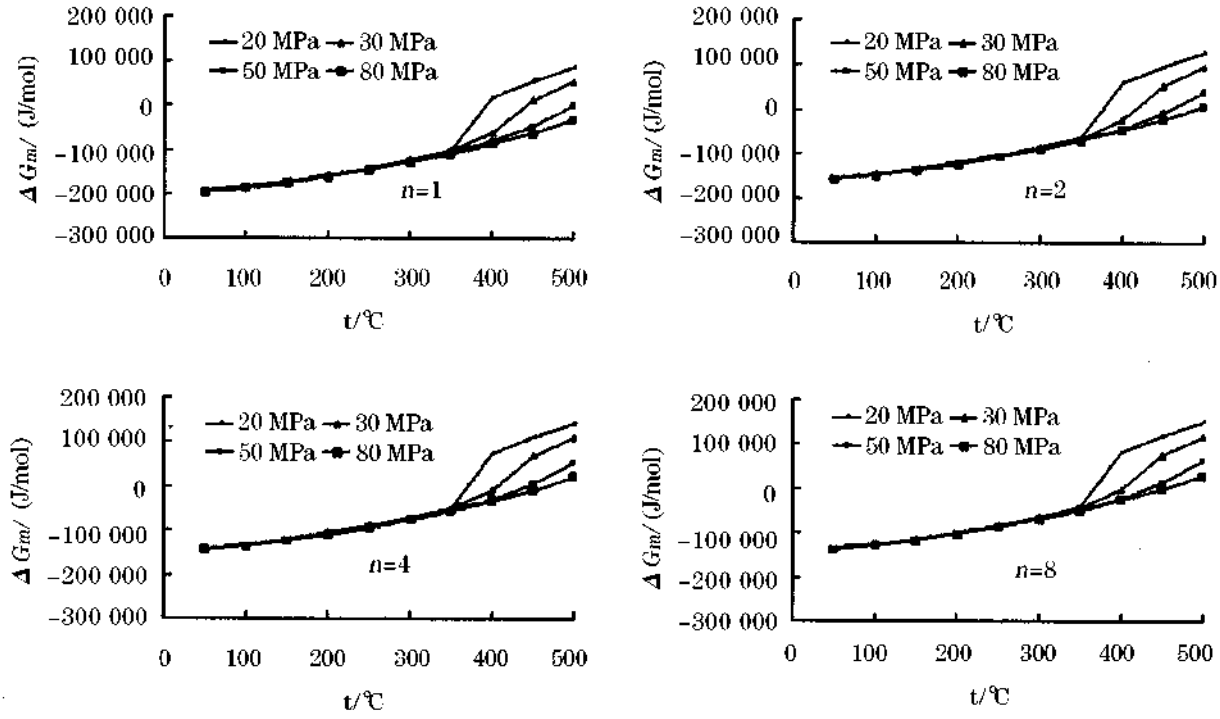

Fig.1 ΔGm of reaction at differenttem peratures

Using thermodynamic data and software, the molar Gibbs free energy change (?G_m) of the reaction was calculated across different temperatures and pressures, indicating that lower temperatures and higher pressures favor the formation of alkanes. Equilibrium analysis shows that methane is the predominant hydrocarbon formed, with higher hydrocarbons being less favorable.

Catalytic Role of Natural Minerals

Suitable catalysts are essential for the reaction between CO_2 and H_2 to form hydrocarbons under hydrothermal conditions. Natural minerals in geological environments can act as catalysts. Research has shown that olivine and its alteration products (serpentine, brucite, and magnetite) can catalyze the formation of CH_4, C_2H_6, and C_3H_8. However, the identification of natural catalysts for the formation of longer-chain hydrocarbons remains a critical area of investigation.

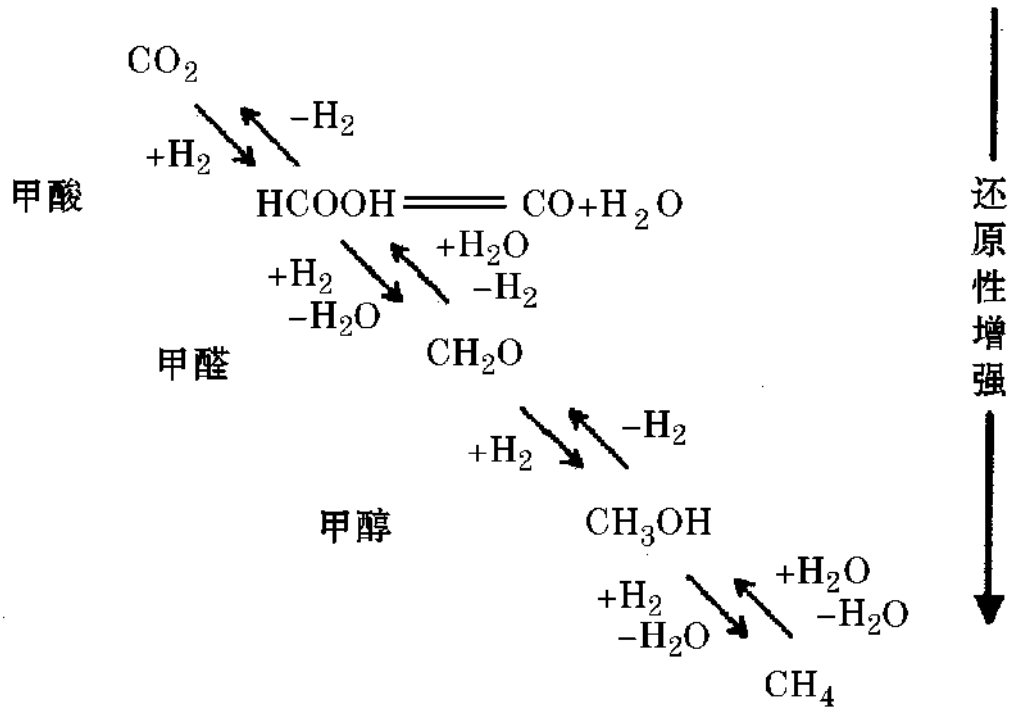

Fig.2 Schem atic representation of CH4 form at ion from CO2 under hydrotherm al conditions

Mechanisms and Isotope Signatures

Understanding the mechanisms of hydrocarbon formation from CO_2 and H_2 under hydrothermal conditions is crucial for distinguishing abiotic hydrocarbons from those derived from organic matter. Investigating C and H isotope fractionation in these reactions can provide valuable insights. Developing comprehensive isotope signatures for hydrocarbons formed by this process will aid in identifying abiotic hydrocarbons in geological environments.

