ECONOMIC COOPERATION ORGANIZATION

ECONOMIC JOURNAL

Publisher

Economic Cooperation Organization

The Economic Journal has been a publication of the Economic Cooperation Organization since 2009.
The journal is published twice a year.

Baku- 2024

ECONOMIC COOPERATION ORGANIZATION
ECONOMIC JOURNAL

Economic Scientific Research Institute (The ESRI)
(Chief Editorial Office)
196 Hasan Bey Zardabi Av., Baku, Azerbaijan,
Postal Code: AZ1122
Tel: *+994 512804335 & +994 124309618*
Fax: *+994 124300215*
E-mail: *office@esri.gov.az*
Website: *http://www.esri.gov.az & http://www.theesri.com*

Economic Cooperation Organization (ECO)

No. 1, Golbou Alley, Kamranieh St., Tehran, Iran,
Postal Code: 19519 – 33114
Tel: *+9821 22831733-4 & 22292066*
Fax: *+9821 22831732*
E-mail: *Registry@ECOsecretariat.org*
Website: *http://www.ecosecretariat.org*

ECO Trade and Development Bank

Silahşör Caddesi Yeniyol Sokak No:8
Kat:14-16
Bomonti 34380 Şişli, Istanbul, TÜRKİYE
Tel: +90-212-3936300,
Fax: +90-212-3936301
E-mail: *info@etdb.org*
Website: *https://www.etdb.org/*

Volume 1, Issue 9, 2024

Table of Contents

Foreword

I am delighted to present the 9th edition of the ECO Journal, a significant milestone in our collective journey. This publication serves as a vital forum for exchanging ideas, viewpoints, and best practices to promote sustainable development and economic cooperation across the diverse ECO Region.

Since we steer the complexities of the global economy and face shared challenges such as technological advancement, climate change, and socioeconomic inequality, collaboration and solidarity among ECO member countries are more crucial than ever.

Economic growth remains central to our collective goals. With a combined GDP exceeding $2 trillion, ECO countries possess significant economic promise. However, to fully realize this potential, we need to invest in critical infrastructure, foster entrepreneurship and innovation, and enhance intraregional trade. This edition explores our efforts, including ecological concerns and transportation's impact on the economy, to stimulate regional economic growth.

Social inclusion and human capital development are paramount for the ECO Region. Despite an average Human Development Index (HDI) of 0.711, indicating modest human development levels, there are disparities among member nations. This publication highlights programs aimed at improving social protection, healthcare, and education systems.

Sustainability is at the core of our development agenda. The ECO region faces significant environmental challenges, including climate change and resource depletion. The 9th edition emphasizes the significance of embracing sustainable practices, including the implementation of the Green ECO Strategy and the expansion of renewable energy within our portfolio.

This publication calls on stakeholders in civil society, governments, and academia across our member states to foster communication and cooperation. By addressing common issues and seizing opportunities for inclusive growth, sustainable development, and regional integration, we can achieve our shared objectives. The journal features expert papers offering diverse perspectives and innovative ideas to advance these goals.

I sincerely thank the authors, readers, and editors of the ECO Journal for their invaluable contributions to creating a brighter future for our region.

Let us reaffirm our commitment to collaboration, solidarity, and mutual benefit. Together, we can build a prosperous future where economic cooperation and sustainability are enduring realities for all ECO member countries.

Khusrav Noziri

Ambassador ECO
Secretary General

From the Editor-in-Chief

The release of the latest issue of the ECO Economic Journal is a noteworthy event. Researchers with progressive perspectives have contributed to the journal and have shared their views on specific topics that are not only significant regionally but globally. Topics such as conflicts, transportation, climate change, and the labor market and their impacts on the economy are researched and analyzed through interdisciplinary studies, utilizing various methodologies to inform policy decisions, optimize resource allocation, and foster sustainable economic development. In this context, there is a high demand for the publication of the ECO Economic Journal, which points up important economic issues.

Natural reserves, agricultural potential, transportation infrastructure, and human capital in member states of ECO have a huge potential to contribute to the region's economic development and integration. The role of the ECO Journal should be perceived as an academic platform, in which researchers analyze the challenges and potentials of the region and share their findings and solutions on specific issues.

The main challenge for the Editorial Board is encouraging the academic community to share their research and to generate interest among readers. Therefore, we must make sure the journal maintains a high academic quality and satisfies worldwide standards. On the other hand, the digitalization of the Journal and the development of the Journal's website are important for attracting a larger audience.

An analytical summary of socioeconomic development and trends, the economic potential and achievements of the ECO Member States, global economic issues, and the impacts on the region are discussed in each edition of the journal. In future journal issues, we will try to develop new strategies to highlight more regionally important topics.

This year is particularly significant for us as we celebrate The Economic Scientific Research Institute's (The ESRI) 60th Anniversary. Within the framework of Azerbaijan's hosting of COP29, we are organizing the 3rd ECO Think-Tank Forum and The ESRI's 60th Anniversary Ceremony. These events provide a unique platform to reflect on our achievements, current issues, and future perspectives.

In conclusion, I would like to express my deepest appreciation to authors and hope readers will derive significant benefit from their contributions.

Arzu Huseynova

Editor-in-Chief of the ECO Economic Journal
First Deputy Chairman of the board
The ESRI, the Republic of Azerbaijan

AI'S DOUBLE-EDGED SWORD: STRIKING BALANCE BETWEEN INNOVATION AND ECONOMIC INEQUALITY IN AZERBAIJAN

Balakhanim Abbaszade,

balakhanim.abbaszade@ruhr-uni-bochum.de
The ESRI, Azerbaijan

This paper examines the dual impact of artificial intelligence on innovation and economic inequality, focusing on Azerbaijan. Through a comprehensive analysis of existing literature and case studies, it explores the transformative potential of AI in driving innovation across various sectors while exacerbating economic disparities. The research delves into Azerbaijan's efforts to embrace AI adoption and digital transformation, highlighting the country's progress and challenges. Moreover, it discusses the implications of AI on employment and income inequality in Azerbaijan, drawing insights from global perspectives and best practices. The paper concludes by emphasizing the importance of policy interventions, such as investing in digital infrastructure, promoting education and reskilling programs, and fostering international collaboration, to ensure inclusive and ethical AI adoption. Ultimately, it underscores the need for a balanced approach that maximizes the benefits of AI while mitigating its adverse effects, thereby shaping a more equitable and sustainable future for Azerbaijan and beyond.

Keywords: artificial intelligence, innovation, economic inequality, digital transformation, policy interventions

1. Introduction

In the realm of the fourth industrial revolution or Industry 4.0, artificial intelligence (AI) stands out as one of the groundbreaking technological advancements with expansive transformative potential. AI's ubiquitous adoption in various sectors promises an innovative future, reshaping the global economy, boosting productivity, and creating novel lines of business (Bessen, 2018).

However, it is equally potent in exacerbating economic inequality, creating a polarised society with wealth concentrated at the helm. This essay explores the contradictory nature of AI with Innovation on one edge and Economic Inequality on the other, particularly in the Azerbaijani context.

The growth trajectory of AI in Azerbaijan primarily began with its Vision 2020 strategy, focusing on economic development through enhancing technological

capabilities, including AI (Azerbaijan 2020, 2011). However, despite all the benefits AI offers, there is a pervasive concern about the simultaneous increase in economic inequality. This accentuates the need to strike a balance and ensure that the benefits of this technology are equitably distributed.

AI has extraordinary potential for driving innovative growth. It serves as a bulwark for systemic improvements, leading to increased productivity and generating new business opportunities. Its application varies across sectors from health to education, from energy to finance, and everything that lies in the spectrum. In Azerbaijan's case, AI forms the backbone of its strategy to diversify its oil-based economy —long reliant on traditional energy sectors— toward a more innovation-centric approach, fostering resilience and adaptability in the face of evolving global economic landscapes.

Even with its rich prospects, the dark underbelly of AI showcases it as a catalyst of economic inequality. AI's potential to create extreme job market polarization raises the stakes of this discourse (McKinsey Global Institute, 2018) The fear of AI replacing jobs and creating redundancies puts those with lower skills at risk while fortifying the technological elite. The latter reaps astronomical benefits creating a stark societal divide. The cascading effect of this division on the broader structure of the economy could be precarious.

The innovation-economic inequality paradox lays bare the nuanced complexity of AI in the contemporary world. Striking a balance between these polarities is both an imperative and a challenge for policy-makers. Ensuring a just and equitable utilization of AI necessitates well-crafted policies, safeguarding the interests of all economic strata without stifling innovation. This is the predicament that Azerbaijan, and indeed the world, faces while weaving the narrative of its digital future. Some innovative solutions, including, but not limited to, repurposing the traditional education system and skills training to adapt to the AI era, fostering a culture of lifelong learning, creating sustenance allowance to aid those economically displaced due to AI, and introducing regulatory mechanisms, will be of crucial importance.

2. AI Adoption and Digital Transformation in Azerbaijan

One of the fundamental shifts undergoing the world today is the digital transformation in various government and private sectors, made possible by the adoption of Artificial Intelligence. Azerbaijan, a developing country in the Caucasus region, a region with great strategic importance, has been making significant strides in this regard, embracing AI and electronic services on a broad scale. Azerbaijan's increasing reliance on electronic services signifies a broader global trend of digitalization seeding economic development and inclusive growth.

In recent years, the Azerbaijani Government's commitment to developing the "Electronic Government" has been profound, which has notably contributed to improving its E-Government Development Index (United Nations E-Government Development

Database, n.d.). Azerbaijan's Electronic Government Portal, offering digital services ranging from tax declarations to health insurance, is illustrative of their continual efforts towards this development, which simplifies the provision of social services, increases transparency, and enhances citizens' satisfaction by reducing the 'distance' between civil servants and citizens (E-Government Portal, n.d.).

The widespread use of such electronic services in Azerbaijan, significantly reducing paper-driven work, not only ensures transparency and efficiency but also fosters environmental sustainability. Further bolstering this digital transformation is Azerbaijan's progressive step in AI integration across various platforms. From healthcare to finance, AI has been revolutionizing all sectors. The advent of AI has resulted in an evolving landscape where efficiency, precision, and informed decision-making drive the central ethos.

The benefits of AI-driven digitalization are immense – streamlined operations, cost-efficient strategies, and improved services, conducive to both economic and social capital growth (McKinsey Global Institute, 2018). However, AI integration is not without its challenges. AI technologies fuel the need for advanced technical skills which raises pertinent issues relating to workforce management and skill redundancy. Consequently, there is a palpable need for upskilling and re-skilling initiatives. Moreover, data privacy concerns surfacing with technological advancement necessitate rigorous regulatory constructs (Parsons, 2023).

The journey of Azerbaijan towards AI adaptation and digitization is a testament to its robust commitment to harness the benefits of technological evolution. The growth of electronic services and the development of "Electronic Government" in Azerbaijan is a shining example for many, depicting a promising direction for their digital future. It is, therefore, incumbent upon policymakers, educational institutions, and businesses to ensure the development and implementation of appropriate strategies focusing on bridging skill gaps, managing data privacy concerns, and promoting a conducive environment for AI integration. By doing so, Azerbaijan will be able to successfully negotiate the challenges presented and fully realize the promise of the AI-enabled digital future.

3. Impact of Artificial Intelligence on Employment and Income Inequality in Azerbaijan

Artificial Intelligence has been an essential invention undergirding numerous sectors of our lives. Its influence on employment and income inequality is an elusive topic that needs to be explored in depth. This brings a need for evaluation of the impacts of AI on employment and income inequality in Azerbaijan.

First, the potential of AI to foster new job opportunities in major industries, such as agro-processing and transportation/storage, is significant. Sectors heavily reliant on manual labor have much to gain from incorporating AI into their operations. The agro-

processing sector for instance can leverage AI technology for precision farming, crop monitoring, or weather prediction. This not only helps in increasing the yield but opens up opportunities for specialized roles that understand the technology. Similarly, AI has the potential to revolutionize the transportation industry with innovations like autonomous vehicles, smart logistics, and intelligent traffic management systems (Bughin et al., 2018).

However, the rise in AI usage also comes with the risks of job displacement as AI systems usurp roles once performed by humans. Financial strain and unemployment can be catastrophic for low-income workers who are more susceptible to AI-driven job displacement. For instance, cashiering, assembly line jobs, and other routine-based jobs are more likely to be automated, rendering the previous workers potentially unemployed (AI, Automation, and the Future of Work: Ten Things to Solve For, 2018)

Moreover, AI can potentially amplify income inequality by preferentially benefiting higher-skilled, higher-income workers. The presence of AI creates a new market for jobs that require advanced skills in AI technology. How will it happen? As AI capabilities advance, there is a growing demand for workers with specialized skills in AI development and implementation. Those who already possess these skills, often highly educated and well-compensated individuals, can leverage AI to further boost their productivity and earning potential. In contrast, workers in routine, automatable jobs face the risk of displacement by AI, pushing them into lower-paying positions or unemployment. This "skill-biased technical change" widens the wage gap between high-skilled and low-skilled workers (Cornelli et al., 2023).

Moreover, the concentration of wealth and power within the AI industry itself contributes to inequality. As AI-driven companies accumulate capital and market share, they can further entrench their dominance, making it harder for others to compete. This "winner-take-all" dynamic exacerbates inequality both within the tech sector and across the broader economy. Those individuals who already possess such skills have the opportunity to gain a significantly larger income than their counterparts who do not have these skills (Kharate, 2024).

Additionally, implementing AI could lead to higher profits for AI-producing firms and AI-adopting firms. These wealth gains often flow to the firm's owners and highly skilled workers, thus exacerbating the wealth gap. AI's increasing pervasiveness makes an argument for regulation and upskilling. Governments and institutions should invest in educational programs and vocational training to prepare individuals, particularly in low-income sectors, for the eventual AI transformation.

This all brings us to the conclusion that while AI yields potential for new job creation and industrial improvement in Azerbaijan, it inherently presents dangers of job displacement and possible intensification of income inequality. A balanced approach grounded with adequate preparation and informed policies can ensure that the rewards of AI are more evenly distributed and not just confined to certain sections of society.

4. Policy Interventions and Strategies for Inclusive AI Adoption Interest and Investment in

The rapid pace of AI adoption, as already discussed, is not without challenges, especially in terms of inclusivity and equity. Policymakers have a critical role in mitigating these challenges through well-thought-out strategies and interventions. A fundamental pillar of inclusive AI adoption is the creation of robust digital infrastructure, which would be more efficient, flexible, and innately intelligent systems that require less data and are more transparent, addressing the limitations of current data-hungry and black-box neural networks. This includes both technological hardware, such as fast and reliable internet connections and digital devices, and software, including digital platforms and tools, and machine learning algorithms (Wilson et al., 2019).

With the current digital divide, the lack of access to such infrastructure often impedes the benefits of AI technologies. Investing in this infrastructure in underprivileged areas, therefore, is a significant step towards closing the digital gap (AI in the Global South– NRI, 2023). While this requires substantial investment, its socio-economic benefits far outweigh the financial implications as it can foster economic development and inclusivity (Reskilling Revolution, n.d.).

Alongside digital infrastructure, another fundamental aspect is education. The future of work is changing dramatically due to AI, altering the nature of jobs and industries. Creating opportunities for individuals to learn AI itself and to build AI capability is, therefore, of crucial importance. More importantly, education, particularly focusing on AI-related skills, also empowers individuals to fully participate and benefit from this ever-progressing field (PwC, n.d.). Reskilling and upskilling programs are also central in preparing the workforce for AI-shaped industries. McKinsey Global Institute reveals that as many as 375 million workers globally will need to switch occupational categories and learn new skills by 2030 because of AI (Manyika et al., 2017). Reskilling programs, if done appropriately, can effectively help workers adapt to the changing job market and ensure that no one is left behind. The key is to offer tailored training programs to enhance the digital literacy and skills of both current and future workers.

While it is important to focus on these aspects, policymakers must also ensure the responsible and ethical use of AI. This can be achieved through the creation of sound ethical guidelines. Policymakers are responsible for defining these guidelines that ensure that AI technologies are used for the best interests of all citizens and that benefits and risks are shared equitably (Future of Life Institute, 2017). Besides, the formulation of regulatory frameworks should also be a priority. These frameworks should encourage innovation, transparency, and accountability, and should be able to address issues such as privacy, bias, and security in AI adoption (Ethics Guidelines for Trustworthy AI, 2019).

In conclusion, inclusive AI adoption is a challenging yet achievable goal. It requires strategic policy interventions from easing the digital divide through investment in digital infrastructure and education to reskilling and upskilling programs, and ethical guidelines and regulatory frameworks. As AI continues to permeate various facets of life, its adoption

should be a force for societal good, fostering economic growth, and improving the quality of life of citizens.

5. Global Perspectives on AI Adoption: Lessons and Prospects for Azerbaijan

As artificial intelligence continues to advance and become more integrated into our daily lives, it is crucial for countries to understand the current state of AI adoption globally. While some nations are at the forefront of AI development and implementation, others are still in the early stages of adoption. By examining the successes and challenges faced by countries leading the way in AI, nations like Azerbaijan can learn valuable lessons to accelerate their own AI strategies and avoid potential pitfalls.

Estonia, dubbed the 'most advanced digital society in the world' serves as a vital comparison, as well as a benchmark for Azerbaijan. Their adoption of AI has extensively affected both employment and inequality rates. While Estonia's employment rates fecundated due to AI, inequalities also rose. Notably, Estonia mitigated these effects through educational reforms and bolstering its IT sectors.

Estonia's adoption of AI has had a mixed impact on employment and inequality rates:

- The risk of losing jobs due to AI is smaller in Estonia compared to other OECD countries. Only 6% of jobs are estimated to disappear in Estonia, versus 9% on average in other OECD member states. This is likely because Estonia has a highly educated workforce able to learn digital skills to manage AI, and a labor market dominated by small companies that are less impacted by automation (Joamets & Chochia, 2020).

- The Estonian Unemployment Insurance Fund uses AI to predict long-term unemployment risks and offer customized services (Aiforgoodstg, 2020). This proactive approach aims to mitigate the potential negative impacts of AI on employment.

This means that Estonia's advanced digital society is yielding rather positive results; therefore, targeted policies to reskill workers and ensure equitable access to AI-driven opportunities will be important going forward. Azerbaijan can learn from Estonia's experience in harnessing AI to improve public services while mitigating potential negative impacts on employment and inequality.

In contrast to Estonia, South Korea serves as an example of a larger economy dealing with AI adoption. South Korea is top-tier regarding AI investment yet is grappling with employment and inequality issues, significantly those from age and gender disparities.

South Korea is grappling with the impact of AI adoption on employment and inequality, particularly issues stemming from age and gender disparities. A study by the Bank of Korea found that AI could replace up to 4 million jobs, or 14% of South Korea's workforce, over the next two decades (Bloomberg - Are You a Robot?, 2023)

To address these challenges, the South Korean government has launched several initiatives:

- The Ministry of Science, ICT and Future Planning (MSIP) laid out the Artificial Intelligence Information Industry Development Strategy to strengthen the foundation for AI growth (Lee & Choi, 2016).

- The government also announced a Comprehensive Strategy for the Artificial Intelligence Information Society to analyze the transformations brought by AI and propose policies to address the socioeconomic implications (ibid).

- The AI strategy document outlines use cases for AI to help address major societal challenges in South Korea, such as an aging population, gender inequality, and online bullying (Choi, 2020).

Such proactive measures taken by the South Korean government can be exemplary for Azerbaijan in dealing with issues pertinent to vulnerable demographics like older and female workers.

Japan, another Asian nation, offers crucial insights as well. Despite enlightened AI adoption, Japan is encountering issues associated with automation and subsequent job losses. Nonetheless, Japan has adopted an AI-focused reskilling approach to maintain employment and reduce inequalities. Industry leaders, such as Keidanren, have been encouraging Japanese companies to take steps to become AI-ready, recognizing that AI is a core technology for achieving Society 5.0 and the Sustainable Development Goals (Using AI to Realize Society 5.0 for SDGs, 2023).

From these countries, Azerbaijan could glean valuable best practices. Notably, the commitment to educational reform, as demonstrated by Estonia, is paramount. Enshrining AI and IT in educational curriculums could be invaluable to Azerbaijan. Concurrently, addressing demographic disparities brought by AI adoption, like South Korea, can inform Azerbaijan's approach significantly, with Japan's focus on reskilling its labor force highlighting the importance of upskilling and reskilling programs in Azerbaijan.

International collaboration offers Azerbaijan support and resources to navigate AI challenges better. Pooling resources and knowledge from international partners, both industry and academia, could expediently facilitate AI adoption in Azerbaijan. The United Nations Development Programme (UNDP), World Bank, and International Telecommunication Union (ITU) all offer relevant platforms for collaboration. Joining global initiatives like the AI for Good movement can bolster Azerbaijan's AI adoption, promote AI ethics, reduce job losses, and address inequalities. In conclusion, while Azerbaijan grapples with the challenges attached to AI adoption and its associated impacts on employment and inequality, it can extract several lessons from countries that are ahead in their AI journey. A concerted effort toward educational reform, coupled with demographic-specific interventions and investment in reskilling programs, all underpinned by international collaboration, can guide Azerbaijan's AI future.

Conclusion

In conclusion, the transformative power of artificial intelligence (AI) presents both unprecedented opportunities and significant challenges for Azerbaijan and the global community at large. As AI becomes increasingly integrated into various sectors, it has the potential to drive innovation, enhance productivity, and foster economic growth. However, this technological advancement also exacerbates economic inequality, poses threats to employment stability, and requires careful navigation to ensure inclusive and ethical adoption.

The case of Azerbaijan exemplifies the complex interplay between AI-driven innovation and economic inequality. While the country has made significant strides in embracing AI and digitization, there remains a pressing need to address the widening gap between technological elites and marginalized communities. Policy interventions aimed at bridging this divide, such as investing in digital infrastructure, promoting education and reskilling programs, and implementing ethical guidelines and regulatory frameworks, are imperative to ensure that the benefits of AI are equitably distributed across society.

Furthermore, global perspectives on AI adoption offer valuable insights for Azerbaijan as it navigates its own AI journey. By learning from countries like Estonia, South Korea, and Japan, which have grappled with similar challenges and devised proactive strategies, Azerbaijan can develop a holistic approach to AI adoption that prioritizes inclusivity, addresses demographic disparities, and fosters international collaboration.

In essence, the future of AI in Azerbaijan hinges on the ability of policymakers, businesses, and civil society to collaborate effectively in harnessing the benefits of AI while mitigating its adverse effects. By embracing a balanced and proactive approach grounded in ethical principles and social responsibility, Azerbaijan can pave the way for a more equitable and sustainable AI-enabled future for all its citizens.

Reference list

AI, automation, and the future of work: Ten things to solve for. (2018, June 1). McKinsey & Company. https://www.mckinsey.com/featured-insights/future-of-work/ai-automation-and-the-future-of-work-ten-things-to-solve-for AI in the Global South– NRI. (2023). https://networkreadinessindex.org/artificial-intelligence-in-the-global-south/

Aiforgoodstg. (2020, November 2). Hits, misses, and lessons learned: How Estonia delivers public services in the age of AI. AI For Good. https://aiforgood.itu.int/hits-misses-and-lessons-learned-how-estonia-delivers-public-services-in-the-age-of-ai/

Bessen, J. (2018). AI and Jobs: The Role of Demand. In NBER Working Paper Series (No. 24235). National Bureau of Economic Research. https://www.nber.org/system/files/working_papers/w24235/w24235.pdf

Bloomberg - Are you a robot? (2023, November 16). https://www.bloomberg.com/news/articles/2023-11-16/ai-could-replace-4-million-jobs-in-south-korea-bok-study-says

Bughin, J., Woetzel, J., & Madgavkar, A. (2018, February 14). How will automation affect economies around the world? McKinsey & Company. https://www.mckinsey.com/featured-insights/future-of-work/how-will-automation-affect-economies-around-the-world

Choi, J. (2020, April). Why Covid-19 only accelerates South Korea's AI ambitions. Lowy Institute. https://www.lowyinstitute.org/the-interpreter/why-covid-19-only-accelerates-south-korea-s-ai-ambitions

Cornelli, G., Frost, J., & Mishra, S. (2023, October 25). Artificial intelligence, services globalisation and income inequality. https://www.bis.org/publ/work1135.htm E-Government portal. (n.d.). https://e-gov.az/en

Ethics guidelines for trustworthy AI. (2019, April 8). Shaping Europe's Digital Future. https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai

Future of Life Institute. (2017, August). Asilomar AI Principles - Future of Life Institute. https://futureoflife.org/open-letter/ai-principles/

Joamets, K., & Chochia, A. (2020). Artificial Intelligence and Its Impact on Labour

Relations in Estonia. Slovak Journal of Political Sciences, 255–277. https://doi.org/10.34135/sjps.200204

Kharate, R. (2024). AI's impact on income inequality. © 2024 Boston University. https://sites.bu.edu/uea/2024/02/05/ais-impact-on-income-inequality/

Lee, H. W., & Choi, Y. (2016, August). What is Korea's Strategy to Manage the Implications of Artificial Intelligence? World Bank. https://blogs.worldbank.org/en/digital-development/what-korea-s-strategy-manage-implications-artificial-intelligence

Manyika, J., Lund, S., Chui, M., Bughin, J., Woetzel, L., Batra, P., Ko, R., & Sanghvi, S. (2017). Jobs lost, jobs gained: What the future of work will mean for jobs, skills, and wages. In McKinsey & Company. https://www.mckinsey.com/featured-insights/future-of-work/jobs-lost-jobs-gained-what-the-future-of-work-will-mean-for-jobs-skills-and-wages

McKinsey Global Institute. (2018). The promise and challenge of the age of artificial intelligence. In BRIEFING NOTE. https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Artificial%20Intelligence/The%20promise%20and%20challenge%20of%20the%20age%20of%20artificial%20intelligence/MGI-The-promise-and-challenge-of-the-age-of-artificial-intelligence-in-brief-Oct-2018.pdf

Order of the President of the Republic of Azerbaijan on preparation of the "Azerbaijan 2020: Looking into the Future" Development Concept, Official website of President of Azerbaijan Republic. (2011). In president.az. https://president.az/en/articles/view/3689

Parsons, L. H. (2023). Digital privacy and security challenges for the workplace of the future. Women in Tech Network. https://www.womentech.net/video/digital-privacy-and-security-challenges-workplace-future

PwC. (n.d.). New world. New skills. https://www.pwc.com/gx/en/issues/upskilling.html Reskilling Revolution. (n.d.). https://initiatives.weforum.org/reskilling-revolution/action

United Nations E-Government Development database. (n.d.). https://publicadministration.un.org/egovkb/Data-Center

Using AI to Realize Society 5.0 for SDGs. (2023, June). Keidanren.

https://www.keidanren.or.jp/en/policy/2023/041.html

Wilson, H. J., Daugherty, P. R., & Morini-Bianzino, N. (2019, August 21). The future of AI will be about less data, not more. Harvard Business Review. https://hbr.org/2019/01/the-future-of-ai-will-be-about-less-data-not-more

APPLICATION OF HUMAN LIFE DAMAGE ASSESSMENT METHODOLOGIES: AGAINST THE BACKGROUND OF THE ARMENIA-AZERBAIJAN MILITARY CONFLICT

***Farhad Mikayilov*[1]**

farhad.mikayilov@esri.gov.az
Economics Scientific Research Institute,
Head of Social Policy and Humanitarian Areas Department
State Technical University, Department of Economics and Statistics,
Associate Professor

The main goal of the research work is to generalize the methodological bases for the compensations to be paid to the persons killed, injured and disabled as a result of the violation of human rights, and at the same time to assess the damage to human life and health in Azerbaijan during the military aggression of Armenia to Azerbaijan.

In order to achieve this goal, the theoretical and methodological bases were summarized, the experience of similar countries was taken into account, and assessments were made based on relevant statistical data.

Here, the damages were estimated as the sum of the amount of benefits and one-time payments paid to the killed, injured or disabled persons of the countries where the compensation will be based on the increase of budget expenses based on the benefits paid directly by the state, and the amount of potential income that those persons can get.

It should also be noted that the income that can be obtained is estimated based on the average monthly salary of that country and the interval until the retirement age, and the period of benefits to be paid is based on the age limit defined by the legislation or the age interval until the expected life expectancy of the recipients of benefits.

Analysis, analysis, synthesis, evaluation methods were used in conducting the research.

In the end, the amount of damage caused to the citizens of Azerbaijan due to the damage caused to human life and health was calculated with appropriate justifications.

Keywords: Human rights, death, enforced disappearance, injury, lifelong disability.

1. Introduction

Human rights, as rights earned simply because they are human, are superior to and independent of state law. Human rights find their place only within a democratic order as a necessary condition for the comprehensive development of the individual. Human rights rules have a universal basis of equality and therefore have a high moral character. All rules that protect human dignity are covered by human rights. Human dignity is the most important tool to measure compliance with legal rules and correctness of decisions. Human rights rules, as a set of superior rules aimed at protecting human value and material and moral development of people, define state-individual relations in all countries and form the basis of world peace and justice at the international level. Any rule or action aimed at destroying the human rights of anyone, any organization or state cannot be accepted and implemented by the highest bodies of any country, as well as international organizations. It is under the direct control and responsibility of the state that a person is not harmed while exercising his rights. The protection of human rights means primarily the protection of the individual, and the main responsibility for this protection belongs to the state.

After World War II, the concept of "crimes against humanity" was reflected in Article 6 of the Nuremberg Tribunal Statute. According to article 6 of the Nuremberg Court Statute, crimes against humanity include murder, extermination, enslavement, deportation, rape, torture, persecution, committed for political, racial or religious reasons, against the civilian population before or during the war. With the intensive development of international criminal law, the concept of "crimes against humanity" has been greatly expanded.

The main criterion that brings this diversity to a common denominator is that these actions are systematically or on a large scale and are aimed at the civilian population. This internationally accepted criterion is also reflected in the legislation of the Republic of Azerbaijan: 105 of the Criminal Code of the Republic of Azerbaijan. 105-113 of this chapter. Intentional acts envisaged in the Articles or as part of systematic attacks are considered crimes against humanity.

It should not be forgotten that one of the most dangerous events that end human freedom occurs during wars. Therefore, war is a tool that jeopardizes free coexistence as well as mass death and injury. One of these wars is the undeclared war of Armenia aimed at occupying Azerbaijani lands. This war started in 1988 and the first phase of the active period mainly covered the years 1988-1994.

At this stage, 20 percent of Azerbaijan's lands were occupied, a ceasefire was implemented as of May 12, 1994, and it was decided to solve the problem through peaceful means. During this ceasefire, the ceasefire was regularly violated, albeit for a short time, and there were casualties.

The chronology of crimes against peace and humanity, as well as serious and especially serious crimes committed by the Armenian armed forces operating illegally in Karabakh and the Armed Forces of the Republic of Armenia in the occupied territories of Karabakh and in the eastern Zangezur regions of the Republic of Azerbaijan can be summarized as follows.

Since 1988, Armenian armed military units operating illegally in Karabakh and the Armed Forces of the Republic of Armenia forcibly displaced the local population of Azerbaijani nationals living in Karabakh, East Zangezur regions and other regions of the Republic of Azerbaijan from their legal residence. , material wealth in residential areas and state facilities, looting and destruction of cultural monuments, horrific torture of Azerbaijani prisoners and hostages, brutal treatment of civilians and other persons protected by international humanitarian law, genocide, deportation, torture and killing of group members in order to destroy, in whole or in part, as a group. crimes against peace and humanity, as well as deliberate murder, sabotage, terrorism and other particularly serious crimes:

Illegally operating Armenian armed military units, soldiers illegally brought from the Republic of Armenia and deployed in Khankendi.

The aggressor Armenia, with such provocative actions, grossly violated the fundamental norms and principles of international law, created a sharp escalation, and committed open conspiracies against the sovereignty and territorial integrity of the Republic of Azerbaijan.

Crimes against the civilian population of Azerbaijan were recorded and documented by the investigation team operating at the scene, and intensive investigative actions were carried out in order to gather relevant evidence of crimes against humanity committed by Armenian soldiers.

As a result of the ceasefire violation, on September 27, 2020, the conflict entered an active phase for the second time and the enemy tried to continue the policy of aggression. However, as a result of the sharp retaliatory attack and counter-attack of the Azerbaijani army, the main part of the occupied territories was freed from the enemy for 44 days. In total, 3,058 people were killed and 5,000 were injured from the 2nd Karabakh war from September 27, 2020 to September 27, 2022.

In general, along with these civilians, up to 25,000 Azerbaijani citizens were martyred and 56,000 were injured at all stages of the aggression carried out by Armenia against Azerbaijan.

We note that the conflict can be divided into stages according to the table below, and in each stage of this stage, the damage due to the killed, wounded and missing citizens can be assessed based on appropriate methodologies.

Table 1.

Gradual number of dead and wounded in the Armenian-Azerbaijani military conflict[1]

	Those who perished	The wounded
1988-1994 (Active Phase 1)	20000	50000
12 May 1994-27 September 2021	1008	1205
2020 (September 27-November 10, 20200 (Active Phase 2)	2908	4620
November 10, 2020 - September 30, 2022	150	360

As can be seen, the damage caused by Armenians to the lives of Azerbaijani citizens continued both during the active period of Armenia's military attack on Azerbaijan and after the signing of the armistice and surrender law.

2. Methodology

It should not be forgotten that one of the most important elements is the implementation of measures to prevent crimes against human life or loss of human health. It is the determination of the damage done against the background of the crime committed and the demanding of appropriate compensation from the aggressor. One of the gravest crimes of a rapist is committing genocide. It should be noted that the word "genocide" was first used in 1944 by Polish lawyer Rafael Lemkin in his book "Axis Rule in Occupied Europe". It consists of the Greek prefix genos, meaning race or tribe, and the Latin suffix cide, meaning to kill. Lemkin coined the term partly in response to the Nazi policy of systematically exterminating the Jewish people during the Holocaust, but also in response to earlier examples of targeted actions in history aimed at destroying certain groups of people. Later, Rafael Lemkin led the campaign to recognize and legislate genocide as an international crime.

Genocide was first recognized as a crime under international law by the United Nations General Assembly (A/RES/96-I) in 1946. It is regulated as a separate crime in the 1948 Convention on the Prevention and Punishment of the Crime of Genocide (Genocide Convention).

[1] Caspian Defense Studies Institute (CDSI) – Xəzər Hərbi Tədqiqatlar İnstitutu (XHTİ) https://caspiandefense.wordpress.com/2021/01/04/44-gunluk-muharib%c9%99-az%c9%99rbaycan-v%c9%99-erm%c9%99nistanin-itkil%c9%99rinin-nisb%c9%99ti-monitorinq/

[1] **Caspian Defense** Studies Institute (CDSI) – Xəzər Hərbi Tədqiqatlar İnstitutu (XHTİ) https://caspiandefense.wordpress.com/2022/01/31/v%c9%99t%c9%99n-muharib%c9%99sind%c9%99n-sonra-az%c9%99rbaycan-azi-110-h%c9%99rbcisini-itirib/

[1] https://caspiandefense.wordpress.com/2016/05/12/az%c9%99rbaycan-1008-h%c9%99rbi-qulluqcu-s%c9%99hid-olub-1205-n%c9%99f%c9%99r-yaralanib-22-illik-at%c9%99sk%c9%99s-c%c9%99bh%c9%99-s%c9%99hidl%c9%99ri-statistika/ baxılıb: 22.12.2020

[1] Caspian Defense Studies Institute (CDSI) – Xəzər Hərbi Tədqiqatlar İnstitutu (XHTİ) https://mod.gov.az/az/news/veten-muharibesinde-sehid-olmus-herbi-qulluqcularin-siyahisi-38067.html baxılıb: 19.04.2022

The convention has been ratified by 149 countries (as of January 2018). The International Court of Justice (ICJ) has repeatedly stated that the Convention includes principles that are part of customary international law. This means that regardless of whether States have ratified the Genocide Convention or not, they are all bound by the principle that genocide is a lawfully prohibited crime under international law. The International Court of Justice also stated that the prohibition of genocide is a binding norm (or ius cogens) of international law, and therefore derogation is not allowed.

II of the Genocide Convention. The definition of the crime of genocide in its article was the result of a negotiation process and reflects the compromises reached between the member states of the United Nations when the Convention was drafted in 1948. Genocide is defined in the Rome Declaration of the International Criminal Court (Article 6) and in the statutes of other international and hybrid judicial bodies in the same terms as in the Genocide Convention. Many states have criminalized genocide in their domestic laws; others have not yet done so.

Damages caused by war to human life can be distinguished and grouped as follows:

- do not perish;
- lost;
- injury;
- lifelong disability.
- It is understood from the studies that different methods are used to evaluate the damage to human life for these identified groups.
- Some authors evaluate human life in terms of average life value in insurance programs.
- Measures the subjective value of another group of people's lives.

Whatever method is chosen, human losses and physical impairments severely reduce the future earning potential of society.

At present, the following can be mentioned as the main quantitative approaches to the assessment of human life (Mikayilov F.G., Ibishov E.I. 2021):

A. The Copenhagen Consensus values human life at $100,000.

B. Life insurance. These compensations are generally applied in traffic accidents observed with more accidents. Insurance premiums are lower in the type of transportation where accidents are frequent, and higher in the safer type of transportation. Thus, human life insurance in the event of an accident in automobile transport ranges from $20,000 to $1,000,000 in a rail accident.

C. General Motors engineer Edward C. Ivey measures the costs of a fatal car accident by fire. The basis of its methodology is a cost-benefit analysis, which includes discounting all future earnings based on average age and average monthly salary. Based on this methodology, the value of a human life is estimated at $200,000.

D. In the United States, the lives of National Guard soldiers are insured for $250,000, which is considered the most honest and reliable by many researchers evaluating the consequences of military conflicts.

F. Another approach is to evaluate the income level based on the Purchasing Power Parity of GDP per capita, one of the United Nations Development Program's measures of human development level. Evaluations can be made according to this indicator. Another advantage of this approach is that it is calculated over the Purchasing Power Parity, which allows comparison between countries. But social security costs and average monthly pensions etc. It can be a bit of a challenge since it is expressed in manat.

G. There is also another approach, in the form of assessment methods as the sum of benefits and one-off payments for people killed, injured or maimed in the attacked country and the amount of potential damage. Income that these people can earn.

The income that can be earned here is determined by the average monthly salary of that country and the range up to retirement age.

At the same time, the duration of the benefits to be paid is estimated based on the age limit set in the legislation or the age range up to the expected life expectancy of the benefit recipients.

H. Another approach is the estimation method based on the potential income that can be obtained according to the education level of the population. Based on this method, a number of studies conducted in the United States have analyzed the relationship between people's education levels and earnings.

Estimates suggest that men with a high school diploma will earn approximately $1.54 million over their lifetime (accumulated earnings over 50 years between the ages of 20 to 69), while those with bachelor's and master's degrees, including associate degrees, will earn $2.43 million and $3.05. It shows that he will earn millions of dollars. they earn dollars respectively.

Women's lifetime earnings are lower than men's, but there are also significant differences in education; Those with secondary education, bachelor's, master's and science degrees are taken as 811 thousand, 1.44 million and 1.87 million dollars, respectively. Thus, the income gap between high school and undergraduate level is about $896,000 for men and about $630,000 for women. (3, p. 10) Considering the above, we can compare the losses as shown in the table below.

Table 2.

The amount of damage in the relevant scenarios, in million manats, according to the total number of dead and missing people at all stages of the war

Category	Number of persons	Estimate for scenario A	Estimate for scenario C	Estimate for scenario D
Deaths	23941	2394,1	4788,2	5985,25
Arrested and missing	3955	395,5	791	988,75
Total (million ABS dollars)		2789,6	5579,2	6974
A total of one million manats		4742,32	9484,64	11855,8

Of these, only item D refers to the life of military personnel (in this case the US National Guard), and this option has been chosen in similar studies, for example in the territory of the former Yugoslavia and in many other conflicts.

At the same time, another approach should be taken into account in the study, in accordance with the assessment method, the sum of the amount of benefits paid for people attacked, injured or disabled, plus one-off payments. country and the amount of potential income they can earn.

The income that can be earned is determined by that country's average monthly salary and the range up to retirement age.

At the same time, the duration of the benefits to be paid is estimated based on the age limit set in the legislation or the age range up to the expected life expectancy of the benefit recipients. (F. G. Mikayilov, N. E. Mammadov, R. R. Guliyev 2019)

It should be noted that the privileges and social security rights granted to the families of martyrs and their peers in our country can be summarized as follows.

Table 3.

Privileges and social security rights granted to the families of martyrs

The name of the concession and social guarantee laws	Privilege and social security rights
One-time mortgage payment	11,000 manat insurance payments are made to the families of the fallen military servicemen (from January 1, 2022 by the Ministry of Labor and Social Protection of the Population)
Financial aid for the organization of the funeral ceremony	payment of financial assistance in the amount of 3,000 manats to the parents (representatives) of the martyr for the organization of the funeral ceremony (by the State Service for Mobilization and Conscription);
Presidency of the Republic of Azerbaijan (monthly)	the martyr's family is paid the pension of the President of the Republic of Azerbaijan (500 manats) (by the Ministry of Labor and Social Protection of the Population);
Family head	if the martyr is entitled to a pension, the family members are paid a pension for the loss of the head of the family (by the Ministry of Labor and Social Protection of the Population)

Assistant (monthly)	If the martyr does not have the right to retirement, each family member is given an allowance of 100 manat for the loss of the head of the family (by the Ministry of Labor and Social Security).
Range coverage	Until January 1, 2020, at the same time, the Ministry of Labor and Social Protection is authorized by the local government to provide flats or detached houses to the families of martyrs who are recorded in need of residence in 2020.
Psychology support	In the post-war period, after the first diagnosis of the family members of the martyr (by the Ministry of Labor and Social Protection), psychological support is provided by using psychological methods such as individual and group consultations and family therapy.
Sanatorium-resort service	Martyr family members are provided with free sanatorium-resort treatment throughout the country with the referral of health institutions (by the Ministry of Labor and Social Protection).
Collection	children of martyrs are exempt from tuition fees (by the Ministry of National Education)
Essence of self-absorption	The families of martyrs are provided with extraordinary participation in the self-employment program as soon as possible and assets in the form of goods and materials are provided for them to establish small family farms and businesses within the framework of the program.
Paid social services	It is ensured that the family of martyrs will be paid for social work as soon as possible;
Investing in social work places	It is ensured that the family of martyrs is sent to the program of the social work places of the martyrs as soon as possible.
Creation of additional workplaces from kvota	100%-minimum costing of martyrs' family members in establishments and workplaces
Creation of social institutions and additional workplaces, execution of commercial programs	Execution of special petitions that will include the families of martyrs, which are among the sensitive categories
Addition	For the sake of the family of martyrs, tax, labor law, and a number of other beautiful people were kept in front of them.

Death: With the exception of 11 min manats for a living allowance and 3 min for financial aid for her death, the judgments of each and every civil martyr's family are together.

Evaluation. It should be noted that the Azerbaijani lands have been occupied by Armenia with such methods and practices since the 90s of the last century, and a 44-day counter-offensive has been carried out since September 27, 2020, in order to liberate these lands from occupation. It is possible to evaluate the damage to the health of Azerbaijani citizens as a result of their operations.

Table 4.
Gradual number of dead and wounded in the Armenian-Azerbaijani military conflict[2] (Caspian Defense Studies Institute (CDSI)

	Those who died	Injured
1988-1994 (Active Phase 1)	20000	50000
12 May 1994-27 September 2021	1008	1205
2020 (27 September-10 November 20200 (Active Phase 2)	2908	4000
10 November 2020 - 30 September 2022	150	360
Total	**24066**	**55565**

According to the information provided by the Ministry of Defense of the Republic of Azerbaijan and other relevant organizations, we can say that 24,066 Azerbaijani citizens were martyred and 55,565 people were injured in all stages of Armenia's attacks on Azerbaijan. Some of our soldiers are being treated in health institutions. At the same time, as of December 21, 2020, the search and identification work of 3,955 military personnel and civilians who are considered to be missing as a result of this war are continuing.

It should not be forgotten that 11,000 manat is paid to his heir at once for each martyr in Azerbaijan and 300 manats are paid monthly. In addition, funeral expenses (3 thousand manats) are provided. In addition, insurance payments are provided to the war disabled (8800 AZN for the 1st degree handicapped, 6600 AZN for the II degree handicapped, 4400 AZN for the III degree handicapped).

As of the end of 2020, social assistance is provided to both the families of martyrs and the disabled in the form of a President's salary, a pension or an average monthly allowance of 700 manat.

In other words, the president's monthly salary (210-230-250 manats per month for the 1st, 2nd and 3rd degree disabled people, 300 manats for the war invalids, 300 manats for the families of the martyrs) and in addition to this salary, monthly or allowance (approximately 400 manats) according to the length of service. manat) is paid. It should also be noted that an additional (55-110 AZN) is calculated for the insurance

[2] (Caspian Defense Studies Institute (CDSI) – Xəzər Hərbi Tədqiqatlar İnstitutu (XHTİ) https://caspiandefense.wordpress.com/2021/01/04/44-gunluk-muharib%c9%99-az%c9%99rbaycan-v%c9%99-erm%c9%99nistanin-itkil%c9%99rinin-nisb%c9%99ti-monitorinq/)
[2] **Caspian Defense** Studies Institute (CDSI) – Xəzər Hərbi Tədqiqatlar İnstitutu (XHTİ) https://caspiandefense.wordpress.com/2022/01/31/v%c9%99t%c9%99n-muharib%c9%99sind%c9%99n-sonra-az%c9%99rbaycan-azi-110-h%c9%99rbcisini-itirib/
[2] https://caspiandefense.wordpress.com/2016/05/12/az%c9%99rbaycan-1008-h%c9%99rbi-qulluqcu-s%c9%99hid-olub-1205-n%c9%99f%c9%99r-yaralanib-22-illik-at%c9%99sk%c9%99s-c%c9%99bh%c9%99-s%c9%99hidl%c9%99ri-statistika/ baxılıb: 22.12.2020
[2] Caspian Defense Studies Institute (CDSI) – Xəzər Hərbi Tədqiqatlar İnstitutu (XHTİ) https://mod.gov.az/az/news/veten-muharibesinde-sehid-olmus-herbi-qulluqcularin-siyahisi-38067.html baxılıb: 19.12.2022 https://caspiandefense.wordpress.com/2021/01/04/44-gunluk-muharib%c9%99-az%c9%99rbaycan-v%c9%99-erm%c9%99nistanin-itkil%c9%99rinin-nisb%c9%99ti-monitorinq/)

part of pensions. It is also worth noting that the average monthly salary for November 2020 is 704.5 manats. At the same time, the families of martyrs and the children of the family members of the disabled people and themselves are exempt from paying tuition fees. Free shipping is provided once a year for sanatorium-resort treatment, and prosthetics and rehabilitation tools are provided free of charge to the war-disabled. They are preferred in active employment programs (self-employment, paid public works, etc.). A mandatory quota has been established for all employers (public and private) to secure their employment. Taxation of family members of martyrs and war invalids etc. in labor legislation. Some concessions have also been made. Using this entire database, we can calculate the amount of damage done to our martyred citizens.

Based on the experiences of the countries concerned and the tools of the experts conducting research in this field, we can say that the damage done by the people killed occurs in three directions. One-time payment and funeral expenses are provided in the first direction.

Table 5.

One-time payment to the martyr's family and funeral expenses[3]

	number of people killed	**payment amount in manat**	**total payment amount, million manats**
The amount to be paid once to the family of each martyr, (Bö)	23941	11000	263,4
Funeral expenses (Dx)	23941	3000	71,8
Total, million manats ($İ_0$)			336,6

$$İ_0 = D_x + B_ö \quad (1)$$

As can be seen from the table, the total loss in this direction was 335.2 million manats.

In the second direction, payments are made to the heirs of the deceased. Payment amounts within the scope of this compensation item are reflected in the table below.

[3] *QEYD: 11 min manat sığorta ödənişi və 3 min manat dəfn üçün maliyyə yardımı istisna olmaqla, hərbi və mülki şəhidlərin ailələrinin hüquqları bərabərdir.*

Table 6.
The main indicators of payments to the heirs of the deceased[4]

Life expectancy, years	75
Average life expectancy of heirs of martyrs, years	33
The difference between the expected life expectancy and the life expectancy of the deceased's heirs, years	42
The family of the martyr and the number of members, the number of people	49754
Average annual payment volume per person, manat	8640
Total payment amount, million manats	**18091.1**

$$I = (L_{av} - A_{ge}) * V * w * 12 \quad (2)$$

Here **I** - the (lost) amount to be paid to the heirs from the period when a certain man was martyred, $\mathbf{L_{age}}$ - the average life expectancy in the country, $\mathbf{A_{ge}}$ - the age of the heirs in the considered period, **V-** number of heirs; **w** – average monthly social security costs for heirs in the country.

$$İ_1 = (75-33) * 49754 * 720 * 12 = 18091.1$$

As can be seen from the table, the total amount of payments made to the heirs of persons who died in the second direction, according to the 2020 year-end base indicators, is equal to 17624.9 million manats.

In the third direction, compensation is determined by the potential income that the deceased could obtain. We can calculate the amount of compensation in this direction according to the following formula:

$$I_2 = ((P_{age} - A_{ge}) * w * 12) + (G - P_{age}) * w_p * 12 \quad (3)$$

Here

I - the amount that he can gain (loss) during his life expectancy from the moment of death,

P_{age} - the accepted retirement age for men in the country,

A_{ge} - the age of a particular person at the time of death,

w is the average monthly salary in the country.

G-life expectancy

Wp is the amount of the average monthly pension in the country.

[4] 1) The widows and orphans of the deceased are paid at the rates specified in the second paragraph. (2) deceased personnel;
a) If single, 50% to mother, 50% to father,
b) If he is married and has no children, 50 percent to his wife, 50 percent to his mother and/or father, if his parents are alive;
c) 100% if married and childless, in case of death of spouse, mother and father;
ç) If they are married and have children, if their parents are alive, 50 percent to their spouse, 25 percent to their children, 25 percent to their mother and/or father;
d) If he is married and has children, 50% to his wife, 50% to his children if his parents are dead; Payment completed. (3) Parents and children are equal heirs among themselves.
(4) Payment of the disabled is made to the debtor himself or his guardian.

Table 7.

Key indicators that determine the potential income a survivor can earn

Life expectancy	**75**
Retirement age limit, years	**65**
Average age of the deceased, years	**28,1**
Difference between retirement age and life expectancy of the deceased, years	**36,9**
Death toll, people	**24041**
Average annual pension per person, manat	**3600**
Average annual payment volume, manat	**8400**
Total payment amount, million manats	**8923.1**

Then, the results obtained in these three directions are summarized.

$$İ_2 = 336,6+18,091+8923,1=27350,7 \text{ (million manat)}$$

It should not be forgotten that one of the aspects of damage to human life in military conflicts is the expenditures made for the first medical aid and treatment for those injured during the conflict. As can be seen here, the provision of medical services is carried out in two directions. It can be attributed to the provision of first aid and inpatient rehabilitation.