Conclusion

Research on the abiotic synthesis of hydrocarbons from dissolved CO_2 and H_2 under hydrothermal conditions is of great significance for understanding the origins of hydrocarbons in oil and gas and the evolution of life in hydrothermal systems. Identifying natural mineral catalysts and establishing isotope signatures are key areas for future research. This work

has the potential to contribute to the understanding of abiotic hydrocarbon resources and the broader implications for geological and biological processes.

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INTERSTITIAL WATER EXCHANGE PROCESSES IN MANGROVES AND SALT MARSH WETLANDS AND THEIR CARBON SINK POTENTIAL

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The negative impact of global climate change on resources, ecology, and the environment is becoming increasingly apparent. Hence, reducing the atmospheric carbon dioxide (CO_2) concentration has become a global concern. Intertidal wetlands (e.g., mangroves and salt marshes) have strong carbon sink functions that can reduce the CO_2 concentration, thus mitigating global climate change. Mangroves and salt marshes are important coastal blue carbon ecosystems characterized by high soil carbon storage. Porewater exchange and associated carbon exchange driven by tides and rainfall in mangroves and salt marshes are challenging issues when estimating the effects of coastal blue carbon sinks. Large amounts of porewater-derived sediment carbon outwellings remain in the ocean and may represent an important carbon sink; however, they are poorly understood, despite being potentially significant components of the salt marsh carbon budget. This review aims to quantify the porewater exchange rate and related carbon fluxes, analyze their driving mechanisms, and reassess the carbon budgets and carbon sink potentials of mangroves and salt marshes. This study promotes understanding the carbon balance and cycle processes associated with mangrove and salt marsh ecosystems, and provides a scientific basis for the construction, protection, and sustainable development of coastal blue carbon sinks in the context of global climate change.

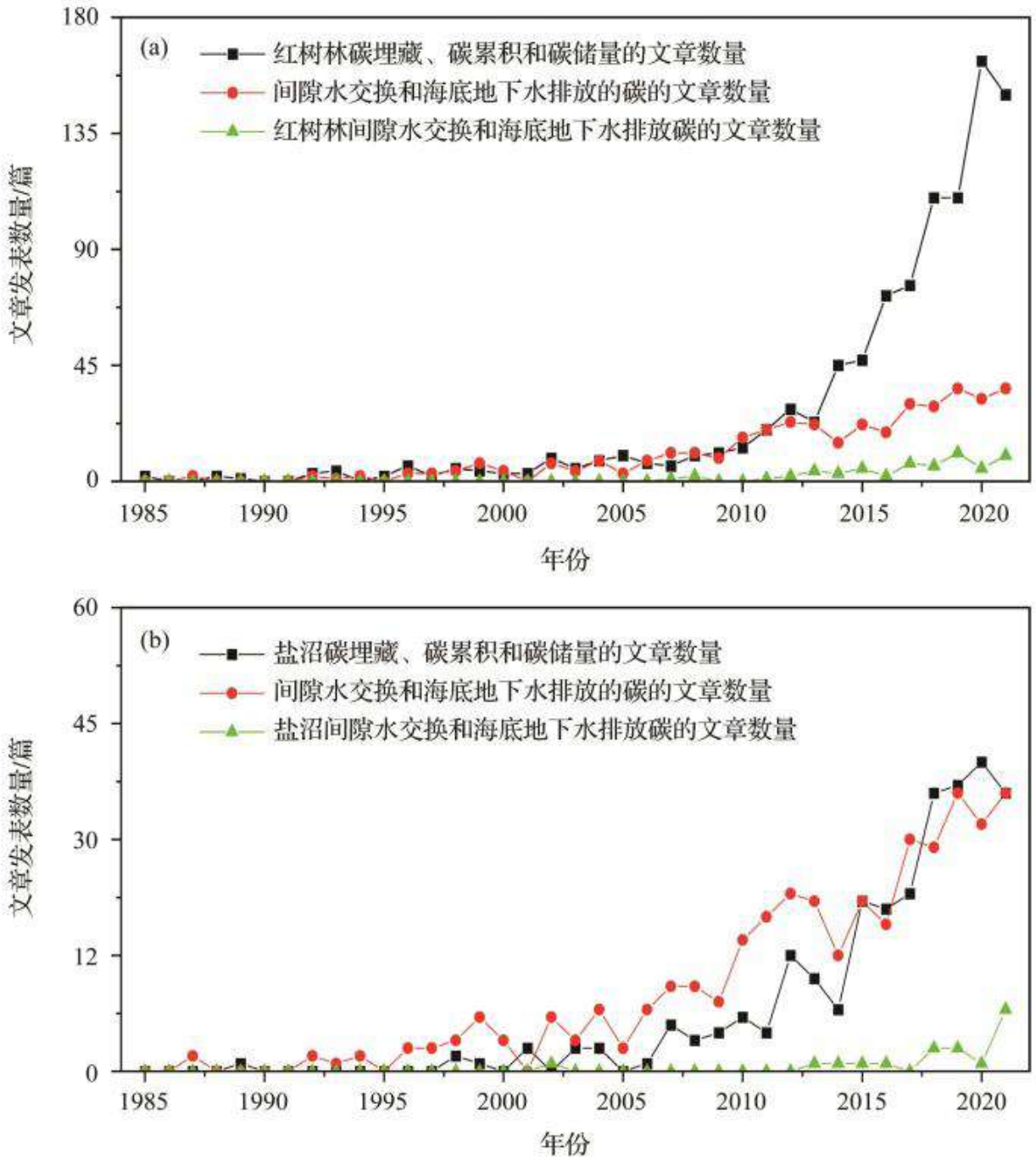

Fig.1. 1) Number of published reports on the carbon cycle of mangroves and salt marshes; 2) The number of publications on carbon cycling in mangroves and saltmarshes

Global climate change has had increasingly negative impacts on resources, ecology, and the environment. As a result, reducing atmospheric carbon dioxide (CO_2) concentrations has become a global priority. Intertidal wetlands, such as mangroves and salt marshes, play a crucial role in carbon

sequestration, serving as significant carbon sinks that can mitigate global climate change. These coastal blue carbon ecosystems are characterized by high soil carbon storage and the ability to absorb and store CO_2 from the atmosphere. However, estimating the effects of coastal blue carbon sinks is complicated by the porewater exchange (PEX) processes driven by tides and rainfall, which facilitate carbon exchange in these ecosystems.

This review aims to quantify the PEX rate and related carbon fluxes, analyze their driving mechanisms, and reassess the carbon budgets and carbon sink potentials of mangroves and salt marshes. Understanding these processes is essential for the construction, protection, and sustainable development of coastal blue carbon sinks in the context of global climate change.

Coastal Zones and Climate Change

The coastal zone, where ocean and land interact, is a complex and fragile area of the global ecosystem. It is home to about 61% of the world's population and two-thirds of its cities. Rapid economic development and population growth have accelerated urbanization, increasing human activities and exacerbating the challenges posed by global climate change. Addressing these challenges requires a dual approach: developing and utilizing green energy and enhancing CO_2 fixation.

Importance of Mangroves and Salt Marshes

Mangroves and salt marshes are effective at sequestering carbon, significantly increasing CO_2 fixation. Research on carbon sequestration and storage in these coastal wetlands has gained attention due to their importance as atmospheric carbon sinks. The carbon cycle in these ecosystems includes carbon burial in sediments, vertical exchange with the atmosphere, and lateral transport to adjacent waters. Lateral export

comprises both surface and subsurface components, with PEX playing a crucial role in the subsurface carbon exchange.

PEX involves the exchange of groundwater and surface water at the interface between sediments and overlying water. This process, driven by tides, rainfall, and bioturbation, facilitates the lateral transport of dissolved inorganic carbon (DIC) and other carbon forms from intertidal wetlands to the ocean. Despite its significance, PEX is often overlooked in carbon cycle studies of mangroves and salt marshes.

Mechanisms of Porewater Exchange

PEX processes are influenced by various factors, including topography, flow fields, and biological activities. Bioturbation, such as the creation of crab holes, increases the contact area between sediments and overlying water, enhancing terrestrial material transport to the sea. PEX can occur in both bare flats and vegetated areas, with vegetation contributing significant carbon sources through root and litter degradation.

Submarine groundwater discharge (SGD) is another important concept related to coastal groundwater-surface water exchange. SGD includes all water flows from the land-sea interface into adjacent sea areas, comprising terrestrial freshwater and recycled seawater. PEX, on the other hand, primarily involves recycled seawater driven by tidal forces, making it a significant component of SGD.

Research Methods

Quantifying PEX rates is challenging due to the complexity of hydrodynamic processes in mangroves and salt marshes. Three main research methods are used: direct measurement, hydrological modeling, and isotope tracing. Direct measurements, such as seepage meters, provide accurate local data but are impractical for larger areas. Hydrological models,

like Darcy's law and numerical simulations, offer insights into exchange processes and mechanisms but require extensive hydrogeological data. Isotope tracing, particularly with radon isotopes (^{222}Rn), is the most effective method, providing high-resolution data on PEX processes and carbon fluxes.

Global Research and Gaps

Research on PEX in mangroves and salt marshes is limited, with most studies conducted in regions like Australia, the United States, and China. There is a need for more research in underrepresented areas such as South America, Africa, and polar regions to better understand PEX on a global scale. Additionally, the interaction between multiple factors affecting PEX, long-term observational data, and uncertainties in research methods need further investigation to improve the accuracy of carbon sink assessments.

Mangrove and salt marsh blue carbon ecosystems have strong carbon sink potential, which is manifested through two pathways: carbon burial and soil PEX. Although existing research results show that the carbon flux of the soil PEX process is as important as the carbon sink process in mangrove and salt marsh blue carbon ecosystems, the research on the PEX process relative to carbon burial is neither at the regional scale nor at the global scale. There is still quite a lack of scientific research, especially in salt marsh wetlands, and some scientific issues still need to be studied in depth:

1) Global scale estimation. At present, research cases on PEX processes in mangroves and salt marsh wetlands are mainly concentrated in regions such as Australia, the United States, and China, while there are very few studies in South America, Africa, and polar regions. Related research is needed in these regions to better conduct global-scale research. calculate.

2) PEX action mechanism. Affected by the interaction between water and sand dynamics, vegetation distribution, topography and intertidal

animals, the PEX process in mangroves and salt marsh wetlands is extremely complex. Most current studies only consider a single factor on the PEX process, but cannot explain PEX and its carbon output under the combined effect of multiple factors. Therefore, it is necessary to couple these comprehensive effects to analyze the PEX action mechanism and carbon sink regulation process in mangroves and salt marsh wetlands, and then lay a solid theoretical foundation for accurate calculation of PEX carbon sink potential.

3) Long-term observations and their controlling factors. How climate change, sea level rise, land use, and extreme weather such as typhoons change many processes such as PEX in mangroves and salt marsh wetlands and the factors that control them remain unclear. Different from long-term observations of rivers and atmospheric deposition, there is currently a lack of long-term observation data of the PEX process, and there is an urgent need to establish long-term relevant experimental stations in the field. Based on the observation data obtained from the long-term experimental station, the controlling factors and dynamic laws of the long-term process are analyzed, and the future change trend of the PEX carbon sink potential of mangroves and salt marsh wetlands under the influence of the long-term process is predicted, thereby serving the national dual-carbon strategy.