Evaluation of lifetime disability.[5] (F. Q. Mikayılov, N. E. Məmmədov, R. R. Quliyev 2019) A common approach here is to calculate the cost per lifetime disability to the state using the following formula, based on the cost to the injured state to the war disabled and wounded:

$$P = (L_{av} - A_{ge}) \cdot p \cdot 12 \quad (4)$$

Here:
P - the estimated total value of the pension paid by the state to a particular person,
L_{av} - the average life expectancy in the country,
A_{ge} - the age of a particular person at the time of disability,
P is the monthly pension paid by the state to a specific person.

[5] F. Q. Mikayılov, N. E. Məmmədov, R. R. Quliyev. İşğal nəticəsində dəymiş zərərlərin qiymətləndirilməsinin metodoloji əsasları. Bakı: İqtisad Universitetinin nəşriyyatı 2019

Table 8.
The main indicators determining the payments made by the state to the war disabled people

Life expectancy, years	75
Average life expectancy of people with disabilities,	27.6
Difference between life expectancy and life expectancy of people with disabilities, years	48.4
number of disabled	34135
Average annual payment volume, manat	8400
Total payment amount, million manats	**13877.9**

However, the compensation demanded from the occupying country is not limited to this amount. To this amount is added the person's loss of income, which is calculated by the following formula:

$$I = (P_{age} - A_{ge}) \cdot w \cdot 12 \quad (5)$$

Here I - the amount that a particular person can earn (loss) from disability to retirement age,

P_{age} - the accepted retirement age for men in the country,

A_{ge} - the age of a particular person at the time of disability,

w is the average monthly salary in the country.

Table 9.
Key indicators of potential loss of income for people with disabilities

Retirement age limit, years	65
Real average life expectancy of people with disabilities, years	27,6
The difference between the retirement age and the life expectancy of the disabled, years	37,4
Number of disabled	34135
Average annual salary payment volume, manat	8406
Total payment amount, million manats	**10731**

Thus, compensation K claimed from the aggressor country is calculated as the sum of the two amounts:

$$K = P + I \quad (6)$$

$$K=13877.9+10731=17136,6$$

At first glance, this may be thought of as an exaggerated formula, and it is sufficient to substitute P' = max(p;w) in formula (F. Q. Mikayılov, N. E. Məmmədov, R. R. Quliyev. 2019). However, this is a fallacy:

- This amount initially paid to the disabled person can only cover financial losses at best, and moral damages such as physical and social inadequacy and inability to lead a normal life cannot be compensated with the amount calculated in (3).
- The second point is that the amount calculated by the formula (F. Q. Mikayılov, N. E. Məmmədov, R. R. Quliyev. 2019) is additional state expenditures as a result of the occupation, and most importantly, instead of healthy people who contribute both to the country's GDP and to the state budget, on the contrary, they become an additional "burden" and this burden also comes from the aggressor country. It goes without saying that it should be requested.

In order to determine all these more accurately, statistical indicators corresponding to the number of patients treated and the number of days of hospitalization are needed. After obtaining such statistical indicators, the cost of medical devices, surgeries and other services provided to these patients is estimated.

As a result, the average cost per patient is determined. It also requires taking into account that there is a certain difference between the number of those treated and the total number of injured. In other words, among the dead, there are those who received treatment for a certain period of time, there are those whose treatment did not yield results, and there are also cases of recurrent injuries. As can be seen, the assessment of damage to injured military personnel (and civilians) is carried out in several stages. First of all, let us state that, based on the information of the Ministry of Labor and Social Protection of the Population, the above-mentioned amounts are given according to the degree of disability of the injured and disabled people, that is, it is 8800 manats for the first person. It is expected that a one-time insurance premium will be paid 6600 manats for the disabled in the third group and 4400 manats AZN for the third group of disabled people.

Since we cannot obtain information about the figures according to the degree of disability, we can calculate the number of injured by averaging the amount to be paid on a group basis.

$$E_1 = 34135 * 0{,}006 = 204.8 \text{ million manats}$$

In the next step, we calculate the cost for each injured man using the following formula[6]:

$$E_2 = e \cdot d \qquad (7)$$

Here

E – the total cost incurred for a particular injured person,

[6] Hebrang A. "An Effectiveness Analysis of the Wartime Health System" (preliminary report), Zagreb, October 2003, p. 2.

e- One-day expenses of the injured in the hospital (these expenses include overnight stay in the hospital, food and equipment expenses, one-day salary of the hospital staff and other expenses),

d-is the number of days the injured person stayed in the hospital.

It should not be forgotten that the expenses of the aid given to the injured who are not in the hospital are calculated from the one-day hospital expenses. The sum of the calculated costs for all casualties gives the total cost. Considering the difficulties of collecting data on all casualties, the cost of casualties was calculated as follows, based on prices determined on a random sampling basis:

$$E=34135*60*350=1828.3 \text{ million manat}$$

When we look at the experiences of many countries, it should be noted that the rehabilitation costs of the wounded and disabled war participants in these countries are estimated to be about 15 percent of the treatment costs.

$$R_x=1828.3*0.15=274.3 \text{ million manat}$$

Thus, as a result of the military attack of Armenia on Azerbaijan, the total amount of damage to human health caused by other assistance to the families of martyrs and veterans (without taking into account the provision of housing to the families of martyrs, direct assistance, organizations donating and organizations sponsoring disabled vehicles) will be as follows.

$$\sum Z= İ_{2+} K + E_1 + E_2 + R_{yx} + R_{mi} \quad (8)$$

$\sum Z$-total damage
I_2 - Damage from losses
K-Damage of being injured and losing health
E_1 – payment of one-time insurance premiums
E_2 - damage during the injury period
R_{yx} – rehabilitation costs
R_{mi} – rehabilitation costs for war participants

$$\sum Z=27687.3+240608.9+204.8+1828.3+274.3+54.8=54657.9 \text{ million manat}$$

According to paragraph 2 of the Decree of the President of the Azerbaijan Republic dated July 1, 2004 No. 298 "On the approval of the State Program for improving living conditions and increasing employment of refugees and internally displaced persons",

property forms of internally displaced persons in 1992-1998 , their evacuation from public buildings, apartments, plots and other objects in which they temporarily live is suspended until they return to their homeland, as well as move to new settlements and houses. the purpose of temporary living;

For the obligatory orphans and their loved ones, they are given the opportunity to dine at the home of the foreigner's assistant and the communal helpers:

In fact, IDPs (refugees and displaced persons) living in dense temporary settlements are paid a one-time allowance of 33 AZN per month, and refugees and displaced persons living in other settlements are paid a one-time allowance of 60 AZN per month. At the same time, the consumption expenses (electricity, natural gas, water and domestic waste transportation) consumed by the internally displaced persons temporarily settled in densely populated areas are covered by the state. According to the Decree of the President of the Republic of Azerbaijan dated August 4, 2003, students studying in public higher and secondary educational institutions are exempted from paying tuition fees. Pursuant to the Decree of the President of the Republic of Azerbaijan dated September 14, 2011, from the 2011/2012 academic year, newly admitted and studying undergraduate and graduate students of state higher education institutions are paid from the state budget.

Free textbooks are provided to internally displaced students in secondary general education schools;

It has pre-emptive rights to be employed while reducing the number of personnel and workers in offices, enterprises and establishments;

It is covered from the state budget with the drugs specified in the list of drugs given according to free drug prescriptions approved by the Ministry of Health of the Republic of Azerbaijan;

They are provided with free examination and treatment;

They are exempt from the fee for issuing an identity card;

They are exempt from the fee to apply to the court with a petition;

They are exempt from income tax up to 55 times the traditional financial unit;

They are exempt from notary fees when buying and selling apartments or houses.

Social expenses paid for IDPs

Social costs paid for IDPs

$$M_{kö}=28*332.6=9312,8 \text{ million manat}$$

Conclusion

As can be seen in general, it is possible to look at various generalized and applied methodologies in the assessment of damage to the dead, injured or disabled and missing persons in the first active phase, the ceasefire phases and the second active phases. Armenian-Azerbaijani military conflict. This problem can be both a basis for insurance companies' human life insurance and an assessment based on a methodology defined for any country, or it can also be addressed in contracts accepted by international organizations. However, we believe that the most appropriate method can be based on the methodology adopted by many post-conflict countries. As the costs incurred for the recovery and rehabilitation of these persons.

According to our calculations based on this methodology, the total amount of damage caused by Armenia to the life and health of Azerbaijani citizens for the periods or stages mentioned is 54.7, according to the assessment data (average monthly pension) as of the end of 2020. , social assistance given to the families of martyrs, the amount of manat given, etc.) was equal to billion manat.

If we add to this loss the public service payments made to the displaced people based on the 2020 indicators, the total damage to human life will be 64 billion manats.

It should be noted that over time, the total amount of damage caused by Armenia to the life and health of Azerbaijani citizens is likely to increase. Thus, the development of the country's economy, average monthly salary, retirement level, etc. may increase, causing damage. In most international methodologies, the last year is taken as the base year.

Reference list

Mikayılov F. Q., Məmmədov N. E., Quliyev R. R.. İşğal nəticəsində dəymiş zərərlərin qiymətləndirilməsinin metodoloji əsasları. Bakı: İqtisad Universitetinin nəşriyyatı 2019.

Mikayilov F.G., Ibishov E.I. Evaluatıon of the damage to human lıfe and health ın Azerbaıjan ın the second karabakh war PalArch's Journal of Archaeology of Egypt/Egyptology 18 (08), 2184-2191 2021.

The Economist special report. - Copenhagen Consensus, June 5th 2004, pp. 64-65 https://www.ncbi.nlm.nih.gov, Christopher R. Tamborini, ChangHwan Kim, and Arthur Sakamoto "Education and Lifetime Earnings in the United States", Demography. 2015 August.

Hebrang A. "An Effectiveness Analysis of the Wartime Health System" (preliminary report), Zagreb, October 2003, p.

Ball, B., Betts, W., Scheuren, F., Dudukovich, J., and Asher, J. (2002) Killings and Refugee Flow in Kosovo March-June 1999, ICTY Expert Report, http://shr.aaas.org/kosovo/pk/toc.html/

https://mod.gov.az/az/xeberler-791/

http://ulfet-az.com/news/sehid-ailelerine-ve-mueharibe-elillerine-verilecek-mueavinetler

https://www.stat.gov.az/source/labour/

https://www.sosial.gov.az/shehidailesihuquq

Missing persons and victims of enforced disappearance in Europe

Zwierzchowski Jan , Tabeau Ewa The 1992-95 War in Bosnia and Herzegovina: Census-Based Multiple System Estimation of Casualties' Undercount 1 February 2010 Conference Paper for the International Research Workshop on 'The Global Costs of Conflict' The Households in Conflict Network (HiCN) and The German Institute for Economic Research (DIW Berlin) 1-2 February 2010, Berlin.

Ball, B., Betts, W., Scheuren, F., Dudukovich, J., and Asher, J. (2002) Killings and Refugee Flow in Kosovo March-June 1999, ICTY Expert Report, http://shr.aaas.org/kosovo/pk/toc.html.

Spagat, M., Mack, A., Cooper, T., Kreutz, J. (2009) Estimating War Deaths: An Arena of Contestation, Journal of Conflict Resolution, Vol. 53, No. 6, p. 934-950.

Spiegel, P., and P. Salama (2000) War and Mortality in Kosovo, 1998-1999: An Epidemiological Testimony. Lancet 2204 (355).

Tabeau, E., and Zwierzchowski, J., (2009) A New Compilation of Results on Casualties of the 1992- 95 War in Bosnia and Herzegovina and 1975-1979 Khmer Rouge Regime in Cambodia.

Conference paper presented at the international conference: "Casualty Recording and Estimation" Carnegie Mellon University in Pittsburgh and University of Pittsburgh, Pittsburgh, Pennsylvania, 23-24 October 2009.

Tabeau, E., Bijak, J., (2005) War-related Deaths in the 1992-1995 Armed Conflicts in Bosnia and Herzegovina: A Critique of Previous Estimates and Recent Results, European Journal of Population, Vol. 21, No. 2-3, p. 187-215.

FEATURES OF REGIONAL DEVELOPMENT OF AZERBAIJAN

Mrs. DSc. Prof. Gulshen Yuzbashiyeva,
ygulshan@hotmail.com
Mrs. PhD. AP Samira Abasova,
abasovasamira@rambler.ru
Institute of Economics, Ministry of Science and Education, Baku, Azerbaijan

Mr. PhD. Israfil Yuzbashiyev,
i.yuzbasiyev@mail.ru
Company SOCAR Trading SA, Geneva, Sweden

This article examines the features of Azerbaijan regional economy, assesses the opportunities and economic potential of liberated lands, evaluates investments in restoration of regional economy, reveals economic indicators for Azerbaijan regions and recommends the improving measures for Azerbaijan national economy development and strengthening. This article uses methods of observation, statistical analysis and grouping of data, and comparison of the results obtained. The authors used also SWOT and PEST analyzes to provide an expert assessment of Azerbaijan opportunities. The main objectives of study are: 1) study of theoretical characteristics of Azerbaijan regional economy; 2) analysis of competitive advantages of Azerbaijan liberated lands' economy; 3) study of industrial development and features of Azerbaijan regions' economies; 4) PEST and SWOT analysis of Azerbaijan regions' economic potential; 5) preparation of recommendations to strengthen the economic potential of the regions of the republic.

The authors propose: 1) introduce government measures to increase investment and innovation activity, 2) carrying out restructuring and reforming of enterprises, development of small and medium-sized businesses in newly liberated lands of Azerbaijan; 3) take measures to restructure natural monopolies and implement targeted programs for economy infrastructure development; 4) create a competitive environment; 5) create equal conditions in certain industry markets.

Keywords: regions of Azerbaijan, regional economics, SWOT analysis, PEST analysis, strategic objectives,

1. Introduction

The process of rational distribution of industry on economic regions, as is known, is carried out based on the characteristics of the territorial division of labor, taking into account local mineral resources, socio-economic and scientific-technical prerequisites.

Accordingly, the most important question arises - how to actually carry out the process of forming a regional industrial structure acceptable to Azerbaijan by rationally distributing it throughout the country.

We will try to answer this question, but it should be noted that rational does not mean uniform distribution, since it is "unevenness" that is the most important component of "any organized economic space" (The Path to the 21st Century, 1999, p. 575).

Modern conditions of economic growth and development require a more in-depth study of the regional structural factor. Changes in the regional structure, as well as in the sectoral structure, occur as a result of the further division of labor, deepening specialization of production, ongoing shifts in the distribution of natural and labor resources, and the achieved level in the development of production and social infrastructure.

Reproduction is largely predetermined by the characteristics of the demographic situation and the reproductive structure of basic production and non-production assets. It is at the regional level that this relationship becomes most noticeable (the relationship between the reproduction of products, demographic conditions and the specifics of the created production apparatus).

2. Regional economy: investigation of competitive advantages of economy of liberated lands of Azerbaijan

Regional policy contributes to the real unification of the actions of the government, ministries and departments in order to achieve acceptable results for each region and as a whole (Yuzbashiyev, 2010). Therefore, the methods of implementing regional policy are:

- identification of areas in need;
- complete restoration of territories mined and destroyed during the 30-year period of Armenian occupation;
- restoration of depressed areas;
- "compensatory and stimulating" policies that reduce social disparities in the level and quality of life of the population, creating conditions for innovative development (Yuzbashiyeva, 2010, p. 478.).

It should be noted that regional policy measures in "depressed", "needy" and fully recovering areas include direct financial assistance, favorable loans and credits, tax incentives, the creation of industrial and social infrastructure at the expense of the state, increasing the importance of government orders, implementing policies migration flows of the population (in particular, the resettlement of former refugees to their original places of residence).

Non-state regional economic policy is the one pursued by associations, self-government bodies, foreign states and their companies, international financial

organizations, manufacturing companies and banks, their combined structural forms and associations. As a result, it can be noted that the following stand out (Yuzbashiyev, 2010):

- regional policy – different attitudes towards different regions, and the common goal is some redistribution of resources between regions, achieving an optimal territorial structure in order to transform the regional economies into innovation-oriented, competitive systems. Regional policy ultimately helps to reduce existing economic and social disproportions between individual regions in terms of income sources, imbalance, unevenness and differentiation of the level of socio-economic development, migration of internal and external migrants, development of the banking services market. Changing structural policy priorities;
- regional policy – the available methods for regional authorities to influence their territory to ensure sustainable economic development of the region;
- issues of rational placement of regions must comply with general efficiency requirements. Achieving interconnection of production (inter-industry agreement) in a certain territory is not an end in itself, but a means of achieving real results. The goal is to determine the main directions and priorities of structural transformations of industry, ensuring the creation and effective use of competitive advantages, increasing the level of its competitiveness.

The strategic priorities of structural restructuring and increasing the competitiveness of the country's economy are: real development directions corresponding to the chosen country, coupled with existing/identified economic benefits from foreign trade conditions; existing/identified opportunities for entering new international markets and strengthening the position in traditional markets, expanding the export structure in new and traditional markets; protection of national interests in world markets (Yuzbashiyeva, 2010, p. 478).

There are certain competitive advantages for this:

- favorable economic and geographical location;
- developed transport communications system and production infrastructure in general;
- minerals, water, land and forest resources;
- significant scientific, technical and technological potential;
- diversified industrial complexes, technology parks, clusters, industrial zones, free and special economic zones;
- high general educational level of the population, etc.

Azerbaijan, uses its advantageous geographical location, introduces progressive transport and logistics infrastructure in the region, and develops the renewable energy sector by restoring the economy of its liberated lands. President of Azerbaijan MR. Ilham Aliyev notes in his speech at the 16th Economic Cooperation Organization (ECO) Summit:

"*The transport and logistics infrastructure of Azerbaijan is available to the ECO member countries. In recent years, Azerbaijan has invested billions of US dollars in its transport infrastructure and has become one of the transport and logistics hubs of Eurasia along the East-West and North-South transport corridors. Construction of the Azerbaijani sections of both corridors has already been completed. We are currently working to expand rail capacity along these corridors. Over the past twenty years, more than $310 billion has been invested in Azerbaijani economy, of which about $200 billion comes from the non-energy sector.*

This is the result of a favorable investment climate in our country. Despite the fact that Azerbaijan is rich in oil and gas resources, we pay special attention to the development of the renewable energy sector… In the near future, Azerbaijan will become a potential exporter of green energy, including hydrogen energy… In 2021-2023 in liberated Karabakh and Eastern Zangezur, hydroelectric power stations with a total capacity of 170 MW were put into operation.

By the end of 2024, this figure will reach 270 MW. In a few years, the total capacity of our hydroelectric power stations in the territories liberated from the Armenian occupation will be 500 MW." (Aliyev I., 2023). Let's consider Table 1.

Table 1.

PEST analysis of structural transformations in regions of Azerbaijan

Positive aspects	Negative aspects
Political factors	
➢ multilateral agreements are being created in the field of investment, tax benefits, simplification of customs duties between Azerbaijan and other countries; ➢ the "Single Window" system was introduced in trade operations.	crisis, pandemic, local wars indicate the vulnerability of the oil and gas market to political events.
Economic factors	
➢ Since 2020, a progressive transport and logistics infrastructure has been introduced in liberated territories of Azerbaijan with the attraction of foreign investments; ➢ The renewable energy sector is developing - huge areas of wind generators are being created, solar panels are being introduced to generate energy; ➢ smart and green cities are being built, historical cities are being revived; ➢ preferential taxation of industrial and agricultural enterprises for 10 years; ➢ access to financial resources for entrepreneurs has been expanded.	➢ the growth of government spending has a dual impact on economic growth: on the one hand, it increases the stability of the economy, and on the other, it contributes to a decrease in entrepreneurial activity; ➢ regions have different rates of development of industrial production; ➢ the structure of industrial production is different; ➢ all economic regions, except Baku, were subsidized; ➢ not always, government support contributed to the rational use of available financial resources; ➢ there is an unequal volume of output per capita; ➢ the integrated nature of the region's development presupposes the achievement of optimal economic efficiency through real

	interconnection of production, taking into account the high degree of its concentration and specialization of related enterprises.
Social factors	
➢ Residential, administrative and social facilities, as well as schools and kindergartens are being massively built in the cities of Agdam, Fizuli and Jebrail, Lachin, Shusha, Khankendi and Khojaly; ➢ Specialists with modern knowledge and experience are invited.	➢ In 2023 inflation in Azerbaijan has dropped to 8.8%, but still remains high; ➢ An opportunity is created to reduce vulnerability from corruption through administrative measures.
Technological factors	
➢ Airports of international standard are being created, transport infrastructure is being updated; ➢ Telecommunications and ICT engineering structures are being improved; ➢ Industrial parks and free economic zones are being created in the liberated territories.	➢ Monopolization and growth in energy demand create the basis for the formation of the resource component of inflation, leading to a decrease in competitiveness, productivity, and increased imports of foreign goods.
Ecological factors	
➢ "Green energy" zones are being created in the Karabakh and East Zangezur regions; ➢ Creation of new resorts and new types of tourism such as ecotourism, mountain tourism, religious tourism, entertainment tourism.	➢ The development of alternative types of energy shows the reaction of inflation to the structure of energy supply; ➢ The influence on the inflation process is manifested even with a minimal share of alternative types of energy (15-25%)

Note: assessment by S.Abasova on sources (Yuzbashiyeva and others, 2022; Yuzbashiyeva and others, 2023)

The most important task, as noted above, is the revival of lands liberated from occupation and their integration into the country's economic system, which is what all the activities of the country's government are aimed at. In this regard, the regional development of country and improvement of the regional structure become one of the priorities of current policy. As the main, electric power and main network infrastructure develops in the returned territories, the most capital-intensive projects are also scheduled to start here - the construction of new cities and industrial facilities.

In particular, in 2023, massive construction of residential, administrative and social facilities in Aghdam, Fizuli and Jebrail cities were carried out. In the shortest possible time, a master plan for the restoration of Lachin city was prepared, which allowed the gradual settlement of this city to begin in the fall of this year... New comfortable houses are being built in Karabakh, cities and villages are being built, and the rich industrial and agricultural potential of the liberated region is developing in the form of the formation of large industrial and agricultural complexes.

And for this, all comprehensive approaches are being taken, laying the foundation for transforming the liberated territories into a stimulating force for our economy. The industrial parks of the Aghdam and Jebrail regions will become a catalyst for economic growth and a key incentive for economic activity... the industrial parks of Karabakh have already attracted more than 200 million manats of private investment, and in general, according to the Ministry of Economy, applications for participation in projects in the

liberated territories were submitted by over 1,500 local and foreign companies" (Khalilova, 24.10.2023).

The President of the country has created conditions for the revival of lands (Tagiyeva, 2022a):

- "benefits: from January 1, 2023, for ten years they will not pay income tax for legal entities, as well as income and property taxes for individuals. In addition, not only profits from the sale of goods and services, but also non-operating income are exempt from taxes. At the same time, imports of goods, materials and raw materials for enterprises in the liberated territories are also exempt from value added tax (VAT) for a period of 10 years;
- benefits are also provided for utility services for entrepreneurs engaged in production activities on liberated lands;
- expanded access to financial resources for entrepreneurs carrying out various types of work in the liberated territories, and strengthening of the necessary state support in this direction;
- benefits for attracting highly qualified personnel to de-occupied lands (specialists with modern knowledge and experience, as well as improving procedures for issuing work permits);
- It is planned to provide additional tax benefits to entrepreneurs engaged in the processing of agricultural products.

As you know, the Karabakh and East Zangezur regions have been declared a "green energy" zone. Industrial parks and free economic zones (priority areas of investment for foreign entrepreneurs engaged in the industrial sector) are being created in liberated territories. At the first stage, investments in the amount of more than 50 million manats are planned in Aghdam Industrial Park, financial injections totaling over 30 million manats are expected in the economic zone of the Araz Valley (Tagiyeva, 2022a).

Along with agriculture, it is planned to expand the manufacturing industry (the expansion of agricultural production will contribute to the production of finished, processed agricultural products, which will increase the export value of the agricultural sector. Karabakh is also considered by Azerbaijan as a future tourism center".

3. Industrial development and economic features of Azerbaijan regions

Historical features and industrial development of the region had a significant impact on the territorial structure of the economy, predetermining its inconsistency with the spatial distribution of the most important natural resources. Real rational development of regions presupposes the interconnection of a complex of processes associated, first of all, with the production, distribution, exchange and consumption of material goods, indicating the versatility of this problem.

The structure of region's industrial production is the more perfect if region development created in rational terms. Ultimately, all this will contribute to the rationalization of the overall industrial structure. It is by overcoming years of existing differences in the level of development of regions that it helps to increase the overall level of economic development. But this does not mean that everything will be the same in different regions. There will be different rates of development of industrial production, its different structure, and unequal volume of output per capital.

The integrated nature of the region's development presupposes the achievement of optimal economic efficiency through real interconnection of production, taking into account the high degree of its concentration and specialization of related enterprises with the aim of an economically acceptable division of labor on a national scale. It is important to answer the question: *How to overcome unevenness in regional development?* Based on the above, let us consider the structure of the gross regional product (see Table 2).

Table 2.

Gross regional product (GRP) and its structure

Azerbaijan regions	Structure (%)						Changes:
	2017	2018	2019	2020	2021	2022	Improvement (+) or deterioration (-)
Total	100.0	100.0	100.0	100.0	100.0	100.0	
Baku city	73.42	75.39	72.24	61.52	65.5	71.4	- 2.2
Nakhchivan Autonomous Republic	3.44	3.13	3.09	2.04	3.1	2.3	- 1.14
Absheron-Khyzy region	3.53	3.52	4.62	5.41	5.8	5.3	+ 1.77
Upland Shirvan region	0.89	0.87	0.95	0.71	1.2	1.0	+ 0.11
Ganja-Dashkesan region	2.76	2.57	2.71	3.07	2.8	2.3	- 0.46
Karabakh region	1.40	1.31	1.36	2.25	2.0	1.7	+ 0.3
Qazakh-Tovuz region	2.18	2.05	2.15	3.43	3.0	2.6	+ 0.42
Quba-Khachmaz region	1.84	1.78	2.06	2.85	2.5	2.1	+ 0.26
Lankaran-Astara region	2.49	2.30	2.34	3.18	2.84	2.4	- 0.09
Middle Aran region	3.41	3.02	3.18	4.03	3.5	2.9	- 0.51
Mil-Mughan region	1.72	1.51	1.70	2.59	2.3	2.0	+ 0.28
Sheki-Zagatala region	1.97	1.82	2.04	2.82	2.4	1.9	- 0.07
East Zangezur region	0.01	0.01	0.01	0.11	0.09	0.1	0 – neutral
Shirvan-Salyan region	2.53	2.48	2.60	3.08	2.744	2.3	- 2.23

Note: changing was calculated by S.Abasova

Source: (Regions of Azerbaijan, 2023)

As can be seen from Table 2, in the structure of GRP, Baku city has got larger share (71.4% in 2022), which indicates the presence of disproportions in regional structure of Azerbaijan. The share of Baku decreased slightly compared to 2017 (73.42%). Despite the small percentage, the share in structure of GRP of Azerbaijan regions has increased. All economic regions, except Baku, were subsidized. The situation is improving, along with overall regional development, by channeling funds from the national budget to regional budgets. All this is a consequence of the ongoing economic policy, which is producing positive results.

It is advisable to use an ordinal approach to measuring the structural changes to reduce the existing regional asymmetry (a pairwise comparison of the industry of individual regions in terms of their structural development, which helps to increase the efficiency of the structure). For this purpose, it is advisable to carry out innovative modernization of a wide range of promising industries on the basis of mutually beneficial ties between the state, business, science, culture and education, which will help raise the level and improve the quality of life of the population of a certain territory.

It is advisable to develop the production and entrepreneurial sector, since entrepreneurship should become the basis of the reproduction process. Growing consumer demand will stimulate innovation in the services and manufacturing sectors. The situation has improved in the regions due to significant assistance from the head of state to the regional budgets for the purpose of their development and improving not only the economic but also the social status of the regions to reduce differences in regional development.

It is advisable to actually use the advantages of the budget structure and the presence/absence of clear budget policy priorities. Different countries have different budget structures, reflecting some specific socio-economic and political characteristics of countries, depending on the priorities of economic development.

The stability of the budget system is important, since its expenditure side shows the degree of importance and usefulness of the state given the existing budget constraints, indicates the level of state participation in the economy and the extent to which budget policy priorities are real and long-term (Yuzbashiyev, 2010). But, at the same time, it should be noted that the growth of government spending has a dual impact on economic growth: on the one hand, it increases the stability of the economy, and on the other, it contributes to a decrease in entrepreneurial activity.

At the same time, it is important to take into account how much the state's expenses correspond to its wealth, that is, a rich state spends a lot or a poor state spends little (the role of the state in economy is an indicator of the share of expenses in GDP and the level of wealth of a country is an indicator of GDP per capita).

The positive relationship between state participation in the economy and state wealth is important. Differences in the shares of expenses reveal the priority of budget policy, the ability to determine whether an increase in a given budget item occurs with an

increase in the budgetary capabilities of the state. You can have the same level of expenses, but different standards of living (Yuzbashiyeva, 2019).

This comparison contributes to the study of not only the development of the region, but also the gradual convergence/removal in their development due to the influence of various factors (institutional and political conditions for economic development) (Sharipova & Chabakaur, 2004). So, for example, consider the level of government spending and the standard of living of the population (see Table 3.)

Table 3.

Government expenditures and living standards

Azerbaijan regions	Government expenditures, million manats					Standard of living, manat		
	2020	2021	2022	2023	2024	2020	2021	2022
Azerbaijan	7548.7	7623.5	12156.96	13779.2	14090.6	8485.5	10693.8	14766.2
Baku city	6305.3	6322.9	10542.8	11814.8	12482.8	22960.8	30860.4	45714.1
Nakhchivan Autonomous Republic	370.6	378.1	457.6	452.8	343.3	3780.5	7269.97	7280.4
Absheron-Khyzy region	175.82	182.34	227.0	261.3	271.6	8091.2	10790.3	9086.7
Upland Shirvan region	32.63	33.94	47.37	52.62	111.1	1854.5	3816.9	4463.8
Ganja-Dashkesan region	82.88	88.87	113.18	117.82	155.4	4307.9	4909.4	5728.5
Karabakh region	72.93	78.03	90.23	77.30	70.97	2127.8	2370.9	3473.9
Qazakh-Tovuz region	61.77	63.53	81.28	85.22	110.2	4278.6	4701.2	5746.7
Quba-Khachmaz region	67.21	71.31	94.60	98.40	112.4	4367.9	4762.5	5772.5
Lankaran-Astara region	55.84	66.68	84.27	81.27	90.8	2828.94	3213.9	3905.5
Middle Aran region	84.73	102.63	110.43	108.39	118.03	4674.5	5140.4	5972.2
Mil-Mughan region	56.65	58.46	75.76	78.45	83.92	4245.3	4721.5	5769.5
Sheki-Zagatala region	81.59	87.10	101.23	87.03	68.96	3837.6	4039.1	4599.1
East Zangezur region	27.89	31.11	40.31	29.69	17.95	252.97	296.6	427.4
Shirvan-Salyan region	54.51	58.61	72.80	77.36	87.68	5274.9	5908.7	6878.3

Source: (Finance of Azerbaijan, 2022; Budget of Azerbaijan, 2024).

As can be seen from Table 3, an increase in government spending contributes to an increase in standard of population living, even despite a slight decrease in government spending in 2020. For example, there is an increase in GRP per capita in all economic regions and in Baku city. Azerbaijan ranked 50th among 163 countries (73.5 points) in 2022 with according the goals and objectives of SDGs (Global Sustainable Development Goals Index) (Official website of Azerbaijan Ministry of Economy, 2024). The “Strategy for the Socio-Economic Development of the Republic of Azerbaijan for 2022-2026” was adopted, which defines the country’s development priorities in accordance with the goals of sustainable development (Tagiyeva, 2022b).

The measures taken contributed to increasing the efficiency of budget expenditures. Thus, the efficiency of budget expenditures has increased using the budgetary coverage ratio. In general, the efficiency of budget expenditures for Azerbaijan in 2020 it was equal to 2.74, in 2021 – 2.84, in 2022 – 3.17. The efficiency of budget expenditures only by region was equal to 0.75 in 2020, in 2021 – 0.76, in 2022 – 1.21. An increase means an increase in its efficiency and costs from a social point of view. Efficiency has also increased taking into account the increase in budget expenditures. In 2020 it was equal to 0.94, in 2021 – 0.99, in 2022 – 0.90. The higher this indicator, the more effective the spending, since a small increase in it provides a greater increase in GDP.

There are noticeable differences across regions by indicator of budget expenditures' efficiency. So, in Baku in 2020 this indicator was equal to 2.70, in 2021 – 2.71, in 2022 – 4.51. In Nakhichevan was equal to 0.80 in 2020, in 2021 – 0.82, in 2022 – 0.98. In the Absheron-Khizi economic region was equal to 0.20 in 2020, in 2021 – 0.21, in 2022 – 0.26. In Nagorno Shirvan the budget expenditures' efficiency indicator was equal to 0.11 in 2020, in 2021 – 0.11, in 2022 – 0.15. The budget expenditures' efficiency indicator in Ganja-Dashkesan in 2020 was equal to 0.14, in 2021 – 0.15, in 2022 – 0.19. This indicator in Karabakh in 2020 was 0.10, in 2021 – 0.11, in 2022 – 0.12. In Gazakh-Tovuz in 2020 this indicator was 0.09, in 2021 – 0.10, in 2022 – 0.12. In Guba-Khachmaz the budget expenditures' efficiency indicator in 2020 was equal to 0.13, in 2021 – 0.13, in 2022 – 0.18. In Lankaran-Astara this indicator in 2020 was– 0.06, in 2021 – 0.07, in 2022 – 0.09. In Central Aran this indicator in 2020 was equal to 0.12, in 2021 – 0.15, in 2022 – 0.16. In Mil Mugan this indicator in 2020 demonstrated index 0.11, in 2021 – 0.12, in 2022 – 0.15. In Sheki-Zagatala this indicator in 2020 was equal to 0.13, in 2021 – 0.14, in 2022 – 0.16. In Eastern Zangelan in 2020 – 0.10, in 2021 – 0.11, in 2022 – 0.14. In Shirvan-Salyan in 2020 – 0.11, in 2021 – 0.12, in 2022 – 0.15.

As you can see, there is some growth in economic regions, but a very low level of efficiency of budget expenditures (the shadow economy, monopoly, corruption have a great influence). As is known, with the dominance of fossil hydrocarbons in the global energy balance, the structure of global energy supply has a high degree of monopolization.

Monopolization and growth in energy demand create the basis for the formation of the resource component of inflation, leading to a decrease in competitiveness, productivity, and increased imports of foreign goods.

As the President of Azerbaijan MR. I.H. Aliyev noted: "One of the main problems of the Azerbaijani economy is monopoly... If there is no competition, there will be no development, there will be no quality products... in the future, the main direction of economic development will be export... I have repeatedly said that we are preparing very seriously for this, and it has already been said here that we are creating logistics centers abroad. Why are we investing outside the country? In order for our products to reach

there, enter new markets. We are doing this so that entrepreneurs get new opportunities and can conveniently sell their products" (Official website of Azerbaijan President I. Aliyev, 2015).

Not always, government support contributed to the rational use of available financial resources. The development of alternative forms of energy shows the reaction of inflation to energy supply structure. The influence on the inflation process is manifested even with a minimal share of alternative types of energy (15-25%). In 2022 inflation in Azerbaijan was equal to 13.6%, in 2023 – 8.8%. An opportunity is being created to reduce vulnerability to corruption through administrative measures.

The crisis, pandemic, local wars indicate the vulnerability of the oil and gas market to political events. Therefore, it is advisable: providing targeted loans from the state in order to support long-term investments; create conditions for human potential development; conditions for increasing investment attractiveness and competitiveness, specialization, coordination, co-operation, integration, reducing the subsidy component of regions and their dependence on central financial policy, etc. This is important, since financial conditions are improving, but conditions are being created for their irrational use, risks and bankruptcies.

To this end, the Government is taking measures to optimize the management system, increase transparency, introduce new management mechanisms, and increase the efficiency of using existing economic and personnel potential. (see Table 4.)

Table 4.

Structure of investments and fixed assets (%)

Economic regions	Structure of investments, %					Structure of fixed assets, %					
	2018	2019	2020	2021	2022	2017	2018	2019	2020	2021	2022
Azerbaijan	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Baku city	62.2	58.8	61.8	60.6	53.2	61.5	60.9	66.6	66.9	60.7	61.0
Nakhchivan Autonomous Republic	5.9	5.6	6.1	6.3	5.6	13.0	9.2	7.4	6.6	7.7	10.4
Absheron-Khyzy region	7.1	13.7	12.6	7.3	3.9	1.7	6.7	5.8	12.1	9.0	9.5
Upland Shirvan region	1.8	2.1	1.3	1.3	1.6	1.1	0.9	2.5	1.0	2.2	0.9
Ganja-Dashkesan region	2.7	1.8	2.8	2.5	1.9	3.4	2.1	2.0	1.5	1.0	4.8
Karabakh region	2.2	1.5	1.5	8.0	10.6	2.12	1.5	1.5	1.3	2.7	1.74
Qazakh-Tovuz region	1.7	3.0	2.9	1.6	1.5	1.8	1.1	3.0	2.0	1.34	1.0
Quba-Khachmaz region	2.6	3.6	2.6	2.7	2.4	1.9	5.9	2.0	2.1	4.2	1.3
Lankaran-Astara region	2.9	1.5	1.2	0.9	1.7	2.5	1.9	1.6	1.4	4.4	2.3
Middle Aran region	2.4	2.6	2.2	0.9	1.0	4.4	1.8	2.6	2.3	3.1	1.6
Mil-Mughan region	1.9	1.7	0.6	0.5	0.7	2.0	1.3	2.2	0.6	1.5	1.3
Sheki-Zagatala region	2.2	2.2	2.7	1.2	1.4	1.7	2.2	1.1	0.7	0.95	2.3
East Zangezur region	0.01	0.01	0.13	5.1	12.5	0.2	0.1	0.0	0.0	0.2	0.5
Shirvan-Salyan region	2.5	2.0	1.5	0.9	1.8	2.7	2.2	1.9	1.7	1.1	1.4

Source: (Regions of Azerbaijan, 2023)

As the data in Table 4 shows, a larger percentage of investments and fixed assets belongs to Baku city, which indicates the presence of imbalances in regional development of Azerbaijan. Thus, the share of Baku in 2022 will be 53.2% of all investments and 61.0% of fixed assets. The remaining percentage was distributed between Nakhichevan and 12 economic regions of Azerbaijan. To improve the current situation, it is advisable to produce uncomplicated high-tech projects and create conditions for production of less complex products in order to create the foundations for sustainability and competitiveness.

The measures taken by the Government to reduce of inflation level which will influence to reduce inflationary pressure on investment processes and increase efficiency and investment activity in Azerbaijan regions (see Table 5.).

Table 5.

Investment activity in Azerbaijan regions and distribution of regions by gross output

Azerbaijan regions	Investment activity in regions, %						Gross output, million AZN	GDP per capita villages, manat	Index of efficiency of use of fixed assets	
	2017	2018	2019	2020	2021	2022	2022	2022	2020	2022
Azerbaijan	23.3	20.5	21.3	20.1	15.5	11.96	142486.2	14.07	1.30	0.33
Baku city	21.6	16.9	17.34	20.2	14.3	8.9	105536.7	45.17	1.87	0.34
Nakhchivan Autonomous Republic	39.2	38.6	38.4	59.7	31.6	29.4	3762.9	8.08	4.41	2.51
Absheron-Khyzy region	17.4	41.3	63.14	46.8	19.7	8.7	6643.1	7.60	6.37	0.98
Upland Shirvan region	44.6	43.3	47.24	37.0	17.96	19.8	1032.6	3.25	1.13	0.17
Ganja-Dashkesan region	24.4	21.6	13.7	18.14	14.1	10.0	2575.96	4.32	0.19	0.74
Karabakh region	44.9	34.3	23.5	13.5	62.4	73.8	3569.7	4.85	0.24	0.16
Qazakh-Tovuz region	17.8	17.3	30.1	17.2	8.4	6.7	2727.2	4.04	0.43	0.04
Quba-Khachmaz region	29.2	30.1	37.7	18.3	16.7	13.7	2402.7	4.42	0.65	0.08
Lankaran-Astara region	29.1	25.8	14.0	7.3	4.9	8.5	2453.8	2.64	0.18	0.18
Middle Aran region	17.1	16.1	17.7	11.2	3.96	4.1	2722.1	3.28	0.38	0.07
Mil-Mughan region	23.9	25.9	21.2	4.9	3.4	4.4	2262.84	3.73	0.06	0.11
Sheki-Zagatala region	24.8	25.1	22.8	19.1	7.6	8.4	2003.9	3.80	0.05	0.23
East Zangezur region	388.4	44.3	30.3	24.7	84.3	95.2	2258.6	7.52	0.001	0.67
Shirvan-Salyan region	22.8	20.3	16.4	9.8	5.24	9.6	2534.1	5.16	0.36	0.09

Note: Calculated by G.Yuzbashiyeva based on data (Regions of Azerbaijan, 2023)

As can be seen from the data in Table 5, an increase in investment activity is observed in Nagorno-Shirvan (19.8%), in Karabakh (73.8%), in Lankaran-Astara (8.5%), in Central Aran (4.1%), in Mil Mugan (4.4%), in Sheki-Zagatala (8.4%), in Eastern Zangezur (95.2%) and in Shirvan-Salyan (9.6%). Compared to 2017 there was a decrease and only in Karabakh there was an increase. Growth of the index of efficiency of use of fixed assets in 2022 in relation to 2020 observed in Ganja-Dashkesan (0.74), in Mil Mugam (0.11), in Sheki-Zagatala (0.23) and in Eastern Zangezur (0.67).

Despite the wave-like changes in investment activity and in the index of efficiency of use of fixed assets, the situation is explained by the most important task - the revival of lands liberated from occupation and their integration into the economic system of the country, which is what all the activities of the country's government are aimed at. Measures taken by the government to reduce inflationary pressure will help improve the efficiency of investment in fixed assets through increased investment activity, rational use of the number of employees and increased productivity of the number of operating enterprises (see Table 6).

Table 6.

Structure of the number of employees and the number of operating enterprises (%)

Azerbaijan regions	Structure of number of operating enterprises, %					Structure of the number of employees, %				
	2017	2019	2020	2021	2022	2017	2019	2020	2021	2022
Total:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
State	20.5	17.7	16.4	15.3	13.7	-	-	-	-	-
private	79.5	82.3	83.6	84.7	86.3	-	-	-	-	-
Baku city	48.5	52.7	53.9	54.2	55.2	46.0	49.5	50.8	51.3	51.8
Nakhchivan Autonomous Republic	4.9	3.4	3.2	3.0	2.7	6.5	6.4	6.4	6.4	6.3
Absheron-Khyzy region	9.1	10.4	10.1	10.3	10.8	5.5	5.5	5.5	5.8	5.8
Upland Shirvan region	1.74	1.64	1.54	1.6	1.5	1.9	1.7	1.7	1.6	1.6
Ganja-Dashkesan region	6.6	5.8	5.7	5.3	4.6	5.2	4.8	4.75	4.7	4.6
Karabakh region	2.5	2.34	2.3	2.3	2.3	4.5	4.2	4.0	3.8	3.8
Qazakh-Tovuz region	2.94	2.84	2.7	2.7	2.8	4.1	3.8	3.6	3.5	3.5
Quba-Khachmaz region	3.6	3.3	3.3	3.4	3.3	3.4	3.15	3.1	3.1	3.2
Lankaran-Astara region	3.3	3.2	3.2	3.2	3.2	4.6	4.2	4.1	4.0	3.9
Middle Aran region	5.38	4.5	4.3	4.3	4.2	5.2	4.7	4.5	4.4	4.4
Mil-Mughan region	2.6	2.34	2.4	2.3	2.2	3.1	2.9	2.7	2.6	2.5
Sheki-Zagatala region	4.8	4.3	4.2	4.5	4.4	4.8	4.4	4.3	4.3	4.2
East Zangezur region	0.4	0.44	0.4	0.3	0.5	1.5	1.4	1.3	1.3	1.2
Shirvan-Salyan region	3.56	2.94	3.0	2.7	2.7	3.7	3.3	3.2	3.2	3.2

Source: (Regions of Azerbaijan, 2023)

As can be seen from Table 6, there is a decrease in the share of state-owned enterprises and an increase in the number of enterprises in Baku (55.2% in 2022). Accordingly, there is an increase in the number of workers in Baku (51.8% in 2022). Despite the increase in number of operating enterprises and number of employees in Baku, certain measures are being taken in Azerbaijan regions to improve the current situation.

Measures are being taken to ensure compliance between the number of employees and the availability of jobs. This requires the development of existing human potential in various industries and sectors, which will help reduce unemployment and underemployment. Table 7. demonstrates the SWOT analysis of Azerbaijan regions' economic potential.

Table 7.

SWOT analysis of Azerbaijan regions' economic potential

Strengths	**Weaknesses**
➢ the measures taken by Azerbaijan Government to reduce the level of inflation help reduce inflationary pressure on investment processes and increase efficiency and investment activity in the regions; ➢ conditions for increasing investment attractiveness and competitiveness, specialization, coordination, cooperation, integration, reducing the subsidy component of the regions and their dependence on the financial policy of the center, etc.	➢ in economic regions has observed some growth; ➢ a very low level of efficiency of budget expenditures (in case of shadow economy, monopoly, corruption have a great influence); ➢ not always, government support contributed to the rational use of available financial resources; ➢ there are conditions for irrational use of finances, risks and bankruptcies.
Opportunities	**Threats**
➢ an opportunity is created to reduce vulnerability to corruption through administrative measures; ➢ advisable: provision of targeted loans from the state in order to support long-term investments; create conditions for the development of human potential; ➢ the financial conditions of the regions of Azerbaijan are improving.	➢ crisis, pandemic, local wars indicate the vulnerability of the oil and gas market to political events; ➢ monopolization and growth in energy demand create the basis for the formation of the resource component of inflation, leading to a decrease in competitiveness, productivity, and an increase in imports of foreign goods.

The activities of Azerbaijan government promote the proportional development of industries and sectors of regional economy, the development of auxiliary and service industries that ensure the effective development of specialization, the balanced development of agriculture, processing industries, the construction materials industry, and local industry.

Conclusion

The most important objectives of structural policy are: increasing investment and innovation activity, stimulating the rapid development of the high-tech sector of the economy; stimulating restructuring and reforming of enterprises, development of small and medium-sized businesses; restructuring of natural monopolies, ensuring tariff regulation of their services; implementation of targeted programs for the development of transport, communications and telecommunications, formation of a competitive environment, creation of equal conditions not only for economic activity, but also in certain industry markets (Yuzbashiyeva, 2010, p.478).

Regional factors and regional policies determine the regional situation, that is, we observe at one time or another the state of the region and the trends in its change. In turn, the regional situation influences regional factors and policies. The result of the interaction of regional factors, policies and situations gives the entrepreneurial climate, that is, the conditions and opportunities for doing business in a given territory.

Real solutions to problems are only possible by combining general problems with local problems. The sectoral division of labor accelerates the technical progress of production and is determined by the interests of its development. In some cases it connects enterprises of related and related industries, and in others it separates them from each other, and regional always unites them spatially. As a result, the rational distribution of industry across regions contributes to the rate of its growth as a whole, with a correct, constantly improving structure in conditions of maximizing the degree of complexity of industrial production. The objective reasons for systematic rationalization are:

- strengthening the role of each region in the social division of labor, subject to the effective use of local resources;
- maximizing the needs of the economy and population of each region through the growth of local production of relevant industrial products, taking into account technical progress and, if profitable, focusing on imported raw materials.

Recommendations

- to reduce the existing regional asymmetry, it is advisable to use an ordinal approach to measuring structural changes, that is, a pairwise comparison of the industry of individual regions in terms of their structural development, which helps to increase the efficiency of the structure. For this purpose, it is advisable to carry out innovative modernization of a wide range of promising industries on the basis of mutually beneficial ties between the state, business, science, culture and education, which will help raise the level and improve the quality of life of the population of a certain territory;

- It is advisable to develop the production and entrepreneurial sector, since entrepreneurship should become the basis of the reproduction process. Growing consumer demand will stimulate innovation in the services and manufacturing sectors.
- It is advisable to actually use the advantages of the budget structure and the presence/absence of clear budget policy priorities.
- growth in government spending has a dual impact on economic growth: on the one hand, it increases the stability of the economy, and on the other, it contributes to a decrease in entrepreneurial activity.
- it is advisable to ensure proportionality in the development of specialization industries, auxiliary and service industries. Sectors of specialization express the economy's orientation towards production. Service and auxiliary industries must in due time ensure the effective functioning of specialization industries.
- it is advisable to balance the development of agriculture and industries processing agricultural raw materials. The poor development of processing industries and the production infrastructure of the complex leads to large losses of agricultural products, both at the harvesting stage and at the stage of transportation and storage.

Referance list

Aliyev, I. (2023). 16th Summit of the Economic Cooperation Organization (ECO). Speech by President MR. I. Aliyev. 09.11.23 https://azertag.az/ru/xeber/v_tashkente_sostoyalsya_16_i_sammit_organizacii_ekonomicheskogo_sotrudnichestvav_meropriyatii_prinyal_uchastie_prezident_azerbaidzhana_ilham_aliev_obnovleno_3_video-2819830 (in Russian) - Алиев, И. (2023). 16-й

Саммит Организации экономического сотрудничества (ОЭС). Выступление Президента И.Алиева. 09.11.23г.

Budget of Azerbaijan. (2024) Baku, State Statistic Committee, https://ru.wikipedia.org/wiki/бюджет

Finance of Azerbaijan. (2022). Baku, State Statistic Committee, https://ru.wikipedia.org/wiki/budget_Azerbaijan.

Khalilova, T. (24.10.2023). Stimulating factor. Investments in the development of the liberated part of the country will grow. Interview with Milli Majlis deputy, DSc in economics, prof. R. Guliyev. Newspaper “Baku Worker”, p. 6. https://br.az/file/journal/1698110120_24.10.2023.pdf (in Russian) - Халилова, Т. (24.10.2023). Стимулирующий фактор. Инвестиции в развитие освобожденной части страны будут расти. Интервью с депутатом Милли Меджлиса, д.э.н, проф. Р.Гулиевым. Газета «Бакинский рабочий», с. 6. https://br.az/file/journal/1698110120_24.10.2023.pdf (на русском)

Regions of Azerbaijan. (2023) Baku, State Statistics Committee, 865 p.- https://www.stat.gov.az/source/regions/

Official website of Azerbaijan Ministry of Economy (2024) – https://www.economy.gov.az

Official website of Azerbaijan President I. Aliyev. (2015). Speech by President of Azerbaijan Ilham Aliyev at a meeting of the Cabinet of Ministers dedicated to the results of socio-economic development for nine months of 2015 and upcoming tasks. - https://president.az/ru/articles/view/17375/videos- Официальный сайт президента Азербайджана И.Алиева. (2015). Выступление Президента Азербайджана Ильхама Алиева на заседании Кабинета министров, посвященном итогам социально-экономического развития за девять месяцев

2015 года и предстоящим задачам. - https://president.az/ru/articles/view/17375/videos

Sharipova, E., Chabakaur, G. (2004). Public policy and budget structure: analysis of fiscal development of economies in transition and developed countries. - https://www.iep.ru/files/text/confer/2004_09_13-14/sharipova_ru.pdf. (in Russian) - Шарипова, Е., Чабакаур, Г. (2004). Государственная политика и структура бюджета: анализ бюджетного развития экономик переходного периода и развитых стран. - https://www.iep.ru/files/text/confer/2004_09_13-14/sharipova_ru.pdf.

Tagiyeva, A. (2022a) How Azerbaijan is turning Karabakh into a paradise for investors. 11/16/2022. Sputnik. - https://az.sputniknews.ru/20221116/kak-azerbaydzhan-prevraschaet-karabakh-v-ray-dlya-investorov-448603592.html - Тагиева, А. (2022a) Как Азербайджан превращает Карабах в рай для инвесторов. 16.11.2022. Sputnik. - https://az.sputniknews.ru/20221116/kak-azerbaydzhan-prevraschaet-karabakh-v-ray-dlya-investorov-448603592.html

Tagiyeva, A. (2022b) The Strategy for Socio-Economic Development of the Republic of Azerbaijan for 2022-2026 was approved. Satellite of Azerbaijan. 07/22/2022 - https://az.sputniknews.ru/20220722/utverzhdena-strategiya-sotsialno-ekonomicheskogo-razvitiya-ar-na-2022-2026-gody-444271772.html-Тагиева А. (2022b) Утверждена Стратегия социально-экономического развития АР на 2022-2026 годы. Спутник Азербайджана. 22.07.2022 - https://az.sputniknews.ru/20220722/utverzhdena-strategiya-sotsialno-ekonomicheskogo-razvitiya-ar-na-2022-2026-gody-444271772.html

The Path to the 21st Century: Strategic Problems and Prospects for the Russian Economy (1999). Department of Economics of the Russian Academy of Sciences / Head. auto count D.S. Lviv. Scientific editorial council of the publishing house "Economy", M.: Economics, 795p.http://www.cemi.rssi.ru/publication/booksomega/index.php?SECTION_ID=18&ELEMENT_ID=832
- Путь в XXI век: Стратегические проблемы и перспективы российской экономики (1999). Отделение экономики РАН / Рук. авт. кол. Д.С. Львов. Научный редакционный совет изд-ва "Экономика", М.: Экономика, 795с. - http://www.cemi.rssi.ru/publication/booksomega/index.php?SECTION_ID=18&ELEMENT_ID=832

Yuzbashiyev, I.H. (2010). Development and international economic links' improving of Azerbaijan with GUAM countries. Baku, Elm, 198p. (monograph in Russian)

Yuzbashiyeva, G.Z. (2010). The influence of the Azerbaijani mentality on the economic development of the country. Baku, Elm, 2010, 478 p. (in Russian) - Юзбашиева, Г.З. (2010). Влияние азербайджанского менталитета на экономическое развитие страны. Баку, Элм, 2010, 478 с.

Yuzbashiyeva, G.Z. (2019). "GDP and Real Economy". Monograph. Baku, Elm, 112p. (monograph in Russian)

Yuzbashiyeva, G.Z., Abasova, S.H., Yuzbashiyev, I.H. (2022). «Innovations and Investments like as Providing Sources of Economic Growth in Azerbaijan in Pandemic Conditions». Proceedings of the IX International Scientific and Practical Conference - "Current Problems of Social and Labour Relations" (ISPC-CPSLR 2021), p.424-432, - «Advances in Social Science, Education and Humanities Research» (ISSN (Online): 2352-5398) – Publishing house «Atlantis Press (part of Springer Nature)», Retrieved from: https://www.atlantis-press.com/proceedings/ispc-cpslr-21/125970680

Yuzbashiyeva, G.Z., Abasova, S.H., Yuzbashiyev, I.H. (2023) Innovative Factors' Influencing to Azerbaijan National Economy Transformation. International Journal of Applied Engineering and Technology. Vol.5, No 4, December, p.217-227. - https://romanpub.com/jaetv5-4-2023.php

THE ECONOMIC VALUE OF CROP WATER IN IRAN- 2019

Dr. Banafsheh Najafi

b_najafi@sci.og.ir
PhD of Economics,
Group leader of production and institutional accounts,
Statistical Centre of Iran.

Water resource management is one of the challenges that societies have faced in recent decades; The growing shortage of fresh water to meet the demand of various sectors of the economy droughts, floods and quantitative and qualitative reduction of water resources, engineering "water supply" on the one hand and population growth, urbanization and the growing of water consumption, Management of the "water demand" side, on the other hand, makes it necessary. The price is considered one of the main tools of demand management, which protect the water resources, its storage and sufficient income for the public water service unit. The main purpose of this study is to determine the economic value of water. For this purpose, 28 crops in 31 provinces of the Iran are considered and the economic value of these crops are obtained using translog production function method. The results of the research show that, in 2019, the economic value of water of these crops in the Iran was 17100 Rl per cubic meter. The elasticity of crop production with respect to water is also 21%, which shows that a one percent changes in water consumption, increases crop production by 21% assuming other conditions are constant.

Keywords: economic value of water, crops, translog production function

1.Introduction

Economics is the study of the allocation of limited and scarce resources between unlimited uses and needs. According to the definition, an economic goods is a commodity that has utility for the society and is somewhat scarce compared to the demand. It is scarcity that creates value, willingness to pay and opportunity cost; and if a commodity can be valued, it can be traded in the market and valued using some form of money.

Before the 20th century, due to the abundance of water resources compared to the demand and the lack of population pressure and other types of water demands, water resources were known as a low value and free commodity; But after that, due to rapid population growth, economic development that requires development in all economic sectors and the formation of new types of demand, rising living standards, responding to all types of water demand, etc., its consumption increased sharply. It caused the attention

of managers and policy makers as a rare commodity and was considered as an economic commodity and a limited input; In this direction, water economy was formed, which includes topics such as the application of economic principles in the management and exploitation of water resources, the economy of water resource development plans, the description of different methods to improve the efficiency of water economy, the evaluation of water sector policies and allocation systems pay. In fact, the economic dimension of water is an important feature in the integrated management of water resources, and the two important goals of this management are maximizing the economic value of water and investing in the water sector in order to justice and environmental sustainability.

Iran is one of the countries that is most vulnerable to water shortage, being located in the least watery region of the world. More than 90% of Iran's population and gross domestic production are in areas where withdrawal of water resources is more than sustainable exploitation (World Bank, 2017). 61% of the country's area is in dry and ultra-dry climates, which is 1.3 times the global percentage. The most important feature of these climates is that their average annual rainfall is less than 50 millimeters (Ministry of Agriculture of Iran, 1400). Of course, the level of these areas also depends on the climatic conditions and human factors of desertification, such as population increase, excessive grazing, withdrawal of water from underground water resources, groundwater pollution through industrial, urban and agricultural waste water, land use change, improper management of pastures and unprincipled management of agricultural lands are increasing. Therefore, the importance and value of water in this territory is very high.

Water pricing is effective in increasing productivity and reducing water consumption when, in addition to knowing the cost of providing water as the lower limit of pricing, the economic value of water as the upper limit of pricing is also known.

This study was compiled with the purpose of determining the economic value of water. For this purpose, the registered data of the Information and Communication Technology Center of the Ministry of Agriculture and the Iran Water Resources Management have been used. The geographical scope of the research is at the level of the whole country(Iran) in 2019. The organization of this article is that after the introduction, in the second part of the literature, the theoretical foundations and background of the research are stated. The third part is dedicated to the introduction of statistical data and the research method, the fourth part is the results and discussion and the final part is dedicated to concluding remarks and recommendations.

2-Theoretical foundations and background of research

Iran is facing a severe water crisis. Despite this, the price of water in urban areas of Iran is among the lowest prices in the world (World Water Council, 2016), so it does not warn about the value of water and the need to save. At the same time, water suppliers are limited in providing water, forcing the government to pay huge subsidies for water supply, production and maintenance. Along with the scarcity of water resources, the country's environment suffers the most damage.

Demand management is the implementation of strategies aimed at influencing demand, in order to efficiently and sustainably obtain a scarce resource, which, in addition to efficiency, should also promote environmental justice and integrity. The category of water management is dynamic, and with the increasing scarcity of water resources and the increase in economic competition for it, the role of economics in water allocation and management has become increasingly important. However, the cultural and environmental characteristics of water, the economic tools and principles in its allocation and exploitation, face problems in practice. Water has unique characteristics such as public goods, private goods, vital goods, environmental goods, etc., which are necessary to know in water management in order to achieve social and environmental goals. These characteristics make water more complicated than other goods and affect its market as well. The characteristics of water supply and demand and the inability of the market, make the economy unable to solve the water problem alone and need a comprehensive approach should be created in terms of environmental, technical and institutional factors along with economic criteria and principles.

In the absence of a water market or real water pricing, the value of irrigation water is often determined using shadow prices (Ziolkowska, 2015). The shadow price of water shows the value of the products produced by the final unit of water consumption and other inputs such as labor and machinery, and it means the income (production equal to the market price) created with the last cubic meter of water consumption (Bierkens et al., 2018). The shadow price is the marginal value of water (Young and Loomis, 2014), which represents the value that water has for the farmer or the maximum price that the farmer is willing to pay for the last cubic meter of irrigation water used. Producers use an input until its price is equal to the additional value of using one unit of the input (Williams et al., 2017).

Valuing water, on the one hand, contributes to the efficiency, equitable allocation and proper distribution process and reduces the harmful environmental effects with economic tools, on the other hand, it increases market awareness, so that policy makers consider the importance of ecosystems or natural resources and reconsider the investment decisions that cause damages in the long term and have adverse effects on the natural environment and human livelihood. It also reduces the scope of market failure and causes farmers to change their traditional irrigation to low-consumption irrigation, reconsider their product selection and change their product pattern with other products with higher economic efficiency and less water requirement.

The contribution of the value added of the agricultural sector in Iran in 2019 was 8.6% and the contribution of labor force (15 years and older) in this sector was 17.9%. If this sector is divided into sub-sectors such as planting crops (cultivation and horticulture), animal breeding, forestry and fishing, it can be seen that cultivation and horticulture have the highest contribution of value added in the agricultural sector in 2019 and It was 68.4 percent (SCI[7], 2019).

[7] Statistical Center Of Iran

Growing crops is the science and technology of cultivation and exploitation of water, soil and annual plants, and the contribution of labor force in this sub-sector was 37.2% of the total agricultural sector. In the crop year 2018-2019, the area of crops was about 12 million hectares, of which 51.8% were Irrigated agricultural area and 48.2% were rain fed agriculture.

In this crop year, about 82.7 million tons of crops have been harvested, so that 90.6% of crop production belongs to Irrigated agricultural area and 9.4% of the rest belongs to rain fed agriculture. Growing crops is one of the most influential groups in the economy, especially the agricultural sector. In 2019, the contribution of water consumption in the manufacturing, agriculture and services sectors was 5.1%, 83.1% and 11.7% of the total water consumption, respectively. The agricultural sector has the largest contribution; And this is while 77% of water consumption in the agricultural sector belongs to the cultivation of crops(Iran Water Resources Management &SCI). The set of these factors causes more attention to the control of water consumption in the cultivation of crops.

One of the methods of determining the value of water is the function of production, and the economic value of water is obtained through the marginal product of water input in the production process. In the production function method, water input is considered as an independent variable and after estimating the function, the value of the marginal product of water input is determined as its economic value. When the purpose of estimating a production function is to use its parameters to calculate the economic value of a production input, this calculation can be used as the basis for determining its price.
If “Y” represents the amount of production, “W” is the volume of water input and “X” is other inputs. The value of the marginal product of water is equal to multiplication marginal product of water and the price of the product, which is the optimal point of using the input and is the economic value of water (Chambers, 1988). So:

$$Y=f(W, X) \tag{1}$$

$$P_w = \left(\frac{\partial Y}{\partial W}\right) \times P_y = Mp_w \times P_y = Vmp_w$$

So that in the above equation, Vmp_w is the value of marginal product or the economic value of water, Mp_w is the marginal product of water input and P_y is the price of the product whose water input is used in its production process. The elasticity of crop production with respect to water or the percentage of changes in the amount of production to the percentage of volume of water changes can be obtained from the following equation;

$$E_w = \frac{\partial Y}{\partial W} \times \frac{W}{Y} = \frac{\partial Ln(Y)}{\partial Ln(W)} \quad (2)$$

And the marginal product is displayed as follows;

$$Mp_w = \frac{\partial Y}{\partial W} = E_w \times AP_w = \frac{\partial Ln(Y)}{\partial Ln(W)} \times AP_w \quad (3)$$

The studies conducted are in a wide range in terms of method, value and measurement units. Estimated values are also assigned to monetary units and different measuring units such as acres or feet. The estimated values in these studies indicate that the inconsistencies resulting from these results cannot be explained only by technical considerations related to the methods, and institutional considerations (business space and different exploitation and production systems) also explain this inconsistency, must be considered.

Among the studies in the field of irrigation water pricing and its allocation effects, we can mention Tsur, Y. and A. Dinar in 1995. According to them, the water pricing policy is a sufficient incentive for the effective use of water resources, and as a result, it contributes to the environmental goals of water.

In 2002, Arriaza and his colleagues estimated the water input demand functions of different groups of farmers in southern Spain by using the mathematical programming method, and by considering different scenarios of fixed and exogenous water supply, they estimated the marginal product value of different groups of farmers for the water input. They has been used its inequality between different groups to determine the type of participation in the market and to exchange water and transfer it between groups. After estimating the equilibrium price of water from the intersection of the water supply and demand curve in the market, they calculated the volume of exchanges in the market, the volume of exchanges and the value of exchanges and investigated the economic and social effects of creating a water market in the region.

In 2009, Liu et al., in an article entitled "Evaluating and Predicting Shadow Prices of Water Resources in China and Its Nine Major River Basins", they used input-output tables of the nine Chinese major river basins, and combining input–output analysis method with linear programming method.They developed a linear programming model with restrictions on the final demand, total output, trade balance and water availability and estimated the water shadow prices for industrial water and productive water for the nine Chinese major river basins.The results were compared with the real price of industrial water and productive water, using Gauss-Newton nonlinear simulation method, two nonlinear models that are related to the ratio of the volume of water used to the total volume of water resources with shadow prices and used to predict the shadow

price of industrial water and productive water in 2020 and 2030 in China and the nine great river basins of China.

Bierkens et al showed in 2018 that one of the reasons for the reduction of underground water resources is the price that users pay for water, which does not reflect its scarcity and value. One way to evaluate the value of water is to calculate the shadow price or its marginal product value, which was estimated in this research for five products and eleven countries. To determine the shadow price, the method of production functions and the global hydro logical model were used, and the results show that the fluctuations of the shadow prices for the main products are very high in several countries, which indicates the inefficient economic use of water resources, including non-renewable underground water. Also, the effects of reallocating irrigation water between crops show that changes in water allocation can lead to an increase in the economic efficiency of water consumption or a decrease in irrigation water consumption.

3- Statistical data and the research method

The production process is a flow or process that converts production inputs into production goods and services (products) for consumption or investment, and the production function is a technical relationship between factors and production inputs and the product. It represents the maximum product that can be obtained from the set of inputs assuming that other conditions are constant. In the production function method, water input is considered as an independent variable and after estimating the function, the value of the marginal product of water input is determined as its economic value. When the purpose of estimating a production function is to use its parameters to calculate the economic value of a production input, this calculation can be used as the basis for determining its price.

Since the parameters of the water production function are effective in policies and the estimation value of these parameters is affected by the shape of the production function, before any action to estimate the model, it is necessary to decide on the shape of the production function. Functions used in production are divided into two categories: flexible functions and inflexible functions. Inflexible functions impose restrictions on model parameters, so that the collected information and statistics cannot freely describe the behavior of economic producers (Samuelson, 1979).

Flexible functions do not impose restrictions, and as a result, show the real behavior of economic factors in a more appropriate way (Diewert, 1971). The use of flexible functional forms, which can also represent the third area of production, are preferred over inflexible functional forms and are considered as superior forms. Of course, the flexibility of a function is not enough to directly select it as a production function, and it is necessary to estimate different functional forms and choose the best form based on econometric tests and criteria.

The characteristics of the production function of neoclassical economics include monotony, concavity, essentiality, non-negativity, continuity, twice-differentiability, which define the general framework of the behavior of production functions. Therefore,

the forms of the function that provide these characteristics can be considered as the desired function to express production relations (Chambers, 1988).

Based on the Monotony condition, the form of the production function should be such that with the increase in the consumption of an input, its total production will also increase, and as a result, the final product, which is the first derivative of the function, will be positive. Despite the concavity feature, the final product of the production function is decreasing. Accordingly, linear functions cannot be considered. The different forms of production functions show the production technology and the way of combining different inputs, and the difference in the conditions of production and management of farmers causes them to combine production inputs in different ways. Therefore, there is a need for functions that show this difference better.

Translog production function was first proposed in 1972 by Christensen-Jorgenson and Lau. This function is actually the logarithmic transcendental production function in which substitution and production elasticities change according to the level of consumption of inputs. Also, in addition to the parameters of the main variables of the coefficients, this function also estimates the interrelationships of the variables (Debertin, 2016). Translog function provides all the features of neoclassical economics production function. Another characteristic of this function is that it allows substitution elasticities and production elasticities to change depending on the level of consumption of inputs. In addition, the first derivative of this function has no restrictions in terms of sign (positive or negative). In other words, translog function shows all three production areas and the final production is increasing, decreasing or negative. The essentiality condition is not defined in this function, and by having translog form, it is possible to test whether this function can be converted to Cobb Douglas or not; Therefore, the Cobb-Douglas function is considered a special case of this function (Griffin et al., 1987). If there are n inputs, the number of parameters of this function is n/2) n+3).

$$Y = \alpha \prod_{i=1}^{n} x_i^{\beta i} \prod_{i=1}^{n} x_i^{0.5 \sum_{j=1}^{n} \gamma_{ij} lnxj} \qquad i \neq j \qquad \gamma_{ij} = \gamma_{ji} \tag{4}$$

$$Ln(Y) = \alpha + \sum_{i=1}^{n} \beta_i Ln(x_i) + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} (Lnx_i)(Lnx_j) \tag{5}$$

$$Mp_i = (\beta_i + \sum_{j=1}^{n} \gamma_{ij} (Lnx_j))(\frac{Y}{x_i}) \tag{6}$$

$$Ex_i = \beta_i + \sum_{j=1}^{n} \gamma_{ij} (Lnx_j) \tag{7}$$

In the above production functions, x_i are production inputs, Y is the product amount, α ،β_i و γ_{ij} are model parameters and Ln is the natural logarithm.

Restrictions of translog production function

The restrictions of the model are as follows:
1-Condition of constant return to scale;

$$\sum_{i=1}^{n} \beta_i = 1$$

2- Homogeneous conditions (Boisvert, 1982);

$$\sum_{i=1}^{n} \beta_i = 1 \quad (8)$$

$$\sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} = \sum_{i=1}^{n} \gamma_{ij} = \sum_{j=1}^{n} \gamma_{ij} = 0 \quad (9)$$

3- Homothetic condition (Tzouvelekas, 2000);

$$\sum_{i=1}^{n} \gamma_{ij} = 0 \quad (10)$$

Production function variables

The variables used to determine the economic value of water in crops and to estimate production functions are as follows;

- The price of each kilogram of production per hectare in Rials (Y)
- The volume of water consumption per hectare in cubic meters (W)
- The consumption value of each kilogram of other inputs including chemical fertilizers, chemical poisons and seeds per hectare in Rials (O)
- The number of workers per hectare per day (L)
- The average cost of using machinery in one hectare in Rials (M)
-The average selling price of one kilogram of agricultural crops in Rials (P)

In this study, the economic value of water in agricultural crops is estimated using production function method and translog function form. The estimation of parameters has been done by OLS method and through Eviews software. The significance coefficient of the total regression (F), the significance coefficient of each of the coefficients (t), the coefficient of determination or explanatory power of the model, the specification error, the Heteroscedasticity, Residual Normality will also be examined and compared in the model.

The form of the production function and the value of the marginal product of crop water is as follows:

$$Ln(Y) = \alpha + \beta_1 Ln(W) + \beta_2 Ln(O) + \beta_3 Ln(L) + \beta_4 Ln(M) + 0.5\gamma_{11}(LnW)^2 + 0.5\gamma_{22}(LnO)^2 + 0.5\gamma_{33}(LnL)^2 + 0.5\gamma_{44}(LnM)^2 + \gamma_{12}(LnW)(LnO) + \gamma_{13}(LnW)(LnL) + \gamma_{14}(LnW)(LnM) + \gamma_{23}(LnO)(LnL) + \gamma_{24}(LnO)(LnM) + \gamma_{34}(LnL)(LnM) \quad (11)$$

$$Vmp_w = Mp_w \times P_y = \left(\frac{\partial LnY}{\partial Lnw}\right)\frac{Y}{w} \times P_y \quad (12)$$

$$Mp_w = (\beta)_1 + y_{11}(LnW) + y_{12}(LnO) + y_{13}(LnL) + y_{14}(LnM)) \times \frac{Y}{w} \quad (13)$$

$$E\_w = (\beta)\_1 + y\_11\ (LnW) + y\_12\ (LnO) + y\_13\ (LnL) + y\_14\ (LnM) \quad (14)$$

Research is a systematic process of collecting and analyzing information (data) in order to find facts or deep understanding of issues. For this purpose, the researcher needs appropriate tools to achieve this goal. The source of the required statistical information regarding the determination of the economic value of crop water is the registered data of the Information and Communication Technology Center of the Ministry of Agricultural of Iran and the Iran Water Resources Management. The geographical scope of the research is in the whole country in 2019. Information is collected separately for 31 provinces and for 28 crops.

It should be noted that the water consumed by each product was calculated through the NETWAT software; The NETWAT software, which is also known as the National Water Document, is used to estimate the water requirements of garden and agricultural plants in Iran, and the output and result of the project is the "net irrigation requirement of Iran's agricultural and garden crops" which was carried out by the Ministry of Agricultural of Iran and Meteorological Organization has done. In this software, information related to evaporation, transpiration and net irrigation requirement in terms of cubic meters per hectare of cultivated plants is available in 620 plains of Iran.

4. Results and discussion

With the aim of determining the economic value of water for crops that consume the most volume of water among other agricultural products, the production function was first estimated. The model is estimated with 316 observations and through cross-sectional data and has 15 coefficients. The whole model is significant at a significance level of 95%. The restrictions of the translog function are tested in order to be able to transform it into the Cobb-Douglas production function. The test used is the Wald test and the test result of each restrictions is shown in the table below.

Table.1

The result of Wald's test for model restrictions

Restriction	H_o	Value	Probability	Result
Constant return to scale	$\sum_{i=1}^{n} \beta_i = 1$	8.5	0.0037	reject the null hypothesis
Homogeneous	$\sum_{i=1}^{n} \beta_i = 1$ $\sum_{i=1}^{n}\sum_{j=1}^{n} y_{ij} = 0$	4.5	0.0048	reject the null hypothesis
Homothetic	$\sum_{i=1}^{n} y_{ij} = 0$	4.8	0.0009	reject the null hypothesis

Source: research findings

The results of the test show that the applied restrictions are not correct and the intended function is a non-Homogeneous and non-Homothetic and has not constant return to scale.

In the next step, since the data are cross-sectional and there is a possibility of Heteroskedasticity, White's test is performed. According to Table 2, the result of the test shows the existence of Heteroskedasticity. The result of Jarque-Bera statistic in this model shows residual normality, and the result of Ramsey Reset statistic also shows that there is no specification errors in model.

Table.2

The result of model tests

White Test		Jarque-Bera Test		Ramsey Reset Test	
stat	**Prob**	**F-stat**	**Prob**	**F-stat**	**Prob**
2.22	0.00	0.6	0.7	1.8	0.18

Source: research findings

In order to fix Heteroskedasticity, the weighted method (WLS) with Standard deviation weight is used. The result of the model is presented in Table 3.

Table.3

The result of estimating the model after fixing Heteroskedasticity

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-117.7326	19.57805	-6.013501	0.0000
LW	5.369124	2.138296	2.510935	0.0126
LL	-4.714167	0.635792	-7.414642	0.0000
LO	7.319318	1.312412	5.576996	0.0000
LM	7.854923	2.018278	3.891894	0.0001
0.5*(LW^2)	0.184386	0.155540	1.185459	0.2368
0.5*(LL^2)	-0.006862	0.021854	-0.313977	0.7538
0.5*(LO^2)	-0.004281	0.069521	-0.061580	0.9509
0.5*(LM^2)	-0.096155	0.147163	-0.653390	0.5140
LW*LL	0.151316	0.036050	4.197428	0.0000
LW*LO	-0.259963	0.095539	-2.721021	0.0069
LW*LM	-0.188413	0.112112	-1.680584	0.0939
LL*LO	0.079219	0.034276	2.311227	0.0215
LL*LM	0.155195	0.041671	3.724289	0.0002
LO*LM	-0.336580	0.080617	-4.175025	0.0000
F-statistic	26.19839	**R-squared**	0.549251	
Prob(F-statistic)	0.000000	**Adjusted R-squared**	0.528286	
		Durbin-Watson stat	1.434983	

Source: research findings

Finally, according to the obtained coefficients, the marginal product of water is obtained. Since the dependent variable is the value of each kilogram of production per hectare, the amount of the marginal product is actually the value of the marginal product of water and it does not need to be multiplied again by the selling price of the product. The elasticity of crop production with respect to water is also calculated. Table 4 shows the results of the relevant calculations.

Table.4

The elasticity of crop production with respect to water and its economic value in Iran-2019

Elasticity(%)	economic value(Rials)	Price of water
21	17100	1447

Source: research findings

The results indicate that the weighted average economic value of crop water[8] in Iran in 2019 was 17,100 Rials. Since the use of underground water and wells in Iran is free and the water tariff is different according to the type of product, the geographical location of cultivation and the amount of harvest, it is not possible to use a specific tariff to evaluate the obtained value. Therefore, in order to compare this value and the real price of water, the criterion of the income from the sale of agricultural water is used. According to the statistics and information of Iran Water Resources Management, this year, the total income from the sale of water to the agricultural sector was 5,519,258 million Rials, which according to the volume of water consumption, the average rate of selling water to farmers in the country is 1,447 Rials per cubic meter.

The elasticity of crop production with respect to water is equal to 21%, which shows that a one percent change in water consumption increases crop production by 21% assuming other conditions are constant.

5. Concluding remarks and recommendations

With the increase in the price of water, due to the decrease in its consumption and the subsequent decrease in crop yield, the economic efficiency of farmers decreases, therefore, in order to respond to these changes, farmers change their cultivation pattern towards rain fed crops. On the other hand, farmers choose the hydroponics model that has high economic benefits compared to other crops.

Paying subsidies to the energy consumption of the agricultural sector makes the extraction of water from deep wells and the relocation of wells cost-effective, and to a large extent causes the discharge of underground water. Although some actions have been taken, such as increasing the price of energy and expanding the network for monitoring the misuse of underground water tables, the trend of agricultural water consumption has not changed (Madani, 2014). According to several studies, the demand for irrigation water at low water prices is less elastic, and if the price increase is insignificant, it is not possible to expect a decrease in consumption, and it is necessary to increase the price significantly.

The reform and elimination of subsidies in Iran in 2009 showed that policies that are properly adjusted can affect consumer behavior. The appropriate change of water price structures creates a balance between production costs and the necessity of economic efficiency along with justice and ability to pay. Water pricing is effective in increasing productivity and reducing water consumption when, in addition to knowing the cost of providing water as the lower limit of pricing, the economic value of water as the upper limit of pricing is also known.

Although the studies conducted in Iran confirm the effect of the policy of increasing the price of agricultural water on reducing water consumption and preventing the discharge of underground water, the comparative comparison of the conducted studies show that the policy of increasing the price of water in the agricultural sector is an insufficient policy and actions such as investing in improving water harvesting technologies, amending the laws related to the water sector, education and promotion, determining the optimal cultivation pattern and so on should be taken. In addition, in this pricing system, it is necessary to consider the sources of water used by farmers, the size of the farm, the cultivation pattern, and different periods of time. Pricing should be done

[8] The average selling price of one kilogram of product is considered as weight.

based on the volume of water consumed and not the cultivated area, and the benefits due to the price increase and the lost economic benefits should be compared.

The existence of many institutions related to water affair in Iran has caused that the actions related to coordination and innovation do not go well. The lack of a strong and stable legal framework, weak enforcement and insufficient coordination among relevant institutions hinders the efforts of integrated management of water resources.

Reference lists

Arriaza. M., Gomez-Limon. J.A., Upton. M., (2002). *Local markets for irrigation water in southern Spain: a multi-criteria approach*. Aust J Agr Resource Econ 46(1), 21-43.

Bhanumurthy, K.V., (2002). *Arguing a case for the Cobb-Douglas production Function*. Review of Commerce Studies, Delhi, India.

Bierkens, Marc F. P. , Reinhard, Stijn , De Bruijn, Jens A. , Veninga, Willeke, Wada, Yoshihide, (2019). *The Shadow Price of Irrigation Water in Major Groundwater-Depleting Countries*. Water resources research, Volume55, Issue5.

Boisvert, Richard N.,(1982). *-The Translog Production Function:Its Properties, Its Several Interpretations And Estimation Problems*. Department of Agricultural Economics New York.

Chambers, R.G. (1998). *Applied production analysis: A dual approach*. Cambridge University Pres

Christensen, Laurits R., Jorgenson, Dale W., . Lau, Lawrence J.(1973). *Transcendental Logarithmic Production Frontiers*.The Review of Economics and Statistics. Vol. 55, No. 1, 28-45.

David L, Debertin, (1986). *Agricultural Production Economics*. University of Kentucky Department of Agricultural Economic.

De Silva N and Williams R., (2015). *Assessing the option value of the Ogallala Aquifer in Texas High Plains: a contingent valuation approach*. presentation at the Southern Agricultural Economics Association's 2015 Annual Meeting.

Diewert, W.E, (1971). *An application of the Shephard duality theorem: A generalized Leontief production function*. Journal of Political Economics, 79:481-507.

Gallego Ayala J., (2012). *Selecting irrigation water pricing alternatives using a multi methodological approach*. Mathematical and Computer Modelling, vol55.

Griffin, R. C., J. M. Montgomery and M. E. Rister, (1987). *Selecting functional form in production analysis*. Western Journal of Agricultural Economics, 12: 216-227.

Information and Communication Technology Center of the Ministry of Agriculture and the Water, (2019). Agricultural statistics.

Iran Water Resources Management, (2019). *The Volume of water consumed by*

economic sectors.

Liu, Xiuli, Chen, Xikang & Wang, Shouyang, (2009). *Evaluating and Predicting Shadow Prices of Water Resources in China and Its Nine Major River Basins*. Water Resources Management 23(8):1467-1478 ·

Mueller J M., Lima RE and Springer AE.,(2017). *Can environmental attributes influence protected area designation? A case study valuing preferences for springs in Grand Canyon National Park*. Land Use Policy, 63, p.196-205.

Madani, K., (2014). *Water Management in Iran: what is causing the looming crisis?* Journal of Environmental Studies and Sciences (4), 315–328.

Samuelson, Paul A., (1979). *Paul Douglas's Measurment of Production Function and Marginal Producties*. Journal Of Political Economy, University Of Chicago Press, Vol. 87.

Statistical Center Of Iran, (2019).*The result of national accounts.*

Tsur, Y. and A. Dinar, (1995). *Efficiency and Equity Considerations in Pricing and Allocating Irrigation Water*. World Bank Policy Research Paper.

Water and Wastewater Company of Iran, (2019). *Yearbook Of Water and Sewage Industry*.

SKILL BIAS IN THE LABOUR MARKET: EVIDENCE FROM URBAN AND RURAL IRAN

Mehdi Mohebi,

meh_moh20@yahoo.com
Research Responsible,
Training and Knowledge Development Department,
Central Bank of Iran.

Most global economies are dealing with the issue of skill bias. In both developing and under-developed countries, skill bias is posing a problem by preventing the educated from participating in the production function of the economy, especially in the long run. This paper expanded the skill-wage relationship and investigates this issue for the case of Iran for the years 1981 to 2021. The relationship of skill and wage is separated to the short and long-run effects by applying Impulse Responses from VECM and Structural VAR model. The structural wage model was estimated using the structural vector auto-regression model. The results show that skill played a significant role in wage determination only for three periods in the short-run, and the effect was neutral in the long horizon which means that skill accumulation by advancement in graduate and post-graduate study will not cause wage increase in the long-run.
JEL Classification: J3, J6, I2, E7, C5, C6

Keywords: skill bias, long-run wage model, human capital, bargaining

1. Introduction

The basic concept of wage-skill relationship is represented through the Mincerian earnings function that establishes a relation between wage levels and corresponding skills. This concept is captured by Jacob Mincer in his study published in 1974, which provided a good background to many studies in the field of human capital. However, these investigations analyse effects of skill on wages mostly by linear regression estimation of the Mincerian wage equation. Recently, it has been observed that although the number of university-educated is increasing globally, this increase in number failed to explain the variations in wage levels meaning that labour force role in wage bargaining is decreasing. This problem is reflective of the skill bias, characterized by high levels of human capital in a society with minimum power in determination of equilibrium nominal wages. Hendricks (2002) revealed that, in the case of Iran, less than 31 percent wage difference between Iran and the US can be explained by human capital. Barro and Lee (2002) conducted a similar investigation for countries with a lower revenue than the US and

concluded that higher skill measured by educational attainment reduces earning per worker between 20 percent for the richest and 40 percent for the poorest countries. This study is mainly dedicated to the analysis of co-integration between wages and number of skilled workers for the short and long runs. For the case of Iran the co-integration and to wages response to a variation in the number of university-educated workers has been analysed. With the data being I(1) according to integration there is enough evidence of co-movement between wages and skills. Although Lazear and Oyer (2007) and Manchester (2010) discussed various types of wage compensations, including various types of non-wage compensations, workers are mainly compensated through just wages in Iran. Hence, wage is a proxy for compensation in this study. Subsequently, a long-run relationship between wages and skills is estimated and the results reflect that skill can determine wages for two to three periods in the short-run and in longer horizons, it is neutral. This finding implies that, at the same level of wages, the share of skilled workers in production in actual data is lower than what assumed to be. This pattern implies the existence of possible skill neutrality that leads to laziness of resources, thereby decreasing the cost of damping skilled labour. This issue, according to Heckman and Klenow (1997), will not only hamper economic growth but will also lead to a lack of equality in technological developments and consequently create negative externalities by increasing social misbehaviour of the unemployed. Concerning the aforementioned long-run wage-skill relationships, vector error correction model (VECM) is used to solve the actual co-movement of skill (which represents the number of workers with a university degree[9]) and wages. The coefficient of skill in the wage model is 2.07, which is approximately equal to the coefficient in the structural vector auto-regression (SVAR) estimated in the subsequent section. In order to prevent the shocks and effect of other variables, exogenous non-accelerating inflation rate of unemployment (NAIRU) (estimated by the state space model solved by the Kalman Filter (Figure I)) is added to the model. The primary goal of this study to examine structural macro-models based on data of wage, unemployment and skill for the years 1981 to 2021 according to works by Becker (1964), Mincer (1974), Rosen (1976), Mankiw et al. (1992), and Jones (2014). The skill data is extracted from the data of Statistical Institution of Iran in which number of university-educated labour force is considered as skilled labour. The results show that in the first decade of this century, firms did not adapt their wage structures to respond to the accumulation of human capital in Iran and only skill explains the wages for two to three periods in short-run, implying skill-neutrality in the long-run (Figure II). In order to analyse the effects of the shocks the SVAR model used to estimate the relationship. The model is identifiable by specific restrictions according to the actual behaviours of wage, skill, and NAIRU. According to results, 1 percent increase in NAIRU will decrease wages by 10 percent in Iran. By applying restrictions like the ones followed by Sims (1999) and Blanchard and Perotti (2002), the model became fully identifiable. According to the

[9] Cunha, Heckman and Schennach (2010) and Schoellman (2013)

estimation results effects of skill shocks on wages last only for two to three periods in the short run, and, in the longer horizon, skill accumulations even after seven periods lead to a decline in wages in the economy. This finding further proves the first analysis of skill bias that while university attendance is increasing in most countries globally, in the long run, the share of educated workers will not play a significant role in wage determination. The structure of the paper is as follows. Section 2 explains the features of the data, Section 3 focuses on establishing a theoretical framework for skill bias, Section 4 contains the structural model of wage for Iran's economy, Section 5 is expanded for estimating the structural wage and human capital models, and Section 6 covers Results and discussions.

2. Features of the data and sampled country

By running a unit root test, the integration of variables in the model has been investigated. All data used in the VECM and structural model, including wages, equilibrium unemployment rates, and skill (as number of labour force with university level education) for the years 1981 to 2021 are integrated at level 1 (I (1)) which implies that the data follow a light random walk process. Therefore, imposing a structural shock in SVAR will decay in impulse-response functions, which is essential to the analysis of structural shocks to wages. According to data collected from 3904 individuals each in urban and rural areas of Iran, only 18.7 percent of currently active workers attained a Bachelor or higher degree which regarding the high growth of university graduated in last decade bring inefficiency to labour market Analysis of the annual data reveals a partially similar paths of both wage and skill; however, unemployment vacillates around a point, but shows a downward sloping trend similar to the linear pattern in scatter plots. The co-integration of wage with skill versus unemployment approves strong two co-integrating patterns in data which tends to decay in level just as I(0). Jones (2014) clarified potential limitations of standard human capital accounting by employing the marginal productivity analysis through the regression model, which focuses on variation in H[10] across countries. In practice, since the variation in H is modest, it appears to contribute negligibly to large income variations. In this study, the decomposition in structural VAR model is done by identification of short run and long run. Concerning the long run, the results prove that wages are skill-neutral, meaning that wages in the long run will not get influence from sill level. As in 2016, only 18/7 percent of labour force attained a Bachelor's or higher university degree. This precisely implies that any co-movement between wages and skills does not sustain in the long run, and hence will undergo a decay in level.

Figure IV illustrates changes in wages with regard to variation in skill level. This can be a direct implication of bias in the labour market, according to which an increase in the number of university educated is not indicator of higher wages.

[10] Human Capital

3. Establishing a theoretical framework for Iranian labour market

To investigate co-movements of wage and human capital, we need to specify co-integration based on the VECM model. Blis and Klenow (2000) and Herrendorf and Schoellman (2018) assumed that the logarithm of average years of schooling is an indicator skill affecting the logarithm of wage that is changed in this paper to number of university level education of labour force as in Equation (1);

$$\text{Log (wage)} = \alpha \text{Log}[\![(\text{number of labour force with university level education(skill)})]\!] + \varepsilon \quad (1)$$

When an economy is at an equilibrium, there is balance between the demand and supply. The pace of technological advancements and complex production procedures requires us to consider precise variables as the proxy for human capital. According to Per Holmstrom (2017), the number of workers with university education is reflective of productive labour supplied by a specific worker who is compensated through wages; therefore, the number of labour force with university level education is a good proxy for skill. Herrendorf and Schoellman (2018) use this relationship to study the effect of schooling, by eliminating the error term from the right-hand side of the equation, and thereby ignoring the influence of shocks on wages. Another important issue in recent years is that there has been a significant surge in the participation rate of the educated workforce, but the rate at which these academically-skilled workers join firms appears insignificant. The problem of low sill workers in Iran is more intensified in the public sector by the dominance of government firms where workers are employed for more than 30 years without any skill improvement mechanisms.

As shown in Figure VII, a hike in the number of educated workers leads to the creation of a proportional gap. Assuming that all points on the long-run line follow, it can be proved that the relationship is like linear relationship ($H^* = \beta(\text{Wage})$). This means that there is long-run steady state phase and any diversion from this state will generate a gap and the dynamics of this co-movement requires it to be placed at a point on the line. Jones (2014) investigated the long-run path for developing and developed nations and found that, in developing countries, the generalized human capital stock and income ratios follow a steep line pattern. Similar results with the co-moving equation approach is approved in the current study. These findings follow those of Jones (2014) for developed Organisation for Economic Co-operation and Development (OECD) countries, that is, they show the same stable steep linear relationship. The high slope of this linear pattern in the cases of the OECD and developing countries confirms the current study's primary claim about the existing skill bias. This bias emerges as a result of the low share of an increasing number of university graduates in firms, which lowers their participation in wage bargaining, and, in turn, leads to the involvement of low-skilled labour in the production process and lowers productivity.

In bellow equation, α_h (error correction coefficient) should be below zero for the procedure to not diverge, and thus the positive shock of an initial increase in the number of educated workers would not last more than 3 periods (that is also approved by the structural impulse-responses) and the number of workers attaining a university degree will converge at initial wage levels.

$$H_t = \alpha_h(H_{t-1} - H^*_{t-1})\Delta \quad (2)$$

In the second method, the adjustment is achieved through wages. Suppose H_t is fixed and and wages are indirectly adjusted to their ratio and we reach the H_t^* point;

$$W_t = \alpha_w(H_{t-1} - H_{t-1}^*)\Delta \quad (3)$$

As is shown in Figure VIII, after divergence from the linear path, wages move from W_1 to W_2. Therefore, there is a movement from the subsequent increase in the number of educated workers in the workplace (H_t) to the potential long-run value of the number of educated workers (H^*). The key intuition of the above graphs is that despite the existence of a new shock and heightened number of educated workers, the ratio of wages to the number of educated workers would remain the same for various levels of wages, and thus human capital would not make an impact on wages, and consequently educated workers will not have any influence over the determination of employees' wages which can be referred as skill bias.

In the third method, the error correction is achieved when the adjustment in Eq. IV is done through skill and wages;

$$H_t = \alpha_h(H_{t-1} - H_{t-1}^*) \quad \alpha_h<0\Delta$$

$$W_t = \alpha_w(H_{t-1} - H_{t-1}^*) \quad \alpha_w>0\ \Delta \quad (4)$$

The magnitude of coefficients explains the pace at which wage and human capital will adjust in the long run (Fig. 9).

Considering the innate skills of workers, Herrendorf and Schoellman (2018), Cervellati and Sunde (2005), and Hassler and Rodrı´guez-Mora (2000) reveal that workers are endowed with one unit of unskilled labour that requires no education and can be supplied immediately to the market. Alternatively, individuals may become skilled through the acquisition of human capital, which is characterized by a high amount of abstract knowledge that facilitates innovation and the development of new ideas. (Fig. X). Subsequently, VECM and above dynamic co-movement is estimated by running the co-integration equations. The coefficient of NAIRU is -2978279, implying that an increase in unemployment by one unit will result in a fall in general wage levels to IRR 2,978,279, as also revealed through the empirical data of private firms. The Mincer coefficient for Iran is estimated to be 2.076 percent, that is, short run and means one percent increase in skill will at last increase wage 2.076 percent which later by specification of wage structural

model according to economic theory intuition and Impulse-Responses will be shown not to be persistent for more than two to three periods and in longer periods, effects decay and impact of human capital will be negative Figure (10), Figure (11). As shown in figure X, the real-world human capital and wage relationship starts at around zero and at low levels of wage.

4. General Structural model of wage

Assuming human capital to be the production agent, recruitment decision of firms will be based on the expectation function of these agents. For better analysis, assume that production is labour intensive, and therefore, in wage model, we can consider complete substitution of both human and physical capitals as follows:

$$\text{Log(wage)} = \alpha\log(\text{Equilibrium Job Demand}) + \beta\iint \left(\frac{\text{Physical Capital}}{\alpha}\right)\left(\frac{\text{Human Capital}}{\beta}\right)\text{dpdh} + \Omega_t \quad (7)$$

As human capital tends to accumulate over time, we used the double integration index at capital part of our formula. In the above equation, *dpdh* is the first difference of physical and human capitals, and to remove the cost effects of job search and to achieve homogeneity in job demand, inflation computed according to the Phillips Curve is excluded from expectations that determine labour decisions regarding the job search method.(8)

$$\log(\text{Equilibrium Job demand}) = \text{Log}\left(^{Gross\ Job\ Demand}/_{net\ inflation}\right) \quad (8)$$

such that,

$$\text{Equilibrium Job demand} = (\text{Equilibrium Job demand Rate})(\text{LP});$$

$$\text{Gross Job Demand} = (\text{LP})(\text{Unemployment Rate})$$

Substituting equation (8) by its components gives:

$$\log\left(^{(\text{LP})(\text{Unemployment Rate})}/_{\text{net inflation}}\right)\ \log((\text{Equilibrium Job demand Rate})(\text{LP})) \quad (9)$$

Eliminating LP factor from both sides will give the form $\log\left(^{(\text{Unemployment Rate})}/_{net\ inflation}\right)$ in right-hand side.

This will give the unemployment rate filtered by the effects of inflation in the right-hand side; it is also known as NAIRU or the equilibrium job demand rate.

The total capital in the production process by a firm in the second part of Eq. 7, based on the assumption of the Leontief type production process, can be substituted by human capital, because technology growth requires workers of a higher quality. The wage deterministic equation with regard to the equilibrium unemployment will eventually take the following form:

$$\text{Log(wage)} = \alpha\log(\text{Equilibrium Job Demand}) + \beta\log(\int_{t=12}^{t=18} \text{Human Capital})dH + \Omega_t \quad (10)$$

where t is the number of years of university attendance (between 12 and 18 years) of a sample worker; it takes 12 years to complete pre-college education in Iran., as the summation implies the accumulation of human capital, similar to Rodolfo and Ananth (2014), I assume that the accumulation of technology is the same during the schooling, will at last positively affect average wages.

5. Procedure for estimating the structural wage-human capital model for Iran

The SVAR is considered the most beneficial macro-econometric tool, proposed by Christopher Sims that I applied on aggregated microdata. To know the effects of skill on wages, we use the intuition that an increase in the workers' skills leads to better adjustment to job positions and puts them in higher place in negotiation with firms and thus get higher wages by matching procedure. In order to estimate the effects of variations of skilled labour on wages, I identify and isolate purely exogenous and independent movements or shocks to the variable of interest or wage and examine how the variable reacts to these movements; the reaction is reflected in the impulse-responses. To identify skill shocks, we need to identify the structural model. The structural model facilitates isolation of purely structural shocks and gets the responses of exogenous variables after the economy heats by these shocks. Getting the structural model means to determine the proper identification for our models. Sims (1986) stated that 'identification is the interpretation of historically observed variation in data in a way that allows the variation to be used to predict the consequences of an action not yet undertaken.' After the identification of structural shocks and the computation of responses of variables. Hence, the main challenge is to identify purely identified shocks. Suppose the structural model follows the following form;

$$AX_t = \beta_0 + \beta_1 X_{t-1} + u_t \quad (11)$$

In our model, the vector X_t depends on its own lag and structural shocks u_t. These structural shocks are independently distributed. Suppose that X has the following three variables: $X_t = \begin{bmatrix} W \\ NAIRU \\ Skill \end{bmatrix}$, where W denotes the Wage, NAIRU the equilibrium unemployment to suppress the inflationary movements in the model, and the number of

employees with graduate level studies is denoted by skill. In such variable specifications, the system will be expressed through the following three equations;

$$W_t + \alpha_{12}NAIRU_t + \alpha_{13}Skill_t = \beta_{10} + \beta_{11}W_{t-1} + \beta_{12}NAIRU_{t-1} + \beta_{13}Skill_{t-1} + u_{wt}$$
$$\alpha_{12}W_t + NAIRU_t + \alpha_{23}Skill_t = \beta_{20} + \beta_{21}W_{t-1} + \beta_{22}NAIRU_{t-1} + \beta_{23}Skill_{t-1} + u_{NAIRUt}$$
$$\alpha_{31}W_t + \alpha_{23}NAIRU_t + Skill_t = \beta_{30} + \beta_{31}W_{t-1} + \beta_{23}NAIRU_{t-1} + \beta_{33}\,Skill_{t-1} + u_{Skillt} \quad (12)$$

This system can also be expressed in matrix form as follows:

$$\begin{bmatrix} 1 & \alpha12 & \alpha13 \\ \alpha21 & 1 & \alpha23 \\ \alpha31 & \alpha32 & 1 \end{bmatrix} \begin{bmatrix} Wt \\ NAIRUt \\ Skillt \end{bmatrix} = \begin{bmatrix} \beta10 \\ \beta20 \\ \beta30 \end{bmatrix} + \begin{bmatrix} \beta11 & \beta12 & \beta13 \\ \beta21 & \beta22 & \beta23 \\ \beta31 & \beta32 & \beta33 \end{bmatrix} \begin{bmatrix} Wt-1 \\ NAIRUt-1 \\ Skillt-1 \end{bmatrix} + \begin{bmatrix} uwt \\ uNAIRUt \\ uSkillt \end{bmatrix} \quad (13)$$

The diagonal matrix A plays a crucial role in the identification process. This matrix reflects contemporaneous relationships between the three endogenous variables, which is reflected in the SVAR specification. Coefficients α_{12}, α_{13}, α_{21}, α_{23}, α_{31}, and α_{23} represent contemporaneous relationships between wage, NAIRU, and Skill are nonzero elements of matrix A. It is also important that when we have a vector of autoregressive model with a matrix that is different from the identity in front of X_t, which includes several variables at time t and simultaneous relationships, is in fact the determinant of structural model of wage dynamics. If we pre-multiply this VAR specification by the inverse of matrix A(A^{-1}), then we will get the reduced form VAR;

$$A^{-1}AX_t = A^{-1}\beta_0 + A^{-1}\beta_1X_{t-1} + A^{-1}u_t$$

G_0 ← $A^{-1}\beta_0$ → G_1

$$X_t = G_0 + G_1\,X_{t-1} + \varepsilon_t \qquad A^{-1}A = I \quad (14)$$

where vector X depends on its own lag and forecast error ε. Multiplication of this matrix by its inverse gives us the identity matrix. Additionally, the matrix A is also related to the structural shocks and the forecast error as $\varepsilon_t = A^{-1}u_t$. These errors are linear combinations of structural shocks u (if $\varepsilon_t = A^{-1}u_t$), as shown below;

$$\varepsilon_{wt} = (u_{wt} - \alpha_{12}u_{NAIRUt} - \alpha_{13}u_{Skillt})/(1 - \alpha_{13}\alpha_{31})$$
$$\varepsilon_{NAIRUt} = (-\alpha_{21}uwt - \alpha_{23}uskillt + u_{NAIRUt})/(1 - \alpha_{13}\alpha_{31})$$
$$\varepsilon_{skillt} = (-\alpha_{31}uwt - \alpha_{32}u_{NAIRUt} + u_{Skillt})/(1 - \alpha_{13}\alpha_{31}) \quad (15)$$

To further clarify, it can be pointed out that the outcome of unexpected skill growth cannot be predicted. Precisely, several factors or structural shocks may have a combined effect on wages. The SVAR cannot be directly estimated because it is a theoretical construct. Sims intuition is that it is the un-interpretation of historical data due to the

availability of time series at hand or the history on the past evolution of variables. When using the variables to estimate the VAR, we regress each variable on its previous value and the previous values of other variables included in the VAR calculation; thus, in our

specification, $X_t = G_o + G_1X_{t-1} + \varepsilon_t$, we get the coefficient G and the forecast error for the reduced-form residuals. Additionally, by identifying matrix A, we can determine the effects of shocks.