4) Uncertainties such as research methods. Whether at the regional scale or the global scale, the uncertainty of PEX has always been the difficulty and focus of relevant research. These uncertainties are reflected in the selection of methods, the spatiotemporal heterogeneity of wetlands, the joint action of multiple driving forces, etc., and need to be considered. Interpret from a mechanistic perspective and combine with numerical simulations or models to improve and enhance the accuracy of assessment. Therefore, in future

research, it is necessary to conduct cross-integration with other disciplines in order to reduce PEX errors caused by uncertainties such as research methods, promote the research and development of PEX and carbon sink functions of mangroves and salt marsh wetlands, and then propose An effective way to maintain the sustainable and healthy development of mangroves and salt marsh wetlands.

The negative impacts of global climate change on resources, ecology and the environment are increasingly apparent, and reducing atmospheric CO 2 concentration has become the focus of global attention. Intertidal wetlands (such as mangroves and salt marshes) have strong carbon sink functions and are an important way to reduce CO 2 concentration and slow down global climate change. Mangroves and salt marshes are important coastal blue carbon ecosystems, and their soils have extremely high carbon storage capacity. Controlled by driving forces such as tides and rainfall, the interstitial water-carbon exchange process in mangrove and salt marsh soils has greater uncertainty in the estimation of coastal blue carbon sinks.

At the same time, the water-carbon exchange process in the interstitial space between mangroves and salt marshes is also a cutting-edge scientific issue in research related to coastal blue carbon sinks, which is quite challenging. Interstitial water exchange between mangroves and salt marshes promotes the export and storage of carbon in large amounts of sediments to the ocean. It may be another important carbon sink in addition to carbon burial in wetlands, but this has not yet been systematically studied.

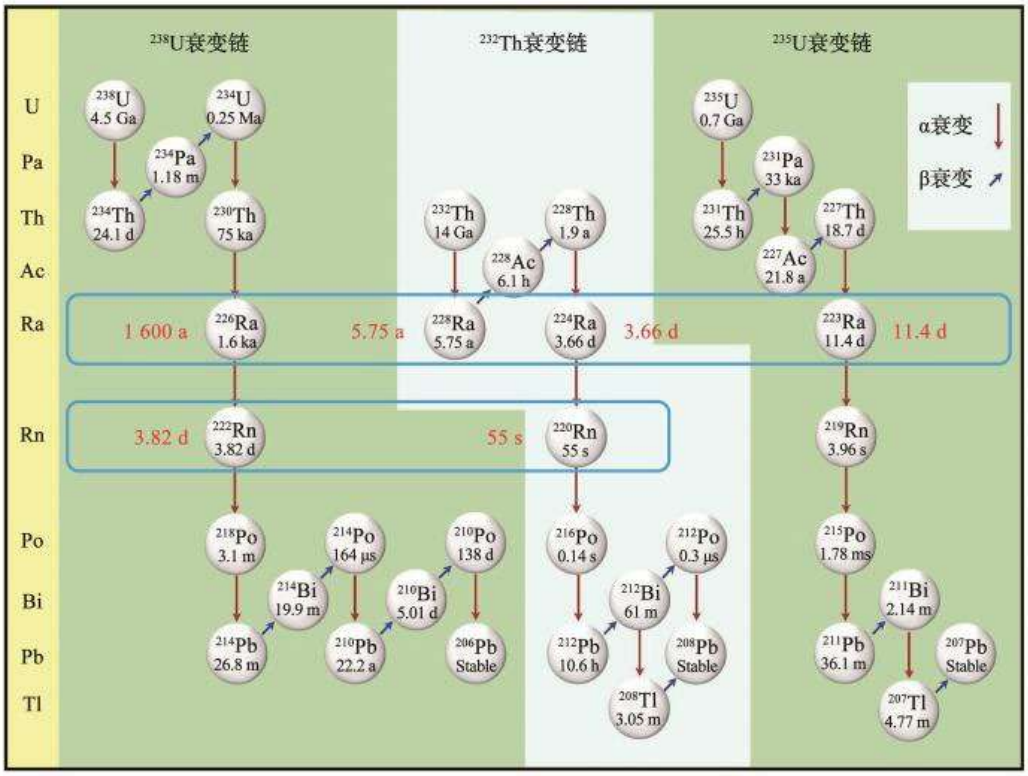

Figure 2. Three major natural radioactive decay systems

The summary describes the soil interstitial water exchange rate in mangrove and salt marsh habitats and its blue carbon flux and controlling factors. It is expected to be used in the assessment of the blue carbon budget and carbon sink potential of global mangrove and salt marsh ecosystems. The blue carbon flux carried by the interstitial water process has attracted sufficient attention. This will deepen the understanding of the carbon balance and cycle process of mangroves and salt marsh ecosystems, and further provide a better way to better utilize the blue carbon sink function of coastal zones and promote the development of mangrove and salt marsh ecosystems in the context of global climate change. Provide scientific support for construction and protection as well as sustainable development of coastal zones.