1. Identification, IR analysis, and variance decomposition

In order to ensure our model is identified and obtain matrix A, we assume our model has the form $X_t = G_o + G_1X_{t-1} + \varepsilon_t$, or the following form when expanded,

$$\begin{bmatrix} wt \\ NAIRUt \\ skillt \end{bmatrix} = \begin{bmatrix} g10 \\ g20 \\ g30 \end{bmatrix} + \begin{bmatrix} g11 & g12 & g13 \\ g21 & g22 & g23 \\ g31 & g32 & g33 \end{bmatrix} \begin{bmatrix} wt-1 \\ NAIRUt-1 \\ skillt-1 \end{bmatrix} + \begin{bmatrix} ewt \\ eNAIRUt \\ eskillt \end{bmatrix}$$

$$w_t = g_{10} + g_{11}w_{t-1} + g_{12}NAIRU_{t-1} + g_{13}skill_{t-1} + e_{wt}$$

$$NAIRU_t = g_{20} + g_{21}w_{t-1} + g_{22}NAIRU_{t-1} + g_{23}skill_{t-1} + e_{NAIRUt}$$

$$skill_t = g_{30} + g_{31}w_{t-1} + g_{32}NAIRU_{t-1} + g_{33}skill_{t-1} + e_{Skillt} \quad (16)$$

With the estimation of the above system, we obtain 12 coefficients (g), and 3 coefficients are obtained by the 3-variance-covariance matrix of the residuals. We totally have 18 parameters in our structural wage model for estimation, including, 12 coefficients, 3 variances, and 3 co-variances. Additionally, according to equation (2), we have 21 unknowns, including the 3 variances of the model. It is assumed that the structural shocks are totally independent and will lead our covariance to be zero. The problem is that we have more number of unknowns than equations in our study. Additionally, since all the information in this study consists of 18 parameters that can be estimated with the reduced form VAR, it was essential to impose three restrictions on the structural parameters to estimate the model, based on economic intuition. Additionally, these theoretical characterizations were set on matrix A, which included restrictions on the contemporaneous relationships between endogenous variables of the structural wage model, and these binding of the inter-relations will be resulted in identification of our model. In the system Eq. 1, we impose $\alpha_{12} = 0$, $\alpha_{21} = 0$ and $\alpha_{32} = 0$, which reflect that as stable character of NAIRU desire and therefore wage is not affected by shocks to equilibrium unemployment and NAIRU also is neutral of shocks to wages and surprises to NAIRU will not affect number of educated in firms ant shocks to NAIRU will only affect wage and skill with a lag but shocks to skill will change Equilibrium. By restricting our model, we achieve equality between the number of unknown parameters in the structural model and the number of equations estimated via the VAR and our model will estimate 18 parameters with set of equations provided in the appendix.

The impulse-response analysis consists of tracing the effects of structural shocks to labour skills on endogenous variables of our wage system at impact t, t-1, and so on. Building on the responses of endogenous variables to structural shocks through skill required an identification of the wage system with regard to known structural parameters; this identification required transforming the structural autoregressive wage vector of the

form $AX_t = \beta_o + \beta_1 X_{t-1} + u_t$ into a sum of shocks or Wold representation; $X_t = \mu + \Sigma_{t=o} C_i u_{t-i}$.

The knowledge of forecast errors is important in identifying the variance between the system variables, which gives the proportion of movements of a variable due to shocks to itself and to other variables. In the recursive ordering of w, NAIRU, and skill, all the one-period variance of the forecast-error in wages can be attributed to u_{wt}, with an explanatory share of shocks in the longer horizon. These shocks will diminish primarily because wage is placed first in the ordering and shocks to NAIRU do not affect wages contemporaneously, and, with diminishing shock effects, the variance of the forecast error will increase with an increase in the horizon.

Following Blanchard and Perotti (2002) and Bernanke and Milov (1998), I impose minimal restrictions to facilitate the identification of the model by estimating the parameters of the structural model by semi-recursive variables with general model of errors and shocks in the dynamic wage SVAR by $Ae_t = Bu_t$. The specifications of these equations can have both errors and shocks in the right-hand side. To obtain system responses to shocks, I solved the equation in relation to e_t and got $e_t = A^{-1}Bu_t$ or $e_t = Fu_t$, thereby estimating A and B in order of computing $F = A^{-1}B$. On the right-hand side, the shocks to wages, NAIRU, and skills illustrate the change in the left-hand side matrix A consisted of the error term of the original equation system. Sims (1992) applied the recursive identification approach, while another important macro econometric study on SVAR performed by Blanchard and Perotti (2002) engaged a non-recursive method.

To estimate the SVAR, restrictions are imposed to errors in Eq.15 to allow both surprises hit on influence wage model through e_t and structural shocks influence the model by parameter u_t via the variance-covariance matrix. Demographic studies on microdata collected from sampled individuals both in urban and rural areas confirm that a one-percent increase in the long-run equilibrium unemployment is simultaneous to wages falling by about 10 percent. This intuition was applied in the wage model error specification by assigning a value of 10 to the coefficient of eNAIRU in ewageeNAIRU ($\alpha 11$). Additionally, the impact of wages considering labour supply is direct and as pioneered by N. Gregory Mankiw et al. (1992); the neoclassical model is augmented by adding human capital. Besides, the neoclassical theory implies that the opposite coefficient (eNAIRUewage ($\alpha 32$)) also has a value of 10, indicating a symmetric wage and unemployment relationship. Moreover, a one-to-one impact of structural shocks on wage and NAIRU was assumed, implying that their coefficients were equal to one.

Results show that human capital shocks in the short run leads to an increase in wages, which is according to the impulse-response function for about 2 to 3 by coefficient equal to 2.07 significant at five percent meaning that one percent increase in number of workers with university degree by its short-run surprise is concurrent of wages moving 2.07 percent lasting for about 3 periods. On the other hand, in the long run, if the structural shock of human capital affects wages, the wages will dwindle by -2.217 percent, which will be significant at a 5 percent level. These results prove my initial assumption

that educated workers play a minimum role in wage bargaining when compared to other workers with different qualities, implying that a rise or fall in wages does not happen as a result of firms' stock of human capital. This phenomenon leads a smooth curve in figure (X), by increasing the general levels of wages in horizontal axis. Structural shocks of NAIRU to human capital is positive with a small coefficient of 0.004; it implies that being unemployed will drive skilled workers to increase their job-search efforts. These workers search for jobs using complicated methods like costly registration in private job campaigns, which, according to statistics, increased significantly among the educated in recent years. Despite an increase in the share of university-educated workers, their share in firms increased by about 0.004 percent by 1 percentage point of more search. Moreover, an increase in the number of PhD students in recent years is another adjustment that is considered in the study to show the extent to which these students can contribute toward increasing the share of university-educated workers in firms. This is revealed through the increase in the unemployment rate in the past 25-30 years, which is the period within which a PhD student is expected to attain a PhD degree.

The short-term effects of human capital shocks can be proven further by estimating the response of wage to skill shocks, as in figures (XII) and (XIII). According to the IR figure, the response of wage to human capital shocks as the intercept of IR shows and discusses above for the short run starts at a point 2 percent; it means that a one-unit shock of human capital will increase the wages by about 2 percent. This positive feedback will increase to about 5 percent in the second- and third period, and will start to decline after that point, becoming smaller than zero after seven periods, and thereby supporting our result that an increase in human capital in firms in the long run will cause wages to drop. This implies a low bargaining power in wage bargaining and smoother long-run human capital-wage relationships.

2. Results and discussion

In this study, the missing link in the existing literature on wage and human capital models has been investigated. In other words, although there is an increase in human capital owing to a recent expansion in university education, the low rate of educated workers' employment in firms and their role in wage bargaining reduce their influence in wage determination. This problem is reflective of the bias of the highly educated workers which in this study is defined as skill bias. Estimation of the co-moving equation by VECM gave a coefficient of 2.06 for skill which was also proved through the SVAR estimation. After configuration a model of wage for Iranian economy, subsequently it has been solved using the SVAR approach. The results reflect that skilled workers play a significant role in wage determination only for two to three periods, and, in the longer horizons comprising about seven periods, the educated population has no influence on wages. The results imply that human capital causes negative externalities both for the macro-economy and individuals, which minimizes the significance of education. This

phenomenon is referred as skill bias, where education, which is intended to facilitate labour market wage negotiations, lose its effectiveness and become neutral, as illustrated for the case of Iran.

Reference list

Barro, Robert J., and Jong-Wha Lee, "International Data on Educational Attainment: Updates and Implications." Oxford Economic Papers 53(3)(2001): 541–63.

Card, David, "Estimating the Return to Schooling: Progress on Some Persistent Econometric Problems." Econometrica 69(5)(2001): 1127–60.

Ciccone, Antonio, and Giovanni Peri, "Long-Run Substitutability Between More and Less Educated Workers: Evidence from U.S. States, 1950–1990." Review of Economics and Statistics 87 (4)(2005): 652–63.

Hall, Robert E., and Charles I. Jones, "Why Do Some Countries Produce So Much More Output Per Worker Than Others?" Quarterly Journal of Economics 114(1)(1999): 83–116.

Hendricks, Lutz, "How Important Is Human Capital for Development? Evidence from Immigrant Earnings." American Economic Review 92 (1)(2002): 198–219.

Jones, Benjamin F, "The Human Capital Stock: A Generalized Approach: Dataset."(2014): American Economic Review. http://dx.doi.org/10.1257/aer.104.11.3752.

Klenow, Peter J., and Andrés Rodríguez-Clare, "The Neoclassical Revival in Growth Economics: Has It Gone Too Far?" In NBER Macroeconomics Annual, Vol. 12(1997), edited by Ben S. Bernanke and Julio Rotemberg, 73–103. Cambridge, MA: MIT Press.

Mankiw, N. Gregory, David Romer, and David N. Weil, "A Contribution to the Empirics of Economic Growth." Quarterly Journal of Economics 107 (2)(1992): 407–37.

Barro, Robert J., and Jong-Wha Lee, "A New Data Set of Educational Attainment in the World, 1950–2010."(2010): National Bureau of Economic Research Working Paper 15902.

Becker, Gary S, "Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education." Chicago(1964): University of Chicago Press.

Ben-Porath, Yoram, "The Production of Human Capital and the Life Cycle of Earnings."

Journal of Political Economy 75(4)(1967): 352–65.

Heckman, James J., Lance J. Lochner, and Petra E. Todd, "Earnings Functions and Rates of Return." Journal of Human Capital 2 (1)(2008): 1–31.

Manuelli, Rodolfo E., and Ananth Seshadri, "Human Capital and the Wealth of Nations: Dataset." American Economic Review.(2014). http://dx.doi.org/10.1257/aer.104.9.2736.

Bagger, Jesper, François Fontaine, Fabien Postel-Vinay, and Jean-Marc Robin, "Tenure, Experience, Human Capital, and Wages: A Tractable Equilibrium Search Model of Wage Dynamics: Dataset."(2014). http://dx.doi.org/10.1257/aer.104.6.1551.

Barlevy, Gadi, "Identification of Search Models Using Record Statistics." Review of Economic Studies 75(1)(2008): 29–64.

Cahuc, Pierre, Fabien Postel-Vinay, and Jean-Marc Robin, "Wage Bargaining with On-the-Job Search: Theory and Evidence." Econometrica 74(2)(2006): 323–64.

Postel-Vinay, Fabien, and Hélène Turon, "On-the-Job Search, Productivity Shocks, and the Individual Earnings Process." International Economic Review 51 (3)(2010): 599–629.

Robin, Jean-Marc, "On the Dynamics of Unemployment and Wage Distributions." Econometrica 79 (5)(2011): 1327–55.

Holmstrom, Bengt, "Pay for Performance and Beyond." American Economic Review 107(7)(2017): 1753–1777.

Hansen, G. D.. "The Cyclical and Secular Behaviour of the Labour Input: Comparing Efficiency Units and Hours Worked." Journal of Applied Econometrics 8 (1)(1993): 71–80.

Heckman, James J., Lance J. Lochner, and Petra E. Todd "Earnings Functions, Rates of Return and Treatment Effects: The Mincer Equation and Beyond." In Handbook of the Economics of Education, edited by Eric A. Hanushek and Finis Welch, (2006): 307–458. Amsterdam: Elsevier, North Holland.

Huggett, Mark, Gustavo Ventura, and Amir Yaron, "Human Capital and Earnings Distribution Dynamics." Journal of Monetary Economics 53 (2)(2006): 265–90.

Figures:

Figure 1.
Unemployment in equilibrium rate removing inflationary pressures

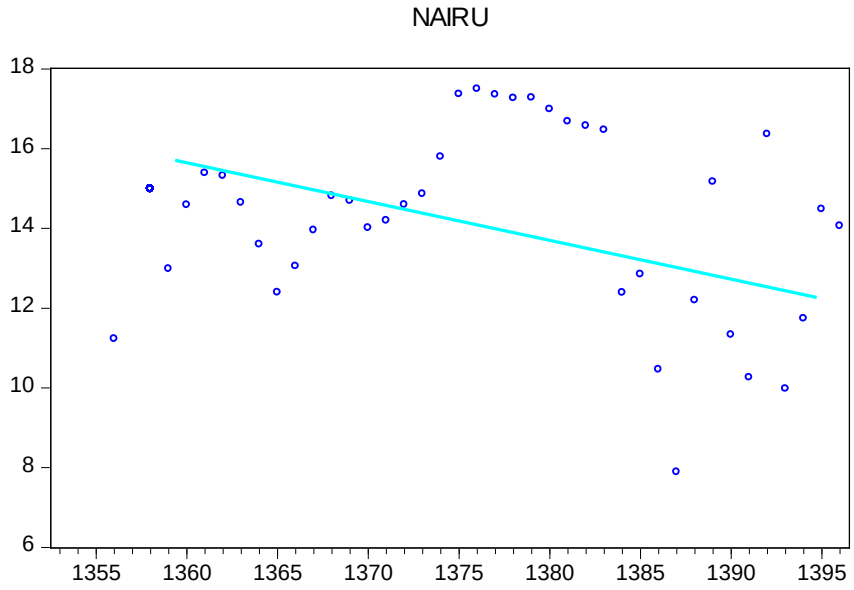


Figure 2.
Average yearly wage of all agents in economy according to Microdata of National Census

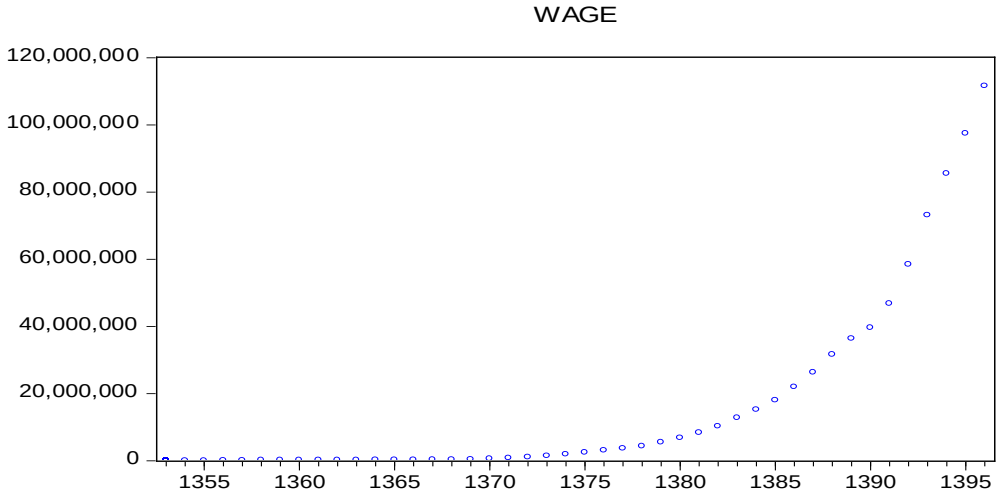


Figure 3.

Number of Skilled[11] workers for whole nation according to Microdata of sample firms on Census data

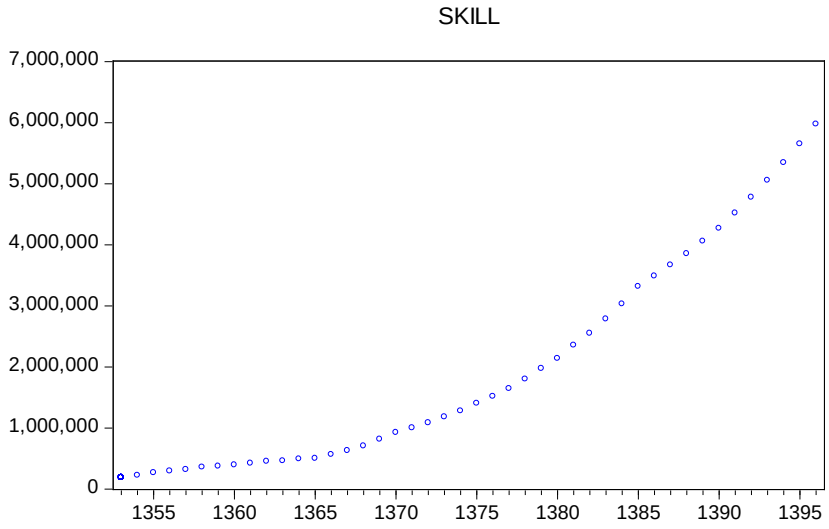
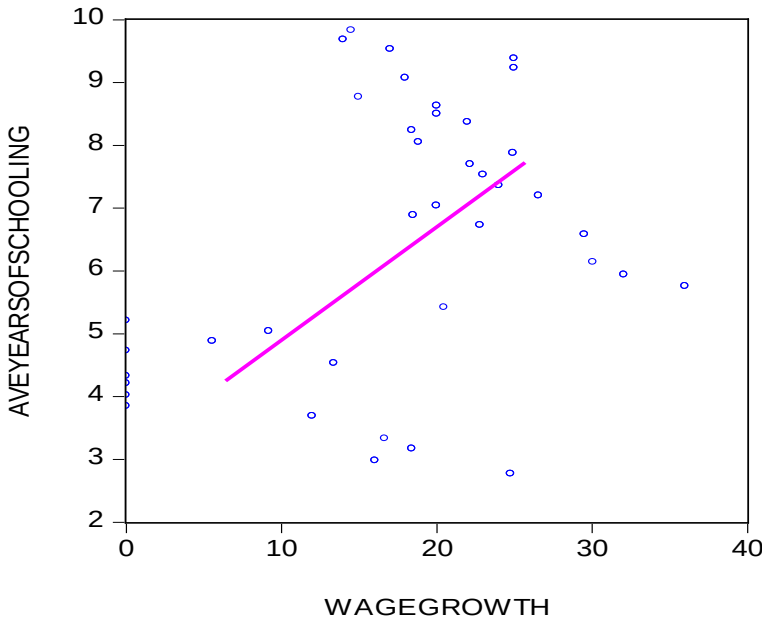


Figure 4.

Scatter of wage variations and long-run changes in number of workers with school education attainments



[11] By definition I supposed University Education is a proxy for skilled worker.

Figure 5.
Distance between skilled labor force growth and minimum compensation growth

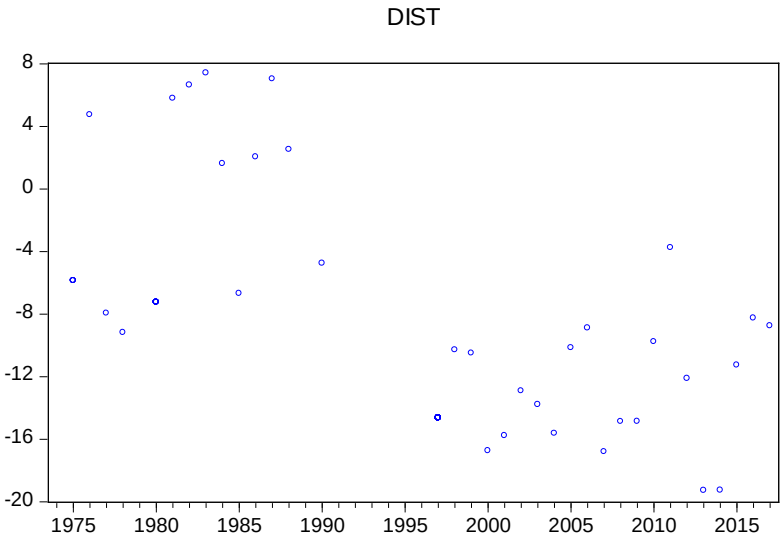


Figure 6.
Long-Run relationship of human capital, wage and NAIRU by suppression of inflationary pressures in co-movements

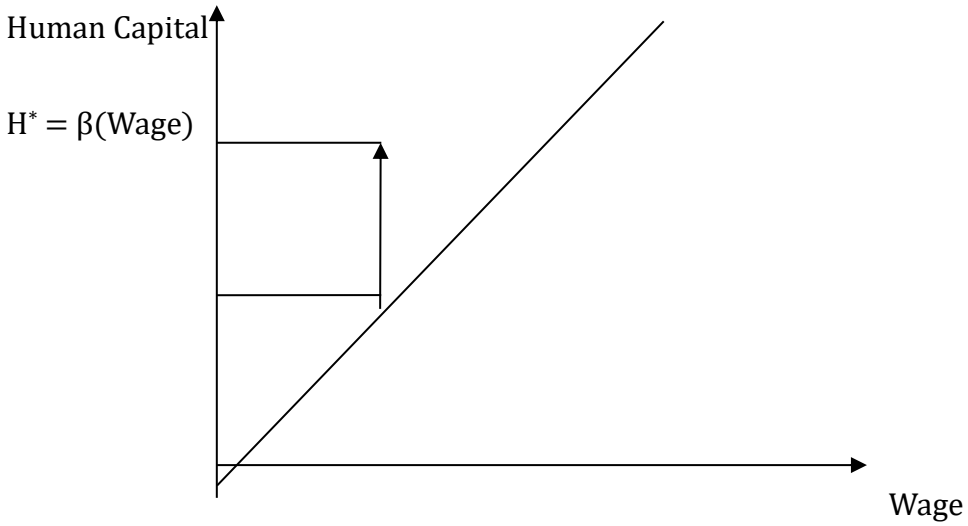


Figure 7.
Convergence by involvement of Human capital, wage and stabilizing long-run unemployment rate (NAIRU)

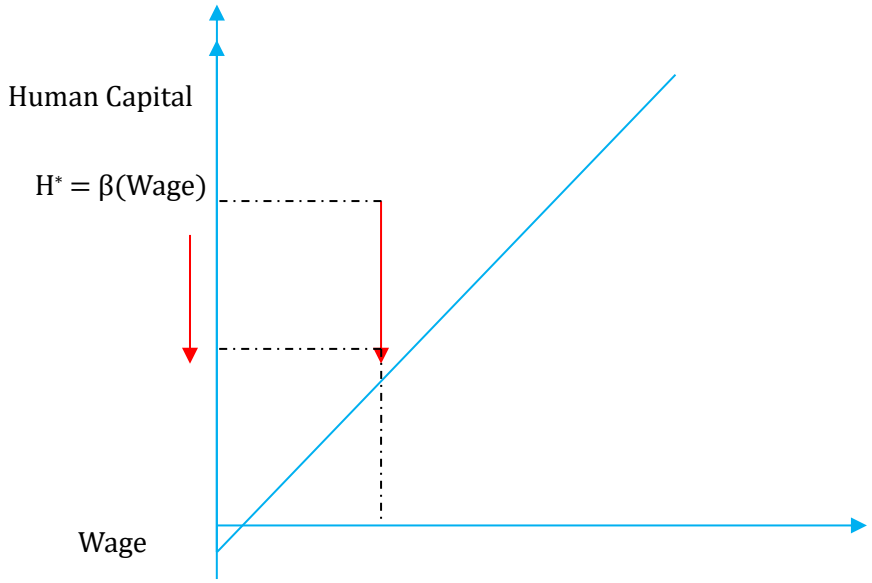


Figure 8.
Convergence through wages to long-run skill/wage potential levels

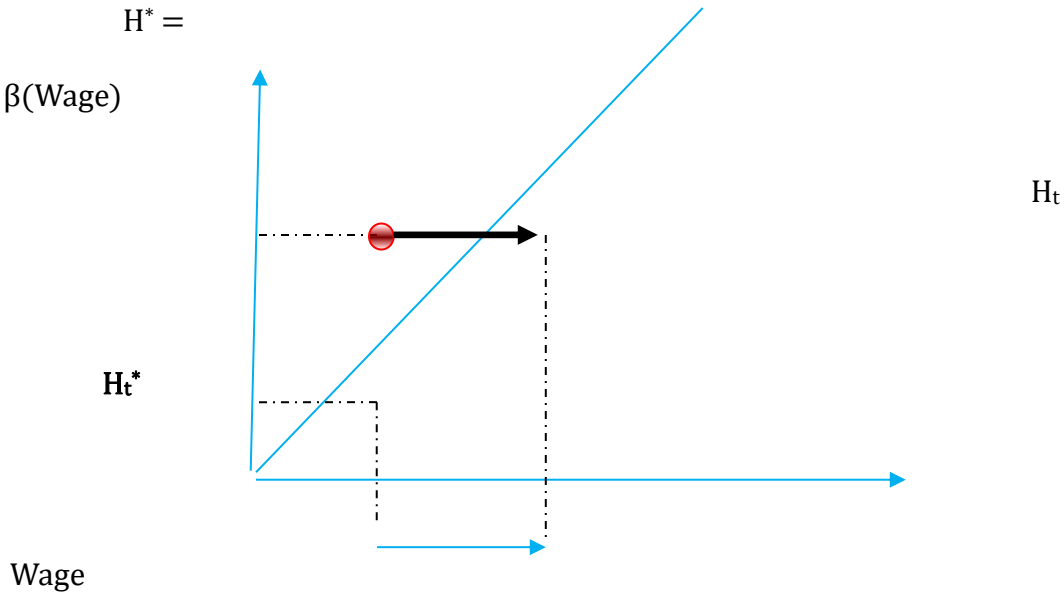


Figure 9.
Convergence achieved through both Human Capital wages to long-run skill/wage potential levels

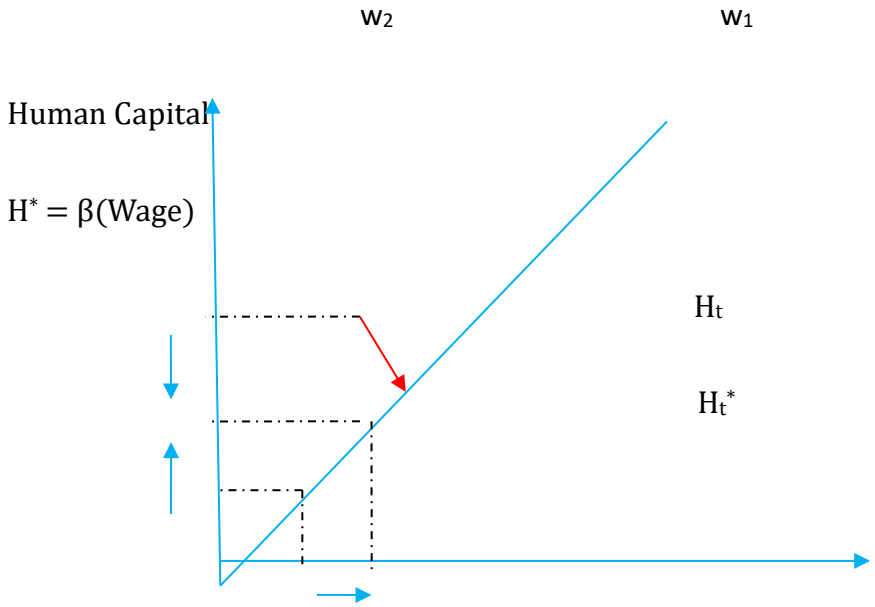


Figure 10.
Dynamic long-run relationship with search probability

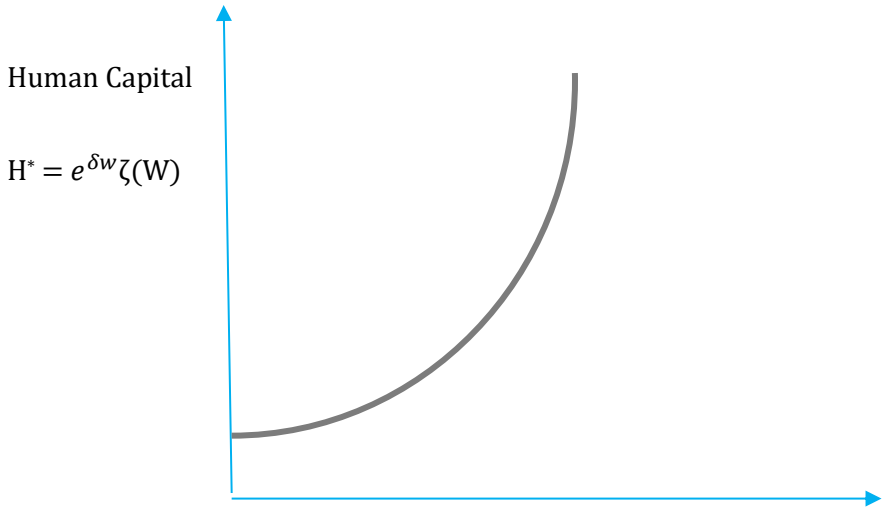


Figure 11.
Skill bias in Iran economy

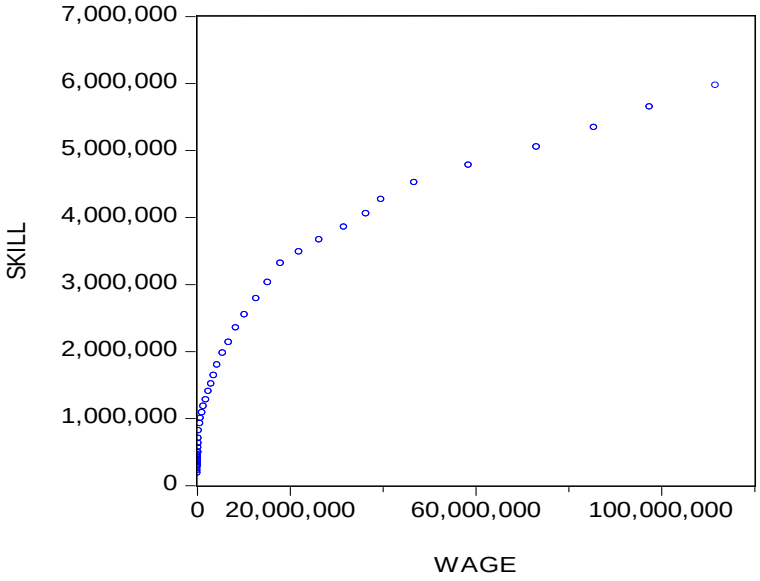


Figure 12.
Solving model with baseline scenario

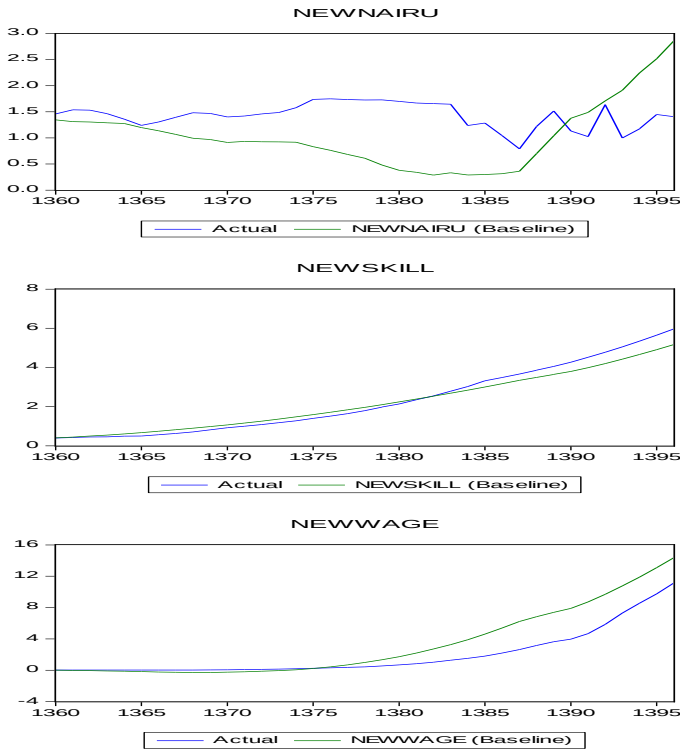


Figure 13.

Response of wage to one standard structural shock hit of three endogenous variables.

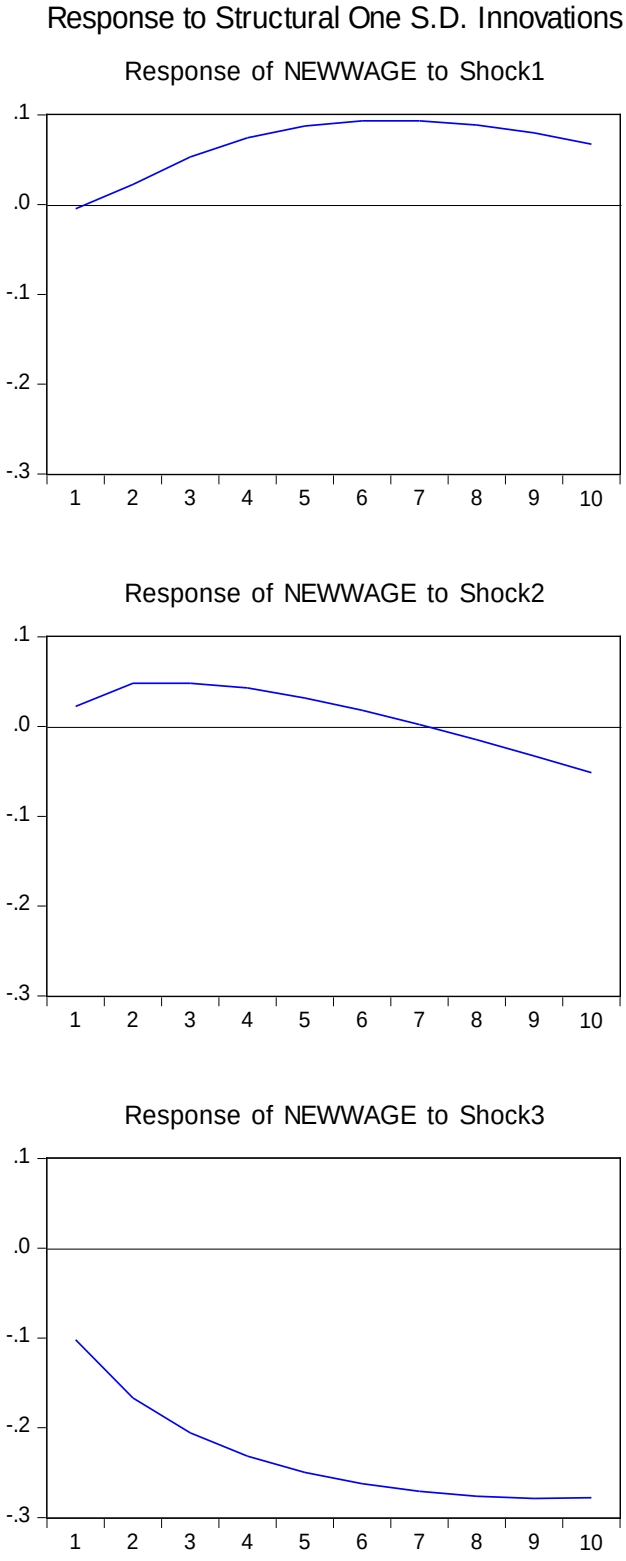


Figure 14.

Responses of three endogenous variables to one structural shock hit in wage model

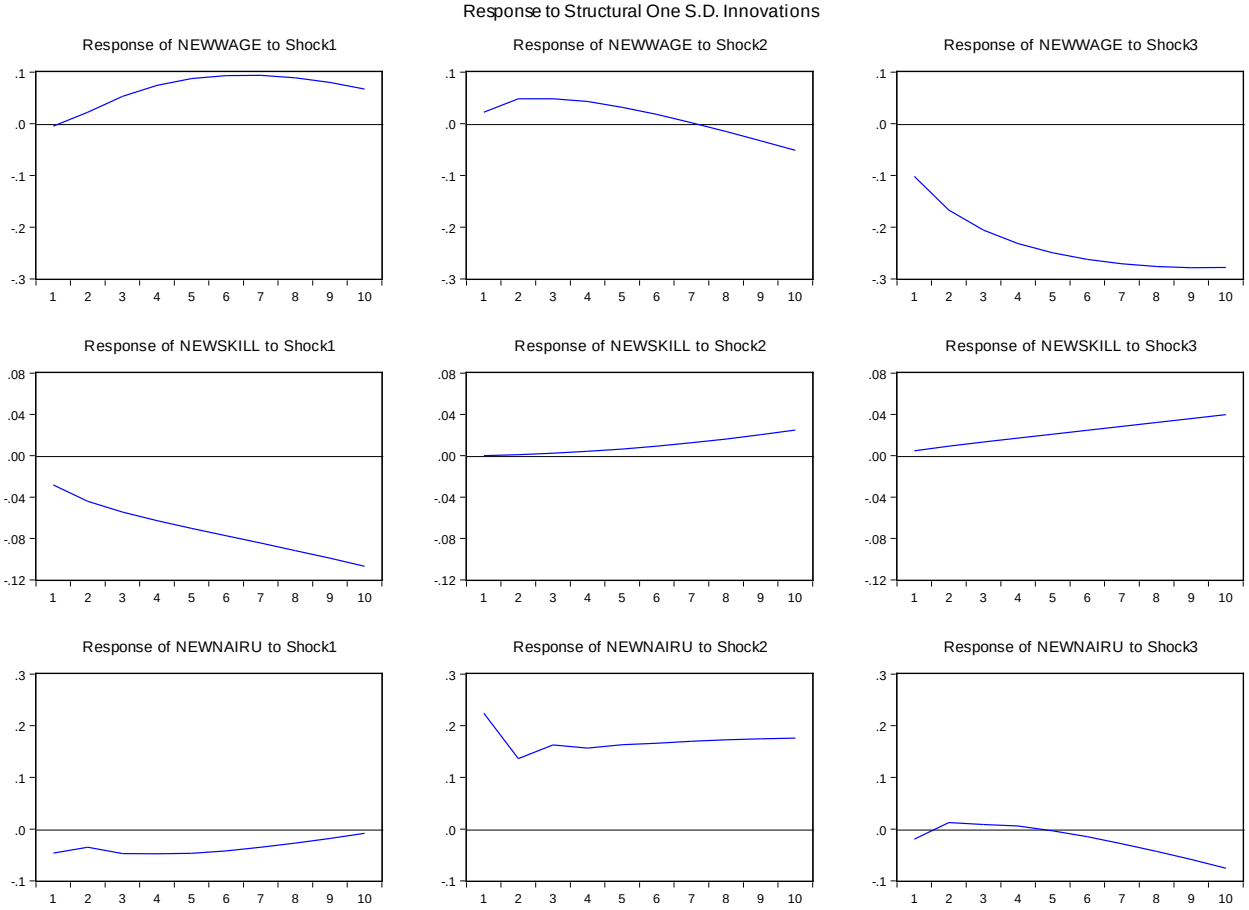


Figure 15.
Residuals of endogenous variables in SVAR model

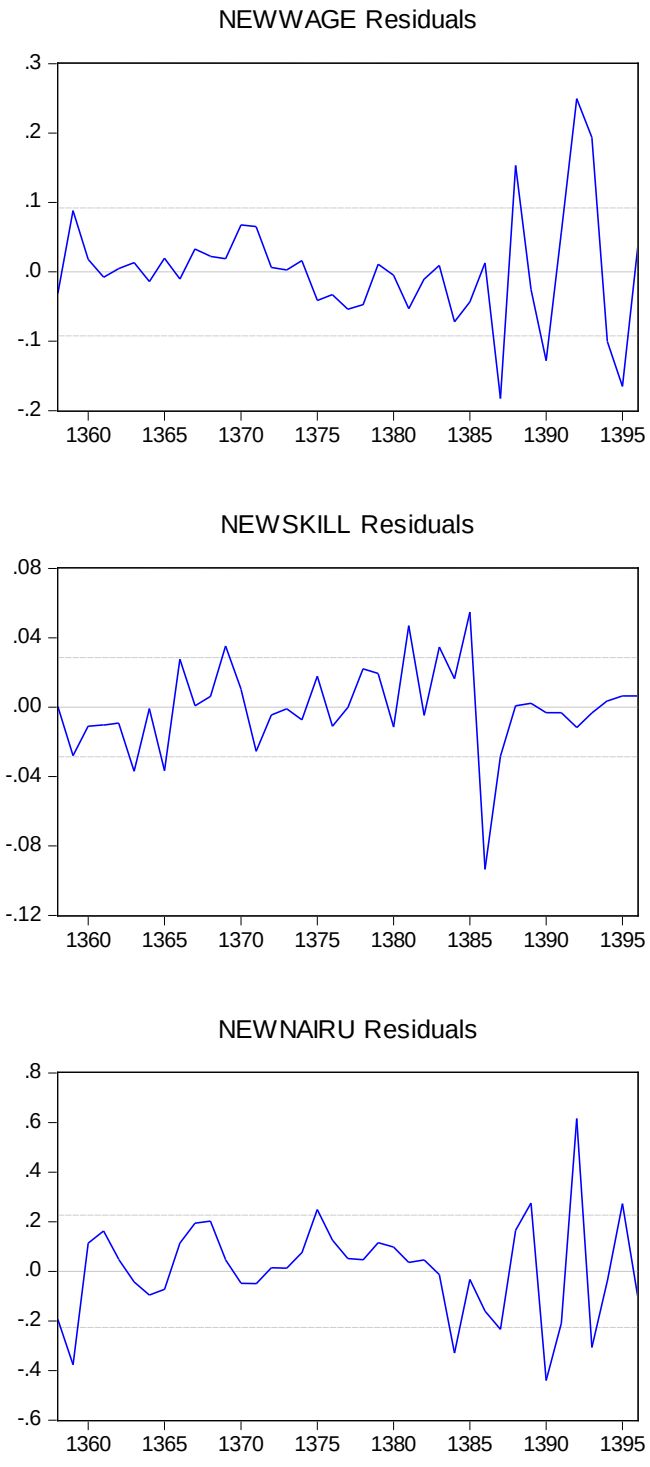


Table 1.

Results of estimation of VECM model and co-movement equations

		Dependent variable
		Wage
Exogenous variable	Skill	2.076
Independent variable	NAIRU	-2978279
R-squared	0.909	
F-statistic	114.25	

The Role of National Statistical Offices in Developing the Climate Change Statistics,A Case Study from the Statistical Centre of Iran

Seyyed Mahdi Sadati Nooshabadi,

m_sadati@sci.org.ir
Expert on International Affairs and Statistics,
Statistical Centre of Iran;

This paper is a case study on the role of the national statistical offices (NSO) in developing the climate change statistics. The NSOs are the best resources for statistics on the progress made within the countries in line with the international agreed-upon development agenda. One duty of the NSOs is to provide timely, relevant, and reliable statistics to public and international agencies to report on the progress made in every country within the national or international development programs. This research looks at the statistical information on the environment and climate change issues which the Statistical Centre of Iran as the focal point for official statistics in the I.R. Iran publishes annually.

There are two chapters in the Iran Statistical Yearbook which present the statistics on the climate and environment. Chapter one (land and climate) includes statistics on 'geographical characteristics and administrative divisions,' and 'climate.' Chapter 2 (environment) presents statistics collected from various resources on water, soil, and air. The only available data on climate change in this publication is about Sustainable Development Goal indicator 13.2.2: total greenhouse gas emissions per year, which shows statistics on emission of greenhouse gases such as the vapour of H2O, CO2, NO2, CH4, O3, HFCs, and PFCs. There are no statistics for other SDGs indicators related to climate change such as indicators 1.5.1, 1.5.2 and 1.5.4 for Goal one, indicator 2.4.1 for Goal 2, indicator 11.b.2 for Goal 11, indicators 13.1.1, 13.1.3, 13.3.1 for Goal 13. These data gaps show that climate change domain has been narrowed to the greenhouse gas emissions and statistics for other aspects of climate change aren't collected or available in a disaggregated way. The findings of this research show that various government agencies in Iran collect and publish the related statistics on the effects of climate change on the economic and ordinary lives of people but these statistics are not available in the Iran statistical Yearbook. This paper recommends that the NSOs in every country should take the responsibility of harmonizing and mobilizing the available statistical resources in their countries and make the needed arrangement among the stakeholders responsible for collecting and disaggregating data on the climate change indicators. It's suggested that every country should have a National Strategy for Development of Statistics. This strategy can be a road map determining the duties of concerned agencies responsible for

producing the statistics on the Sustainable Development Goals indicators. Moreover, this national strategy acts like a guideline for production and dissemination of official statistics needed by national and international users by full consideration of the Fundamental Principles of Official Statistics and using state-of-the-art technologies and modern methodologies, especially register-based methods.

Keywords: Climate Change, National Statistical Office, National Strategy for Development of Statistics, Sustainable Development Goals

1. Introduction

Climate change is a side effect of natural processes or external forces in the nature. The external forces include the generation of greenhouse gases mainly as a result of our production and consumption of goods. Over the period of 1951–2010, the warming of the atmosphere has been caused by human activities (IPCC, 2014). Climate change has shown its existence through significant phenomenon such as change in precipitation patterns, melting of glacial, increase in sea levels, and abundance and intensity of environmental disasters across the countries such as drought, flood and wildfire. The reason behind these changes can be attributed to increase in global temperature. The Intergovernmental Panel on Climate Change (IPCC) in 2001 reported that the world climate is changing and the global temperature is increasing (IPCC, 2001a).

The climate change is an issue of importance of which effects on human life and economic development should be a priority in every development plan. Knowing the impacts of the climate change on the social and economic lives of people requires precise, timely and up-to-date statistics which are the foundations upon them the policy-makers prepare the development strategy for the wellbeing of their people. The Statistical Commission of the United Nations in its 47th session (2016) decided to urge countries to develop and strengthen their environment statistics which are necessary for the effective monitoring of climate change. In this line, several goals, targets and indicators related for sustainable climate and environment were determined and the United Nations reports annually on the progress made in achieving these goals across countries.

In the past few years, various initiatives have been launched to try to curb climate change. Prominent among them are the 17 Sustainable Development Goals (SDGs) promoted by the United Nations since 2012. The title of one of these goals is Climate Action (Goal number 13).

The success of these initiatives is largely dependent on environmental literacy drives among populations who are often strangers to these major political agreements, and on the development of a culture of care for the climate. The environmental literacy is to educate citizens, especially children, and raise their awareness regarding the causes and consequences of climate change on their lives.

The National Statistical Offices (NSO) in every country are the best resources for statistics on the progress made within each country in line with the international agree-upon development agenda. One duty of each NSOs is to provide timely, relevant, and reliable statistics to public and international agencies for reporting on the progress made in their country within the national or international development programs. The NSOs constitute an essential element in improving the ability of the government to make informed decisions, develop appropriate policies, manage the economy and social development reform policies, monitor improvements in the living standards of the people and report back this progress to the public using solid evidence.

This paper looks into the available data on the effects of climate change in the economy of the I.R. Iran which the Statistical Centre of Iran (SCI) publishes annually in its Statistical Yearbook. In the following sections, the research on the climate change effects on different economic aspects of the I.R. Iran is presented. Then, the statistics related to the climate change and global warming collected by the SCI as the focal point for the official statistics in Iran are assessed. The results of this research show that the statistics on climate change and its effects are not properly reflected by the SCI and these statistics have low status in the Iran Statistical Yearbook. At the end, it's proposed that due to existence of various organizations collecting the related statistics on the touch of climate change in the economy of Iran and also the limited domain of the statistics related to the impacts of climate change and global warming in the Iran statistical Yearbook, we need to have a mechanism for extending cooperation among the statistical stakeholders to harmonize the statistics flow and facilitate the access to needed statistics. This mechanism is a National Strategy for Development of Statistics (NSDS) which the SCI is benefiting to improve the quality of official statistics on Iran. This NSDS is necessary for mobilizing and harmonizing the statistics flow and methodologies for official statistics and also improving the coverage of statistics to show the impacts of global matters such as climate change on the lives and economic activities of Iranian people.

2. Research on Effects of Climate Change in the I.R. Iran

Dell et al. (2008) studied the climate change and economic growth in the past half-century. Their finding was that the climate change has been the one of the driving forces behind the decrease in the economic growth in the poor countries but this factor has had no significant impact on the economic growth in the developed countries. According to them, the climate change has resulted in fall in crop products and industrial production in the less developed countries.

Several studies with various topics have investigated the impacts of global warming issues and the effects of climate change on different aspects of the economy of Iran. These

studies covered different topics such as the economic growth at provincial level (Panahi and Darjani 2020), national sustainable management (Abbaspour and Tabibiyan, 2006), sensitive coastal ecosystems (Vafadar and Abedini, 2018), tourism in the southern coasts of Caspian Sea (Roradeh et al., 2018), the sensitivity of bioclimatic areas of Iran (Shaemi, 2008), effect of the environmental pollutants in the trade balance of the economy at provincial level (Javadi Pashaki et al., 2020) and the emission of carbon by different economic sectors (Akhbari, 2004; Manzoor and Haghighi, 2012; Ghezelbash and Esfandiari,2011; Nasrollahi and Ahmadi, 2013; Sadeghi et al., 2014; among others) and other related fields.

Abbaspour and Tabibiyan (2006) studied the challenges facing the policy-makers in the I.R. Iran for national sustainable management. According to them (2006:5 – 7) the effects of drought in the provinces is one of the environmental and economic challenges which needs urgent and responsive reactions by the authorities.

Shaemi (2008) used the statistics of a normal thirty years of synoptic station (1965–1995) to assess the sensitivity of bioclimatic areas of Iran toward the global warming. He assessed the rate of sensitivity of Iran bioclimatic regions by using Holdridge life zone model and hypothetical scenario. He found that some geographical areas in Iran such as Alborz and Zagrous Mountains have experienced the most environmental changes due to global warming. Cold temperate regions have experienced the highest change. The steppe and forest ecosystems had much sensitivity in new condition (drier and warmer conditions) but desert types had little change in warmer and drier conditions.

Ebrahimi (2010) studied the relation between climate change and water consumption in the agriculture sector in Mashhad province, Iran. He (2010:117) found that the water consumption in the agriculture sector of Iran would dramatically increase due to the global warming and climate change originated in industrialization, and greenhouse gasses emission. He proposed that the authorities should consider the solutions based on water management to tackle this problem.

Koocheki and Kamali (2010) evaluated the impacts of climate change on the growth and yield of rainfed wheat at the country level in Iran. They generated the weather forecast by using the General Circulation model based on the ICP scenarios for the target years of 2025 and 2050. They (2010:515 – 517) concluded that the potential impact of climate change on rainfed wheat yield was more tangible in eastern regions of Iran compared to the western areas. The overall country level reduction of rainfed wheat yield was estimated to be in the range of 16 to 25% and 22 to 32% for the years 2025 and 2050, respectively

Khaleghi et al. (2015) assessed the impact of climate change on the agriculture sector, production of the other sectors and national production in the Iran's economy. They (2015:117) found that for the period of 2000–2025, due to global warming the agriculture production in Iran will decrease by -5.37 percent, manufacturing sector by –

2.27 percent and services sector by -1.64 percent. Their results also showed that decreases in the national production due to this shock would be -9.5 percent. Decrease in the production of the agriculture sector will affect households in low deciles of rural areas and high deciles of urban areas more than other income groups in Iran.

Azaram et al. (2017) studied the effect of increased energy carriers' price on damages cost of pollution emission in Fasa city, Shiraz province. They found that a 50 present increase in the price of gasoil and electricity has led to decrease in wheat production and pollutant damage cost per hectare.

Vafadar and Abedini (2018) concluded that increase in temperature has severe effects on the economic activities of people who live in coastal areas of Iran. Since the main activities of these people are agriculture, fishing, and manufacturing, any change in the biodiversity of the seas and seasonal rivers of Iran happened by the increase in the air and water pollutants will increase the risk of financial uncertainty for these people.

Roradeh et al. (2018) investigated the effects of global warming on the tourism economy of the southern coasts of the Caspian Sea. They measured the Tourism Climate Index (TCI) for three provinces in the south area of Caspian Sea. The results of their study indicated that there would be an increase in the TCI of these provinces in the future and the global warming can't have negative effects on the tourism industry for these provinces.

Alibakhshi et al. (2019) investigated the effects of climate change on the agricultural market of Iran. They (2019:80) found that climate change will probably increase farmers' income in hot, cold, and temperate sub-climate areas. Their results also showed that the climate change will have negative effect on the net exports of wheat, barley and maize for 2025 and the country will remain an importer of these agricultural products. They emphasized that a price protection policy should be adopted to increase the consumer purchase power.

Malakoutikhah and Farajzadeh (2020) studied the effect of climate change on the economic growth of Iran. They used the Solow-Swan growth model to investigate economic growth under climate-changing environment. The growth models were estimated using time-series data for 1971–2016. They (2020:233) found that the increase in temperature will negatively affect economic growth in Iran. According to them (2020:233) one-degree increase in average temperature is expected to reduce Iranian GDP by 5–6. 6 percent.

Javadi Pashaki et al. (2020) calculated the pollution resulted from 33 economic activities in Sistan & Baluchestan province, Iran in the form of input-output table and the ecological footprint of pollutants in the trade balance of this province with the outside world. They found that 372,617 tons of virtual gases have been exported to the outside world and 514,669 tons of virtual gases have been imported to this province.

Panahi and Darjani (2020:79) concluded that the increase in temperature has led to fall in the economic growth experienced in the provinces of Iran.

Faryadi and Alavi (2021) conducted research on proposing an appropriate participatory policy for mitigation of the global warming effects in the Tehran Province, the capital of Iran. They used the LARS-WG software to model the climate data for the future of this city. According to their modeling, the average temperature in this city will probably increase for the period of 2046–2065 and this city will experience decline in precipitation. In this regard, they proposed that people should be involved in the process of policy making for adopting necessary provisions for curtailing the emission of greenhouse gases. According to them people play a key role in realization and achieving of low carbon policies.

3. Iran Statistical Yearbook and Statistics on Climate Change

In the beginning of the twenty-first century, the world leaders emphasized the environmental protection as part of the Millennium Development Goals (MDGs) and one of the three principles of sustainable development (environmental sustainability, economic sustainability, and social sustainability) due to its increasing importance and impacts on other socio-economic activities. In this regard, the SCI considered a separate chapter on 'Environment Statistics' in the Iran Statistical Yearbook since 2013.

There are two chapters in this publication which present the statistics on the climate and environment. Chapter one (land and climate) includes statistics on 'geographical characteristics and administrative divisions,' and 'climate.' Chapter 2 (environment) presents statistics collected from various resources on water, soil, and air.

The only available data on climate change in this publication is about SDGs indicator 13.2.2: Total greenhouse gas emissions per year, which shows statistics on emission of greenhouse gases such as the vapour of H2O, CO2, NO2, CH4, O3, HFCs, and PFCs which are available in the tables 2.9 to 2.15. The Ministry of Energy is the source of this statistic. The table 2.9 in the Iran Statistical Yearbook presents statistics on emission of pollutant and greenhouse gases resulted from burning of fuels in agriculture sector by type (table 1).

Table 1.

Statistics presented in the table 2.9 of the Iran Statistical Yearbook (2018-2019)

Year	NO_X	SO_2	SO_3	CO	SPM	CO_2	CH_4	N_2O
1385[12]	66602	68185	415	18968	29072	11114290	000	000
1390	61058	62829	382	14168	26673	12376837	643	4148
1393	53635	55140	338	12150	23443	12409905	586	3647
1394	50629	51951	317	11259	22141	12521393	566	3447
1395	50305	51610	315	11397	21997	13157453	577	3425
1396	46248	47619	292	10214	20211	12967919	544	3148
1397	***50239***	***51771***	***318***	***11038***	***21953***	***14526008***	***598***	***3420***
Motor spirit	2	//	0	50	//	340	//	//
Burning oil	10	47	0	15	0	50585	2	//
Gas oil	50162	51416	314	10973	21946	8833744	495	3410
Fuel oil	66	308	5	//	7	21183	1	//
Natural gas	0	0	0	0	0	5620156	100	10

The table 2.10 in the Iran Statistical Yearbook includes statistics on emission of pollutants and greenhouse gases resulted from burning of fuels in manufacturing sector by type (table 2).

Table 2.

Statistics presented in the table 2.10 of the Iran Statistical Yearbook (2018-2019)

Year	NO_X	SO_2	SO_3	CO	SPM	CO_2	CH_4	N_2O
1385	131299	138668	1995	16473	15157	61522460	000	000
1390	171045	187546	2769	24900	17340	97431899	2102	277
1393	183806	172457	2527	22371	18675	107210113	2258	291
1394	165955	107698	1545	17011	16767	100018058	2030	249
1395	172371	98739	1401	18426	17442	104764985	2109	256
1396	179655	94109	1322	23410	18185	109900745	2203	266
1397	***185569***	***92365***	***1286***	***21952***	***18871***	***114048412***	***2284***	***275***
Motor sprit	574	64	0	14890	55	101215	4	1
Burning oil	65	311	0	101	0	337761	14	3
Gas oil	14375	45137	575	575	4312	8100802	328	66
Fuel oil	9913	46525	711	4	991	3200905	124	25
Liquefied gas	0	//	0	2	0	3857	0	//
Natural gas	160642	328	0	6381	13512	101463357	1809	181
Coke gas	000	000	000	000	000	105027	2	0
Blast furnace gas	000	000	000	000	000	735488	3	0

[12] It is the Iranian Year which usually begins on the day of 21 March of Gregorian calendar. To find the corresponding year of Gregorian calendar, add 621 or 622 (depending on the time of the year) to a solar Hijri year. For example, the corresponding year of the year 1397 in Gregorian calendar is (21 March 2018-20 March 2019).

The table 2.11 in the Iran Statistical Yearbook includes statistics on emission of pollutants and greenhouse gases resulted from burning of fuels in the transportation sector by type (table 3).

Table 3.

Statistics presented in the table 2.11 of the Iran Statistical Yearbook (2018-2019)

Year	NO_X	SO_2	SO_3	CO	SPM	CO_2	CH_4	N_2O
transportation sector								
1385	853845	350932	3725	9512573	273446	111500973	0	0
1390	877376	415104	4629	7794380	311352	127119584	42746	5841
1393	938677	409938	4431	9034641	324425	137610013	48718	6385
1394	881766	370024	3943	9202907	293876	132880460	49806	6086
1395	907030	405813	4461	9736569	295212	139062250	51996	6288
1396	956277	392839	4154	10428797	311749	144516638	54442	6687
1397	***1018770***	***410578***	***4311***	***11512870***	***325961***	***153892123***	***57858***	***6685***
Motor sprit	437536	48615	0	11343525	42133	77105523	36717	3560
Gas oil	535717	333335	3968	142858	261906	55906731	2942	2942
Liquefied gas	000	000	000	000	000	11164	16	1
Natural gas	000	000	000	000	000	16424670	18152	59
Fuel oil	146	683	10	0	15	47016	000	000
Jet fuel (JP_4)	561	62	0	14538	0	99372	1	3
Jet oil fuel (ATK)	44811	27882	332	11950	21907	4297647	30	120
Road and marine transportation								
1385	813084	326264	3433	9466815	254052	107402790	0	0
1390	830800	386634	4291	7756310	288974	122496090	42667	5367
1393	886059	377672	4048	8996824	299064	132396374	48625	5827
1394	827777	336794	3548	9170258	267761	127553954	49713	5529
1395	845564	367971	4011	9699925	265472	132997296	51888	5640
1396	890889	352460	3674	10395935	280074	138083562	54328	6000
1397	***973389***	***382632***	***3979***	***11486125***	***304053***	***149495104***	***57828***	***6562***
Motor sprit	437526	48614	0	11343267	42132	77105523	36717	3560
Gas oil	535717	333335	3968	142858	261906	55906731	2942	2942
Liquefied gas	000	000	000	000	000	11164	16	1
Natural gas	000	000	000	000	000	16424670	18152	59
Fuel oil	146	683	10	0	15	47016	000	000
Railway transportation	8200	5102	61	2192	4009	804228	0	0
1385	9234	5746	68	2462	4515	963676	54	372
139	11043	6871	82	2945	5399	1152433	65	445
1393	10908	6787	81	2909	5333	1138345	64	439
1394	12788	7957	95	3410	6252	1334546	75	515
1395	13580	8450	101	3621	6639	1417234	79	547
1396	***000***	***000***	***000***	***000***	***000***	***000***	***000***	***000***

1397	000	000	000	000	000	000	000	000
Air transportation								
138	32561	19565	231	43565	15385	3293955	0	0
1390	`	22724	269	35607	17863	3659817	26	102
1393	41575	25395	301	34872	19962	4061206	28	114
1394	43081	26442	314	29739	20783	4188161	29	117
1395	48677	29885	355	33234	23488	4730408	33	132
1396	51808	31929	379	29241	25035	5015843	35	140
1397	***45381***	***27946***	***332***	***26746***	***21908***	***4397019***	***31***	***123***
Jet fuel (JP_4)	561	62	0	14538	0	99372	1	3
Jet oil fuel (ATK)	44811	27882	332	11950	21907	4297647	30	120
Motor spirit	10	1	0	258	1	000	000	000

Table 2.12 in the Iran Statistical Yearbook includes statistics on emission of pollutants and greenhouse gases resulted from burning of fuels in transportation, households, trade, and public sectors (table 4).

Table 4.

Statistics presented in the table 2.12 of the Iran Statistical Yearbook (2018-2019)

Year	NO_X	SO_2	SO_3	CO	SPM	CO_2	CH_4	N_2O
1385	121164	87244	956	71176	12576	125869250	000	000
1390	115886	52953	583	47103	11286	136859996	3837	492
1393	115289	37170	392	48079	11194	137220803	4166	523
1394	116817	30116	296	47026	11371	127922931	4170	518
1395	125916	29764	291	51406	12296	148849653	4338	534
1396	118776	26641	261	48869	11606	140532545	4159	510
1397	***129115***	***24948***	***250***	***52839***	***12635***	***150632787***	***4312***	***521***
Motor spirit	825	92	0	21377	79	145309	6	1
Burning oil	1108	5316	0	1728	0	5768195	241	48
Gas oil	5123	16086	205	205	1025	2886969	117	23
Fuel oil	627	2945	45	0	63	202584	8	2
Liquefied gas	1343	29	0	13437	0	6168672	98	10
Natural gas	120089	480	0	16092	11469	129854667	2315	231
Animal waste	000	000	000	000	000	144538	43	6
Bush and thorn	000	000	000	000	000	1004201	301	40
Firewood	000	000	000	000	000	4415875	1183	158
Charcoal	000	000	000	000	000	976	0	//
Coal	000	000	000	000	000	40801	0	2

Table 2.13 in the Iran Statistical Yearbook includes statistics on emission of pollutants and greenhouse gases resulted from burning of fuels in refinery sector by type (table 5).

Table 5.
Statistics presented in the table 2.13 of the Iran Statistical Yearbook (2018-2019)

Year	NO_X	SO_2	SO_3	CO	SPM	CO_2	CH_4	N_2O
1385	000	000	000	000	000	000	000	000
1390	000	000	000	000	000	12227299	263	34
1393	000	000	000	000	000	15574965	322	40
1394	000	000	000	000	000	15049435	302	36
1395	000	000	000	000	000	15297163	322	40
1396	000	000	000	000	000	15965245	313	35
1397	***000***	***000***	***000***	***000***	***000***	***17267316***	***325***	***35***
Gas oil	000	000	000	000	000	226178	9	2
Fuel oil	000	000	000	000	000	313521	12	2
Natural gas	000	000	000	000	000	12147759	217	22
Refinery gas	000	000	000	000	000	4029165	79	8
Liquefied gas	000	000	000	000	000	550692	9	1

Table 2.14 in the Iran Statistical Yearbook includes statistics on emission of pollutants and greenhouse gases resulted from burning of fuels in power plants affiliated to the Ministry of Energy, private sector, and large industries by type sector by type (table 6).

Table 6.
Statistics presented in the table 2.14 of the Iran Statistical Yearbook (2018-2019)

Year	**NO_X**	**SO_2**	**SO_3**	**CO**	**SPM**	**CO_2**	**CH_4**	**N_2O**
1385	172332	192733	2943	222	20728	110207121	0	0
1396	634884	709408	5130	148500	30724	165184877	4087	666
1393	651610	627934	4586	177660	31105	177744913	4243	654
1394	627724	437381	4158	162624	30330	174010543	4201	630
1395	641280	295919	2481	160434	25154	171686989	3622	485
1396	651833	239623	2044	156100	25159	182746913	3701	471
1397	***672622***	***239911***	***2259***	***151021***	***25563***	***184880721***	***3722***	***483***
Ministry of Energy								
Gas oil	18836	10432	308	620	1278	3908941	146	29
Natural gas	211840	0	0	79144	6144	55754272	987	99
Fuel oil	25403	152285	711	48832	2974	11550076	372	74
Private sector								
Gas oil	98358	43266	1124	1464	4666	14090575	534	107
Natural gas	299879	0	2	18872	9646	91226157	1549	155
Fuel oil	5044	33906	114	20	477	1912013	60	12
large industries								
Gas oil	9	21	0	2	2	3786	0	//

Natural gas	13252	0	0	2066	376	3706044	60	6
Coke gas (2)	000	000	000	000	000	86992	2	0
Blast furnace gas(2).	000	000	000	000	000	2641866	10	1

Table 2.15 presents statistics on emission of pollutant and greenhouse gases resulted from burning of fuels in power plants affiliated to the ministry of energy, private sector, and large industries by type of power plant and pollutant sector by type (table 7).

Table 7.
Statistics presented in the table 2.15 of the Iran Statistical Yearbook (2018-2019)

Description	NO_X	SO_2	SO_3	CO	SPM	CO_2	CH_4	N_2O
Total	***672622***	***239911***	***2259***	***151021***	***25563***	***184880721***	***3722***	***483***
Ministry of Energy								
Thermal plant	146671	152803	719	124395	6260	40728935	898	127
Gas power plant	44892	5289	165	1730	2269	17258946	333	41
Combined cycle	64394	4257	129	2472	1845	13159150	272	33
Diesel power plant	122	369	6	0	23	66258	3	1
Private sector								
Thermal plant	48432	34242	122	12233	2035	16485907	309	37
Gas power plant	64407	17351	376	2721	4706	35281155	684	86
Combined cycle	290442	25579	742	5401	8047	55461682	1151	150
Large industries	13261	21	0	2069	378	6438688	73	7

Studying other chapters of Iran Statistical Yearbook showed that there are no statistics for the SDGS indicators related to climate change such as indicators 1.5.1 (number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population), 1.5.2 (Direct economic loss attributed to disasters in relation to global gross domestic product (GDP) and 1.5.4 (proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies) for Goal one (end poverty in all its forms everywhere), indicator 2.4.1 (proportion of agricultural area under productive and sustainable agriculture) for Goal 2 (end hunger, achieve food security and improved nutrition and promote sustainable agriculture), indicator 11.b.2 (proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies) for Goal 11 (makes cities and human settlements inclusive, safe, resilient and sustainable), indicators 13.1.1 (number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population), indicator 13.1.3 (proportion of local governments that adopt and implement local disaster risk reduction

strategies in line with national disaster risk reduction strategies), 13.3.1 [Extent to which (i) global citizenship education and [ii] education for sustainable development are mainstreamed in [a] national education policies; (b) curricula; (c) teacher education; and [d] student assessment] for Goal 13 (take urgent action to combat climate change and its impacts). This situation and data gaps result in two assumptions. One assumption is that the climate change has been narrowed to the greenhouse gas emissions. The second assumption is that maybe the statistics for other aspects of climate change are not available in a disaggregated way in Iran Statistical Yearbook or they are available in other places.

In chapter one on climate, meteorological data of capitals of provinces are presented in tables 1.7, 1.8, 1.9, 1.12, 1.13, and 1.15 and the source for this statistic is I. R I. Meteorological Organization. In table 1.7 statistics on maximum daily precipitation, mean of relative humidity, number of frosty days, dusty days, bright sunshine and maximum wind speed (table 8, annex one) are shown. These data are useful to track the changes in the temperature of Iran and finding whether or not the temperature of this country is subject to global warming or not. In table 1.8 of the Iran Statistical Yearbook, the statistics on highest maximum temperature, lowest minimum temperature and average monthly temperature are available (table 9, annex one). In table 1.9 of the Iran Statistical Yearbook, the statistics on the total precipitation in capitals of provinces are presented (table 10, annex one). These statistics are useful to find the changes in the amount of precipitation in this country. In table 1.12 of the Iran Statistical Yearbook, the statistics on total annual precipitation in capitals of provinces in different years are presented (table 11, annex one). In table 1.13 of the Iran Statistical Yearbook the average annual height of precipitation in provinces in different years is compared (table 12, annex one). These data are important to study and track the drought in the provinces. In table 1.15 of the Iran Statistical Yearbook, the statistics on volumes of precipitation in the main basins for different aquatic years are shown (table 13, annex one).

The statistics available in the chapter one is useful for tracking the changes in precipitation patterns in Iran but no information about the water change in Caspian Sea and increase in sea level (if available) in the Persian Gulf or Oman Sea, which is connected to the Indian Ocean, can be found in this chapter.

In other chapters of the Iran Statistical Yearbook many statistics are available which researchers can use to assess the impact of climate change in different areas. In chapter 2 on environment, statistics on area of forests, ranges, desert (table 2.2), cases and areas under conflagration in forests and ranges (table 2.3), combating desertification (table 2.5) are also available (table 14, table 15, table 16 respectively). The source for these statistics is the Forests, Range and Watershed Management Organization.

Table 8.

Statistics presented in the table 2.2 of the Iran Statistical Yearbook (2018-2019)

Province	Forests	Ranges				Desert phenomena (1)
		Total	Good (dense)	Fair (semi-dense)	Poor (low dense)	
Total country	***14319063***	***84814991***	***7181250***	***21419151***	***56214590***	***32576492***
East Azarbayejan	143467	2473441	703729	1359707	410005	112370
West Azarbayejan	100958	2472508	553792	1063376	855340	181103
Ardebil	51665	903896	427906	457642	18349	1337
Esfahan	411847	6328655	280070	403988	5644597	2985827
Alborz	2420	438169	187209	125480	125480	12657
Ilam	634461	1112357	27835	479788	604735	33923
Bushehr	204306	1262995	8777	409208	845010	331682
Tehran	23895	848298	220289	349042	278967	143529
Chaharmahal & bakhtiyari	335654	908152	182315	390823	335013	118893
South Khorasan	712033	6288092	6184	632226	5649682	1129364
Khorasan-e-Razavi	667341	6558356	304530	2147046	4106780	593620
North Khorasan	424740	1555206	112615	627244	815348	43279
Khuzestan	938326	2477691	571073	1353096	553522	521341
Zanjan	61113	1137060	240442	425301	471317	79931
Semnan	340168	3731083	210807	585093	2935183	5112294
Sistan & Baluchestan	370786	10648499	217096	908129	9523274	4804956
Fars	2218925	7319987	57706	1735276	5527005	669725
Qazvin	26871	853485	252550	430122	170813	29151
Qom	4149	723019	2498	34830	685691	176383
Kordestan	372307	1294397	437855	494212	362330	3354
Kerman	591823	8186300	81323	2214046	5890931	7860548
Kermanshah	528507	1188438	164352	476166	547920	25916
Kohgiluyeh & Boyerahmad	795786	478812	63966	144418	270428	40427
Golestan	415221	862825	381317	401887	79621	26
Gilan	545576	244986	98843	131684	14459	1779
Lorestan	1226367	883505	146857	672209	64439	11741
Mazandaran	1006518	584711	357671	205068	21973	1086
Markazi	1548	1772951	465804	1140366	166781	73143
Hormozgan	1053745	4093342	712	210907	3881724	1515013
Hamedan	1441	665767	323505	283977	58285	26372
Yazd	107096	6518007	91623	1126795	5299589	5935725

Table 9.

Statistics presented in the table 2.3 of the Iran Statistical Yearbook (2018-2019)

Year	Conflagration (case)			Area under conflagration (ha)		
	Total	Forests	Ranges	Total	Forests	Ranges
1380	801	369	432	7744.0	3184.0	4560
1385	1237	611	626	11132.0	2752.0	8380
1390	1324	447	877	36972.0	23656.0	13316
1393	2016	1134	882	18828.0	6789.0	12039
1394	2088	887	1201	18480.0	4716.0	13764
1395	2298	905	1393	21512.0	8712.0	12800
1396	1780	1179	601	9595.0	5869.0	3726
1397	***1312***	***814***	***498***	***4745 .8***	***2648 .8***	***2097***

Table 16.

Statistics presented in the table 2.5 of the Iran Statistical Yearbook (2018-2019)

Year and province	Plant nursery (ha)	Plastic bag seedling (1000)	Plantation (ha)	Seeding (ha)
1380	25.0	4290.0	34556	59610
1385	32.0	7349.0	31056	27724
1390	13.0	2569.0	8212	4748
1393	1.0	1163.0	13807	878
1394	17.0	1467.0	32134	2148
1395	7.2	535.6	11443	764
1396	124.0	40577.0	48880	642
1397	***13 .6***	***531 .5***	***14434***	***700***
East Azarbayejan	0.0	0.0	0	0
West Azarbayejan	0.0	20.0	0	0
Esfahan	0.0	0.0	78	0
Alborz	0.0	0.0	0	0
Ilam	0.0	0.0	40	0
Bushehr	0.0	57.0	0	0
Tehran	0.0	0.0	184	0
South Khorasan	0.5	43.0	621	0
Khorasan-e-Razavi	3.0	120.0	1080	0
North Khorasan	0.0	0.0	0	0
Khuzestan	0.0	0.0	11720	0
Semnan	0.5	40.0	0	700
Sistan & Baluchestan	9.6	43.5	0	0
Fars	0.0	0.0	0	0
Qazvin	0.0	0.0	0	0
Qom	0.0	0.0	0	0
Kerman	0.0	115.0	70	0
Golestan	0.0	0.0	308	0
Markazi	0.0	93.0	283	0

Hormozgan	0.0	0.0	0	0
Hamadan	0.0	0.0	50	0
Yazd	0.0	0.0	0	0

Year and province	Seed gathering (ton)	Mulching (ha)	Windbreak (not living) (km)	Windbreak (ha)	Preservation (ha)	Preparation of projects for combating desertification (1000ha)
1380	489.0	1650	468	0	703937	289
1385	230.0	4452	42	1087	816831	254
1390	72.0	0	23	518	408404	8000
1393	92.0	0	1	1493	247073	23
1394	77.0	605	17	336	210602	0
1395	28.0	7	318	808	693816	25
1396	37.0	21416	290	1476	785346	78
1397	***38.1***	***10622***	***0***	***465***	***457218***	***0***
East Azarbayejan	0.0	0	0	0	0	0
West Azarbayejan	0.0	0	0	90	0	0
Esfahan	0.0	0	0	135	53571	0
Alborz	0.0	425	0	0	1500	0
Ilam	0.0	0	0	0	0	0
Bushehr.	0.0	0	0	0	0	0
Tehran	0.0	0	0	0	47200	0
South Khorasan	11.0	0	0	0	0	0
Khorasan-e-Razavi	13.0	0	0	0	100	0
North Khorasan	0.0	0	0	0	0	0
Khuzestan	0.0	8020	0	0	112000	0
Semnan	14.0	550	0	48	100000	0
Sistan & Baluchestan	//	0	0	0	0	0
Fars	0.0	0	0	0	0	0
Qazvin	0.0	0	0	0	10500	0
Qom	0.0	1157	0	0	6787	0
Kerman	0.0	0	0	192	0	0
Golestan	0.0	0	0	0	0	0
Markazi	0.0	470	0	0	125000	0
Hormozgan	0.0	0	0	0	0	0
Hamadan	0.0	0	0	0	0	0
Yazd	0.0	0	0	0	560	0

In chapter three, the statistics on registered death for urban and rural areas, age groups are presented in tables 3.26 and 3.27 but these data are not disaggregated (table 17 and table 18 respectively). The source for these statistics is National Organization for Civil

Registration. The statistics for reason of death due to natural disaster or other reasons are not available, too.

Table 18.
Statistics presented in the table 3.27 of the Iran Statistical Yearbook (2018-2019)

Year and province	Total			Urban areas	Rural areas
	Both sexes	Male	Female		
1380	421525	223669	197856	243435	178090
1385	408566	229489	179077	257436	151130
1390	383504	214707	168750	278141	98343
1393	446333	222221	223739	302184	144149
1394	374827	210117	164590	280765	94062
1395	369751	207884	161774	274870	94788
1396	376731	210691	165987	278448	98230
1397	***377245***	***211518***	***165675***	***279525***	***97668***
East Azarbayejan	22530	12352	10178	16042	6488
West Azarbayejan	15081	8302	6779	9555	5526
Ardebil	6877	3780	3097	4637	2240
Esfahan	23970	13333	10602	21068	2867
Alborz	10678	6065	4613	10255	423
Ilam	2515	1445	1070	1626	889
Bushehr	4162	2356	1806	2920	1242
Tehran	57882	32959	24923	57633	249
Chaharmahal & Bakhtiyari	4100	2423	1677	2526	1574
South Khorasan	3827	2073	1754	2059	1768
Khorasan-e-Razavi	30277	16476	13795	21503	8768
North Khorasan	4642	2561	2081	2455	2187
Khuzestan	20131	11305	8825	16902	3228
Zanjan	5275	2940	2335	3289	1986
Semnan	3387	1872	1514	2585	801
Sistan & Baluchestan	13528	7568	5959	7178	6349
Fars	21610	12326	9284	15738	5872
Qazvin	5999	3350	2649	3982	2017
Qom	5935	3323	2612	5594	341
Kordestan	7325	4184	3141	4652	2673
Kerman	13340	7493	5847	9813	3527
Kermanshah	10976	6518	4458	8129	2847
Kohgiluyeh & Boyerahmad	2773	1634	1139	1621	1152
Golestan	8989	4978	4004	4760	4222
Gilan	16575	9050	7525	9384	7191
Lorestan	8938	5133	3805	6098	2840
Mazandaran	16587	8966	7621	9169	7418
Markazi	7764	4376	3387	4671	3092
Hormozgan	6505	3875	2630	3394	3111
Hamedan	10330	5879	4451	6173	4157
Yazd	4737	2623	2114	4114	623

Age group	Total			Urban areas			Rural areas		
	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
Total	***357687***	***203195***	***154492***	***267384***	***152461***	***114923***	***90303***	***50734***	***39569***
Under 1 year	7530	4060	3470	5612	3029	2583	1918	1031	887
1 – 4 years	3385	1825	1560	2367	1265	1102	1018	560	458
5 – 9 years	2431	1324	1107	1523	847	676	908	477	431
10 – 14 years	2132	1227	905	1426	798	628	706	429	277
15 – 19 years	4408	3128	1280	3126	2232	894	1282	896	386
20 – 24 years	5517	4093	1424	3969	2966	1003	1548	1127	421
25 – 29 years	6954	5040	1914	5218	3827	1391	1736	1213	523
30 – 34 years	8553	5764	2789	6390	4415	1975	2163	1349	814
35 – 39 years	9063	6149	2914	6912	4777	2135	2151	1372	779
40 – 44 years	9111	6090	3021	6959	4710	2249	2152	1380	772
45 – 49 years	11445	7691	3754	8981	6067	2914	2464	1624	840
50 – 54 years	14278	9340	4938	11422	7543	3879	2856	1797	1059
55 – 59 years	20220	13054	7166	15960	10370	5590	4260	2684	1576
60 – 64 years	25694	16006	9688	20135	12649	7486	5559	3357	2202
65 – 69 years	28838	16382	12456	22355	12970	9385	6483	3412	3071
70 – 74 years	31458	16870	14588	23973	13034	10939	7485	3836	3649
75 and over	163272	83306	79966	118398	59494	58904	44874	23812	21062
Not specified	3398	1846	1552	2658	1468	1190	740	378	362

In chapter 7 on oil and gas, the statistics on consumption of oil products are presented (table 7.4) but the statistics on consumption of fuels in different economicsectors are not available (table 19). The source for these statistics is the Ministry of Oil. Amount of emission of pollutants and greenhouse gases resulted from burning of fuels in economic sectors (agriculture, manufacturing, and transportation sectors) at provincial levels are not available. These statistics can be used to calculate the amount of greenhouse gases emitted.

Table 19.

Statistics presented in the table 7.4 of the Iran Statistical Yearbook (2018-2019)

Product	Year							
	1380	**1385**	**1390**	**1393**	**1394**	**1395**	**1396**	**1397**
Motor spirit	16723	26887	20884	25135	26856	25762	34317	000
Jet fuel G.P.4	157	99	000	000	000	000	000	000
Jet fuel A. T. K	943	1155	000	000	000	000	000	000
Kerosene	8954	7199	7257	7899	7322	7559	6218	000
Gas oil	25215	31471	29427	30683	31794	28131	29102	000
Fuel oil	15245	15644	19909	21920	18939	19747	9593	000
Lubricants	390	000	000	000	000	000	000	000
Bitumen	2100	4202 (2)	000	000	000	000	000	000
Liquefied gas	4163	3922	2739	1880	1447	1839	2079	000
Crude lubricants	351	1668	000	000	000	000	000	000
Benzinc solvents	12	42	000	000	000	000	000	000
Naphtha	2	42	000	000	000	000	000	000

The statistics on the other aspects of climate change impacts such as carbon emission per unit of output, carbon footprint-adjusted loans, environmental taxes and government expenditure on environmental protection alongside the statistics on emission of pollutants and gas emission per household and also the clean and green energy is not available in the Iran statistical yearbook.

A closer look at the current situation in the Iran Statistical Yearbook implies that there are other factors which we need to consider. If the statistics are not available in a publication, it does not necessarily mean that the statistics are ignored or not collected.

The NSO in each country is responsible for collection, compilation, analysis and publication of a wide range of statistical information about a wide range of activities. This fact doesn't prevent other government departments or institutions from collecting their own statistical data for their internal purposes. For example, the Demographic and Migration Statistics bureau of Iran National Organization for Civil Registration and Vital

Statistics (CRVSID), which is responsible for registering the vital statistics (birth, death, marriage and divorce), collects and publishes the Iran vital statistics for different years.

In this publication, statistics on death, cause of death and age groups at provincial levels are available (figure 1). This information is needed for calculation of indicators 1.5.1

(number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population) and indicators 13.1.1 (number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population).

Figure 1.

Statistics on death [Cause of Death, Sex] based on ICD 10 available at Iran Vital statistics, Yearly summary published by Demographic and Migration Statistics of Iran National Organization for Civil Registration and Vital Statistics*

8-Death Statistics in I.R. Iran [Cause of Death*, Sex]

Province & year (Male & Female)	Total	A00-B99	C00-D48	D50-D89	E00-E88	F00-F99	G00-G98	I00-I99	J00-J98	K00-K93	L00-L98	M00-M99	N00-N98	O00-O99	Q00-Q99	P00-P96	R00-R99	V01-X59	Indeterminate	other
2015	375,134	13,724	36,930	2,525	5,609	1,355	5,802	139,048	28,798	8,431	123	810	6,610	175	6,494	4,501	43,265	27,451	39,894	3,589
Azarbaijan(E)	21,628	435	2,454	392	393	107	477	6,805	1,764	453	20	18	394	10	228	91	3,513	1281	2,569	224
Azarbaijan(W)	14,713	189	2,046	47	167	96	239	4,947	696	169	1	13	215	12	146	119	1518	942	2934	217
Ardabil	6,818	157	967	29	145	45	51	2,196	357	108	0	4	113	4	255	124	1447	400	355	61
Esfahan	22,309	555	2,457	87	335	40	446	9,894	1,721	379	3	86	555	7	502	145	2,143	1641	1,370	143
Alborz	8,751	440	655	83	101	13	139	3,844	1,283	177	0	5	131	1	68	107	323	532	592	257
Ilam	2,762	108	212	20	25	17	4	1052	102	26	1	5	29	2	143	28	388	311	192	97
Bushehr	4,163	72	262	45	62	11	47	1,411	388	81	1	7	68	3	75	57	628	380	557	28
Tehran	54,693	4,296	6,070	124	846	58	663	24,137	5,315	2,223	0	32	1200	1	403	109	2,749	2,870	3,503	94
ChaharMahal &Bakhtiyari	7,655	188	406	73	66	19	36	1,504	398	330	21	75	69	3	348	168	891	538	2,471	51
Khorasan(S)	3,797	97	261	11	19	10	64	1,386	343	66	0	7	65	7	92	57	761	303	221	27
KhorasanRazavi	28,854	741	3,792	324	601	154	575	10,029	3,512	605	3	47	631	4	601	781	2373	2044	1689	348
Khorasan(N)	4,703	99	427	22	54	10	36	1,329	353	106	0	2	57	0	76	81	712	394	913	32
Khuzestan	19,571	834	1,230	222	563	86	641	9,021	1,191	329	14	116	325	6	324	144	1461	1542	1323	199
Zanjan	6,714	251	595	121	50	29	77	1,741	392	116	0	10	72	4	107	106	681	382	1,944	36
Semnan	3,257	44	326	26	37	2	63	1,471	295	59	0	6	93	1	49	22	303	211	219	30
Sistan&Baluchestan	15,717	774	564	172	103	96	262	3,165	759	446	4	53	140	31	415	142	1663	1627	5089	212
Fars	21,710	346	2,071	132	261	111	498	8,921	1,283	516	18	54	409	19	831	434	2007	2109	1434	256
Qazvin	6,481	302	477	27	52	16	107	2,298	497	133	0	9	54	3	107	136	765	464	1,015	19
Qom	5,541	502	424	13	15	6	7	2,373	730	115	0	4	99	1	46	72	138	404	551	41
Kurdistan	8,443	81	737	24	57	27	73	2,356	322	87	1	10	122	2	119	171	1877	597	1696	84
Kerman	13,012	497	959	122	75	55	123	4,620	1,829	287	19	100	127	2	105	104	1607	1378	1100	123
Kermanshah	11,406	283	1,212	56	120	20	80	4,743	676	177	0	16	207	5	150	258	940	991	1,298	174
Kohgiluyeh & BoyerAhmad	2,699	25	301	9	19	10	51	928	136	49	0	19	46	8	45	52	372	292	284	53
Golestan	9,772	487	1,012	38	220	59	106	2,963	494	197	0	11	140	8	167	141	1788	654	1216	91
Gilan	16,171	382	1,741	48	365	31	224	6,194	930	217	3	37	288	1	195	44	3557	966	828	120
Lorestan	8,594	224	818	41	52	29	146	3,651	675	196	5	12	153	3	185	48	866	779	544	167
Mazandaran	15,923	403	1,991	51	394	66	195	6,295	624	236	1	23	241	6	131	103	2799	1139	1152	73
Markazi	8,043	133	745	47	94	14	133	2,971	668	179	1	5	163	5	52	83	911	523	1251	65
Hormozgan	6,537	224	367	61	53	22	51	1920	296	136	4	13	81	3	87	382	1551	709	487	90
Hamedan	10,134	250	834	43	141	87	93	3205	597	190	2	6	195	12	371	131	2311	734	780	152
Yazd	4,563	305	517	15	124	9	95	1878	392	83	1	5	128	1	71	61	242	314	317	25

The Ministry of Energy of Iran publishes the Iran Energy Balance Sheet annually. In this publication statistics on different aspects of extraction and use of energy in Iran are available. The statistics on renewable energy is found in this publication (figure 2).

Figure 2.

Data available in Iran Energy Balance Sheet on clean and renewable energy, 2018-2019. (in Persian)

1.7 Renewable Energies	**56**
1.7.1 Hydro power	**56**
1.7.2 Wind energy	**56**
1.7.3 Solar energy	**57**
1.7.4 Geothermal energy	**57**
1.7.5 Biomass energy	**57**
1.7.6 Other types of renewable energies	**59**
1.7.7 Quarantined purchase of power from resources of renewable energies	**59**
1.8 Nuclear Energy	**59**
1.8.1 Development of nuclear plants	**60**

The Department of Environment of Iran which is responsible for preserving the natural heritage and environment of this country has a office for statistics which collects and publishes the statistics for its activities. In its annual report on the status of environment of Iran, this office reports on different aspects of environment such as gas emissions, pollutants, forest coverage, water, other related issues. Valuable statistics are presented in this publication which can be used to predict and assess the environmental economic activities in different areas of Iran. In this publication, there are recommendations for mitigating the effects of pollutants. In this publication there is a section for climate change statistics which just include the emissions of gas pollutants.

There is no tax titled 'carbon tax' in Iran but according to the law of value-added tax, the Iranian National Tax Administration must charge one percent of sale price of products of the companies which do not comply with the standards and regulations of the Department of Environment. These statistics are available in the Iranian National Tax Administration but not in the Iran Statistical Yearbook.

For researchers who investigated the change of temperature on the economy of Iran, the data on temperature and its change trend during the past years are accessible from the Iran Meteorological Organization. This information is available in the Iran Statistical Yearbook (for the most recent year) and the researchers for obtaining the disaggregated data should refer to the Iran Meteorological Organization publications.

According to the international cooperation, Iran presented three National Communications to the United Nations Framework Convention on Climate Change (UNFCCC) in 2003, 2011, and 2017. The third report includes updated statistics on national greenhouse gas (GHG) emission inventory, national GHG mitigation policies, vulnerability and adaptation, national strategies, a Global Climate Observation System (GCOS), research and education and economic assessments. Several Ministries namely as The Ministries of Energy, Oil, 'Industry, Mine and Trade', Roads and Urban Development, Agriculture (Jihad-e-Agriculture), Interior, Health and Medical Education, Guidance and Islamic Culture, Education, 'Science, Research, and Technology', Justice,

Economic Affairs and Finance and other organizations such as Vice Presidency for Science and Technology, Meteorological Organization, the Forest, Range and Watershed Management Organization, University of Tehran, Presidency Office, Iranian National Institute for Oceanography and Atmospheric Science, I.R.I Broadcasting Organization, Plan & Budget Organization, Iranian National Standards Organization and Pertinent GOs, cooperated with the Department of Environment of Iran to prepare this report. Iran's National Climate Change Office (NCCO) among other responsibilities, including raising public awareness and national coordination of the Subcommittee for Sustainable Development, has built national capacity to systematically address climate change thorough measures such as providing Iran's Low-carbon Economy Document, Intended National Determined Contribution (INDC) and the National Strategic Plan on Climate Change all of which necessitated a considerable amount of duly recognized effort in providing these inputs.

In line with IPCC guidelines, a number of professional work groups were considered to carry out the necessary research, collect the requisite data and prepare the report. In addition, the National Action Plan was elaborated in more detail compared to the previous versions presented, as per Iran's First and Second National Communications.

In the Third National Communication to UNFCCC different chapters related to the statistics on national greenhouse gas emissions inventories from energy and agriculture sectors, industrial processes and product use (IPPU), managed soils, land use change and forestry and waste sector are available. The statistics for greenhouse gases emissions from energy and agriculture sectors are available in the Iran Statistical Yearbook but the statistics for industrial processes and product use, land use change and forestry and waste sector are not available. The following tables and figures show the findings of this report on gasses emissions inventories from industrial processes and product use (IPPU), managed soils, land use change and forestry and waste sector.

Figure 3.

Contribution of Different Sources to CO2 Emissions from IPPU in 2010 presented in the Third Iran Communication to UNFCCC

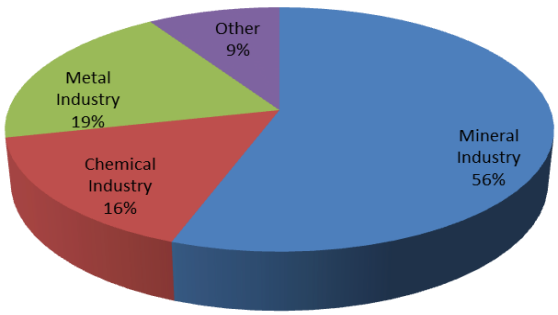


Table 20.

Summary of CO2 Emission from Different Sources in 2010 presented in the Third Iran Communication to UNFCCC

Emission Sources	CO_2 Emission (Gg)
Mineral Industry	34,432.8
Chemical Industry	9,885.4
Metal Industry	12,090.6
Other (Non-Energy Products from Fuels and Solvent Use)	5,448.4
Total	**61,857.2**

Table 21.

CH4 Emissions from Chemical and Metal Industries Sources in 2010 presented in the Third Iran Communication to UNFCCC

Emission Sources	*CH4 Emission (Gg)*	*Share (%)*
Chemical Industry	**28.48**	**85.7**
Carbide Production	0.00	
Methanol	7.13	
Ethylene	21.13	
Ethylene Dichloride	0.01	
Ethylene Oxide	0.20	
Carbon Black	0.01	
Metal Industry	**4.77**	**14.3**
Iron and Steel Production	4.7	
Ferroalloys Production	0.07	
Total	**33.25**	**100**

Table 22.

Total GHG Emissions (Gg) for Industrial Processes in 2010 presented in the Third Iran Communication to UNFCCC

GHGs / IPPU Subsectors	CO_2	CH_4	N_2O	HFC_{134a}	SF_6	PFCs	
						CF_4	C_2F_6
Mineral Production	34,432.1	-	-	-	-	-	-
Chemical Production	9,885.4	28.47	1.88	-	-	-	-
Metal Production	12,090.6	4.77	-	-	-	0.60	0.04
Other	5,448.4	-	-	0.34	0.006	-	-
Total	61,857.3	33.24	1.88	0.34	0.006	0.60	0.04
GWP	1	21	310	1,300	22,200	5,700	11,900
Total CO_2 Equivalent	61,857.3	698.0	582.8	442	133.2	3,420	476

Table 23.

N2O Emission from Agriculture Sector in 2010 presented in the Third Iran Communication to UNFCCC

Source of emissions		N_2O-N (Kg/Yr)	N_2O (Kg/Yr)
Direct N_2O emission from Soil	Synthetic fertiliser	8,165,798	12,831,968
	Animal manure	853,354	1,340,985
	Urine and dung deposited on range, pasture and paddock	18,445,066	41,526,939
	Crop residue	4,358,084	6,848,418
Total direct emission from Soil		31,822,302	62,548,310
Indirect N_2O emission from Soil	Synthetic fertiliser	-	-
	Animal manure	-	-
	Urine and dung deposited on range, pasture and paddock	1,946,223	3,058,350
	Soil leaching	4,088,722	6,425,135
	Atmospheric deposition	1,946,223	3,058,350
Total indirect N_2O emission from Soil		7,981,168	12,541,835
N_2O emissions from manure management (kg)			13,200,325
N_2O emissions from burning agricultural residues (kg)			540,005
Total N_2O emission (Gg)			76.3

Table 24.

CO2 Emissions/Uptake in Forest Land Remaining Forest in 2010 (Gg) presented in the Third Iran Communication to UNFCCC

Emission Sources	CO_2 Uptake	CO_2 Emission	Net Emission (Gg)
Annual biomass gain due to growth	-21,553.3	-	-21,553.3
Annual carbon loss due to wood removals	-	8,094.4	8,094.4
Annual carbon loss due to fuelwood removal	-	7,480.2	7,480.2
Annual carbon loss due to disturbance	-	2,019.7	2,019.7
Total	-21,553.3	17,594.3	-3,953.0

Table 25.

CO2 Emissions/Uptake in Land Conversation in 2010 presented in the Third Iran Communication to UNFCCC

Emission Sources	CO_2 Uptake	CO_2 Emission	Net Emission (Gg)
Annual increase in carbon stocks in biomass due to growth	-46,090.1	-	-46,090.1
Annual loss or decrease in biomass due to commercial filings	-	63,642.6	63,642.6
Annual biomass loss due to fuelwood removal	-	7,848.1	7,848.1
Annual carbon loss due to disturbance	-	28.1	28.1
Total	**-46,090.1**	**71,518.8**	**25,428.7**

Table 26.

GHG Emissions (Gg) from On-Site Burning in 2010 presented in the Third Iran Communication to UNFCCC

GHGs	Emission
CO2	58.9
CH_4	0.8
N_2O	0.1
NO_X	1.4
CO	23.8

Table 27.

GHG Emissions (Gg) from Different Waste Sub-sectors in 2010 presented in the Third Iran Communication to UNFCCC

Sub-sectors	CO_2	CH_4	N_2O
Solid Waste	29.00	27.20	0.002
SWDS	-	23.00	0.00
Biological Treatment	-	0.024	0.002
Open Burning	29.00	4.18	0.00
Liquid Waste Sector	0.00	1281.00	1.30
Domestic Wastewater	-	110.00	1.30
Industrial Wastewater	-	1171.00	0.00
Total	29.00	1308.2	1.302
GWP	1	21	310
Total CO_2 equivalent	**29.00**	**27472.2**	**403.62**

Moreover, in the Third Iran Communication to UNFCCC there is specific chapter on the direct and indirect economic impacts of climate change on the economy of Iran. According to this report, it is predicted that the occurrence of climate change intensifies shortage of water resources and high frequency of droughts occurrence by increasing temperature and changing patterns of rainfall (table 28 and table 29).

Table 28.

The Summary of Economic Impact of Climate Change on Agriculture Sector in 2016–2035 Period presented in the Third Iran Communication to UNFCCC

Agricultural products	Normal (baseline)	Optimistic Scenario		Median Scenario		Pessimistic Scenario		Very pessimistic	
		Amount	% change	Amount	% change	Amount	% change	Amount	% change
Activity level (1000 ha)									
Wheat	7661	8661	13.04	7679.6	0.2	7045.4	-8	_____	_____
Paddy rice	501	473.5	-5.5	515.7	2.9	495.6	-1.1	_____	_____
Potato	148.3	141.4	-4.6	147.4	-0.6	148.4	0.1	_____	_____
Oil seeds	32	371.2	6.0	220.7	-4.9	154.7	-33.3	_____	_____
Sugar beet	167.7	188.5	12.4	156.5	-6.6	101.6	-39.4	_____	_____
Livestock (1000 heads)	125870	133989	6.5	122707	-2.5	116484	-7.5	_____	_____
Production amount (1000 tons)									
Wheat	18008.3	20781.6	15.4	17244.7	-4.2	14726.3	-18.	_____	_____
Paddy rice	2452.6	2359.4	-3.8	2399	-2.1	2249.8	-8.3	_____	_____
Potato	3903.6	297.7	-2.5	3741.7	-4.1	3668.8	-6	_____	_____
Oil seeds	452.7	756	67	443.9	-1.9	330	-27.1	_____	_____
Sugar beet	6687.8	7844.8	17.3	6094.5	-8.9	3738	-44.1	_____	_____
Red meat	1005.9	1071.3	6.5	989	-1.7	894.7	-11.1	_____	_____
Chicken	2101	2172.4	3.4	2059	-2	1964.9	-6.5	_____	_____
Production amount (1000 tons)									
Wheat	15847.3	17416.2	9.9	15562.8	-1.8	15439.4	-2.5	_____	_____
Paddy rice	2884.3	2794.9	-3.1	2850.1	-1.2	2752.5	-4.8	_____	_____
Potato	3020.3	3183.4	5.4	2994.2	-0.9	2935.9	-2.9	_____	_____
Plant Oil	1322.3	1371.2	3.7	1319.9	-0.2	1288	-2.55	_____	_____
Sugar	1185.7	1294.8	9.2	1180.3	-0.5	1175.6	-0.4	_____	_____
Red meat	1094.6	1129.6	3.2	1074.1	-1.9	1029.6	-7	_____	_____
Chicken	1806.3	1815.3	0.5	1770	-2	1690	-7.2	_____	_____
Foreign trade volume (1000 tons)									
Total of import	10132.5	9281.3	-8.4	10608	4.7	13099.4	29.3	14381.2	41.9

Total of export	742.9	750.2	2.2	742.9	0.0	634.3	-14.6	634.3	-14.6
Total of net export	-9389.6	-8522.1	9.2	-9865.1	5.1	-12465.1	32.8	-13746.9	46.4
Economic surpluses (billion rials)									
Total economic surplus	549658.4	584286.9	6.3	538068.9	-2.1	532119.3	-3.2	527967.3	-3.9
Consumers surplus	431280.8	436456.2	7.6	420436.4	-2.5	409752.9	-5.0	399647	-7.3
Producers surplus	316611.4	340673.9	1.2	312975.8	-1.15	319843.1	1.02	325263.6	2.7
Welfare loss/total income of crops and livestock sector	-	10.9		3.7		5.54		6.85	

Table 29.

Total Economic Impacts of Climate Change in Iran in the Period of 2016–2035 Period presented in the Third Iran Communication to UNFCCC

Climate scenarios	Direct economic impacts		Indirect economic impacts		Total (direct + indirect) economic impacts
	Consumers	Producers	Demand driven	Supply driven	
Pessimistic	-31483.5	-8548.5	-6815.0	-6140.5	-52997.5
Median	-10782.0	-3482.7	-2776.6	-2506.2	-19747.5
Optimistic	32777.3	3799.3	3039.4	2735.5	42351.5

There is also a section for direct and direct impact of climate change specially changes in regional temperature and sea level on the energy sector such as oil, gas, petrochemical industries in Iran.

Looking at these statistics published on climate change and the responsibilities of government agencies reveal that statistics on climate change effects on different aspects may be available but not published in the Iran Statistical Yearbook. If it is true, there is a need to expand cooperation among these stakeholders to publish these statistics in a proper way and easy to access for users and researchers. By considering this fact that each organization produces the statistics of its activities, it seems that there is a necessity for a mechanism to harmonize their statistics activities in line with producing timely and

accurate data on different aspects of economic and social activities. This mechanism is realized through a strategy for statistics. In the next section, this mechanism for harmonizing the statistics activities of the concerned agencies in Iran is described.

National Strategy for Development of Statistics in the I.R. Iran

The planners and decision makers in the I.R. Iran took a new look at the national statistical system in 2004 while organizing the Fourth National Development Plan. This new look led to direct inclusion of statistical system into the text of law for country development plans. Because of this approach, the Article 56 of the Fourth National Development Plan, specialized for statistical system, was approved and the First National Strategy for Development of Statistics (2005–2009) was prepared in line with the implementation of this Article. After the approval of the National Statistical System by the High Council of Statistics and implementation of the executive decrees for this system, many useful activities were done for organizing the National Statistical System and the important role of the high-quality statistics in the preparation and analysis of the National Development Programme was highlighted. The help received from all the stakeholders of the National Statistical System especially the SCI helped to continue this movement and establish the unique status of the National Statistical System in the country Development Programme. In this system, the SCI was duty-bound to calculate many of macro socio-economic indices including the statistical indices required for monitoring the Fifth National Development Plan. Moreover, the legislature body appointed the SCI as the statistical focal point for production and dissemination of official statistics in the National Statistical System.