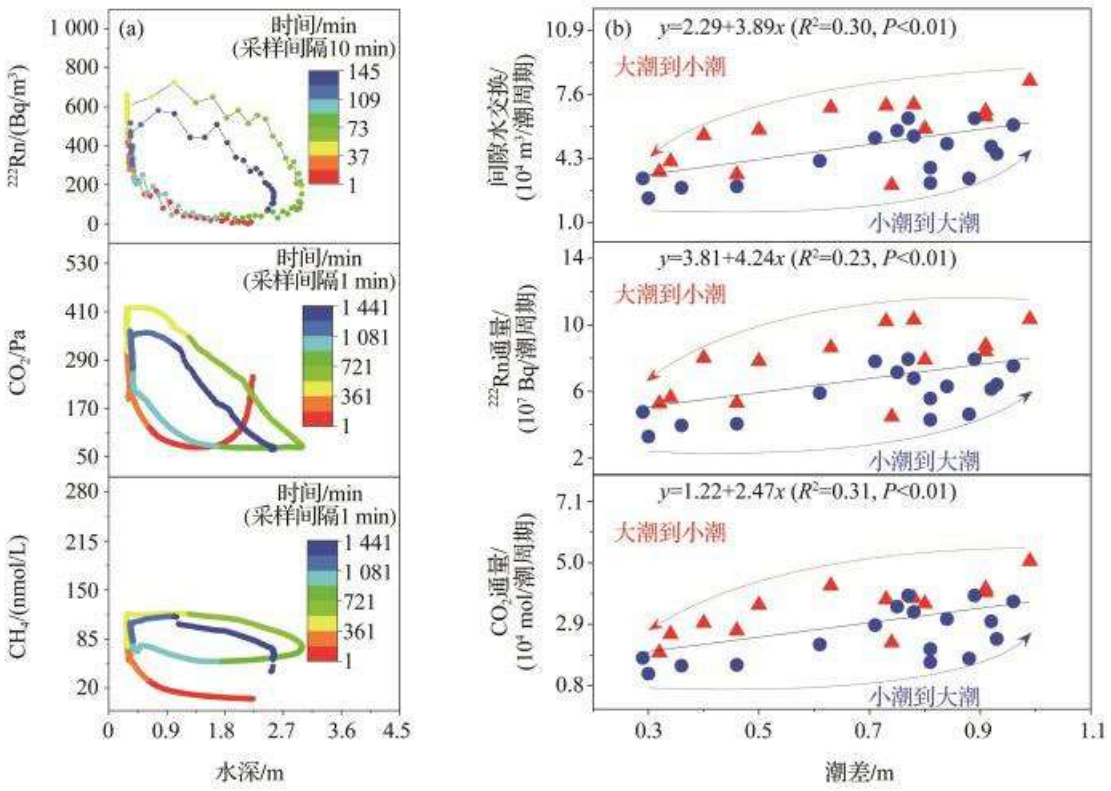

Figure 3. Research on gas hysteresis effect in intertidal wetlands

Conclusion

Mangroves and salt marshes are critical coastal blue carbon ecosystems with significant carbon sequestration potential. Porewater exchange processes play a vital role in the carbon balance and cycling of these ecosystems, yet they are often overlooked. By enhancing our understanding of PEX mechanisms and their contributions to carbon sequestration, we can better assess the carbon sink potential of mangroves and salt marshes. This knowledge is essential for the development of effective strategies to mitigate global climate change and support the sustainable management of coastal blue carbon sinks.

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EXTENSIONAL DEFORMATION AND TECTONIC IMPLICATIONS OF THE YINCHUAN-JILANTAI RIFT SYSTEM IN THE WESTERN NORTH CHINA CRATON

Xin Li, Associate Professor, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences

The Yinchuan-Jilantai rift system (YJRS) is a significant Cenozoic intracontinental rift zone located along the northwestern margin of the Ordos Block in western North China. Despite the absence of volcanic activity suggesting a passive origin, the tectonic driving forces and deep processes associated with the rift remain poorly understood. In this study, newly acquired broadband magnetotelluric (MT) data were used to image the lithospheric electrical structure along an approximately 500-km-long profile across the YJRS. The resulting model at middle to lower crustal levels reveals several subvertical, crustal-scale conductors that spatially correlate with the

rift-parallel, high-angle normal faults. These features are attributed to the combined effects of saline fluids and partial melt, resulting from the recent influx of heat and volatiles into the crust from below. The reactivated crustal-penetrating normal faults during extension act as permeable pathways for deep fluid migration. In the uppermost mantle, a roughly 400-km-wide zone of enhanced conductivity suggests the presence of partial melt, interpreted as evidence of lithospheric modification through upwelling and decompressional melting of the volatile-enriched mantle. Compared to the narrow (<100-km-wide) mantle conductors imaged beneath the Shanxi rift system along the eastern margin of the Ordos Block, this broader feature indicates a greater extent of lithospheric modification in the YJRS. This essential difference is attributed to the inherited lithospheric heterogeneity and the diminishing eastward impacts of the India-Eurasia collision, supported by additional geologic and geophysical observations.

The western North China Craton (NCC) has undergone significant extensional deformation throughout the Cenozoic era, forming extensive rift systems around the stable Ordos Block (OB). This thesis aims to elucidate the tectonic driving forces and deep processes underlying these rifts by analyzing magnetotelluric (MT) data, which are sensitive to deep fluid distribution. The study focuses on the Yinchuan-Jilantai rift system (YJRS) along the northwestern margin of the OB. Key findings include the identification of isolated high-conductivity features in the deep crust and a wide zone of enhanced electrical conductivity in the uppermost mantle, indicating lithospheric modification through low-degree melting of a volatile-enriched mantle. Comparative analysis with the Shanxi rift system reveals greater lithospheric modification in the YJRS, attributed to inherited lithospheric heterogeneity and the eastward decreasing impact of the India-

Eurasia collision. This research enhances our understanding of the dynamic processes driving rifting in the western NCC.

The western North China Craton (NCC) has experienced widespread extensional deformation during the Cenozoic, leading to the formation of several rift systems surrounding the Ordos Block (OB). Despite being far from active plate boundaries, these rifts exhibit characteristics typical of active continental rifts, including elongated sedimentary grabens, elevated rift flanks, syn-depositional normal faults, and high seismic activity. The circum-Ordos rifts are largely amagmatic, suggesting passive rifting driven by lithospheric extension from far-field tectonic loading stresses. However, the specific tectonic processes driving this extension remain controversial, with some attributing it to the India-Eurasia collision and others to the subducting Pacific plate. This thesis investigates the Yinchuan-Jilantai rift system (YJRS), one of the most prominent Cenozoic continental rifts in China, to understand the deep dynamic processes and tectonic implications of rifting around the OB.

The Ordos Block is tectonically stable, surrounded by orogenic belts and fault systems that have experienced significant deformation. The YJRS, located along the northwestern margin of the OB, is characterized by NE-striking grabens and horst-type mountain ranges bounded by normal faults. The rift system has undergone two main phases of extension, beginning in the Eocene and continuing from the Late Miocene to the present. The Alxa Block, adjacent to the OB, exhibits high seismicity and active fault systems, contrasting with the stability of the OB. The Helan Shan, a horst between the Ordos and Alxa blocks, has experienced NE-SW compression and significant uplift since the Late Miocene, influencing the subsidence of the Yinchuan and Jilantai grabens.