The Second National Strategy for Development of Statistics (2011–2015) was prepared after the announcement of the 20-Year National Vision of the I.R. of Iran and in line with the implementation of the paragraph B of the Article 54 of the Fifth National Development Plan. The aim of this strategy was to pave the way for improving the status of the National Statistical System at the national and international levels. It was expected that the full and comprehensive implementation of this strategy would lead to remove the obstacles and provide the country planners and decision makers with the needed high-quality statistics for preparation and assessment of development programs. Although some achievements were accomplished but many of the objectives of the First and Second National Strategy for Development of Statistics weren't fulfilled due to facing structural and organizational difficulties and lack of cooperation among the concerned stakeholders.

The SCI and government agencies prepared the Third National Strategy for Development of Statistics (NSDS) (2017–2021) with the approach of institutionalizing the transformation in the National Statistical System and the High Council of Statistics

approved it. This NSDS was prepared in line with Article 10 of the Permanent Decree of National Development Plans in Iran.

At the first step, the functions of the National Statistical System during the years of conducting The Second National Strategy for Development of Statistics (2011–2015) and its strong and weak points, and challenges were analyzed and assessed. Then, the expert workgroups in collaboration with government agencies determined the vision and mission of statistical system and the macro goals and strategies of the NSDS (2017–2021) were determined. To realize these strategies, the NSDS was prepared and presented in collaboration with government agencies in the fields of revision of the laws, regulations and organizational structure of the statistical system; production of statistics and establishing of a register-based system, national accounts and macro indices; information technologies; research and education of statistics; monitoring and managing the statistics quality; promotion of public trust in statistics, and developing national and international statistics. According to the NSDS, the Iranian National Statistical System is a system in which all the government agencies are its member, the SCI is the statistical focal point and the High Council of Statistics is responsible for directing this system. This system is responsible for production, dissemination and promotion of official statistics by full consideration of the Fundamental Principles of Official Statistics and national rules and laws.

In this system the Official Statistics is the statistic which the government agencies produce and disseminate and decision-making at national level is done based on it. The list of Iran official statistics should include the title of this type of statistics.

The Statistical Focal Point in the Iranian National Statistical System is a government institution which is professional and unbiased and is responsible for production, dissemination and documentation of the national official statistics. This focal point is obliged to integrate, organize and build capacity in the Iranian National Statistical System. Only those national official statistics shall be authorized to be published enjoying the approval of this focal point.

The Vision of the National Statistical System (NSS) of Iran is to establish an integrated system which is accountable, trusted by the public and professionals, the provider of high quality official statistics. The Mission of the NSS is production and dissemination of official statistics needed by national and international users by full consideration of the Fundamental Principles of Official Statistics and using state-of-the-art technologies and modern methodologies, especially register-based methods.

1. The macro goal of NSS is to create an integrated statistical system capable of producing official statistics of high quality to increase the accountability and public trust. The strategy which is used to achieve these goals are a) revising and modification of laws and rules related to the NSS in order to integrate, organize and remove any parallel activities in the production and dissemination of official statistics, b) playing the role of statistical focal point, promoting the application of official statistics within the principles of the Higher Council of Statistics, being

accountable for providing statistics and information needs, enhancing users' trust, reducing respondent burden and distributing statistics production in order to prevent duplicated statistics production.

2. Revising the organizational chart, and terms of references of the components of National Statistical System, strengthening and developing the capacities of human resources involved in statistical activities in government agencies, attending the international events in order to improve their efficiencies and effectiveness, and maximum use of the capacities of the Higher Council of Statistics and Statistical Sectoral committees for modernizing the National Statistical System.
3. Approving laws and rules ensuring one-way-traffic administrative microdata flow needed by Iran Statistical Registers System to the Statistical Centre of Iran
4. Implementing the Quality Management System and observing the statistical standards in meeting the statistical requirements
5. Systematizing the dissemination and information supply of official statistics at the national and international levels based on the approvals of the Higher Council of Statistics through using of state-of-the-art technologies, organizing, preparing and observing Publication Calendar of national official statistics.

According to Article 4 of the NSDS, the SCI is obliged to submit a draft bill of new Act of statistics to the High Council of Statistics after it is reviewed in the specialized Commission and also prepare guidelines, regulations, standards and executive procedure compatible with the Act of National Statistical System in collaboration with other government agencies and submit them to the High Council of Statistics.

The government agencies are obliged to prepare their administrative and organizational structures compatible with goals of NSDS in collaboration with the SCI and propose it to the State Administrative and Recruitment Organization after the approval of NSDS by the High Council of Statistics. The government agencies are obliged to put the empowerment of their statistics and information units, recruitment, maintenance and strengthening of the statisticians in priority. The SCI is obliged to prepare the plan for 'organizing and developing the use of private sector capacities in carrying out statistical activities' in cooperation with the Statistical Research and Training Centre (SRTC) and government agencies.

According to Article 5 of NSDS, in order to establish Comprehensive System of Iran Statistical Registers (IRANSTARS) and to meet the needs of the national statistical database, the government agencies are obliged to submit their micro-data to the SCI and have other necessary cooperation with the SCI to launch and connect the four basic registers including: Population, Activity, Business and Properties and Real Estates in accordance with the requirements of the SCI.

According to Article 6 of NSDS, for the purpose of comparability and additivity of statistical information and integration, production, development and improvement of the quality of official statistics, the SCI is duty-bound to prepare the 'List of Iran official

statistics' and 'Quality of Iran Official Statistics Regulation' and communicate them to government agencies. In cooperation with government agencies, the SCI is duty-bound to provide the statistical indices required for producing and monitoring the development programs and macro policies of the country, and disseminate these indices in the form of needs assessment and statistical indices profile.

For quality concerns, according to Article 9, in order to implement the quality management system and to observe statistical standards, supervise and monitor and continuously evaluate the National Statistical System in line with implementation of the NSDS, the SCI is obliged to prepare the general framework for the quality management of official statistics in the National Statistical System (National Quality Assurance Framework).

The Statistical Centre of Iran is duty-bound to provide the necessary standards for preparation and dissemination of the government agencies statistical yearbook, and communicate them to the government agencies. According to this NSDS, all the agencies should send their statistics to the organization which is the focal point of official statistics to be assessed and obtain the approval for publishing.

By considering the significant role of the NSDS and NSS to establish an integrated statistical system in Iran, the SCI and every NSO can use this benefit to harmonize statistics the government agencies produce to remove the parallel working. They also can prepare the needed methodologies for government agencies to produce the statistics on the SDGs indicators in a timely and accurate manner.

Having the NSDS, the SCI and government agencies has cooperated to prepare the list of official statistics of the I.R. Iran which many of its indicators are based on the SDGs indicators. The profile of these indicators has been prepared and according to the NSDS the responsible agency for collecting the statistics and the methodology needed for calculation of every indicator has been determined. Step by step the list of indicators which will include the indicators related to the economic aspects of climate change will be prepared. By considering the cooperation among government agencies based on the NSDS, the available statistics in each government agency will be reviewed and the parallel working will be removed. By considering the fact that statistics on climate change and its effects may be available and produced by some agencies, the NSDS will facilitate and pave the way for publishing the timely and high-quality data on the effect of climate change and global warming in the economy of Iran.

Having timely statistics on important matters such as the economic effects of climate change on the economic lives of people requires accessing to a statistical system which is efficient and productive. This efficiency and productivity are obtained by having an established mechanism which facilitates the processes of collecting and publishing of data among different bodies.

4. Conclusion

Statistics help us to obtain a clear idea on the real situation and pave the way for informed policies. Adopting policies to counteract the effects of the climate change needs timely and accurate statistics on all the activities which are responsible for carbon emission in the atmosphere. According to Gates (2021) the greenhouse gas which is the main source of global warming is mainly emitted by our actions for making things (cement, steel, plastic), plugging in (electricity), growing things (plants and animal), getting around (planes, trucks, and cargo ships) and keeping warm and cool. These activities are integral parts of our daily economic lives. Understanding the relationship between economy and climate change is an important component of adapting to and mitigating climate change impacts.

The SDGs contain several goals and targets related to sustainable development and environment which contribute to the promotion and sustainability of our daily life. There are various indicators which show the progress and improvement in achieving sustainable environment and climate. Studying the environment and climate statistics which the SCI collects and publishes show that climate change isn't fully covered in figures and there are no statistics on many SDG indicators showing the impacts of climate change on the economic activities in the I.R. Iran. In other words, the climate change has a narrow domain and is limited to gas pollutants in this important statistical publication used by Iranian policy-makers. This lack of comprehensive statistics on environment will have severe effects for the future activities aimed at reducing the effects of climate change on economic activities in this country. In this regard, the national strategy for harmonizing the statistical system in the country will paves the way for integrating the statistical activities and information of the government agencies in order to avoid the parallel working and providing the timely information on official statistics. Since some statistics on the climate change indicators such as death mortality, gas pollutants, fuel consumption by different economic sectors are collected and published by different organizations, the SCI and each NSO benefiting from the provisions of the established NSDS can enrich their statistics and broaden their domain to fully cover the touch of every important factor such as climate change and global warming on different aspects of lives of people in their country. The established NSDS in Iran facilitates the collecting and publishing of statistics on various issues such as SDGs indicators by providing the guidelines for statistical stakeholders and harmonizing their statistical activities to remove the parallel working and provide access to the high-quality statistics.

Annex One

This annex includes the meteorological data of capitals of provinces in Iran which are presented in the tables 1.7, 1.8, 1.9, 1.12, 1.13, and 1.15 of the Iran Statistical Yearbook (2018-2019).

Table 8.

Statistics presented in the table 1.7 of the Iran Statistical Yearbook (2018-2019)

Capital of Province	Air temperature (°C)					Annual precipitation (mm)
	Average max	Average min	Mean	Absolut min	Absolut max	
Arak	21.6	8.9	15.2	-8.0	39.8	526.7
Ardebil	17.0	5.7	11.3	-12.4	36.8	303.4
Orumiyeh	19.8	6.2	13.0	-9.0	39.6	515.2
Esfahan	24.5	11.0	17.7	-5.4	40.0	154.2
Ahvaz	34.0	20.5	27.2	2.9	52.4	332.5
Ilam	23.7	10.8	17.2	-5.4	41.2	1028.6
Bojnurd	21.3	8.2	14.8	-6.4	41.2	301.5
Bandar Abbas	33.0	21.9	27.4	6.7	44.8	117.7
Bushehr	30.3	22.6	26.4	8.3	45.6	357.7
Birjand	24.9	9.1	17.0	-8.8	39.5	196.8
Tabriz	20.1	9.2	14.6	-8.6	41.0	364.3
Tehran	23.7	14.1	18.9	-2.8	41.4	272.2
Khorramabad	25.5	10.3	17.9	-4.1	45.3	889.4
Rasht	22.0	13.9	17.9	1.0	36.4	1083.5
Zahedan	27.6	11.4	19.5	-6.2	42.0	52.2
Zanjan	20.2	5.9	13.1	-10.9	40.0	307.4
Sari	23.7	14.5	19.1	-0.4	38.0	887.9
Semnan	24.4	13.9	19.1	-2.4	43.0	178.1
Sanandaj	23.3	7.7	15.5	-7.6	42.8	551.0
Shahr-e-Kord	21.2	3.2	12.3	-20.3	36.8	336.1
Shiraz	26.9	10.8	18.8	-5.0	40.6	243.9
Qazvin	22.7	8.5	15.6	-6.8	41.7	331.6
Qom	27.1	11.8	19.4	-4.9	45.5	205.3
Karaj	22.5	10.6	16.6	-5.5	41.0	353.0
Kerman	26.1	8.4	17.3	-9.7	40.6	100.7
Kermanshah	23.8	8.4	16.1	-9.6	43.5	692.6
Gorgan	24.8	12.8	18.8	-3.1	43.5	647.6
Mashhad	23.1	10.3	16.7	-5.0	44.2	238.1
Hamedan	20.6	5.3	13.0	-15.4	39.5	519.5
Yasuj	20.4	6.4	12.9	-6.0	38.0	1054.7
Yazd	27.8	14.5	21.2	-3.2	43.0	70.7

Capital of *Province*	Max. daily precipitation (mm)	Mean of relative humidity (%)		Number of frosty days	Number of dusty days	Bright sunshine (hours)	Max. wind speed (Mps)
		Max.	Min.				
Arak	35 .0	66	30	70	69	2761 .2	22
Ardebil	20 .0	88	54	90	9	2491 .7	23
Orumiyeh	41 .0	79	39	89	4	2898 .4	16
Esfahan	29 .0	55	22	50	20	3316 .9	27
Ahvaz	59 .0	62	28	0	62	3053 .3	24
Ilam	105 .0	64	32	45	80	2943 .3	23
Bojnurd	32 .0	77	36	76	38	2912 .5	18
Bandar Abbas	43 .0	82	45	0	47	3217 .6	13
Bushehr	59 .0	77	54	0	22	000	000
Birjand	20 .6	49	16	60	35	3425 .9	16
Tabriz	25 .3	69	36	73	18	2822 .3	18
Tehran	25 .0	51	24	14	7	3011 .3	22
Khorramabad	38 .0	69	29	42	52	2878 .9	20
Rasht	66 .0	96	61	0	1	1803 .6	16
Zahedan	24 .0	40	17	44	115	3343 .1	20
Zanjan	19 .0	78	35	95	24	2802 .8	19
Sari	112 .0	93	57	2	0	1869 .0	25
Semnan	45 .7	51	26	21	8	3009 .0	16
Sanandaj	44 .0	72	28	67	50	2886 .0	60
Shahr-e-Kord	22 .4	66	23	114	38	3125 .1	48
Shiraz	27 .1	59	19	49	50	3301 .6	13
Qazvin	23 .7	77	35	62	6	2794 .8	21
Qom	18 .3	62	27	37	64	3055 .0	30
Karaj	25 .0	70	31	30	5	2983 .1	20
Kerman	18 .0	41	11	73	29	3388 .4	24
Kermanshah	46 .1	66	26	56	45	2658 .3	15
Gorgan	147 .0	92	55	20	1	2316 .2	30
Mashhad	26 .0	65	31	40	23	2935 .1	16
Hamedan	28 .0	73	32	98	14	2943 .0	24
Yasuj	84 .0	64	22	68	52	3042.6	15
Yazd	22 .0	40	15	10	65	3409 .1	22

Capital of province	Month								
	Farvardin[13]			Ordibehesht			Khordad		
	Highest Max. Temp.	Lowest Min. Temp.	Mean Temp	Highest Max. Temp.	Lowest Min. Temp.	Mean Temp	Highest Max. Temp.	Lowest Min. Temp.	Mean Temp
Arak	27 .8	1 .0	14 .2	25 .8	4 .8	15 .0	35 .0	10 .0	22 .4
Ardebil	26 .6	-7 .9	9 .4	25 .2	0 .0	12 .3	30 .2	5 .7	16 .8
Orumiyeh	24 .2	-2 .0	12 .1	25 .2	1 .4	13 .8	30 .6	8 .4	19 .7
Esfahan	30 .0	4 .6	17 .1	29 .6	8 .8	18 .8	38 .6	11 .8	26 .6
Ahvaz	40 .5	13 .7	25 .7	42 .7	16 .3	29 .5	49 .2	24 .0	37 .6
Ilam	28 .2	2 .7	15 .4	29 .8	6 .1	16 .7	35 .4	13 .9	24 .6
Bojnurd	30 .8	0 .4	13 .1	32 .4	4 .0	16 .7	36 .6	8 .8	22 .8
Bandar Abbas	38 .0	15 .1	26 .8	39 .8	20 .1	30 .4	44 .8	22 .3	33 .3
Bushehr	34 .1	17 .5	25 .0	39 .0	21 .5	28 .5	42 .3	23 .8	33 .4
Birjand	32 .8	2 .5	17 .2	34 .2	6 .4	20 .1	39 .4	11 .1	26 .4
Tabriz	24 .2	0 .2	12 .9	26 .8	3 .0	15 .1	31 .2	10 .6	21 .4
Tehran	30 .3	3 .2	17 .6	29 .4	7 .6	19 .5	37 .2	16 .8	26 .8
Khorramabad	30 .3	3 .3	15 .3	30 .0	5 .6	17 .2	37 .0	11 .8	24 .6
Rasht	29 .4	1 .6	13 .3	29 .2	7 .2	19 .1	31 .6	14 .4	23 .0
Zahedan	34 .5	3 .6	20 .5	36 .0	7 .1	24 .0	41 .6	11 .5	28 .0
Zanjan	27 .2	-4 .4	11 .8	25 .8	1 .0	13 .3	31 .9	7 .8	19 .3
Sari	34 .6	4 .2	15 .4	35 .0	10 .2	20 .4	34 .4	16 .4	24 .2
Semnan	30 .6	2 .8	18 .3	31 .2	9 .0	20 .5	38 .6	19 .6	28 .4
Sanandaj	27 .8	1 .1	14 .0	29 .0	3 .6	15 .2	35 .4	9 .6	21 .8
Shahr-e-Kord	25 .7	-5 .5	10 .5	25 .5	1 .8	13 .4	34 .0	3 .3	19 .1
Shiraz	30 .8	4 .4	17 .3	32 .4	8 .0	20 .2	40 .2	14 .0	27 .4
Qazvin	30 .0	-2 .4	13 .9	28 .0	3 .8	15 .9	34 .9	9 .0	22 .5
Qom	34 .2	3 .3	19 .0	34 .8	7 .4	21 .0	41 .0	14 .4	27 .9
Karaj	29 .8	-0 .3	14 .9	29 .0	5 .7	17 .0	35 .3	11 .0	23 .6
Kerman	32 .9	0 .0	16 .9	33 .6	6 .1	19 .7	39 .1	9 .8	26 .8
Kermanshah	28 .2	1 .2	14 .2	28 .0	3 .3	15 .2	34 .8	10 .3	22 .1
Gorgan	31 .9	1 .8	14 .6	37 .0	8 .5	20 .1	38 .5	13 .8	25 .6
Mashhad	32 .9	1 .0	14 .5	36 .1	8 .4	19 .4	40 .1	13 .7	25 .4
Hamedan	26 .2	-1 .5	11 .7	25 .0	2 .8	12 .7	31 .8	7 .4	18 .7
Yasuj	27 .4	3 .2	13 .6	27 .0	4 .8	15 .2	36 .2	9 .2	23 .0
Yazd	34 .9	6 .6	20 .3	33 .9	12 .6	22 .3	41 .5	18 .9	30 .8

[13] **Iranian months and their equivalent in Gregorian calendar:**
Farvardin (21 March-20April) , Mehr (23 September-22 October), Ordibehesht (21 April-21 May), Aban (23 October-21 November), Khordad (22 May-21 June), Azar (22 November-21 December), Tir (22 June-22 July),Dey (22 December-20 January), Mordad (23 July-22 August), Bahman (21 January-19 February), Shahrivar (23 August-22 September), Esfand (20 February-20 March)

Table 9.

Statistics presented in the table 1.8 of the Iran Statistical Yearbook (2018-2019)

Capital of province	Month								
	Tir			Mordad			Shahrivar		
	Highest Max. Temp.	Lowest Min. Temp.	Mean Temp	Highest Max. Temp.	Lowest Min. Temp.	Mean Temp	Highest Max. Temp.	Lowest Min. Temp.	Mean Temp
Arak	39 .8	16 .0	28 .6	39 .0	17 .6	29 .4	36 .8	12 .2	25 .0
Ardebil	36 .8	8 .0	21 .5	33 .2	8 .2	20 .2	33 .4	6 .5	17 .5
Orumiyeh	39 .6	11 .6	25 .4	38 .6	12 .5	25 .1	34 .0	6 .4	21 .3
Esfahan	39 .6	17 .8	29 .7	40 .0	18 .6	29 .7	37 .8	15 .6	27 .1
Ahvaz	52 .4	26 .9	39 .4	50 .2	27 .9	39 .0	48 .2	25 .0	37 .3
Ilam	41 .2	16 .7	29 .5	41 .1	18 .1	29 .6	39 .5	16 .2	27 .6
Bojnurd	41 .2	13 .6	27 .7	38 .8	13 .6	26 .5	37 .0	7 .0	22 .1
Bandar Abbas	44 .7	27 .3	34 .4	43 .1	28 .6	34 .9	39 .7	25 .4	32 .4
Bushehr	45 .6	26 .8	33 .8	39 .7	28 .6	34 .1	41 .3	28 .1	33 .8
Birjand	38 .4	16 .0	28 .4	39 .5	14 .3	27 .3	37 .8	7 .9	22 .7
Tabriz	40 .8	17 .2	29 .3	41 .0	16 .6	28 .7	36 .2	14 .0	24 .6
Tehran	41 .0	23 .4	32 .6	41 .4	19 .8	32 .2	37 .6	19 .2	28 .4
Khorramabad	44 .5	15 .2	30 .7	45 .3	16 .4	31 .3	42 .7	12 .0	27 .9
Rasht	36 .4	19 .2	28 .4	35 .0	20 .0	27 .3	32 .6	17 .6	25 .3
Zahedan	41 .7	17 .1	29 .7	42 .0	17 .0	29 .0	37 .2	10 .5	23 .5
Zanjan	40 .0	10 .8	26 .3	39 .0	9 .8	26 .3	35 .9	6 .2	21 .8
Sari	38 .0	18 .4	29 .5	38 .0	21 .6	29 .0	35 .2	17 .2	26 .6
Semnan	41 .6	23 .6	33 .8	43 .0	22 .6	33 .1	39 .0	17 .0	28 .6
Sanandaj	42 .6	11 .8	28 .3	42 .8	14 .2	29 .5	39 .8	10 .4	24 .9
Shahr-e-Kord	36 .8	6 .5	23 .4	36 .2	9 .5	23 .6	35 .6	4 .4	21 .0
Shiraz	40 .6	16 .0	29 .7	40 .6	18 .0	30 .1	40 .2	14 .4	28 .0
Qazvin	40 .9	13 .7	29 .3	41 .7	13 .7	28 .7	36 .6	12 .3	24 .5
Qom	45 .5	17 .6	32 .9	45 .0	18 .8	33 .2	41 .6	14 .1	28 .3
Karaj	41 .0	16 .1	30 .3	40 .8	14 .8	29 .5	37 .0	13 .9	25 .4
Kerman	40 .6	13 .2	27 .2	39 .4	13 .4	26 .9	37 .0	9 .9	23 .5
Kermanshah	42 .8	11 .9	28 .7	43 .5	14 .8	29 .2	40 .6	10 .2	25 .6
Gorgan	43 .5	19 .9	31 .0	39 .5	20 .1	30 .2	37 .3	14 .5	26 .8
Mashhad	40 .9	18 .3	30 .2	44 .2	17 .4	28 .5	39 .2	9 .0	23 .4
Hamedan	38 .8	10 .6	25 .6	39 .5	12 .5	26 .9	37 .1	7 .1	22 .1
Yasuj	38 .0	14 .4	26 .5	37 .0	16 .8	000	36 .8	13 .6	24 .8
Yazd	43 .0	21 .7	32 .8	42 .9	22 .0	32 .6	41 .1	18 .2	30 .1

Capital of province	Month								
	Mehr			Aban			Azar		
	Highest Max. Temp.	Lowest Min. Temp.	Mean Temp	Highest Max. Temp.	Lowest Min. Temp.	Mean Temp	Highest Max. Temp.	Lowest Min. Temp.	Mean Temp
Arak	31 .6	6 .8	18 .0	23 .8	-0 .4	9 .6	16 .2	-2 .8	6 .4
Ardebil	30 .0	-1 .8	14 .1	23 .9	-2 .8	7 .9	15 .6	-4 .5	5 .8
Orumiyeh	29 .4	4 .8	16 .1	22 .0	-1 .4	8 .6	14 .4	-4 .4	4 .8
Esfahan	33 .4	8 .8	20 .3	27 .0	0 .8	12 .4	18 .0	-2 .6	8 .5
Ahva	45 .8	19 .0	31 .8	34 .0	12 .1	21 .9	26 .5	7 .1	17 .2
Ilam	33 .6	10 .4	22 .4	24 .6	3 .4	13 .0	19 .6	0 .0	9 .0
Bojnurd	29 .8	0 .2	15 .4	30 .0	-3 .0	10 .1	19 .6	-4 .8	6 .7
Bandar Abbas	40 .2	19 .8	30 .6	34 .6	16 .2	26 .1	32 .8	9 .8	21 .2
Bushehr	38 .6	24 .5	31 .4	33 .2	16 .7	24 .1	28 .5	12 .7	19 .8
Birjand	32 .7	-0 .7	16 .8	29 .1	-1 .9	13 .2	22 .0	-3 .6	8 .9
Tabriz	29 .8	5 .4	18 .3	23 .0	0 .8	10 .1	13 .4	-2 .3	5 .4
Tehran	32 .6	12 .2	21 .4	26 .2	5 .8	13 .0	17 .4	3 .4	10 .2
Khorramabad	36 .8	10 .1	22 .3	27 .2	3 .0	13 .9	19 .0	-1 .3	8 .9
Rasht	31 .0	12 .2	20 .5	36 .0	6 .6	15 .5	27 .6	4 .8	12 .5
Zahedan	31 .8	5 .1	19 .3	30 .0	-1 .8	15 .2	23 .6	-3 .8	11 .0
Zanjan	30 .4	2 .3	16 .1	23 .2	-3 .4	8 .0	16 .3	-3 .7	5 .4
Sari	31 .6	11 .2	21 .4	37 .4	8 .0	16 .4	27 .2	5 .6	12 .9
Semnan	32 .4	10 .0	21 .0	27 .2	5 .0	13 .5	17 .4	2 .0	9 .7
Sanandaj	33 .4	6 .6	18 .6	25 .2	-0 .1	11 .3	16 .2	-2 .8	6 .5
Shahr-e-Kord	29 .4	-0 .1	14 .5	23 .0	-4 .4	8 .3	16 .9	-9 .8	4 .8
Shiraz	35 .0	9 .8	21 .7	28 .2	2 .8	13 .9	20 .4	-2 .4	9 .6
Qazvin	32 .7	5 .7	18 .3	25 .2	-0 .2	10 .4	16 .5	-0 .7	7 .5
Qom	35 .9	10 .0	21 .8	31 .2	4 .4	14 .1	20 .4	-0 .7	10 .2
Karaj	31 .4	7 .4	19 .0	26 .3	0 .0	10 .9	17 .5	0 .6	8 .6
Kerman	33 .5	4 .8	18 .1	27 .9	-0 .2	13 .0	23 .9	-6 .4	8 .7
Kermanshah	33 .7	8 .1	20 .3	25 .5	1 .3	12 .3	17 .1	-2 .2	7 .7
Gorgan	33 .4	7 .3	20 .9	39 .6	4 .7	15 .4	26 .1	1 .4	11 .4
Mashhad	30 .0	2 .6	16 .6	30 .8	-1 .3	10 .7	22 .2	-0 .6	8 .7
Hamedan	30 .0	3 .1	15 .9	22 .3	-1 .4	8 .7	14 .8	-5 .0	4 .7
Yasuj	31 .0	6 .2	18 .9	25 .0	-0 .4	10 .9	19 .4	-2 .8	7 .3
Yazd	36 .5	10 .8	23 .0	30 .2	4 .4	15 .2	23 .8	1 .8	12 .3

Capital of province	Month								
	Dey			Bahman			Esfand		
	Highest Max. Temp.	Lowest Min. Temp.	Mean Temp	Highest Max. Temp.	Lowest Min. Temp.	Mean Temp	Highest Max. Temp.	Lowest Min. Temp.	Mean Temp
Arak	16 .8	-8 .0	3 .1	15 .2	-6 .4	4 .5	19 .2	-4 .2	5 .2
Ardebil	12 .0	-11 .1	2 .3	15 .0	-12 .4	2 .8	16 .8	-6 .3	4 .2
Orumiyeh	11 .2	-9 .0	0 .4	11 .6	-7 .5	2 .4	15 .2	-5 .6	4 .6
Esfahan	17 .4	-5 .4	5 .8	19 .0	-5 .0	6 .9	20 .0	-3 .0	8 .4
Ahva	23 .3	2 .9	14 .3	25 .0	4 .3	15 .3	27 .0	7 .1	17 .1
Ilam	15 .8	-5 .4	5 .4	16 .7	-3 .3	6 .2	18 .1	-2 .3	6 .5
Bojnurd	18 .2	-5 .4	4 .7	16 .8	-5 .6	3 .8	22 .0	-6 .4	6 .3
Bandar Abbas	28 .7	6 .8	19 .4	27 .2	6 .7	18 .8	28 .2	10 .7	19 .6
Bushehr	25 .2	8 .3	17 .4	26 .5	8 .3	17 .5	26 .0	11 .0	17 .8
Birjand	22 .8	-7 .7	7 .0	20 .1	-8 .8	6 .2	22 .3	-6 .4	8 .4
Tabriz	10 .0	-8 .4	1 .0	12 .6	-8 .6	2 .4	15 .6	-4 .2	4 .7
Tehran	14 .8	-2 .8	6 .2	15 .4	-1 .6	7 .3	19 .2	-0 .5	9 .6
Khorramabad	18 .7	-4 .1	6 .5	17 .1	-3 .9	6 .7	18 .8	-2 .2	7 .6
Rasht	24 .8	1 .0	9 .7	21 .6	1 .0	8 .9	26 .6	2 .2	10 .8
Zahedan	25 .6	-5 .6	11 .6	22 .8	-6 .2	9 .8	23 .1	-2 .2	10 .9
Zanjan	12 .5	-10 .7	1 .1	13 .9	-10 .9	2 .1	17 .1	-7 .5	3 .7
Sari	25 .8	0 .0	10 .2	24 .3	0 .4	10 .2	29 .8	-0 .4	11 .9
Semnan	13 .8	-2 .4	5 .5	16 .0	-1 .8	7 .1	21 .8	-2 .0	9 .4
Sanandaj	15 .6	-7 .6	3 .5	15 .6	-7 .4	4 .3	17 .2	-4 .8	6 .0
Shahr-e-Kord	14 .6	-12 .1	2 .8	15 .2	-12 .3	2 .3	15 .8	-20 .3	1 .5
Shiraz	19 .0	-5 .0	8 .3	21 .0	-4 .0	8 .4	20 .8	-3 .2	9 .5
Qazvin	12 .8	-6 .8	3 .7	15 .9	-6 .2	5 .0	19 .3	-3 .6	6 .7
Qom	16 .2	-4 .9	5 .7	17 .4	-3 .6	7 .8	22 .9	-3 .5	9 .9
Karaj	14 .8	-5 .5	4 .7	15 .9	-5 .2	5 .6	18 .2	-4 .4	7 .4
Kerman	22 .2	-9 .7	8 .5	20 .0	-9 .5	7 .3	24 .3	-4 .6	9 .1
Kermanshah	16 .1	-9 .6	4 .8	15 .8	-6 .8	5 .4	18 .3	-5 .0	6 .5
Gorgan	23 .5	-3 .1	8 .5	23 .7	-1 .6	8 .9	27 .6	-2 .6	10 .9
Mashhad	21 .6	-3 .6	7 .0	17 .3	-4 .9	6 .0	23 .8	-5 .0	8 .7
Hamedan	14 .8	-15 .4	1 .5	12 .8	-12 .3	2 .1	17 .0	-9 .4	3 .2
Yasuj	15 .6	-6 .0	5 .6	17 .0	-5 .8	5 .1	16 .6	-6 .0	5 .6
Yazd	25 .6	-3 .2	10 .4	24 .7	-2 .9	10 .5	26 .0	2 .2	12 .4

Table 10.

Statistics presented in the table 1.9 of the Iran Statistical Yearbook (2018-2019)

Capital of province	Month					
	Farvardin	Ordibehesht	Khordad	Tir	Mordad	Shahrivar
Arak	19 .6	138 .5	55 .6	0 .0	0 .0	0 .3
Ardebil	10 .8	59 .1	28 .8	4 .3	0 .9	7 .6
Orumiyeh	77 .9	105 .2	22 .6	0 .0	0 .0	2 .6
Esfahan	5 .4	35 .0	7 .9	0 .0	0 .0	0 .0
Ahvaz	31 .8	12 .1	0 .0	0 .0	0 .0	0 .0
Ilam	99 .1	114 .4	0 .1	0 .0	0 .0	0 .0
Bojnurd	24 .8	63 .5	10 .4	0 .1	2 .1	0 .2
Bandar Abbas	2 .3	0 .0	0 .0	0 .0	0 .0	0 .0
Bushehr	0 .3	15 .1	0 .0	0 .0	0 .0	0 .0
Birjand	28 .3	15 .9	0 .0	0 .0	0 .0	0 .0
Tabriz	43 .1	54 .2	35 .9	0 .0	0 .1	9 .8
Tehran	37 .0	32 .9	8 .3	0 .0	0 .0	0 .1
Khorramabad	104 .6	140 .9	12 .9	0 .0	0 .0	2 .4
Rasht	6 .4	36 .9	42 .8	32 .6	46 .6	18 .1
Zahedan	3 .6	0 .1	0 .0	0 .0	0 .0	0 .0
Zanjan	14 .4	61 .0	25 .7	0 .0	0 .7	2 .2
Sari	39 .4	18 .6	11 .7	5 .8	73 .9	12 .8
Semnan	14 .9	27 .0	4 .8	0 .0	0 .1	1 .3
Sanandaj	69 .2	108 .8	5 .2	0 .0	0 .0	0 .1
Shahr-e-Kord	28 .6	48 .6	9 .3	0 .0	0 .0	0 .0
Shiraz	22 .2	38 .2	0 .5	0 .0	0 .0	0 .0
Qazvin	10 .2	58 .7	21 .6	0 .0	0 .0	0 .4
Qom	8 .4	33 .9	15 .2	0 .0	0 .0	0 .0
Karaj	33 .4	37 .6	40 .0	0 .0	0 .0	0 .0
Kerman	26 .7	10 .2	0 .8	0 .0	0 .0	0 .0
Kermanshah	63 .5	168 .0	6 .1	0 .0	0 .0	0 .2
Gorgan	25 .0	17 .8	4 .7	15 .8	22 .0	9 .0
Mashhad	37 .7	41 .8	18 .1	0 .0	0 .0	0 .1
Hamedan	43 .9	129 .3	29 .2	0 .0	0 .0	0 .0
Yasuj	66 .2	128 .6	0 .0	0 .0	0 .0	1 .5
Yazd	10 .9	13 .8	0 .2	0 .0	0 .0	0 .0

Capital of province	Month					
	Mehr	Aban	Azar	Dey	Bahman	Esfand
Arak	5 .5	70 .6	77 .8	75 .5	29 .6	53 .3
Ardebil	8 .9	36 .5	33 .3	28 .5	58 .5	25 .7
Orumiyeh	3 .4	46 .1	102 .2	20 .8	70 .2	63 .9
Esfahan	4 .4	11 .5	30 .0	48 .1	7 .0	4 .8
Ahvaz	13 .9	97 .2	103 .3	29 .8	32 .1	12 .1
Ilam	47 .3	222 .6	165 .2	91 .6	185 .7	102 .6
Bojnurd	15 .9	3 .9	37 .1	32 .9	60 .6	49 .8
Bandar Abbas	0 .5	3 .8	15 .0	0 .1	40 .6	55 .3
Bushehr	30 .0	158 .6	89 .3	23 .0	41 .0	0 .3
Birjand	1 .6	23 .7	5 .2	12 .6	68 .5	40 .8
Tabriz	7 .5	8 .4	86 .6	22 .8	61 .7	33 .9
Tehra	8 .4	49 .9	49 .8	32 .2	29 .6	23 .6
Khorramabad	7 .9	140 .1	146 .8	129 .6	114 .9	89 .1
Rasht	201 .2	145 .9	106 .9	97 .8	218 .9	129 .7
Zahedan	0 .3	0 .1	0 .0	0 .1	6 .0	42 .1
Zanjan	9 .1	26 .3	66 .2	27 .1	47 .3	27 .1
Sari	186 .9	58 .1	45 .1	167 .8	97 .0	170 .4
Semnan	19 .6	10 .6	17 .0	60 .6	11 .3	10 .7
Sanandaj	15 .8	49 .9	111 .8	56 .4	90 .0	43 .4
Shahr-e-Kord	6 .0	54 .4	37 .2	93 .5	20 .0	38 .4
Shiraz	0 .8	42 .9	40 .6	26 .1	55 .1	17 .4
Qazvin	6 .6	39 .6	81 .7	57 .0	27 .9	27 .9
Qom	12 .0	26 .6	21 .7	32 .2	23 .6	31 .5
Kara	17 .8	51 .0	59 .8	45 .7	28 .0	39 .5
Kerman	1 .5	20 .3	0 .6	8 .2	18 .6	13 .8
Kermanshah	30 .1	118 .8	104 .8	34 .9	95 .1	70 .8
Gorgan	54 .5	46 .7	37 .4	125 .5	115 .1	173 .7
Mashhad	6 .9	34 .8	19 .1	13 .4	39 .2	26 .6
Hamedan	17 .7	72 .9	91 .4	50 .3	38 .3	46 .3
Yasuj	0 .4	247 .6	157 .0	180 .5	191 .1	81 .7
Yazd	0 .3	2 .4	0 .2	0 .2	40 .1	2 .3

Table 11.
Statistics presented in the table 1.12 of the Iran Statistical Yearbook (2018-2019)

Capital of province	Year							
	1380	1385	1390	1393	1394	1395	1396	1397
Arak	260	283	199	264	285	374	168	526
Ardebil	234	237	259	279	297	230	232	303
Orumiyeh	228	372	334	347	277	286	244	515
Esfahan	94	220	150	96	96	71	90	154
Ahvaz	235	184	89	137	270	113	90	332
Ilam	598	555	361	383	842	449	559	1029
Bojnurd	176	241	209	250	227	276	121	301
Bandar Abbas	85	277	58	190	152	149	83	118
Bushehr	488	224	124	99	273	80	233	358
Birjand	145	135	95	111	144	97	67	197
Tabriz	210	129	272	300	287	263	315	364
Tehran	192	227	316	134	209	194	160	272
Khorramabad	440	510	286	370	536	563	332	889
Rasht	1262	1476	1637	1318	1388	1479	864	1084
Zahedan	14	55	47	68	104	55	30	52
Zanjan	232	308	366	299	283	230	216	307
Sari	591	684	919	641	725	824	540	888
Semnan	73	177	176	110	108	128	67	178
Sanandaj	310	449	373	265	444	317	337	551
Shahr-e-Kord	334	413	240	297	310	317	150	336
Shiraz	317	305	274	225	272	284	172	244
Qazvin	232	325	424	221	314	297	292	332
Qom	125	111	123	74	112	139	94	205
Karaj	351	302	351	191	221	211	170	353
Kerman	119	134	108	123	110	98	35	101
Kermanshah	357	430	415	224	513	457	342	692
Gorgan	468	522	724	364	478	491	424	647
Mashhad	153	223	254	287	183	287	186	238
Hamedan	225	283	313	172	216	344	208	519
Yasuj	1126	777	661	624	611	533	356	1055
Yazd	60	44	22	43	38	24	24	70

Table 12.

Statistics presented in the table 1.13 of the Iran Statistical Yearbook (2018-2019)

Province	Year								Long term
	1380	1385	1390	1393	1394	1395	1396	1397	
Total country	***195 .98***	***147 .68***	***205 .92***	***220 .2***	***221 .3***	***233 .2***	***232 .3***	***323 .5***	***317 .3***
East Azarbayejan	206 .66	204 .80	295 .60	337 .7	326 .4	279 .0	315 .1	262 .7	256 .8
West Azarbayejan	278 .78	289 .83	407 .57	361 .2	391 .8	319 .2	244 .3	434 .4	379 .8
Ardebil	291 .21	195 .15	378 .85	341 .0	378 .3	338 .2	231 .8	248 .8	301 .4
Esfahan	136 .10	127 .90	144 .56	175 .4	121 .8	128 .9	90 .1	224 .4	167 .8
Alborz	000	000	000	202 .2	388 .9	403 .9	170 .2	191 .3	249 .1
Ilam	432 .08	245 .55	262 .11	357 .5	562 .2	430 .5	559 .0	614 .9	431 .4
Bushehr	457 .87	174 .04	124 .28	124 .3	264 .7	268 .6	233 .0	256 .9	245 .6
Tehran	235 .47	185 .01	380 .99	230 .7	263 .7	307 .0	160 .1	358 .2	304 .7
Chaharmahal & Bakhtiyari	670 .53	432 .25	488 .99	448 .8	500 .0	549 .5	150 .2	386 .6	517 .8
South Khorasan	000	36 .53	99 .10	109 .5	85 .6	94 .4	67 .2	129 .5	113 .4
Khorasan-e-Razavi	114 .95	86 .85	198 .34	236 .1	137 .1	212 .9	185 .9	176 .1	189 .1
North Khorasan	000(2)	185 .51	300 .66	245 .9	257 .3	282 .6	121 .4	207 .4	229 .5
Khuzestan	360 .70	195 .36	179 .27	187 .1	347 .2	244 .6	89 .9	428 .5	285 .3
Zanjan	237 .74	211 .37	383 .55	252 .7	295 .7	280 .4	216 .2	145 .1	286 .1
Semnan	110 .04	105 .22	156 .36	134 .0	111 .3	131 .8	67 .1	186 .2	124 .8
Sistan & Baluchestan	31 .95	48 .78	74 .10	78 .5	71 .0	92 .8	30 .1	58 .3	91 .2
Fars	305 .62	205 .79	226 .74	223 .6	246 .3	374 .2	171 .9	211 .3	267 .1
Qazvin	330 .04	266 .95	422 .24	250 .7	282 .0	283 .2	292 .4	299 .2	289 .2
Qom	107 .95	99 .01	141 .74	80 .5	117 .4	173 .7	93 .6	155 .8	133 .8
Kordestan	399 .62	309 .74	472 .39	392 .1	473 .9	392 .5	336 .8	484 .4	458 .1
Kerman	93 .08	58 .79	79 .30	145 .2	122 .8	135 .1	34 .8	38 .7	128 .9
Kermanshah	370 .12	285 .22	432 .58	331 .8	575 .4	472 .8	341 .8	510 .0	397 .0
Kohgiluyeh & Boyerahmad	712 .05	286 .45	426 .15	417 .2	471 .3	386 .1	356 .2	621 .8	523 .3
Golestan	382 .98	302 .73	567 .95	408 .5	547 .5	557 .6	424 .4	470 .0	435 .0
Gilan	1057 .41	897 .20	1231 .13	1104 .1	977 .2	1011 .6	863 .7	623 .8	1060 .1
Lorestan	405 .97	336 .20	331 .13	412 .2	601 .3	591 .8	331 .5	620 .5	425 .9
Mazandaran	774 .84	570 .26	909 .19	700 .4	722 .4	774 .5	539 .9	712 .2	775 .9
Markazi	193 .89	190 .95	238 .27	232 .5	257 .1	314 .6	167 .7	378 .1	246 .0
Hormozgan	105 .33	93 .91	73 .51	87 .8	184 .2	192 .0	83 .1	111 .5	143 .2
Hamedan	271 .51	248 .53	350 .89	272 .4	354 .9	395 .4	207 .5	416 .4	316 .1
Yazd	76 .19	46 .52	60 .31	87 .8	68 .7	59 .1	23 .7	64 .6	63 .9

Table 13.
Statistics presented in the table 1.15 of the Iran Statistical Yearbook (2018-2019)

Aquatic year	Total country	Caspian Sea	Persian Gulf & Oman Sea	Lake Orumiyeh	Central Plateau	Eastern Border	Qareh Qum
The 49-year average (from the years 1347–1348 through 1395–1396)	405.975	74.973	155.589	17.695	136.521	11.383	9.848
1379-80	299 .550	60 .756	110 .450	12 .031	105 .931	3 .923	6 .459
1384-85	351 .635	66 .164	147 .105	17 .102	109 .583	4 .731	6 .950
1389-90	328 .184	66 .913	120 .200	15 .405	110 .723	8 .331	6 .613
1392-93	357 .175	63 .969	141 .775	14 .635	118 .303	10 .484	8 .009
1393-94	328 .846	80 .725	101 .152	19 .560	108 .311	9 .499	9 .598
1394-9	397 .210	90 .540	153 .160	20 .920	111 .210	10 .070	11 .170
1395-96	378 .390	60 .290	156 .600	14 .360	132 .730	6 .440	7 .970
1396-97	***277.640***	***69.870***	***89.950***	***21.200***	***86.150***	***4.170***	***6.300***

Reference lists

Abbaspour and Tabibiyan (2006). Challenges facing the national sustainable management (In Persian).

Akhbari, M. (2004). The application of data technique has been drawn from the analysis of environmental effects of economic activity and extraction of increasing coefficients of pollution exchange, pollution production, labour and labour productivity, employment. Review of Economic Policies and Policy. (In Persian).

Ailbakhshi, H., & Dourandish, A., & Sabouhi, M. (2019). Investigating the Effects of Climate Change on the Agricultural Market. Agricultural Economics: Iranian Journal of Agricultural Economics (Economics and Agriculture Journal), 13(4), 55 – 86. https://www.sid.ir/en/journal/ViewPaper.aspx?id=756436

Azarm, H., Bakhshoodeh, M., Farajzadeh, Z. (2017). The Effects of Energy Carriers' Price Surging on Damage Cost of Environmental Pollution Emissions in Wheat Production Process in FASA City. *Environmental Researches*, 8(15), 65–76.

Dell, M., Jones, B.F., Olken, B. A., (2008). Climate change and economic growth: Evidence from the last half century. http://www.nber.org/papers/w14132

Ebrahimi, H. (2010). Change on agricultural water consumption regarding to climate changes. Journal of research in crop sciences, 3(9), 109–120. https://www.sid.ir/en/journal/ViewPaper.aspx?id=265435 (In Persian).

Faryadi, S., & Alavi Naeini, A. (2021). Global warming in Tehran and presenting appropriate participatory policies for its mitigation. GEOSCIENCES, 30 (118), 145–152. https://www.sid.ir/en/journal/ViewPaper.aspx?id=813339 (In Persian).

Gates, Bill (2021). How to avoid a climate disaster, the solutions we have and the breakthroughs we need. Canada: Alfred A. Knopf

Ghezelbash, M; Esfandiari. A. (2011). Direct and indirect observations of the creation of various environmental pollutants for different economic sectors. Islamic Azad University of Shiraz. (In Persian).

IPCC, 2018: Annexe I: Glossary [Matthews, J. B. R. (ed.)]. In: *Global Warming of 1.5 °C. An IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the*

context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press

IRAN Meteorological Organization. https://www.irimo.ir/eng/index.php

Iran National Strategy for Development of Statistics, found at https://www.amar.org.ir/Portals/0/map/khane/%D9%86%D9%87%D8%A7%DB%8C%DB%8C%202-%20%20%20%D8%B3%D9%88%D9%85%DB%8C%D9%86%20%D8%A8%D8%B1%D9%86%D8%A7%D9%85%D9%87%20%D9%85%D9%84%DB%8C%20%D8%AA%D9%88%D8%B3%D8%B9%D9%87%20%D8%A2%D9%85%D8%A7%D8%B1%20%DA%A9%D8%B4%D9%88%D8%B1%20%20.pdf (In Persian).

Iran Third Communication to UNFCCC, found at https://unfccc.int/sites/default/files/resource/Third%20National%20communication%20IRAN.pdf, Date: 7 October 2021

Iran Vital Statistics, found at https://www.sabteahval.ir/avej/Page.aspx?mId=49823&ID=3264&Page=Magazines/SquareshowMagazine, Date: 18 September 2021

Iran Energy Balance Sheet, found at https://pep.moe.gov.ir/%D8%A7%D9%86%D8%AA%D8%B4%D8%A7%D8%B1%D8%A7%D8%AA/%DA%86%D9%87%D8%A7%D8%B1-%D8%AF%D9%87%D9%87-%D8%AA%D8%B1%D8%A7%D8%B2%D9%86%D8%A7%D9%85%D9%87-%D8%A7%D9%86%D8%B1%DA%98%DB%8C

Iran Statistical Yearbook, https://www.amar.org.ir/english/Iran-Statistical-Yearbook

Javadi pashaki, K., Ahmad pour, M., Salar pour, M., Ziaee, S. (2020). Measuring the Effect of the Environmental Pollutants in the Trade Balance of the Economy of Sistan & Baluchestan Province based on the input-output Table Pattern. Environmental Research, 11(21), 181–198. (In Persian).

Karbasi, A., Rahimi, N., (2010). Environmental considerations of the energy sector, IEA. (In Persian).

Khaleghi, S., & Bazazan, F., & Madani, S. (2015). The effects of climate change on

agricultural production and iranian economy. Journal Of Agricultural Economics Research, 7 (1 [25]), 113–135. https://www.sid.ir/en/journal/ViewPaper.aspx?id=444291 (In Persian).

Koocheki, A., & Kamali, G. (2010). Climate change and rainfed wheat production in Iran. Iranian Journal of Field Crops Research, 8(3), 508–520. https://www.sid.ir/en/journal/ViewPaper.aspx?id=234444 (In Persian).

Malakoutikhah, Z., & Farajzadeh, Z. (2020). The Effect of Climate Change on Economic Growth in Iran. JOURNAL OF ECONOMICS AND AGRICULTURE DEVELOPMENT, 34(2), 223–238. https://www.sid.ir/en/journal/ViewPaper.aspx?id=758645 (In Persian).

Manzoor, D, Haghighi, A. (2012). In energy prices on environmental pollutants release in Iran, public balance modeling is calculated. Journal of ecology, Year (thirty – seventh number). Winter 90, 12–1. (In Persian).

Nasrollahi, Z, Ahmadi, Z, Eshrati, S. (2013). To measure environmental effects of economic activity in Iran with the data table approach. Quarterly Journal of Economic Modelling (Sixth, Number 1). Spring 2012. (In Persian).

Panahi, H., Esmaeel Darjani, N. (2020). Effects of Global Warming and Climate Changes on Economic Growth (Case Study: Iran provinces during 2002–2012). Journal of Environmental Science and Technology, 22(1), 79–88. (In Persian). doi: 10.22034/jest.2020.22073.3114

Sadeghi K, Karimi, Z, Motafaker Azad, H.Andayesh, H. (2014). Studying the effects of carbon footprint in Iran with the approach of the social accounting matrix (SAM). The Quarterly Review of Economics (former economic studies. [In Persian].

Shaemi, A. (2008). Assessment of Bioclimatic Zone Sensivity under Global Warming by Using Holderich Life Zone Model in Iran. The Journal of Spatial Planning, 12 [2], 79–117. [In Persian].

Summary of Environment status of Iran. Found at https://www.doe.ir/download/gozareshmohitzist.pdf, date: 18 September 2021

Vafadar and Abedini, (2018). The Effect of Global Warming of the Sensitive Coastal Ecosystems. National Symposium of Climate Change and Water ecosystems. Bandar Abbas, Iran. [In Persian]. https://civilica.com/doc/804887

Locating of Semnan General Logistics Park by AHP method and GIS

Seyyed Mohammad Sadat Hosseini

seyyed_mohamad@yahoo.com
Master of Transportation Planning, Imam Khomeini International University, Iran

Seyed Alireza Mousavinejad

Semnan-kala@rmto.ir
kaka.alireza@yahoo.com
Master of Regional Planning, University of Tehran, Iran

The existence of logistics centers in a country makes an appropriate basis for the development of domestic and international freight transportation. In Iran, logistics centers include logistics cities, logistics villages, general and agricultural logistics parks that their locations have been determined in the "preparation document of the country's logistics centers", which was provided by the Office of comprehensive Plan and Transportation Models of the Ministry of Roads and Urban Development of Iran, in November 2018. One of the parks among 12 general logistics parks have been located in Iran, is General Logistics Park of Semnan arena. In this paper, based on technical and specialized criteria related to the locating of logistics centers, especially of general logistics parks, and by Fuzzy Analytic Hierarchy Process (F-AHP) method and also Arc GIS software, the best location for the establishment of general logistics park in Semnan arena, is identified and proposed.

Keywords: F-AHP, Geospatial Information System (GIS), Logistics Centers, Locating of Logistics Park.

1. Introduction

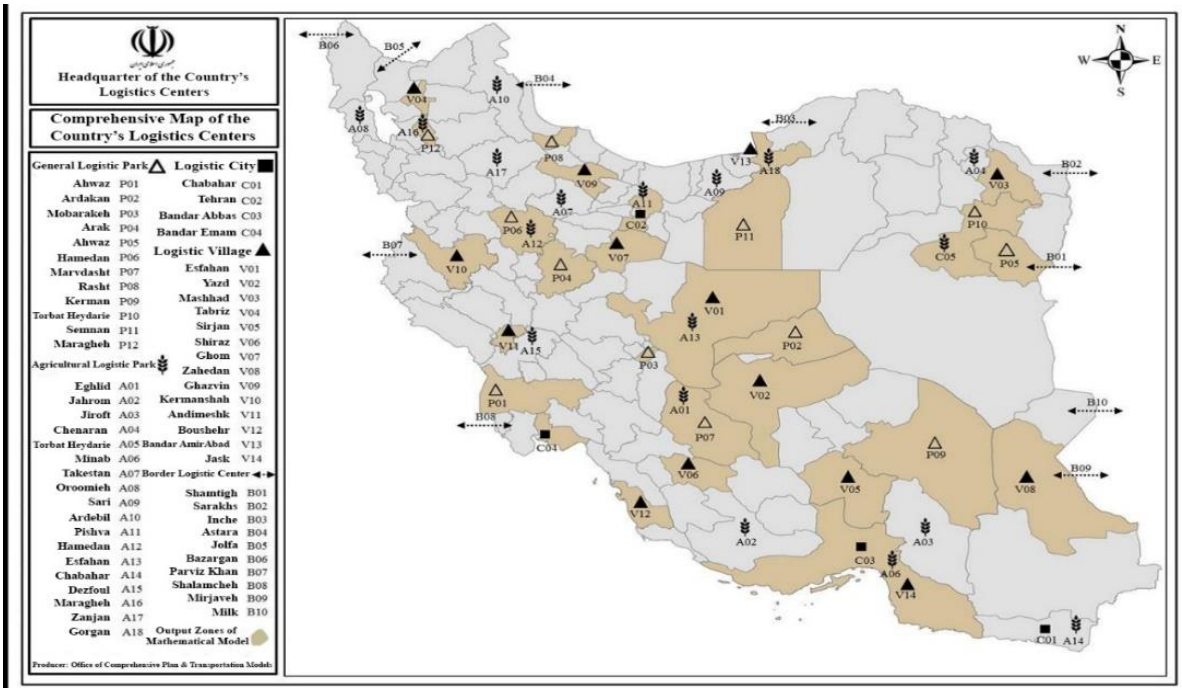
One of the indicators of the economic development of any country is its progress in freight transportation. One of the important infrastructures in the development and expansion of domestic and international freight transportation in each country is the existence of logistics centers such as logistics cities, logistics villages, and general, specialized and agricultural logistics parks. The most important operation of the logistics parks is to create a suitable basis for creating combined or multi-modal transportation

(with at least two modes of transport) to transport all kinds of goods, both domestically and internationally.

In the preparation document of the country's logistics centers, which was prepared by the office of the comprehensive plan and transportation models of the Ministry of Roads and Urban Development in 2018, logistics centers are located in different zones (Figure 1), but it is necessary to determine the accurate location of the logistics center in each zone.

Figure 1:

Comprehensive map of the country's logistics centers in Iran



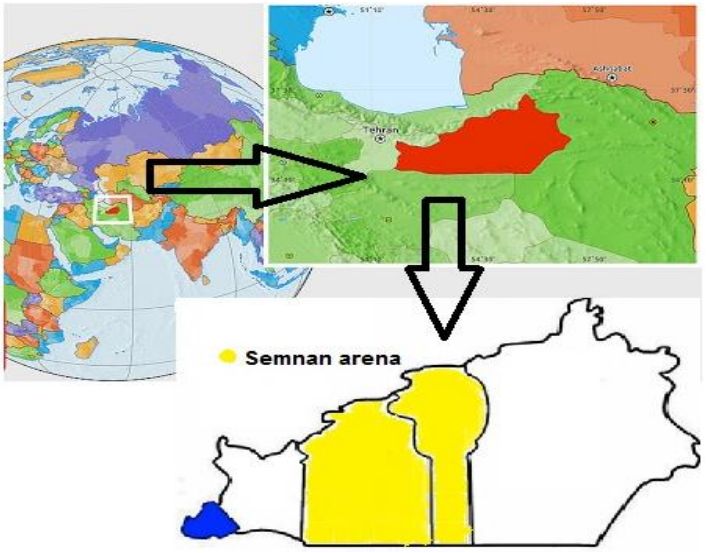
Since Semnan province is located at the crossroads of the north-south and east-west routes in Iran for freight transportation and because of the importance of movement of all kinds of goods in the shortest time and at the lowest possible cost, and the important position of the province Semnan as one of the production-industrial hubs of the country, in this article, we intend to locate one of the logistics centers of the country, namely the general logistics park of Semnan arena (P11 in Figure 1). Semnan arena (including the cities of Semnan and Damghan), with an area of 35,845 Km^2, which is located at the north of the Kavir plain and south of the Alborz Mountain ranges is shown in figure 2. Since in the mentioned preparation document, a general logistics park has been foreseen in the Semnan arena which is one of the 12 general logistics parks in the country, based on technical and specialized criteria related to the locating of logistics centers, especially of general logistics parks, and by Fuzzy Analytic Hierarchy Process (F-AHP) method and Arc GIS software, the best location for the establishment of general logistics park in Semnan arena, is identified and proposed.

1.1 Definition of the logistics center

Logistics centers include the logistics city, logistics village, border logistics center, general and agricultural logistics parks, which must be established in designated places for the development and prosperity of domestic or international freight transportation. To learn more about one of the types of logistics centers, namely general logistics park, we refer to the definition of general logistics park mentioned in "the preparation document of the country's logistics centers":

General Logistics Park: These logistics centers play a centralizing role in logistics services related to domestic cargo. The cargo processed in these centers generally has a domestic origin and destination and belongs to all categories of goods and practically aims to reduce domestic logistics costs, improve combined transport and improve the logistics efficiency of the country by providing a wide range of added-value services. This type of logistics centers have a national scope of activity, have a multi-modal terminal, which provides logistics services to different types of goods groups, including composition, distribution, unloading, loading, storage, legal inspections related to the movement of goods and added-value services [1].

Figure 2.
Location of Semnan arena in Iran



2. Methodology

Its exact location will suggested based on technical and specialized criteria related to the locating of logistics centers, especially of general logistics parks by Fuzzy Analytic Hierarchy Process method (F-AHP) as well as Arc GIS software.

For this purpose, we first consider the main and most important criteria for locating a general logistics park and then seek the opinions of experts and specialists about the prioritization of criteria through the AHP questionnaire. Then we evaluate the reliability of the results obtained from the questionnaires. If the reliability of their opinions is confirmed,

according to their opinions and by the Expert Choice software, each criterion is weighted. Corresponding to each criterion, a layer is defined and uploaded in the GIS software. After we obtain distance layer and fuzzy them, related weights are multiplied in the fuzzy layers and then we combine and overlay the weighted layers in the software to identify a suitable area or areas for the establishment of the logistics park. Finally, the selected areas are compared in terms of area, environmental principles, and proximity to or distance from the city, and the best option is selected.

3. Data analysis

3.1. Introducing criteria for spatial locating

To find the best location for any unit, including commercial, service, etc., many and various criteria are considered, depending on its type of use. Likewise, relevant technical and specialized criteria should be considered to find the best place for the establishment of a general logistics park. In the literature of researches related to the locating of logistics centers and logistics parks, various and different criteria have been presented and proposed.

Ismail Onden et al. Consider spatial criteria including proximity to railways, main roads, seaports, and airports, and some other criteria, such as population, to be important for a suitable location for a logistics center [2]. Kirrilov and Tselin propose the following general criteria for assessing the target area: business climate, financial attractiveness (general and logistics costs), the environmental conditions, consumer market proximity, presence of a competitive environment, logistics infrastructure, availability of professionally trained personnel, market suppliers, political risks and competitive advantages [3]. According to Mironyuk, the main criteria for the placement of logistics centers at the regional level are: the intersection of traffic flow of one or more modes of transport; availability of transport, warehousing, and logistics infrastructure for the processing of traffic and customer service; ability to handle multiple types of transport; urban areas should have high population density; placements should relate to regional development goals [4]. Uysal and Yavuz used the following criteria to analyze the study area: proximity to seaports and airports, distance to residential areas, availability of labor, security of the environment, availability of highways and roads, traffic density [5]. Rao et al. Point to some other criteria such as the price of the leased land, the impact on the environment, the natural conditions, the impact of the logistics center on nearby residents and traffic congestion, etc. [6]. Zak and Weglinski pay attention to the criteria of proximity to the airport, construction cost in urban areas, air pollution, etc. [7]. Rikalović et al. Consider some other criteria for locating a logistics center, such as spatial position, inter-modal connections (road, water, air and, rail transport), the size of the available location, topography, environment, ecological aspect of the location, constraints in the area, etc. [8]. In the technical report prepared for the Asian Development Bank, the connection and intersection of the road, rail and, air modes of transportation in the logistics center have been considered as important criteria [9]. In a research project conducted by Isfahan Management and Planning Organization, regarding the locating of logistics centers in Isfahan province in 2019, these criteria have been considered: distance from environmentally protected areas, land cover constraints, land slope, fault risk areas, distance from flood plains, the environmental limit of cities, Proximity

to airports and customs, proximity to special commercial areas, proximity to industrial areas and industrial towns, agricultural and mining areas, urban and rural settlements, distance from freight entry/exit points of the province, distance from main roads, distance from Railways, distance from electricity, gas and telecommunications infrastructures [10].

From all the proposed criteria mentioned above, and taking into account the economic, environmental, social and, geographical conditions of the study area (i.e. Semnan Arena (including the cities of Semnan and Damghan)), some important criteria that are effective in locating the general logistics park were considered: 1- Low slope regions, 2- Distance from faults and earthquake centers, 3- Distance from rivers, waterways and, floodways, 4- Proximity to production-industrial towns and mines, 5- Proximity to the main roads 6- Proximity to the railway, 7- Proximity to the airport, which are considered as the main geographical or spatial criteria in this article, and the environmental criteria of the region, the area of the selected region, distance from the city or proximity to it, are additional criteria that will be discussed later.

3.2. Opinions of specialists and experts according to AHP questionnaire

After identifying the criteria that are effective and important in locating the general logistics park, it then should be examined which criterion and to what extent is more important than another one. For this purpose, a questionnaire was prepared and the opinions of some experts in the fields of transportation and also urban planning were gathered. In this questionnaire, the criteria affecting the location of the logistics park were compared in pairs. If two criteria were in equal importance for the expert, the number 1, was assigned to it, and if one of the criteria was more important than the other, in expert's opinion, a number from range 2-9 (based on its importance) was assigned to it. For example, if the criterion of "proximity to the main road" is 7 times more important than the criterion of "distance from rivers, waterways and floodways", the number "7", which is close to the criterion of "proximity to the main road", is chosen by the expert.

Figure 3.

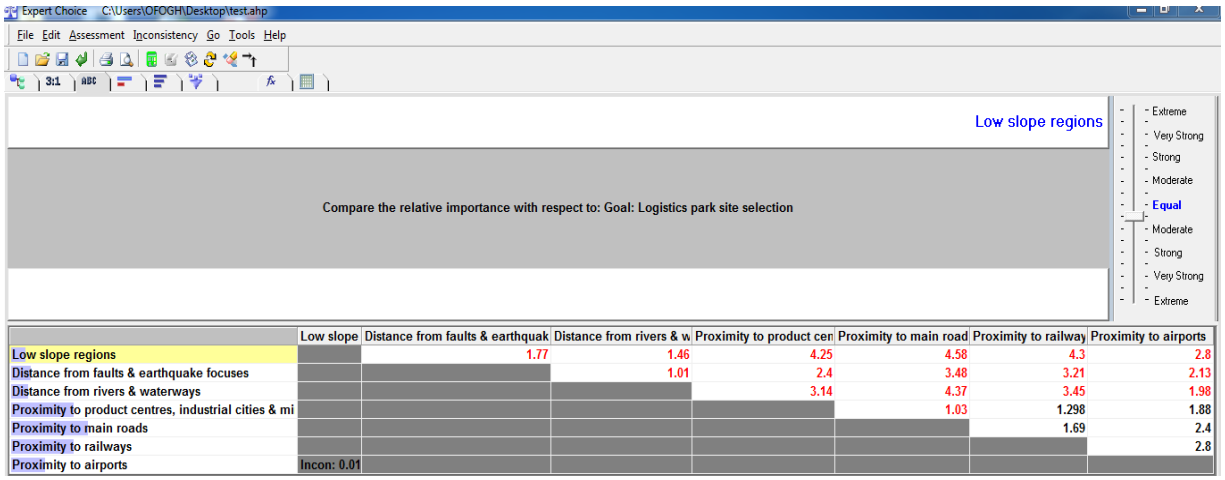
One of the questionnaire tables completed by one of the experts

Criterion j	Priorities																	Criterion i
Proximity to production –industrial towns and mines	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Distance from rivers, waterways and floodways
Proximity to the main roads	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Distance from rivers, waterways and floodways
Proximity to the railway	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Distance from rivers, waterways and floodways
Proximity to the airport	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Distance from rivers, waterways and floodways

To aggregate and average all the opinions of the respondent experts, a geometric mean was taken from their responses to each of the pairwise criteria comparisons. Then the results obtained from the geometric mean were entered in Expert Choice software as a criteria comparison matrix.

Figure 4.

Recording the opinions of experts as a comparison matrix in Expert Choice software



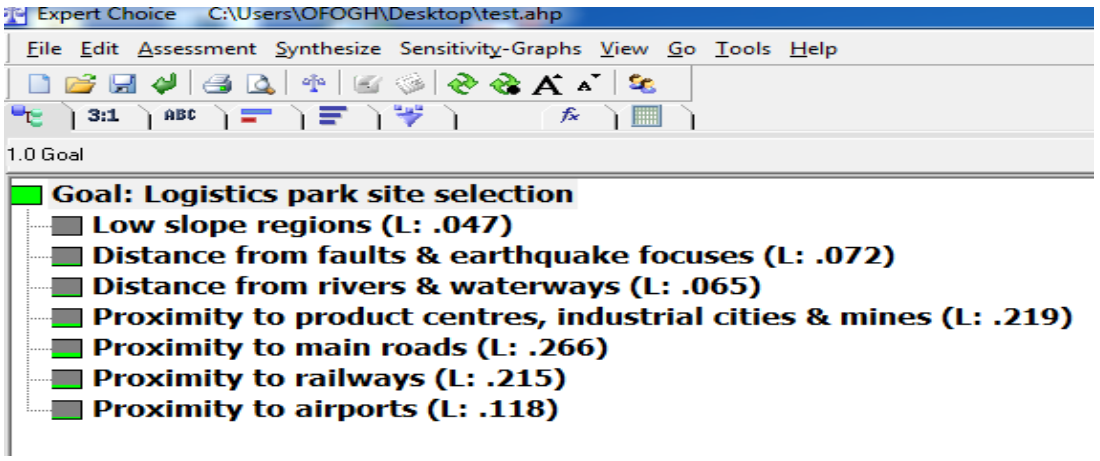
	Low slope	Distance from faults & earthquak	Distance from rivers & w	Proximity to product cen	Proximity to main road	Proximity to railway	Proximity to airports
Low slope regions		1.77	1.46	4.25	4.58	4.3	2.8
Distance from faults & earthquake focuses			1.01	2.4	3.48	3.21	2.13
Distance from rivers & waterways				3.14	4.37	3.45	1.98
Proximity to product centres, industrial cities & mi					1.03	1.298	1.88
Proximity to main roads						1.69	2.4
Proximity to railways							2.8
Proximity to airports	Incon: 0.01						

To control the reliability of the information collected from the questionnaires, we do this: If the inconsistency rate is less than 0.1, the answers and opinions of experts are reliable. As can be seen in Figure 4, the incompatibility rate is 0.01, which (0.1> 0.01) indicates that the average of the answers and opinions of the experts has a good reliability.

After completing the criteria comparison matrix, the weight of each criterion was resulted from Expert Choice software that is shown in Figure 5.

Figure 5.

Weights of criteria resulted from Expert Choice software



The weights of the main criteria is summarized in the following table:

Table 1.
Weights of the main criteria

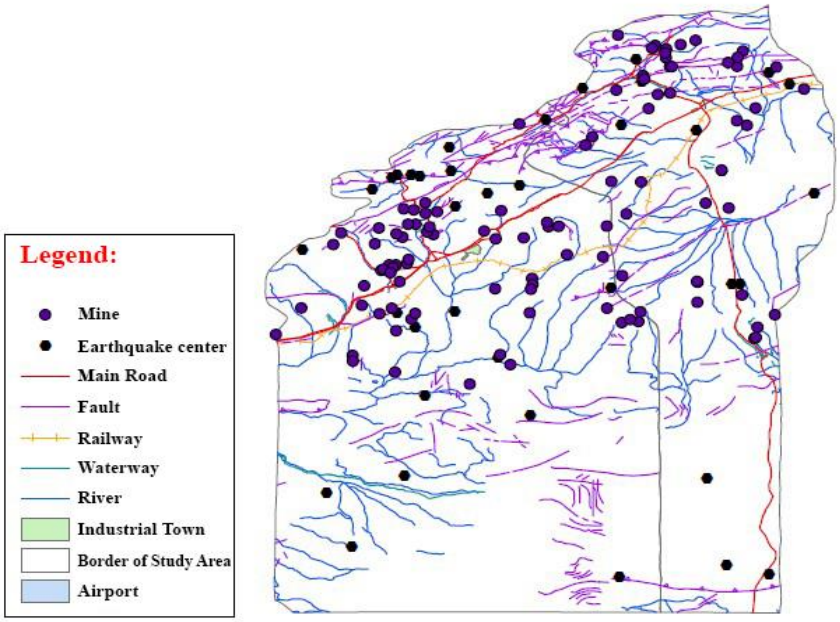
	Regions with low slope	Distance from faults and earthquake centers	Distance from rivers, waterways and, floodways	Proximity to production-industrial towns and mines	Proximity to the main roads	Proximity to the railway	Proximity to the airport
Weights resulted from Expert Choice	0.047	0.072	0.065	0.219	0.266	0.215	0.118

3.3. Input information in Arc map software

Geospatial information System (GIS) is a powerful tool that can be used to locate places with different uses in a variety of specialized fields, including transportation.

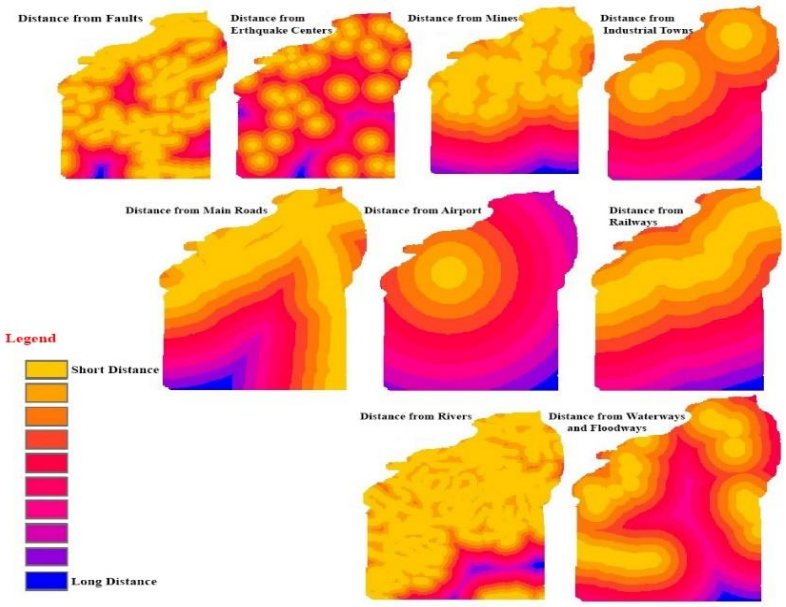
In this study, we used Arc map software version 10.4.1 to upload data and locate the general logistics park. First, we entered the layers of main roads, railways, airport location, slope layer, industrial towns, mines, faults, earthquake centers, rivers and, waterways of the study area in the software environment, which can be seen in Figure 6.

Figure 6.
Study area



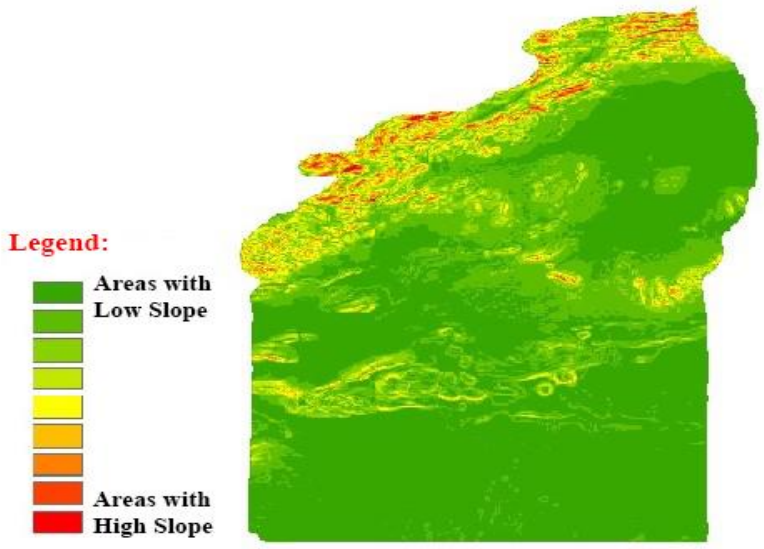
Since to identify the best place to establish a general logistics park, more or less distance from the mentioned 7 items is important and decisive, in the next step, we made the distance layer from each of the mentioned layers by the software that is shown in Figure 7.

Figure 7.
Distance layer of natural features, centers, etc.



Remarkably, the slope layer was made from the DEM layer of the arena that is shown in Figure 8.

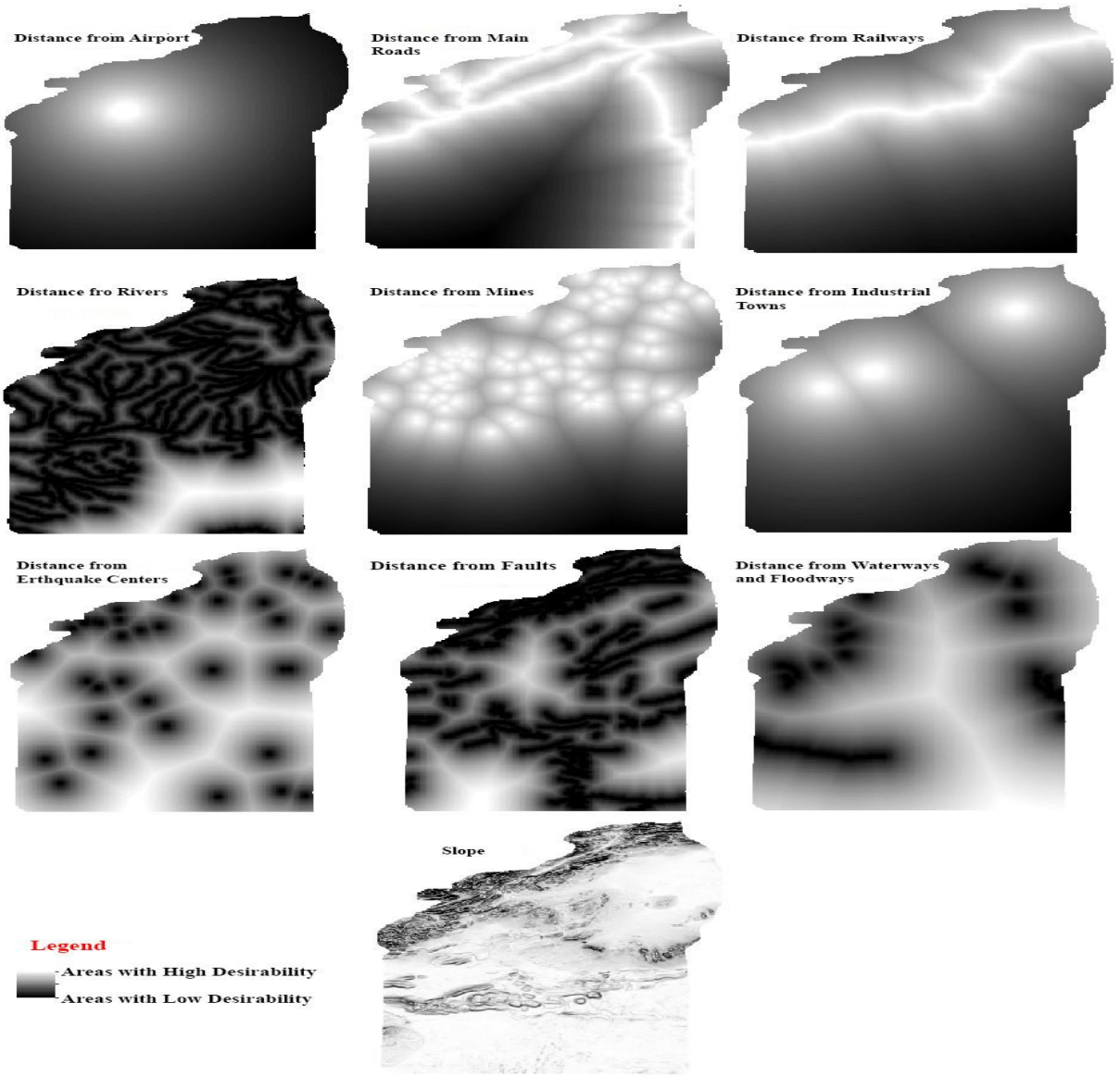
Figure 8.
Layer of the slope of the region



Then, the distance raster made in the previous step, were converted into fuzzy raster by functions or operators like large, small, etc., and then we multiplied the resulting raster

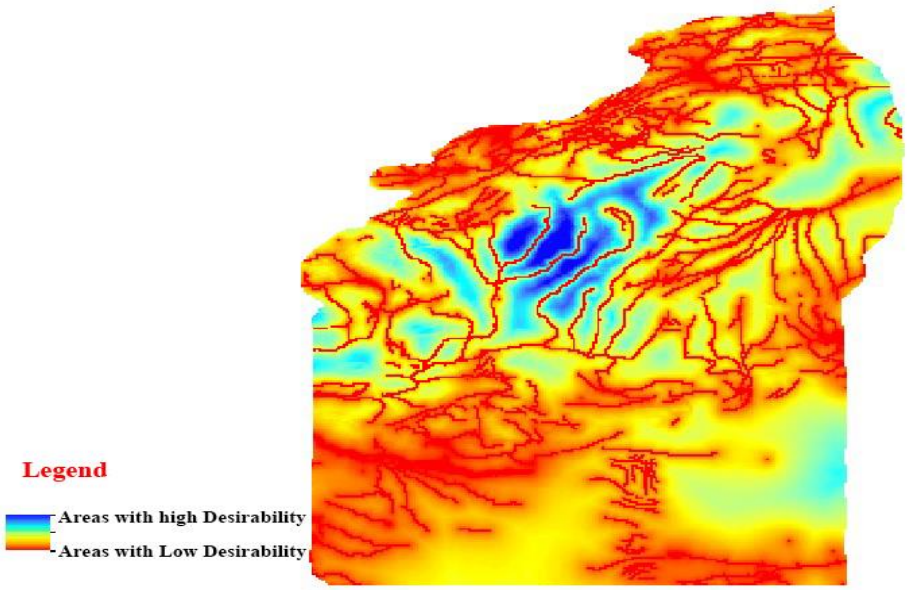
in their weights, which were acquired according to experts' opinions and were summarized in Table 1. So, we multiplied the weight of each criterion into the fuzzy raster and weighed them. For example, to fuzzy the distance raster of the fault, since the greater the distance from the fault is more desirable, we used the function "large", or to fuzzy the raster of "distance from the main road", since the shorter the distance from the main road, the more favorable the region to establish the logistics park, we used function "small". We then weighed all the fuzzy raster that are shown in Figure 9.

Figure 9.
Fuzzy raster that has been weighted



Then we overlay the weighted raster in the software environment using the function "gamma"(with factor 0.7), and finally, the following map was acquired.

Figure 10.
The final result acquired from the software



According to the final map (Figure 10), the dark blue spots indicate the areas that are most desirable for the establishment of a general logistics park, which is totally about 20,000 hectares.

4.Discussion and Findings

Since the distance from the city boundary line, for the establishment of the transportation terminal (unit of class 3) should be at least 250 meters [11] so as not to have environmental hazards for the city, and whereas the blue areas are outside the city limits, so the establishment of a logistics park in the mentioned area is environmentally safe.

Of course, an important issue here is whether the distance from the city is desirable or not. The proximity of the logistics park to urban areas and population centers is desirable because it reduces the cost of moving laborers and park personnel to the logistics park, and proximity to the final consumer or consumption market is a strong point for the logistics park. On the other hand, the proximity to the city leads to environmental and noise pollution for the residents of the city and also is effective in increasing urban traffic. Therefore, to determine distance from the city, the most optimal place should be considered by indigenous experts.

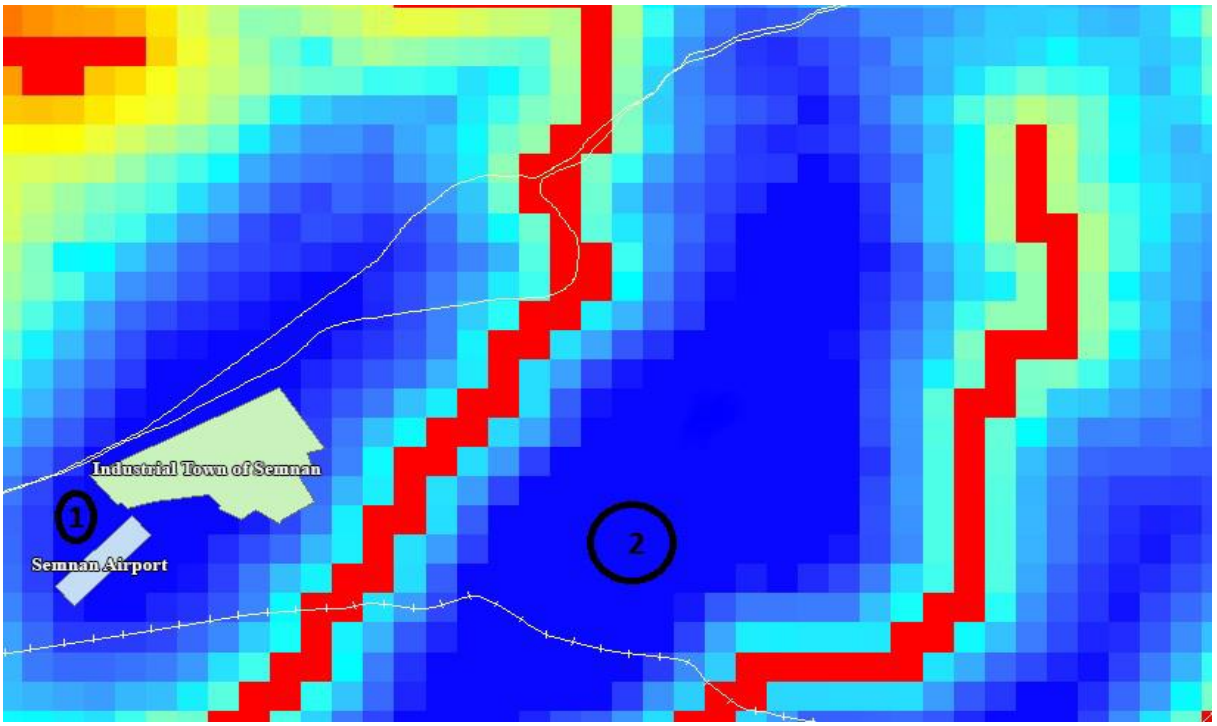
Considering that the desired area for the establishment of a logistics center outside the cities, is at least about 1 square kilometer [12], so to establish a general logistics park, it is necessary to consider an acceptable area.

Considering the mentioned criteria and points, in the area that has the most desirability and was marked in blue, naturally, regions are more desirable that meet the above 7 criteria as much as possible and also meet all the environmental criteria, the acceptable area and the optimal distance from the city mentioned above. It is worth mentioning that to complete the results acquired from the software, it is necessary to conduct a field visit from selected areas to approve the 7 criteria that were controlled by the

software, and also to determine the appropriate location in terms of operational and Executive items, on the ground.

From all the points mentioned, in our opinion, a point in the blue area that has suitable access to the rail and the main road and is proximate to the industrial town and the airport and meets other criteria, is our first suggested option that has been shown by number 1 in Figure 11. In the second priority and if the operational conditions for the implementation of the first option are not met, the second proposed alternative, which is identified by number 2, is another suggestion for the establishment of Semnan General Logistics Park.

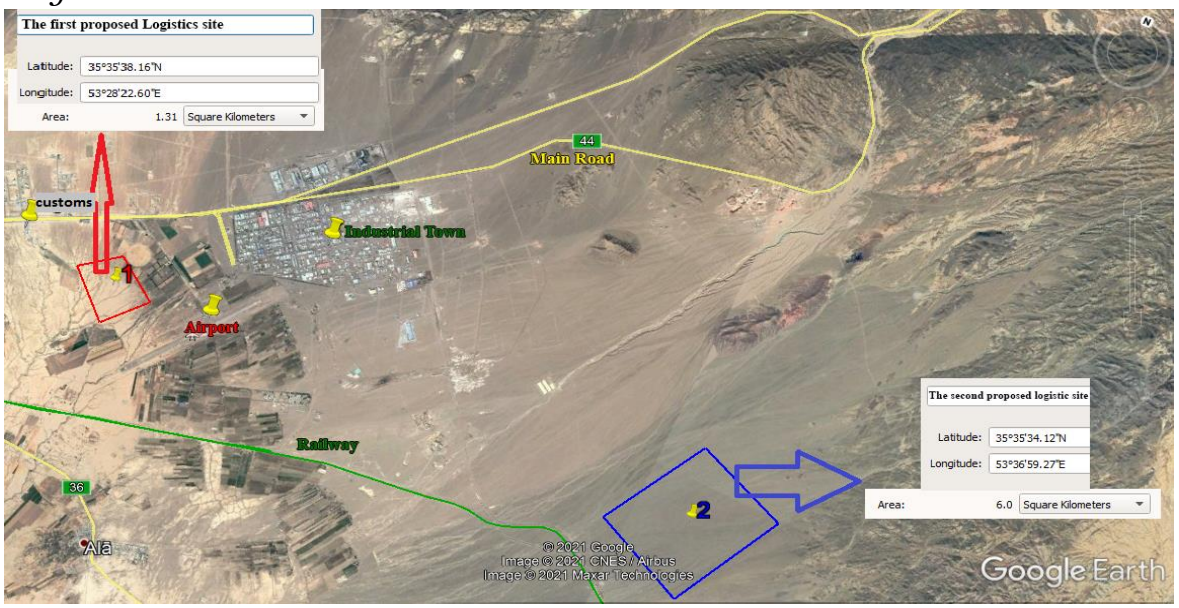
Figure 11.
Suggested alternatives



To clear the geographical characteristics of the two suggested alternatives, by matching the mentioned areas in the Google Earth software, the longitude and latitude of the center of alternatives 1 and 2 are acquired, which their specifications are shown in Figure 12.

Figure 12.

Display of suggested alternatives in Google Earth software by their latitude and longitude



Conclusion

For the establishment of any unit, it is suitable at first to simulate target areas in a computer space according to the criteria, before executing and operating it on the ground, so that either decision making becomes easier for managers or budgets and capitals are spent properly. In this article, we used the AHP method as well as the powerful tool of Geospatial information System (GIS software) to locate the Semnan General Logistics Park so that the best locations for the establishment of the park were introduced in the software environment. Of course, it is necessary to look at the region from a real and operational perspective, by conducting field visits from desired areas resulted from the software to choose the best region or regions.

It is hoped that by the increase in quantity and quality of rail transport infrastructure in the country and hence improving its performance, the desire of goods owners and freight carriers to use rail transport will increase and the natural need for the formation of logistics centers in the country will create and increase day by day.

Reference lists

Preparation document of the country's logistics centers, Deputy Minister of Transportation of Ministry of Roads and Urban Development, Office of comprehensive Plan and Transportation Models, version 1.01, November 2018.

Önden İ, Acar AZ, Eldemir F. Evaluation of the logistics center locations using a multi-criteria spatial approach. Transport. 2018 Jan 26; 33(2):322-34.

Kirillov A, Tselin V. Model postroyeniya seti distributsii na osnove mnogofaktornogo analiza promyshlenno-logisticheskogo potentsiala regionov. Ekonomika regiona, (4), 2015.

Mironyuk V.P. Mttodika opredeleniya polozheniya transportno-logisticheskikh tsentrov na territorii Rostovskoy oblast. Inzhenerniy vestnik Dona, 19(1), 2012.

Uysal H, Yavuz K. Selection of Logistics Centre Location via ELECTRE Method: A Case Study in Turkey. International Journal of Business and Social Science. 2014 Aug 1; 5(9).

Rao C, Goh M, Zhao Y, & Zheng J. Location selection of city logistics centers under sustainability. Transportation Research Part D: Transport and Environment, 36, 29-44, 2015.

Żak J, Węgliński S. The selection of the logistics center location based on MCDM/A methodology. Transportation Research Procedia. 2014 Jan 1; v3:555-64.

Rikalovic A, Soares G, Ignjatic J. Analysis Of Logistics Center Location: A GIS – Based Approach. VI International Symposium New Horizons of Transport and Communications. November 2017.

Cubukgil A. Trade Facilitation and Customs Cooperation. PRC-Xinjiang Uygur Autonomous Region: Logistics Development Strategy. Technical assistance consultant's report. January 2006.

Demand Analysis and Locating of Logistics Centers, Isfahan Management and Planning Organization, Isfahan, Iran, May 2019.

Environmental criteria for the establishment of service units, Environmental Assessment Office of the Environmental Protection Organization of Iran, March 2020.

Development of commercial infrastructure in the country with emphasis on logistics centers, Institute of Business Studies and Research, Department of Internal Business Studies and Research. Iran, February 2020.

NEXUS OF CLIMATE CHANGE, SUSTAINABLE DEVELOPMENT GOALS AND VULNERABILITY OF MARITIME SECTORS – CASE OF PAKISTAN

Fasiha Safdar

fasiha.nima@bahria.edu.pk

Wajih Ur Rehman

wajihurrehman2014@gmail.com

Salman Ul Haq

ulhaqsalman14@gmail.com

National Institute of Maritime Affairs,

Bahria University, Shangrilla Road, Sector E-8, Islamabad, Pakistan.

The seas and coasts worldwide are vulnerable to climate change because of being at the natural ecosystems, at the forefront of changing weather patterns. The maritime sector of any country has the potential of transforming it into an economic force if sustained and managed properly. Oceans provide great ecosystem services, benefitting coastal communities in the process as well. However, increasing vulnerabilities due to climate change impact the vital coastal areas. Rising sea levels may result in inundation of low-lying areas, degradation of crucial mangrove forests, compromised water quality, and disrupted ecosystem services. The convergence of natural and anthropogenic factors exposes Pakistan's maritime sectors to heightened vulnerability. A case of maritime sector's vulnerability, studying Pakistan as a case, has been presented here in light of the changing properties of the Indian Ocean. The role of sustainable development in uplifting the local coastal communities and reducing vulnerability of the maritime sector has been explored in the study as well.

Keywords: climate change, vulnerability, maritime sector, SDGs, coastal communities.

1.Introduction

Temperatures are rising, not only on land but also in the oceans. Intergovernmental panel on Climate Change (IPCC) has repeatedly proclaimed that human-induced climate change is real and happening at full pace. According to the World Meteorological Organisation (WMO), 2023 was the warmest year on record with the highest temperatures not only on land but also in seas around the globe and unprecedented levels of ocean acidification, sea level rise and ice sheets/glacier retreat. IPCC has reported that global surface temperature have reached 1.1°C above 1850-1900 in 2011-2020 while the increase in ocean water temperatures lies around 0.88°C during the same period (Calvin et al., 2023).

The unprecedented rise in global temperatures has had a drastic impact on the ocean systems of the world. Because of their valuable services to the climate and biodiversity, oceans are at the core of the climate change crisis. The most evident impacts of ocean warming, and ocean acidification are manifested in the form of negative effects on food production from fisheries and shellfish aquaculture in some oceanic regions.

Oceans also play an important part in regulating the climate of Earth; by not only acting as a sink for Carbon Dioxide but also for extra heat in the atmosphere (IPCC, 2013). Due to higher heat capacity of water, large bodies of water can absorb heat and store it. Excess CO_2 also gets absorbed into the bodies of water, making them acidic and ultimately harming the millions of fish and other marine biodiversity forms. The ocean doesn't just store solar radiation, it also helps to distribute heat around the globe. Powered by solar radiation, Earth's rotation and evaporation, Ocean currents help to distribute heat and wind around the planet (NOAA). Without these vital services, biodiversity on the planet could not have thrived, however, all these services have been compromised due to changing temperatures of water bodies and related impacts of climate change.

In the past 30 years (since 1990), marine heatwaves have increased in frequency by around 50% (Smale et al., 2019). These heatwaves are a result of a vast range of events happening at different spatial and temporal scales, from localized factors such as air-sea heat flux to large-scale climatic processes, such as the El Niño Southern Oscillation (ENSO) (Smale et al., 2019). Marine heat waves have been defined as "periods when daily sea-surface temperatures (SSTs) exceed a local seasonal threshold (that is, the 90th percentile of climatological SST observations) for at least 5 consecutive days" (Hobday et al., 2016). Marine heatwaves have been given increased importance in the recent years because they have a range of ecological impacts like loss or shifting of aquatic species, bleaching of coral reefs and economic impacts due to losses in fish productivity.

2. Climate change impacts in the indian ocean

Indian Ocean has attained great significance over the years and has evolved into the most concentrated area where global economic activity meets political interests. It is a home to world's busiest waterways and chokepoints (Fatima & Jamshed, 2015). However, the importance of Indian Ocean is not only limited to its political and economic significance, it's ecological and environmental significance is also paramount.

Recent research and the Intergovernmental Panel on Climate Change (IPCC) reports point out that the Indian Ocean and the western Boundary Current have warmed the fastest since the 1950s. The Sea Surface Temperature (SST) warming trend in the Indian Ocean was strongest during the last seven decades (1950–2020), at a rate of 0.12°C per decade. These trends are very small compared to the projected surface warming of 3°C between 2020 and the end of the century, if emissions from human activities continue to increase at the current rate (Roxy et al., 2024).

The geography of Indian Ocean makes a majority of the Indian Ocean filled with the tropical warm water, with a permanently warm surface temperature of greater than 28°C, and is therefore often called the "heat engine of the globe"(Beal et al., 2020).

Warming trend in the Indian Ocean has impacts on the temperature and rainfall on land. It has contributed to increasing monsoon droughts and floods, and pre-monsoon heatwaves over South Asia by altering the temperature gradient between land and sea surface temperatures (Wang et al., 2020). It has also led to repercussions in Eastern Africa in the form of more frequent droughts and occasional locust outbreaks (Roxy et al., 2024), a phenomena which has also been observed to a surprisingly frequent extent in Pakistan's agricultural plains as well, threatening food security in this region.

The increase in ocean heat content has resulted in a rise in sea level via thermal expansion of seawater, a potential increase in extremely severe cyclones and their rapid intensification. Sea Surface Temperatures drive the circulation patterns through process like El Niño-Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD)(Kumar et al., 2024). SST, thus has a crucial role in regulating terrestrial climate as an influential external factor, manifesting it's impacts on drought conditions, precipitation, temperature, soil moisture, and photosynthetic activity of vegetation, highlighting the link between oceans and terrestrial ecosystems.

The increase in atmospheric CO_2 and the associated ocean warming have very likely contributed to biogeochemical changes in the tropical Indian Ocean. These biogeochemical changes include the observed decreasing trends in pH, dissolved oceanic oxygen concentrations and marine phytoplankton distribution in the tropical Indian Ocean. Combined, the more frequent marine heatwaves and biogeochemical changes potentially impact the marine ecosystem and fisheries in the tropical Indian Ocean (Roxy et al., 2024; Smale et al., 2019; Hobday et al., 2016).

3.Climate change impacts on coastal areas of Pakistan

Mean monthly temperature data from Pakistan Meteorological Department has been used to investigate the changing patterns of temperature over Pakistan in this section. Figure 1 shows a significant (p-value < 0.0001) increase of 0.028° C /year over 41 years from 1978-2018. The increase is steeper in the duration of 2008-2018, rise being 0.07 ° C/year. Similarly, there is a significant increase in temperatures during all seasons in Pakistan. Highest increase is observed in pre-monsoon season with 0.05 ° C/year. There is an increasing evidence that increasing SST in the Indian Ocean have resulted in increased heat waves in the pre-monsoon season in the Indian Subcontinent and a decrease in monsoon rainfall in the Indian subcontinent (Kumar et al., 2024; Roxy et al., 2024).

This increase in temperatures has been further investigated by calculating the trends in different climatic zones of Pakistan over different seasons. Figure 2 presents the precipitation trends in the as classified in the study by Safdar et al., 2023.

Figure 1.

Temperature trends over Pakistan. The rise in temperature is steeper in the recent years 2008-2018 (0.07 ° C /year) as compared to the long term trend from 1978-2018 (0.028°C/year)

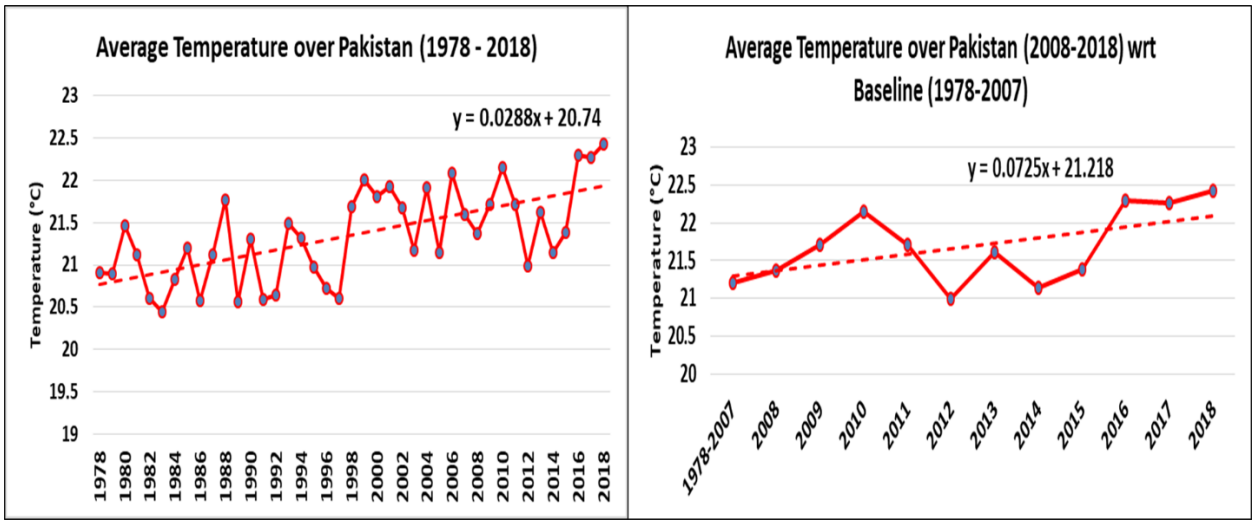
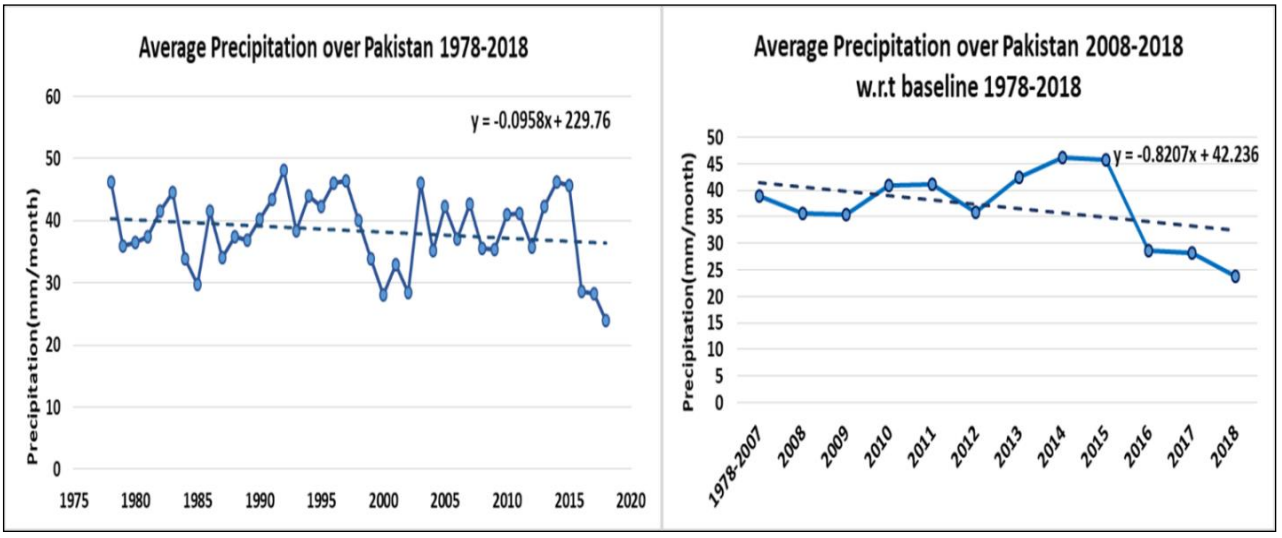


Figure 2.

Precipitation trends over Pakistan. The fall in precipitation is steeper in the recent years 2008-2018 as compared to the long term trend from 1978-2018.



According to the temperature and precipitation changes because of climate change in Pakistan, there has been a reduction in flow of river Indus. As a result, the creeks of Indus delta virtually converted to tidal creek with high salinity value and high pollution load and Sea water intruded up to 65-100 kms within coastland.