Magnetotellurics (MT) is a geophysical method used to image the electrical resistivity of the subsurface, sensitive to the presence of partial melt and aqueous fluids. In this study, broadband MT data were collected along a 500-km transect crossing the western Ordos Block, YJRS, and Alxa Block. The data collection involved recording electric and magnetic fields at 40 locations, with a remote reference site deployed for enhanced data accuracy. A 3-D inverse modeling approach was used to determine the electrical resistivity structure of the crust and uppermost mantle, providing insights into the deep fluid and magmatic processes beneath the YJRS.

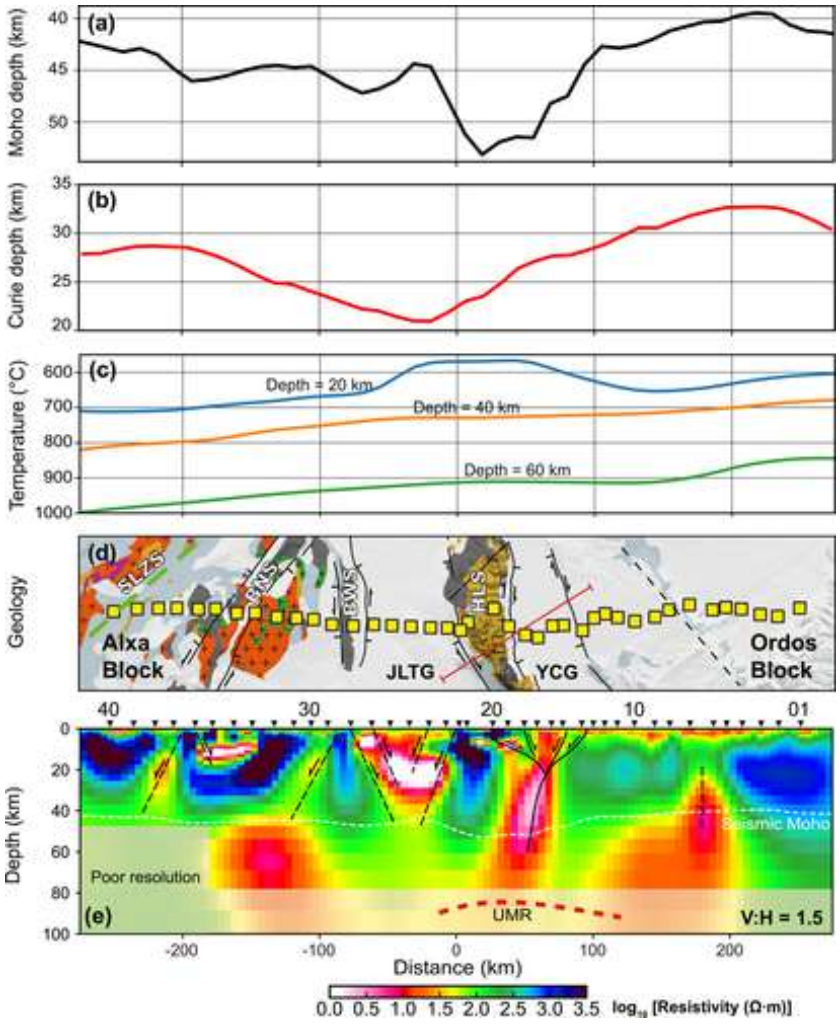

Figure 1. (a) Seismically defined Moho depth profile along the survey line (Wang, Wu, et al., 2017); (b) Curie depth profile from the Global Curie Depth Model (C. Li, Lu, & Wang, 2017; Y. Li, Pan, et al., 2017); (c)

Temperature profiles at different depths (20, 40 and 60 km) extracted from the thermal model of Sun et al. (2013); (d) Geological provinces with the same color scheme as in Figure 2. The black dashed line denotes a buried fault inferred from this study. The red solid line shows the location of the deep seismic reflection profile (Liu et al., 2017); (e) Vertically exaggerated resistivity section through the center of the preferred inversion model (V:H = 1.5: vertical axis has been exaggerated by a factor of 1.5, compared to the horizontal axis). Black solid lines show the geometry of the fault system within the Yinchuan Graben according to the interpretation of seismic reflection data (Liu et al., 2017). Black dashed lines mark our inferred structural geometries. The red dashed line marks a strong upper mantle reflector revealed by deep seismic reflection data (Liu et al., 2017).

The MT survey revealed several key features in the deep crust and uppermost mantle beneath the YJRS. Isolated subvertical high-conductivity features, spatially correlating with rift-parallel normal faults, likely represent pathways for deeply sourced fluids. A 400-km-wide zone of enhanced electrical conductivity in the uppermost mantle suggests lithospheric modification through low-degree melting of volatile-enriched mantle. These findings indicate significant lithospheric reworking beneath the YJRS, contrasting with the less modified lithosphere of the Shanxi rift system.

The greater extent of lithospheric modification in the YJRS compared to the Shanxi rift system can be attributed to inherited lithospheric heterogeneity and the eastward decreasing impact of the India-Eurasia collision. The presence of high-conductivity features in the deep crust and enhanced conductivity in the mantle suggests active mantle processes and fluid dynamics are influencing the rifting in the YJRS. These findings

support a model where both Pacific subduction and extrusion tectonics from the India-Eurasia collision contribute to the Cenozoic extension around the Ordos Block.

This study provides new insights into the tectonic processes and deep dynamic mechanisms driving the rifting in the western North China Craton. The magnetotelluric data reveal significant lithospheric modification and fluid dynamics beneath the Yinchuan-Jilantai rift system, highlighting the complex interplay of inherited lithospheric structures and far-field tectonic forces. The findings enhance our understanding of continental rifting and have broader implications for tectonic studies in similar intracontinental settings.

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ORGANOPHOSPHORUS FLAME RETARDANTS (PFRS) IN HUMAN BREAST MILK FROM ASIAN COUNTRIES: A COMPARATIVE ANALYSIS

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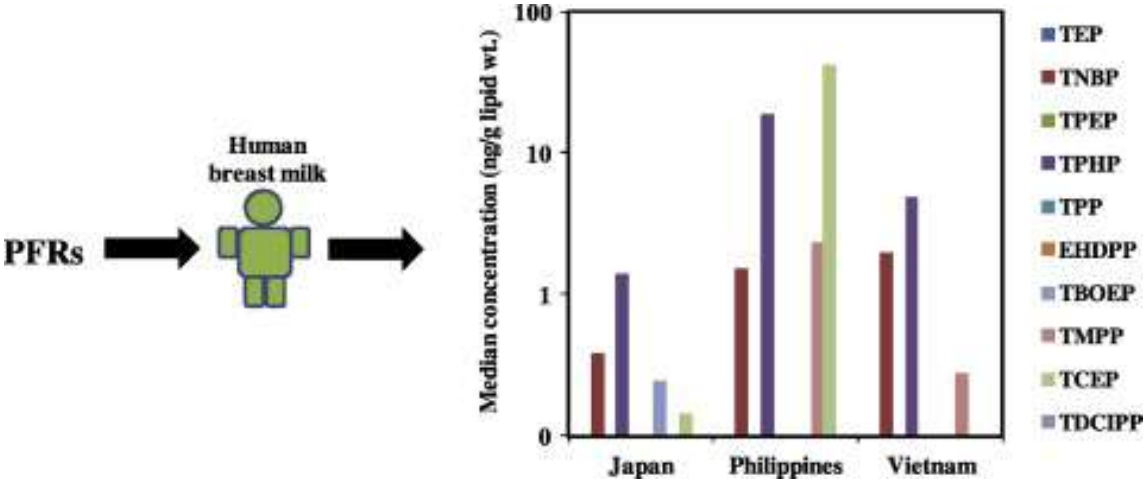
This study investigates the occurrence of organophosphorus flame retardants (PFRs) in human breast milk samples from Japan, the Philippines, and Vietnam. Concentrations of 10 PFRs were measured in 89 samples. Tris(2-chloroethyl) phosphate (TCEP) and triphenyl phosphate (TPHP) were identified as the predominant compounds, detected in over 60% of samples across all three countries. The median PFR concentrations were significantly higher in the Philippines (70 ng g^{-1} lipid wt.) compared to Japan (22 ng g^{-1} lipid wt.) and Vietnam (10 ng g^{-1} lipid wt.). The results suggest higher use of flame-retarded products in the Philippines. Compared to Sweden, PFR levels in the Philippines were 1.5–2 times higher, while those in Japan and Vietnam were 4–20 times lower. The study highlights potential health concerns for infants due to estimated PFR intake via breastfeeding.



Introduction

Organophosphorus flame retardants (PFRs) are widely used to enhance fire resistance in various household and industrial products, including

textiles, electronics, and building materials. Unlike brominated flame retardants (BFRs), which have faced regulatory restrictions due to their persistence and bioaccumulation, PFRs are increasingly adopted as alternatives. Between 2004 and 2006, the demand for PFRs in Europe rose significantly, whereas BFR usage declined. However, the widespread application of PFRs has raised concerns about their environmental persistence and potential health effects.

PFRs have been detected in diverse environmental matrices, including water, air, and sediment, as well as in human tissues such as adipose tissue and breast milk. Previous studies have demonstrated that these compounds can disrupt endocrine functions, impair neurodevelopment, and affect reproductive health. Despite the growing body of evidence on PFR exposure in humans, limited data are available for Asian populations. This study aims to address this gap by analyzing PFR concentrations in human breast milk from Japan, the Philippines, and Vietnam.

Materials and Methods

Sample Collection

Breast milk samples were collected from urban and peri-urban areas in Japan (n = 20), the Philippines (n = 41), and Vietnam (n = 26). Sampling locations included Kanagawa Prefecture (Japan), Malate and Payatas (Philippines), and Hanoi, Bui Dau, and Trang Minh (Vietnam). These areas represent varying degrees of industrialization and environmental exposure.

Analysis

The concentrations of 10 PFR compounds were measured using gas chromatography-mass spectrometry (GC-MS). Detection frequencies (DFs) were recorded for each compound, and statistical analyses were performed to compare concentrations between countries.

Results and Discussion

Concentration Patterns

PFRs were detected in the majority of samples, with detection rates exceeding 90% for most compounds. TCEP and TPHP were the most prevalent, indicating their widespread use in consumer products. Median PFR concentrations were significantly higher in the Philippines, suggesting more extensive usage of flame-retarded materials compared to Japan and Vietnam.

The observed concentration differences may reflect variations in industrial practices, regulatory frameworks, and consumer behavior. For instance, the Philippines' higher PFR levels align with less stringent regulations and proximity to waste disposal sites, as seen in samples from Payatas.

Comparison with Global Data

PFR levels in the Philippines were 1.5–2 times higher than those reported in Sweden, whereas levels in Japan and Vietnam were 4–20 times lower. These findings underscore regional disparities in PFR exposure, potentially driven by differences in product use and environmental management practices.

Health Implications

Estimated daily intake (EDI) calculations suggest that some infants in the Philippines may approach the reference dose (RfD) for TCEP and tris(2-butoxyethyl) phosphate (TBOEP) through breastfeeding. Given PFRs' potential to disrupt endocrine functions and affect neurodevelopment, these findings warrant further investigation into exposure sources and mitigation strategies.

Conclusion

This study provides the first comprehensive analysis of PFRs in human breast milk from Japan, the Philippines, and Vietnam. The results highlight significant geographic variability in PFR concentrations, with the highest levels observed in the Philippines. These findings emphasize the need for targeted policy interventions to reduce PFR exposure and protect vulnerable populations, particularly infants.

Future research should explore the long-term health impacts of PFR exposure and evaluate the effectiveness of regulatory measures in limiting environmental contamination. Enhanced public awareness and improved waste management practices could further mitigate the risks associated with PFRs.

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MODELLING THE ECONOMIC IMPACT AND RIPPLE EFFECTS OF DISEASE OUTBREAKS

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The global economic landscape has been profoundly impacted by various health crises, and the outbreak of the Coronavirus Disease 2019 (COVID-19) serves as a particularly stark example of how disease can extend its reach far beyond public health, disrupting economies on multiple levels. As a highly contagious disease, COVID-19 spread rapidly across borders, amplifying the vulnerabilities in global supply chains. From its origins in Wuhan, China, the virus's exponential spread has caused considerable losses in human lives, global manufacturing output, and economic productivity. This paper explores the methods of evaluating the economic vulnerability that cascades through supply chains due to disease outbreaks, examining impacts at the firm, national, and global levels. With the aid of economic models, epidemiological data, and network analysis techniques, the paper aims to develop strategies for understanding, mitigating, and forecasting the economic consequences of such outbreaks.

The Exponential Spread and Economic Ripple Effects

The emergence of COVID-19 exemplifies the growing risks faced by interconnected global economies. COVID-19 was first reported in December 2019, and by February 2020, over 89,000 cases had been confirmed globally.

The virus's basic reproduction number, R_0, which indicates the number of people that can be infected by a single individual, ranged between 2 and 6.47, with an average of 3.58 (Liu et al. 2020). This high transmissibility made COVID-19 more contagious than several previous outbreaks such as SARS and MERS-CoV, which had lower R_0 values. As a result, countries around the world imposed travel restrictions, quarantines, and lockdowns to curb the virus's spread.

Wuhan, the epicenter of the outbreak, is home to several global manufacturing hubs, including automobile plants operated by General Motors, Hyundai, and Toyota (Conelly, 2020). The pandemic caused these factories, along with multinational companies like Apple, Starbucks, and McDonald's, to halt production, leading to significant disruptions in global supply chains. By the end of January 2020, air travel in China had declined by 40%, and this decline was expected to persist (IATA, 2020). The economic impact was not confined to China but rippled across the globe, as countries reliant on Chinese manufacturing for raw materials and products faced shortages, delays, and rising costs.

The Challenge of Modelling Economic Impact

Various studies have examined the economic impact of pandemics, with different approaches and models attempting to quantify the costs associated with disease outbreaks. Econometric and statistical models have traditionally been used to estimate the impact of pandemics. For instance, Meltzer et al. (1999) estimated the potential economic loss from an influenza pandemic in the United States without considering multiplier effects, which can amplify losses, particularly in workforce availability. Other studies, such as Beutels et al. (2009) and Keogh-Brown and Smith (2008), found that the economic impact of outbreaks like SARS and MERS-CoV was minimal in the

long term, often due to the postponement of consumption rather than a permanent reduction.

However, these models often fail to account for the cascading effects across sectors and regions. Leontief's input-output model (1936), which accounts for the direct and indirect impacts of disruptions on the economy, has been extended to an inoperability input-output model to measure the economic consequences of workforce absenteeism during a pandemic (El Haimar and Santos, 2015). This model highlights the indirect effects, such as those caused by the absence of workers, including those who care for sick family members or are forced to remain at home due to school closures. For example, in the UK, absenteeism rates due to school closures can be as high as 16.1% (Sadique et al. 2008), which exacerbates the shortage of workers, particularly in healthcare.

At the global level, the complexity of interdependencies across economies requires more sophisticated multi-regional analysis. For example, Duan et al. (2018) used multi-regional models to assess the trade effects of disruptions, while Wang et al. (2020) employed a similar approach to examine the sustainability of global supply chains. However, these approaches have yet to fully capture the economic vulnerability stemming from disease outbreaks. The use of multi-regional input-output databases published by organizations such as the OECD and the Asian Development Bank is critical for evaluating the ripple effects that disease outbreaks generate across sectors and countries. As production networks become increasingly globalized, disruptions due to labor shortages, travel restrictions, and plant closures can trigger cascading impacts that extend beyond the initially affected regions.

Coupling Disease Transmission with Economic Models

The integration of disease transmission models with economic models is crucial for more accurately predicting the economic consequences of pandemics. Traditional epidemiological models, such as the Susceptible-Infectious-Recovered (SIR) model, describe the dynamics of disease spread but must be coupled with economic models to account for the effects of workforce absenteeism and other indirect impacts. For instance, mobility data and the spread of infection can be integrated into economic models to estimate the workforce availability and the resulting economic loss. This dynamic approach allows for more accurate forecasts of the economic impact of pandemics.

Additionally, sensitivity analysis can be applied to account for variability in recovery rates and transmission rates. By examining different scenarios based on the severity of the outbreak, policymakers can evaluate the likely economic outcomes and develop more effective intervention strategies. For example, stockpiling essential goods and improving hospital infrastructure are strategies that can mitigate the effects of pandemics on production and trade.

Implications for Risk Management

The COVID-19 pandemic underscores the central role of human resources in economic operations and highlights the vulnerabilities in global supply chains. To build resilience against future outbreaks, it is essential to develop risk management frameworks that consider the interdependencies across different regions, sectors, and countries. These frameworks should include strategies such as the development of disease surveillance databases, the establishment of streamlined processes for vaccine deployment, and the creation of emergency response plans at local, national, and international levels.

Moreover, the application of optimization models in risk management can help identify the most cost-effective interventions. For instance, optimizing resource allocation during a crisis can reduce the impact on production while ensuring that critical sectors, such as healthcare, remain functional. The use of big data and network analysis can further improve decision-making by providing real-time insights into the spread of the disease and the associated economic impact.

Conclusion

The COVID-19 pandemic has exposed the vulnerabilities inherent in the interconnected global economy and demonstrated the need for more robust economic models that account for both direct and indirect impacts. By combining economic models with epidemiological data and network analysis, it is possible to better understand the ripple effects of disease outbreaks and develop strategies to mitigate their economic impact. Future research should focus on creating comprehensive, multi-level frameworks for assessing the economic consequences of pandemics and developing risk management strategies to safeguard against future disruptions. Through these efforts, economies can better prepare for and respond to the next global health crisis.

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