Sea water intrusion contaminates the ground water aquifers and adversely affects the agricultural soils. Due to marked decline in agriculture land the local community has shifted

their traditional profession of agriculture to fishing. This has brought about decline in fish catch (Alamgir et al., 2015).

The decline in wetland productivity has resulted in the local population being more vulnerable to climate change problem and in fact most of the people are living below poverty line where the standard of living is well below as compared to any national or international standard. This area is typically vulnerable for tropical cyclones. Although the frequency of cyclones has not increased significantly but the intensity has increased at an alarming rate. Pakistan has mangrove forest coverage of around 150,000 ha, which has been steadily increasing over the last 30 years. However, the growth of mangroves in Pakistan is facing serious threats including climate change, salt-water intrusion, a shortage of fresh water due to upstream dam construction and agriculture, pollution, and urbanization. Pakistan has no comprehensive laws for the protection of mangroves or wetlands, although there are numerous policies and Acts which provide for the protection of mangroves and which control and monitor their threats. Due to weak institutions, the implementation of these policies and Acts has become difficult.

4.Vulnerability of maritime sectors – case of Pakistan

Pakistan's maritime landscape is diverse, encompassing a spectrum of vital sub-sectors crucial for the nation's economic, environmental, and cultural fabric. From the maritime transportation facilitating regional trade to the intricate ecosystems of mangroves and coral reefs providing invaluable services, each facet plays a pivotal role. The infrastructure of ports and harbors, the Gadani Ship Recycling Yard, marine fisheries, and the interdependent livelihoods of coastal communities constitute essential elements (UNCTAD, 2020). Additionally, maritime tourism, heritage sites, energy resources, coastal ecology, and agricultural productivity face the impacts of seawater intrusion.

Derived from an extensive literature review encompassing scientific studies, reports, and expert insights from focused group discussions, this report has selected 12 major areas that represent the maritime sector of Pakistan (Table 1). Furthermore, to understand the gaps and opportunities for maritime climate response, the report aims to illustrate a repository of the potential repercussions on these maritime sub-sectors due to climate change. The table's contents provide a nuanced understanding of how climate change influences and amplifies vulnerabilities in Pakistan's maritime domains, offering a holistic perspective for informed decision-making and mitigation strategies.

Table 1.

Possible Impacts of Climate-driven Challenges faced by Pakistan's Maritime Sectors

Sectors	Climate Variables Applicable	Possible Impact
Maritime transportation	Ocean: Physical and Biogeochemical; Atmosphere	• Vessel damage due to altering oceanic chemistry and physiology • Degradation of metallic and wooden structures
Ports and Harbors' infrastructure	Ocean: Physical, Biogeochemical, and Biological/ecosystems; Land: Hydrosphere; Atmosphere: Surface, Upper Air	• Degradation of metallic, wooden, carbonaceous, and cemented infrastructure • Loss of infrastructure due to unpredictable and intense extreme weather events • Water logging and salinity
Ship Recycling Operations at Gadani	Ocean: Physical, Biogeochemical, and Biological/ecosystems; Land: Hydrosphere; Atmosphere: Surface, Upper Air	• Coastal erosion by extreme weather events and sea-level rise resulting in the loss of the area of shipbreaking plots • Changing soil properties of the beach
Marine Fisheries	Ocean: Physical, Biogeochemical, and Biological/ecosystems; Land: Hydrosphere, Anthroposphere; Atmosphere: Surface, Upper Air, Atmospheric Composition	• Habitat alteration and loss due to changing oceanic chemistry and physiology • Fish migration and possible extinction of native species • Fluctuation in plankton populations due to pollution, nutrient variability, etc.
Livelihood of Coastal communities	Ocean: Physical, Biogeochemical, and Biological/ecosystems; Land: Hydrosphere, Cryosphere, Biosphere, Anthroposphere; Atmosphere: Surface, Upper Air, Atmospheric Composition	• Diminishing fish stocks impacting fishing villages • Loss of infrastructure and crops due to extreme weather events • Lack of fresh water due to irregular inflow from upstream • Coastal erosion
Mangroves, Coral reefs, and their ecosystem services	Ocean: Physical, Biogeochemical, and Biological/ecosystems; Land: Hydrosphere, Cryosphere, Biosphere, Anthroposphere; Atmosphere: Surface, Upper Air, Atmospheric Composition	• Loss of mangrove species due to pollution, sea / freshwater intrusion, meteorological events • Marine pollution leading to coral bleaching and species die-off Frequent oceanic turbulences affecting coral stability
Maritime Tourism	Ocean: Physical, Biogeochemical, and Biological/ecosystems; Land: Hydrosphere, Cryosphere, Biosphere, Anthroposphere; Atmosphere: Surface, Upper Air, Atmospheric Composition	• Loss of infrastructure due to extreme weather events • Degradation and loss of marine archaeological sites • Polluted waters hindering underwater sports activities • Migration and relocation of coastal communities • Vessel damage due to changing oceanic chemistry

		Degradation of infrastructure
Marine Archaeological resources	Ocean: Physical, Biogeochemical, and Biological/ecosystems; Land: Hydrosphere, Anthroposphere; Atmosphere: Surface, Upper Air, Atmospheric Composition	• Degradation of metallic, wooden, carbonaceous, and cemented infrastructure • Loss of infrastructure due to unpredictable and intense extreme weather events Water logging and salinity
Energy and mineral resources	Ocean: Physical, Biogeochemical, and Biological/ecosystems; Atmosphere: Surface, Upper Air	• Extreme and erratic meteorological events hindering onshore and offshore energy projects and infrastructure • Pollution and anthropogenic introduction of chemicals Altering seabed mineral resources due to pollution and changing sea temperatures
Coastal ecology	Ocean: Physical, Biogeochemical, and Biological/ecosystems; Land: Hydrosphere, Cryosphere, Biosphere, Anthroposphere; Atmosphere: Surface, Upper Air, Atmospheric Composition	• Degradation of metallic, wooden, carbonaceous, and cemented infrastructure • Loss of infrastructure due to extreme weather events • Loss of mangroves and associated species/communities • Loss of infrastructure and crops due to extreme weather events • Lack of freshwater due to irregular inflow from upstream Shrinking of Indus River Delta
Infrastructure alongside the coast	Ocean: Physical, Biogeochemical, and Biological/ecosystems; Land: Hydrosphere; Atmosphere: Surface, Upper Air	• Degradation of metallic, wooden, carbonaceous, and cemented infrastructure • Loss of infrastructure due to extreme weather events • Degradation of foundations due to fluctuating groundwater levels • Damage due to sea-level rise Water logging and salinity
Agricultural productivity	Ocean: Physical, Biogeochemical, and Biological/ecosystems; Land: Hydrosphere, Cryosphere, Biosphere, Anthroposphere; Atmosphere: Surface, Upper Air, Atmospheric Composition	• Underground water level fluctuation • Seawater intrusion • Water logging and salinity • Shift in cropping patterns • Loss of arable land due to saltwater intrusion • Crop yield reduction due to soil salinity

This exercise of identifying the possible impacts arising from climatic changes has helped in understanding various tangible and intangible factors on the selected maritime sub-sectors of Pakistan. Based on this, the report further aims to highlight the vulnerability of these sub-sector to identify high-risk sectors, which will help in guiding strategic planning, capacity building, and specific climate response strategies.

1. Nexus of sustainable development goals with environmental conservation and reducing climate change impacts on oceans

The journey towards the SDGs began with the 1972 United Nations Conference on the Human Environment in Stockholm, Sweden (Bettelli, 2021). This conference marked a turning point in the global recognition of environmental issues and the need for sustainable development. The conference led to the creation of the United Nations Environment Programme (UNEP), which has played a crucial role in promoting environmental sustainability globally (Gasteiger, 2023).

The Brundtland Commission and Agenda 21 (1983-1992)

In 1983, the United Nations created the World Commission on Environment and Development, also known as the Brundtland Commission, which defined sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Gasteiger, 2023). This definition has been a guiding principle for sustainable development efforts ever since. The commission's report, "Our Common Future," was published in 1987 and emphasized the need for sustainable development that balances economic, cultural, and environmental issues.

The first United Nations Conference on Environment and Development (UNCED), also known as the Earth Summit, was held in Rio de Janeiro in 1992 (Gasteiger, 2023). The conference adopted Agenda 21, a comprehensive plan of action to build a global partnership for sustainable development. Agenda 21 addressed various aspects of sustainable development, including poverty eradication, energy, water and sanitation, health, and human settlement.

The Millennium Development Goals (2000-2015)

In 2000, the United Nations General Assembly adopted the Millennium Declaration, which responded to the world's foremost development challenges at the time (Bettelli, 2021). The declaration led to the formulation of the Millennium Development Goals (MDGs), a set of eight goals with numerical sub-targets and deadlines. The MDGs aimed to reduce extreme poverty and hunger, achieve universal primary education, promote gender equality, reduce child mortality, improve maternal health, combat HIV/AIDS and other diseases, ensure environmental sustainability, and develop a global partnership for development (Gasteiger, 2023).

The MDGs drove progress in several areas, including reducing income poverty, providing access to water and sanitation, and driving down child mortality. However, the MDGs faced criticism for lacking strong objectives, disparities between nations, and not adequately addressing issues of equity and gender (Gasteiger, 2023).

The Transition to Sustainable Development Goals (2012-2015)

The United Nations Conference on Sustainable Development (Rio+20) in 2012 served as a pivotal 20-year follow-up to UNCED, where Colombia initially proposed the concept of Sustainable Development Goals (SDGs) during a preparatory event. This idea gained traction and was later endorsed by the United Nations Department of Public Information.

Subsequently, the UN General Assembly Open Working Group (OWG) on Sustainable Development Goals was formed in January 2013 to delineate specific SDGs. After extensive deliberations, the OWG presented a comprehensive framework comprising 17 SDGs and 169 associated targets to the 68th session of the General Assembly in September 2014. Following thorough review, the UN General Assembly approved the Secretary-General's Synthesis Report on December 5, 2014, solidifying the OWG's proposals as the foundation for the post-2015 SDG agenda (Jayasooria & Yi, 2023), (Wadhwani & Malpani, 2023).

The Adoption of the Sustainable Development Goals (2015)

The 2030 Agenda for Sustainable Development, adopted by the United Nations General Assembly in 2015, encompasses 17 Sustainable Development Goals (SDGs) aimed at addressing a wide array of global challenges concerning the well-being of both the planet and humanity (Guachalla, 2023). The SDGs build upon the MDGs and aim to end poverty, protect the planet, and ensure peace and prosperity for all. The SDGs are designed to be action-oriented, concise, aspirational, global, and universally applied to all countries (Bettelli, 2021).

The adoption of the SDGs marked a significant milestone in the history of sustainable development, as it unified nations and states in a global effort to address the complex challenges facing humanity. The SDGs have driven progress in various areas, including poverty reduction, education, health, and environmental sustainability (Gasteiger, 2023).

SDG 14 – Life Below Water

The Sustainable Development Goals (SDGs), adopted in 2015, encompass 17 goals addressing global challenges and promoting sustainable development worldwide (Haas, 2023). SDG 14, "Life Below Water," specifically aims to conserve and sustainably use oceans, seas, and marine resources for sustainable development (Arora, 2023). Implementing SDG 14 is crucial due to the oceans' significant role in regulating climate, providing food and livelihoods for billions, and supporting diverse marine life (Wadhwani & Malpani, 2023). The interconnectedness of the SDGs underscores the importance of achieving each goal to ensure a sustainable and equitable future for all. The SDGs provide a comprehensive framework for action, requiring collaboration among governments, businesses, civil society, and individuals to work towards a more sustainable world.

SDGs which complement SDG-14 for fighting climate impacts on oceans and ocean communities

SDG-14, which focuses on "Life Below Water," is complemented by SDG-13, which addresses "Climate Action," in fighting climate impacts on oceans and ocean communities (Sachs, 2015). SDG-13 aims to combat and curb human-induced climate change, which is crucial for protecting marine ecosystems and addressing the challenges faced by oceans due to climate impacts. By working towards both SDG-13 and SDG-14 simultaneously, efforts can be made to mitigate the effects of climate change on oceans, promote sustainable management of marine resources, and ensure the well-being of ocean communities in the face of environmental challenges (Sachs, 2015).

Furthermore, investing in the sustainable livelihood practices and ecosystem preservation would help meet the targets of SDG1: Reduced Poverty, SDG2: Zero Hunger,

SDG3: Good Health and Wellbeing, SDG4: Gender Equality, and others and vice versa. There is need for inclusive and integrated approach to link SDGs for the improvement in coastal sector. Integrating SDGs in all policies related to maritime sector can significantly reduce the vulnerabilities of the sector. The SDGs would help make policies which are climate mitigative and adaptive.

2. Importance of traditional climate knowledge

Planet Earth is home to about 370 million indigenous people, described as 'original' or 'first' people with a cultural and historic affiliation with the place they live in (Latulippe & Klenk, 2020). For centuries, such communities have upheld their territories, cultures, and the knowledge that has been passed on through generations against the overwhelming intrusion of the modern worldviews. Indigenous patterns of living - without significantly altering the environment but rather, forming a cooperative dependency - are considered closest to the contemporary idea of sustainability (Carmichael et al., 2018).

Indigenous knowledge refers to the collective knowledge, practices, and innovations developed by such communities over generations, rooted in their cultures, traditions, and relationships with the environment. It encompasses a wide range of expertise, including Traditional Ecological Knowledge (TEK), weather forecasting, navigation techniques, and sustainable resource management (Alexander et al., 2011).

In the maritime domain, indigenous knowledge plays a crucial role in climate response. For instance, Indigenous Oceanic and Maritime Traditional Knowledge (IOMTK) offers insights into changes in ocean currents, marine species behavior, and weather patterns. Studies by the Intergovernmental Panel on Climate Change (IPCC) highlight the significance of integrating indigenous knowledge with scientific data for comprehensive climate adaptation strategies. Indigenous communities often possess deep insights into local ecosystems and climate variability, offering valuable perspectives for developing resilient adaptation plans, mitigating risks, and sustaining marine resources (Haque, 2019). The value of indigenous knowledge lies in its holistic approach, complementing scientific methods and offering context-specific solutions that contribute to more effective climate response measures in the maritime domain.

In Pakistan, indigenous people are not explicitly recognized in the 1973 Constitution, and there is a lack of specific laws safeguarding their rights and benefits. However, certain constitutional articles (e.g., Articles 1, 246, 247, 51, and 59) grant tribal people certain rights and political representation. Despite Pakistan's ratification of international treaties like the International Labor Organization (ILO), national and provincial laws can't be extended to tribal areas without the President's approval. While international treaties like Convention 107 include indigenous and tribal populations, Pakistan has not ratified the updated ILO Convention 169 (ADB, 2017).

The World Bank acknowledges that indigenous peoples' lands and resources are integral to their identities, but they face risks from development projects. The 2007 UN Declaration on the Rights of Indigenous Peoples (UNDRIP) is considered landmark but

criticized for potentially reinforcing state-centric control. UNDRIP's interpretation of 'self-determination' was constrained, and it does not support forms of self-determination external to existing state structures.

As younger generations pursue different opportunities, the transmission of traditional knowledge related to fishing techniques, coastal navigation, and ecological understanding is diminishing. On top of the diminishing knowledge and skilled human resource, the fact that these communities are not being equipped with updated technologies is the reason that the coastline of Pakistan is experiencing out migrations (Ur Rehman, 2022). Given the limitations of state-centric approaches, there's a pressing need to restructure national frameworks to acknowledge and respect indigenous communities and their cultures. A more flexible, holistic self-determination criteria is required to allow various communities to assert their unique rights and identity in an increasingly globalized world.

For the fisher folk communities, the knowledge of factors such as changing water temperatures, wind patterns, species' breeding periods and distribution etc. is imperative to ensure safe and productive fishing trips, which has been delivered by the inter-generational observations and community interactions over the years.

Pakistan and the greater South Asian region is particularly vulnerable to climate change, and its impacts on the local fishing communities are manifold (Bhandari & Bhattarai, 2017). In this regard, the recognition of varying metrological patterns in the open sea, altering catch's species and breeding seasons at the major fishing hotspots is crucial, so is the gradual adaptation to different catch types, their associated sea-venturing and hunting methods. Although the technological advancements in weather and catch movement predictions have made fishing easier, traditional knowledge still plays a vital role and can essentially compliment the technologies to yield an effective nexus of socio-ecological and technological elements that can help these vulnerable communities continually adapt to the inevitable impacts of climate change.

Conclusion

The UN's Sustainable Development Goals 11: "Sustainable cities and communities" and 13: "Climate Action" highlight the need for a collaborative and multidisciplinary approach to limit the vulnerability of such communities to the physical, social, economic, and environmental impacts of climate change. There is need for inclusive and integrated approach to link SDGs for the improvement in coastal sector.

The traditional coastal communities in Pakistan are grappling with the impacts of climate change and limited knowledge due to various factors. Therefore, there is a need to protect the rights, knowledge, and identities of certain coastal communities of Pakistan in the wake of challenges like changing weather patterns and accompanied challenges. Integrating SDGs into the development plans of a country can reduce vulnerabilities of any sector (in this case, maritime sector).

Pakistan's coastal ecosystems have enormous potential to capture & store large amounts of CO_2, thereby providing cost-effective 'blue carbon' solutions. Blue carbon is carbon captured by the ocean and coastal ecosystems, and normally covers mangroves, tidal

marshes and seagrass, which play an important role in minimizing coastal erosion and sea level rising, combating the global climate crisis by absorbing carbon, nurturing land and marine biodiversity, and supporting human well-being.

Reference list

ADB. (2017). Climate Change Profile of Pakistan. In *ADB*. https://doi.org/10.22617/TCS178761

Alamgir, A., Khan, M., Shaukat, S., Kazmi, J., Qureshi, S., & Khanum, F. (2015). Appraisal of Climate Change Impacts on the Coastal Areas of Sindh Using Remote Sensing Techniques. *American-Eurasian J. Agric. & Environ. Sci.*, *15*, 1102–1112. https://doi.org/10.5829/idosi.aejaes.2015.15.6.12667

Arora, P. (2023). Life below land: The need for a new sustainable development goal. *Frontiers in Environmental Science*, *11*. https://doi.org/10.3389/fenvs.2023.1215282

Beal, L. M., Vialard, J., Roxy, M. K., Li, J., Andres, M., Annamalai, H., Feng, M., Han, W., Hood, R., Lee, T., Lengaigne, M., Lumpkin, R., Masumoto, Y., McPhaden, M. J., Ravichandran, M., Shinoda, T., Sloyan, B. M., Strutton, P. G., Subramanian, A. C., … Parvathi, V. (2020). A Road Map to IndOOS-2: Better Observations of the Rapidly Warming Indian Ocean. *Bulletin of the American Meteorological Society*, *101*(11), E1891–E1913. https://doi.org/10.1175/BAMS-D-19-0209.1

Bettelli, P. (2021, January 29). *What the World Learned Setting Development Goals*. International Institute for Sustainable Development. https://www.iisd.org/articles/deep-dive/what-world-learned-setting-development-goals

Bhandari, M., & Bhattarai, K. (2017). Institutional Architecture For Sustainable Development (SD): A Case Study from Bangladesh, India, Nepal, and Pakistan. *SocioEconomic Challenges, 1*, 6–21. https://doi.org/10.21272/sec.1(3).6-21.2017

Calvin, K., Dasgupta, D., Krinner, G., Mukherji, A., Thorne, P. W., Trisos, C., Romero, J., Aldunce, P., Barrett, K., Blanco, G., Cheung, W. W. L., Connors, S., Denton, F., Diongue-Niang, A., Dodman, D., Garschagen, M., Geden, O., Hayward, B., Jones, C., … Péan, C. (2023). *IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland*. (First). Intergovernmental Panel on Climate Change (IPCC). https://doi.org/10.59327/IPCC/AR6-9789291691647

Carmichael, B., Wilson, G., Namarnyilk, I., Nadji, S., Brockwell, S., Webb, B., Hunter, F., & Bird, D. (2018). Local and Indigenous management of climate change risks to archaeological sites. *Mitigation and Adaptation Strategies for Global Change*, *23*(2), 231–255.

Fatima, Q., & Jamshed, A. (n.d.). The Political and Economic Significance of Indian Ocean: An Analysis. *South Asian Studies*.

Gasteiger, S. (2023, February 28). Road to 2030 | A brief history of the Sustainable Development Goals (SDGs). *Virchow Foundation | Virchow Prize for Global Health*. https://virchowprize.org/vf-road-to-2030-history-of-sdgs/

Guachalla, F. J. A. (2023). Embracing the SDG 2030 and Resilience for Monitoring and Learning in Emergency and Developing Projects. *Medical Sciences Forum*, *19*(1), Article 1. https://doi.org/10.3390/msf2023019006

Haas, B. (2023). Achieving SDG 14 in an equitable and just way. *International Environmental Agreements: Politics, Law and Economics*, *23*(2), 199–205. https://doi.org/10.1007/s10784-023-09603-z

Haque, M. (2019). Indigenous Knowledge and Practices in Disaster Management: Experiences of the Coastal People of Bangladesh. In *Disaster Risk Reduction: Community Resilience and Responses* (pp. 59–72). https://doi.org/10.1007/978-981-10-8845-2_4

Hobday, A. J., Alexander, L. V., Perkins, S. E., Smale, D. A., Straub, S. C., Oliver, E. C. J., Benthuysen, J. A., Burrows, M. T., Donat, M. G., Feng, M., Holbrook, N. J., Moore, P. J., Scannell, H. A., Sen Gupta, A., & Wernberg, T. (2016). A hierarchical approach to defining marine heatwaves. *Progress in Oceanography*, *141*, 227–238. https://doi.org/10.1016/j.pocean.2015.12.014

IPCC (2013): Rhein, M., S.R. Rintoul, S. Aoki, E. Campos, D. Chambers, R.A. Feely,

S. Gulev, G.C. Johnson, S.A. Josey, A. Kostianoy, C. Mauritzen, D. Roemmich,

L.D. Talley and F. Wang, 2013: Observations: Ocean. In: Climate Change

2013: The Physical Science Basis. Contribution of Working Group I to the

Fifth Assessment Report of the Intergovernmental Panel on Climate Change

Jayasooria, D., & Yi, I. (2023). The Sustainable Development Goals. In *Encyclopedia of the Social and Solidarity Economy* (pp. 310–320). Edward Elgar Publishing. https://www.elgaronline.com/display/book/9781803920924/book-part-9781803920924-54.xml

Kumar, V., Chu, H.-J., & Anand, A. (2024). Impacts of Sea Surface Temperature Variability in the Indian Ocean on Drought Conditions over India during ENSO and IOD Events. *Journal of Marine Science and Engineering*, *12*(1), Article 1. https://doi.org/10.3390/jmse12010136

Latulippe, N., & Klenk, N. (2020). Making room and moving over: Knowledge co-

production, Indigenous knowledge sovereignty and the politics of global environmental change decision-making. *Current Opinion in Environmental Sustainability*, *42*, 7–14. https://doi.org/10.1016/j.cosust.2019.10.010

NOAA,https://oceanexplorer.noaa.gov/facts/climate.html#:~:text=Ocean%20currents%20act%20much%20like,solar%20radiation%20reaching%20Earth's%20surface.

Roxy, M. K., Saranya, J. S., Modi, A., Anusree, A., Cai, W., Resplandy, L., Vialard, J., & Frölicher, T. L. (2024). Future projections for the tropical Indian Ocean. In *The Indian Ocean and its Role in the Global Climate System* (pp. 469–482). Elsevier. https://doi.org/10.1016/B978-0-12-822698-8.00004-4

Sachs, J. (2015, July 1). *Achieving the Sustainable Development Goals*. https://www.semanticscholar.org/paper/Achieving-the-Sustainable-Development-Goals-Sachs/019175f937d25793e3a73e8f23af4e4a07cb6b86

Safdar, F., Khokhar, M. F., Mahmood, F., Khan, M. Z. A., & Arshad, M. (2023). Observed and predicted precipitation variability across Pakistan with special focus on winter and pre-monsoon precipitation. *Environmental Science and Pollution Research*, *30*(2), 4510–4530. https://doi.org/10.1007/s11356-022-22502-1

Smale, D. A., Wernberg, T., Oliver, E. C. J., Thomsen, M., Harvey, B. P., Straub, S. C., Burrows, M. T., Alexander, L. V., Benthuysen, J. A., Donat, M. G., Feng, M., Hobday, A. J., Holbrook, N. J., Perkins-Kirkpatrick, S. E., Scannell, H. A., Sen Gupta, A., Payne, B. L., & Moore, P. J. (2019). Marine heatwaves threaten global biodiversity and the provision of ecosystem services. *Nature Climate Change*, *9*(4), 306–312. https://doi.org/10.1038/s41558-019-0412-1

UNCTAD. (2020). UNCTAD Handbook of Statistics 2020 - Merchant fleet. https://stats.unctad.org/handbook/MaritimeTransport/MerchantFleet.html

Ur Rehman, W. (2022). *Re-imagining indigeneity: From mountains to coast | By Wajihur-Rehman - Pakistan Observer*. https://pakobserver.net/re-imaginingindigeneity-from-mountains-to-coast-by-wajih-ur-rehman/

Wadhwani, D., & Malpani, P. (2023). *United Nations Sustainable Goals: Global to Local Need of the Hour* (SSRN Scholarly Paper 4426147). https://doi.org/10.2139/ssrn.4426147

ASIA-EUROPE/CHINA-EU LAND TRANSPORT AND TRADE ROUTES AND THE POTENTIAL OF THE MIDDLE CORRIDOR

Turgut Kerem Tuncel

tuncel@avim.org.tr

Center for Eurasian Studies, Ankara, Türkiye

As China emerged as a major manufacturing powerhouse and trade between China and the EU expanded, the transport and trade routes linking Asia/China with Europe/EU gained geoeconomic and geopolitical importance. The strategic relevance of these routes has been further intensified by Russia's invasion of Ukraine in February 2022, which prompted Western sanctions aimed at isolating Russia and undermining its military, political, and economic strength. This geopolitical shift has highlighted the Trans-Caspian International Transport Route (TITR)— the Middle Corridor—as an alternative to the Eurasian Land Bridge Economic Corridor- the Northern Corridor, which connects China with Europe via Russia. Initially conceptualized in 2013 and operational since 2017, the Middle Corridor has demonstrated notable growth in recent years. However, it faces significant infrastructural challenges, both hard and soft, that negatively affect its competitiveness relative to the Northern Corridor. To fully realize the Middle Corridor's potential and position it as a primary land route between Asia and Europe, substantial investment and extensive improvements are required. Opportunely, recent developments suggest a growing interest from international stakeholders in investing in the Middle Corridor, indicating its potential to become the dominant intercontinental land transport and trade route between Asia and Europe.

Keywords: Asia-Europe trade, China-EU trade, Middle Corridor, Northern Corridor, Trans-Caspian International Transport Route, transport and trade routes

1. Introduction

The shift from unipolarity to multipolarity marked by intense political, economic, and ideological rivalry among major powers increasingly shapes the global geopolitical landscape. In addition to great power competition, the rising influence of Global South nations and middle powers adds further complexity to global geopolitics. As the number of influential actors grows, so do the contentious issues. In this picture, international transport and trade routes gain prominence due to their strategic value, influencing both economic and geopolitical domains as they sit at the intersection of geoeconomics and geopolitics. It could even be argued that transport and trade routes in recent times are more about geopolitics than economics.

Correspondingly, as China rises as a leading manufacturing force and trade between China and the EU grows, the transport and trade routes connecting Asia and Europe, as well

as China and the EU, become increasingly important. Russia's invasion of Ukraine in February 2022, which led to Western sanctions and efforts to isolate Russia to weaken it politically and economically in the medium to long term, has further augmented the geopolitical relevance of these routes. As a result, the Trans-Caspian International Transport Route (TITR) – the Middle Corridor - linking Asia and Europe/China and the EU through Central Asia, the Caspian Sea, the South Caucasus, the Black Sea, and Türkiye has sat at the center of strategic calculations as a possible alternative to the Eurasian Land Bridge Economic Corridor -the Northern Corridor - which connects China with Europe via Kazakhstan, Russia, and Belarus, and has been the primary transcontinental land-route between Asia and Europe.

Upon that background, this article aims to examine transport and trade routes between Asia and Europe/China and the EU with a particular focus on the Middle Corridor. To do that, it starts with a brief comparison of maritime, land, and air cargo transportation that reveals the dominance of maritime transport. This is followed by a summary of the key features of the three main Asia-Europe/China-EU land transport and trade routes, i.e., the Northern, Southern, and Middle corridors. The article subsequently explores the history and current state of the Middle Corridor, particularly in relation to the Northern Corridor. It continues with the presentation of potential scenarios for the future of the Middle Corridor and a summary of the recent steps taken to improve this route before the conclusion section.

2. Asia-Europe/China-EU Trade and Maritime, Land, Air Cargo Transportation

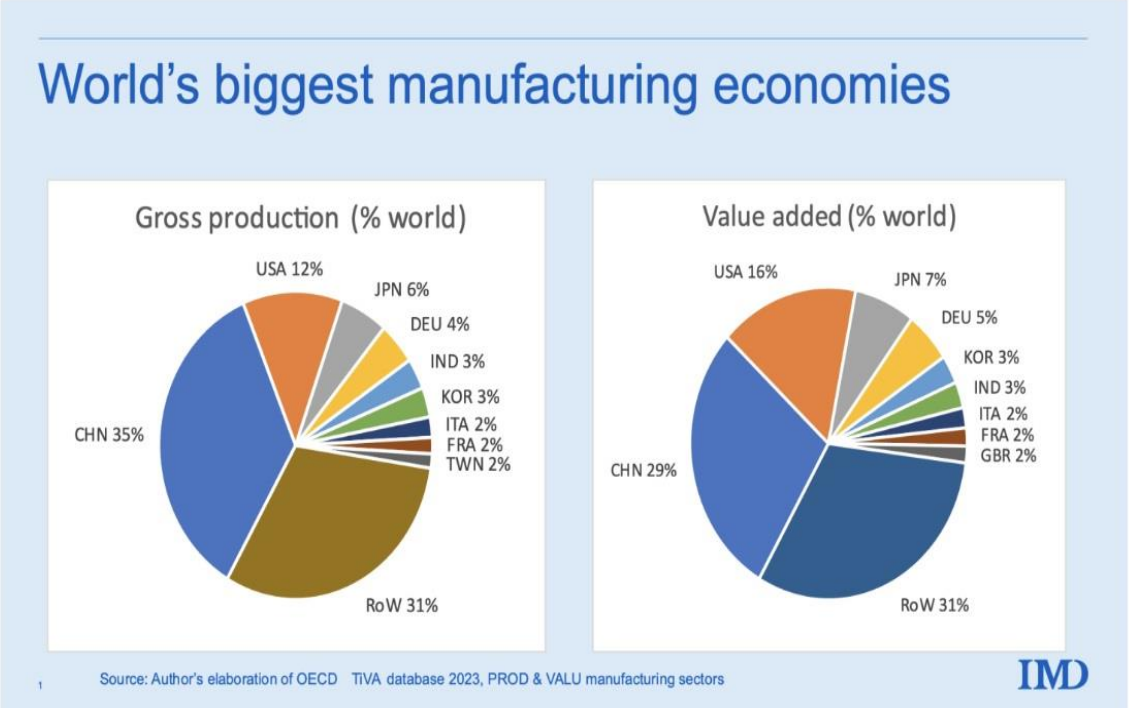
Starting with the economic reforms in 1978, China embarked on a path to become a global manufacturing powerhouse, steadily boosting its manufacturing output. In fact, China achieved an impressive progress in its production capacity so that whereas in 2010 its share of global manufacturing value was 19%, this was raised to 22.5 % in 2012, 28.7% in 2019, 30% in 2021, and 34% in 2023. In 2024, China's share was recorded as 31.63% (see, Figure 3). In that picture, in 2020, China accounted for an impressive 35% of global gross manufacturing output, significantly surpassing other major economies. In comparison, the US contributed about a third of China's share, Japan only a sixth, and Germany a mere ninth (see, Figure 2 and Figure 3). Additionally, China's proportion of global manufacturing exports had surged to 20 % by 2020, up from just 3% in 1995. Notably, Chinese manufacturing sector has maintained its position as the world's largest for the last fourteen consecutive years. Accordingly, China gained a crucial role in the global supply chain as a manufacturer and exporter of goods (Seong, 2024; The State Council Information Office of China, 2024, March 11; The State Council Information Office of China, 2022, June 14; World Population Review, 2024; Zhu, 2024, February 2).

Figure 1.
Share of top ten manufacturing countries to global manufacturing in 2024

Country	Share of Global Manufacturing
China	31.63%
United States	15.87%
Japan	6.52%
Germany	4.78%
India	2.87%
South Korea	2.71%
Russia	1.83%
Italy	1.8%
Mexico	1.69%
France	1.65%

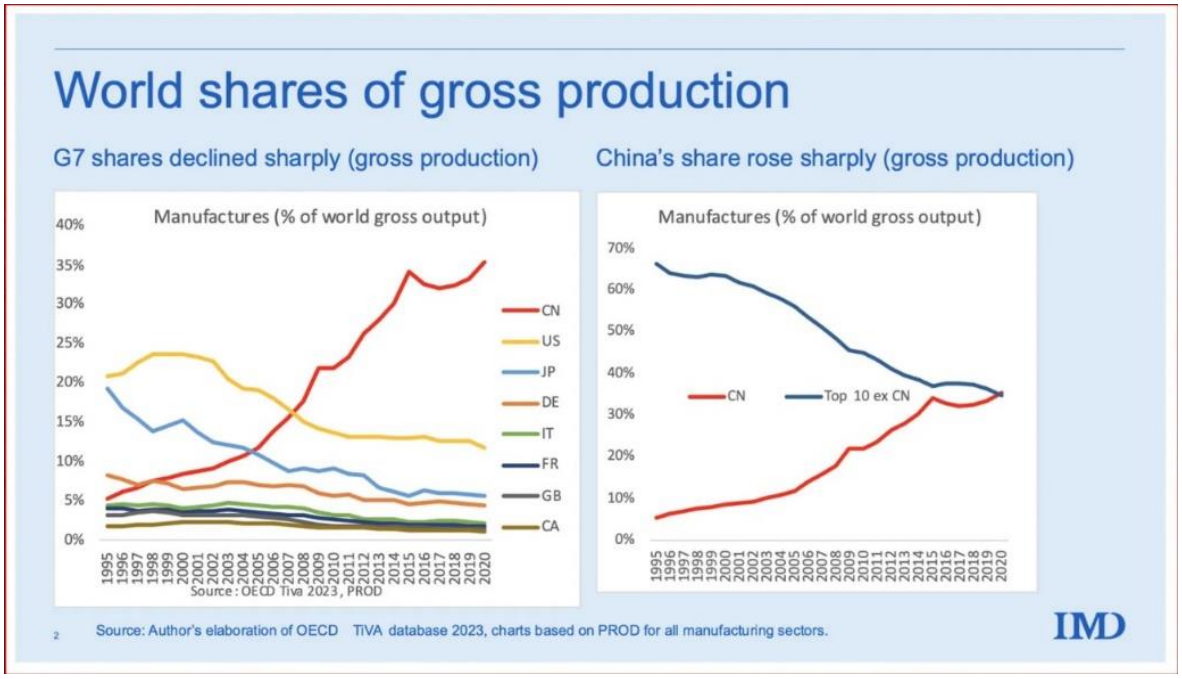
Source: World Population Review (2024)

Figure 2.
World's biggest manufacturing economies in 2020.



Source: Norton (2024)

Figure 3.
World shares of gross production



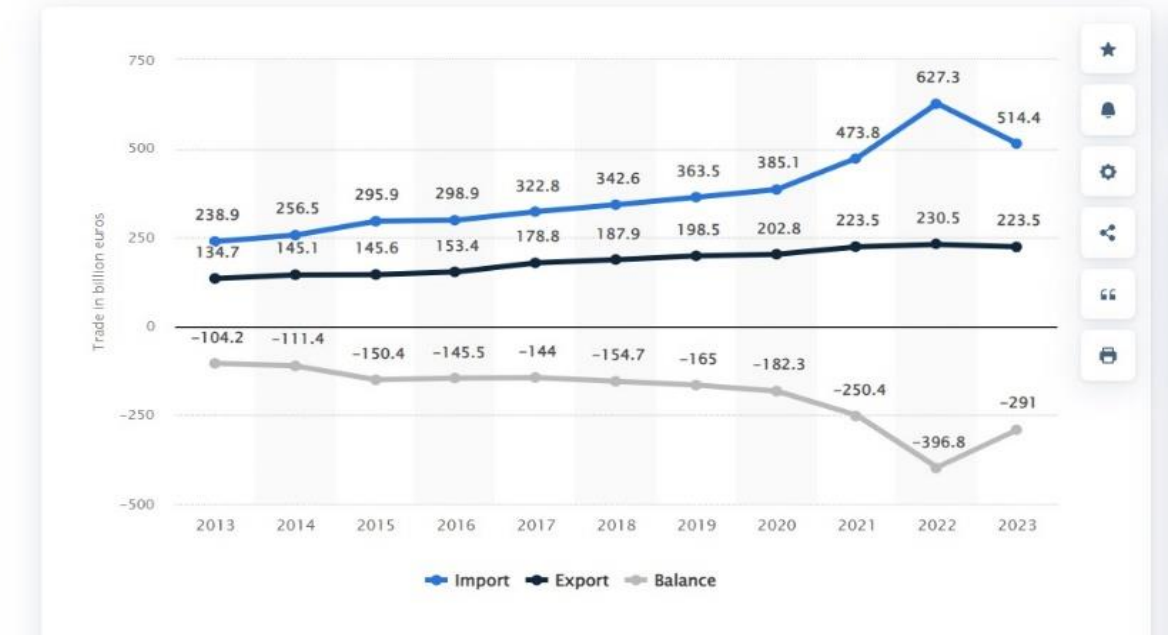
Source: Norton (2024)

As Figure 4 demonstrates, as China set to become an economic powerhouse, its trade with another economic giant, namely, the EU, continuously grew, particularly consequent to rising volumes of China's exports to the EU. In 2020, China surpassed the US to become the EU's largest trading partner in goods, though the US reclaimed the top position in 2022 (Eurostat, 2024, July 12). Consequently, China's economic growth and the China-EU trade, more specifically Chinese exports to the EU, became the main engine of the intercontinental trade between Asia and Europe.[14]

[14] For example, whereas in 2022 total trade between the EU and Central Asia was 47.5 billion Euros consequent to a 38.8% raise compared to 2021 (European Bank for Reconstruction and Development, 2023, p. 11), in the same year China-EU trade was 857.8 billion Euros (Eurostat, 2024, March 4) that is 18 times more than the former.

Figure 4.

Trade balance of the European Union with China from 2013 to 2023(in billion euros)



According to the European Bank for Reconstruction and Development (EBRD) (2023, p.11) approximately 80% to 85% of trade between the EU and China is transported by sea, 10% by land, and the remainder by air. Asian Development Bank (ADB) (2022, p.18), on the other hand, reports that in 2021, 96.3% of Chinese merchandise exports to Europe were carried through the sea.

Figure 5.

Share of rail, maritime, air transport of Chinese merchandise exports to Europe between 2018 and 2021 according to the Asian Development Bank.

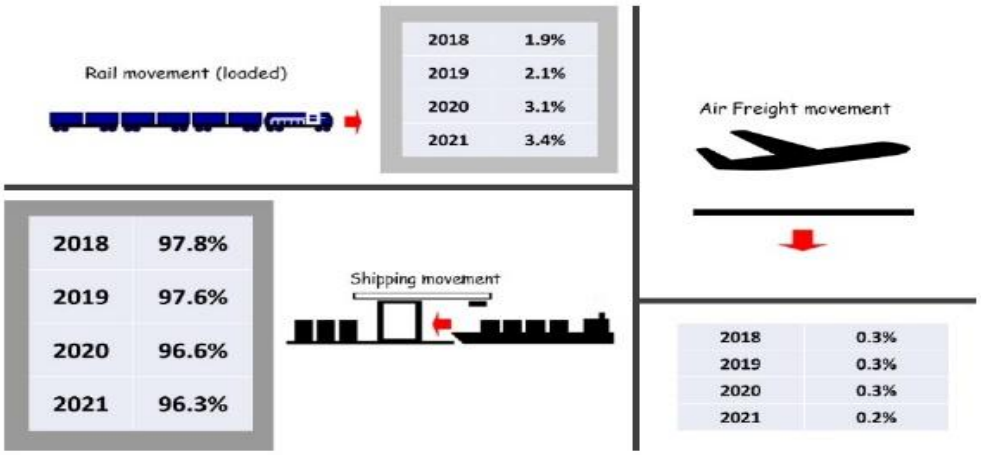


Figure 13 - Modal Market Share 2018-2021

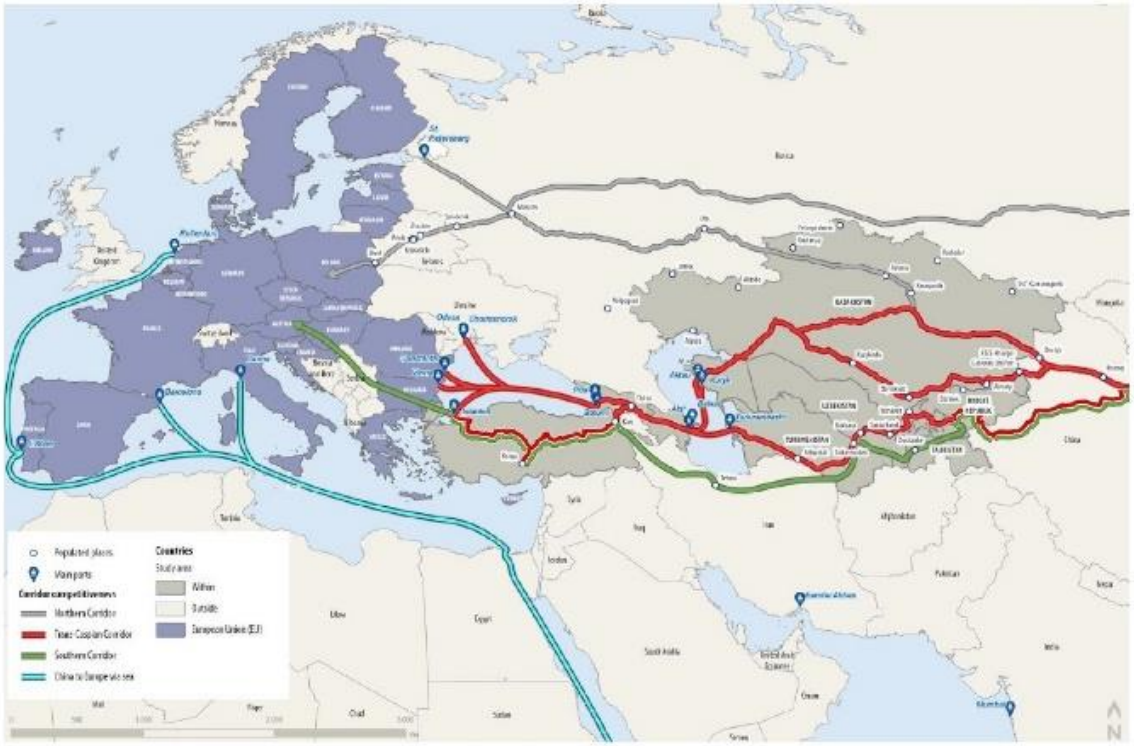
Source: Asian Development Bank (2022, p.18)

Despite variations in trade figures from different sources, it is evident that maritime transportation is the primary method for delivering goods between China and the EU. This is not a novelty since the World Bank Group (2024) reports that 80% of global trade is conducted by sea due to its numerous advantages including efficiency, low transportation costs, flexibility, adaptability to changing conditions, and minimal regulatory barriers (Asian Development Bank, 2022, p.16). While maritime transport dominates, land transportation, however, is an important leg of Asia-Europe/China-EU trade as a complementary mode of transport, the share of which is in an upward trend (see, Figure 5).

3. Asia-Europe/China-EU Land-Based Routes

Figure 6.

Asia-Europe/ China-EU land-based routes: Northern Corridor, Middle Corridor (Trans-Caspian Corridor), Southern Corridor



Source: CPCS.

Source: European Bank for Reconstruction and Development (2023, p.12)

Asia-Europe/China-EU land transportation is conducted through three different routes: the Eurasian Land Bridge Economic Corridor – the Northern Corridor, Southern Corridor, and the Trans-Caspian International Transport Route (TITR) - the Middle

Corridor (see, Figure 6). Each of the three routes has its own unique set of advantages and disadvantages compared to the others.

3.1. The Eurasian Land Bridge Economic Corridor - Northern Corridor

The Northern Corridor is a rail transport network comprised of two primary overland routes: the Trans-Siberian Railway and the New Eurasian Land Bridge (OECD, 2023, p.17). Completed in 1916, the Trans-Siberian Railway stretches from Vladivostok to the European Union. It links Russian Pacific ports with northeastern China and can handle up to 200,000 TEU (Twenty-foot Equivalent Unit) of containerized international transit cargo each year. The New Eurasian Land Bridge (completed during the second half of the 20th century), on the other hand, is the southern part of the Northern Corridor running through China and Kazakhstan, before crossing into Russia (see, Figure 7). From Kazakhstan, two North-South railways connect with the Trans-Siberian while another segment goes directly to Western Russia (OECD, 2023, p.17). In addition to these two main tracks, there is also a railway passing through Mongolia (European Bank for Reconstruction and Development, 2023, p.11).

The Northern Corridor is a well-established railway network that connects the entire Asian continent with Europe. The 2023 OECD report (2023, p.16) indicates that the Northern Corridor spans 12,000 km, while the 2023 European Bank for Reconstruction and Development report (2023, p.11) lists it as 10,000 km. Transit times through the Northern Corridor vary between 14 and 26 days.[15]

From a purely technical point of view, the Northern Corridor is the most efficient land route between China and the EU. It avoids the Caspian Sea, hence does not require shipping across this body of water. With fewer countries to cross, the route faces fewer border crossings and customs checks. These two, together with being a well-established, developed, and customary Asia-Europe/China-EU route, are the most salient relative advantages of the Northern Corridor. Despite these, however, Northern Corridor's efficiency is impeded by operational difficulties, technical obstacles, complex documentation requirements, administrative rules, and customs clearance procedures, which can extend transit times. Prior to the Russian invasion of Ukraine in February 2022, the Northern Corridor was the most frequently used land route between China and the EU, handling approximately 90% of the rail transit container traffic between the two sides (OECD, 2023, p. 16-17; Eurasian Rail Alliance Index, 2023b, p. 3). Despite its technical advantages, the Northern Corridor faces uncertainty about its future due to escalating tensions between the West and Russia.

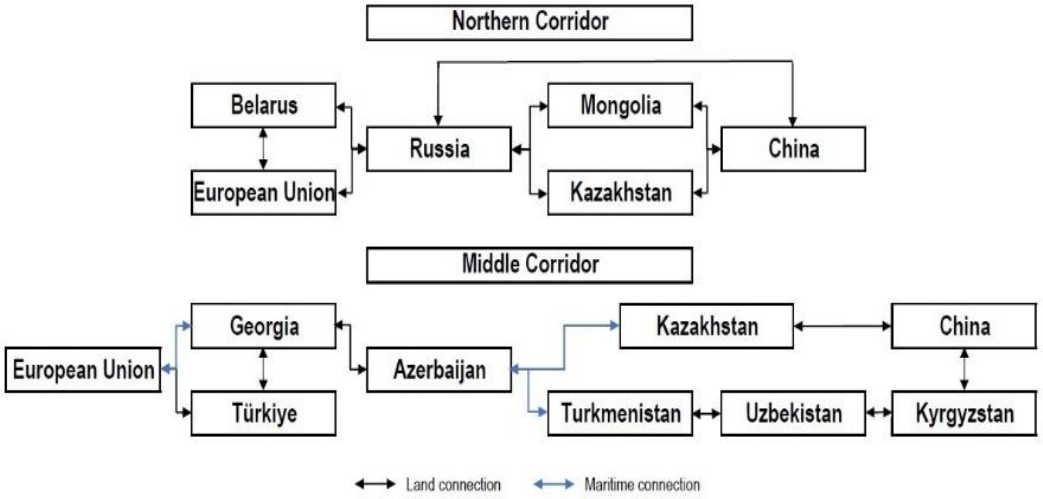
[15] It is important to recognize that various sources provide differing information on transit times for the Northern, Middle, and Southern corridors. For instance, the European Bank for Reconstruction and Development (2023, p. 11) reports an average transit time of 14 days for the Northern Corridor, while the Eurasian Rail Alliance Index (2023a) suggests a range of 20-26 days for the same route. This article presents approximate transit times for these land routes based on the varying figures provided by different sources.

3.2. The Southern Corridor

The Southern Corridor connects China and the EU via the Kyrgyz Republic or Tajikistan, Uzbekistan, Turkmenistan, Iran, and Türkiye before entering Europe via Bulgaria or Greece. Another potential part of the Southern Corridor is the route crossing Afghanistan and Central Asia, though this alternative is not discussed in earnest because of political and security-related drawbacks. A key advantage of the Southern Corridor, similar to the Northern Corridor, is that it is an all-land-based route avoiding the challenges associated with crossing the Caspian Sea. However, this benefit is undermined by the underdeveloped infrastructure in Kyrgyz Republic, Tajikistan, Uzbekistan, Turkmenistan, and Iran. Efficiency is a serious defect of the Southern Corridor that results in unpredictable transit times that can extend to 60 days or more (European Bank for Reconstruction and Development, 2023, p.11). Yet, the major obstacle to the Southern Corridor's development is the geopolitical context. Due to tensions between Iran and the West, there is limited interest from international stakeholders in investing in this route's development.

Figure 7.

Northern and Middle Corridor schematic routes



Source: OECD (2023, p.16)

3.3. The Trans-Caspian International Transport Route (TITR) - Middle Corridor

The Middle Corridor traverses Central Asia, the Caspian Sea, Azerbaijan, and Georgia, and then continues through either the Black Sea or Türkiye before reaching the EU. The primary feature and critical segment of the Middle Corridor is the Caspian Sea crossing, which can be navigated via three distinct tracks: the Northern Trans-Caspian Corridor, the Central Trans-Caspian Corridor, and the Southern Trans-Caspian Corridor (European Bank

for Reconstruction and Development, 2023, p.14). As shown in Figure 8, the Northern and Central Trans-Caspian Corridors cross Kazakhstan, while the Southern Trans-Caspian Corridor goes through Kyrgyz Republic, Uzbekistan, and Turkmenistan, reaching the Turkmensbashi port on the Caspian Sea. Among these options, the Northern and Central routes are the most frequently discussed ones, while the Southern route receives lesser attention, even so that it is not mentioned on the International Association "Trans-Caspian International Transport Route" website (see, Middle Corridor, 2024). According to the EBRD's 2023 report, the Northern Trans-Caspian Corridor is the most suitable of the three. Additionally, the Middle Corridor offers two alternative paths from the South Caucasus to the EU: a maritime route through the Black Sea and a land route via Türkiye.

Figure 8.

Alternative routes between Europe and Central Asia via the Caspian Sea

Source: European Bank for Reconstruction and Development (2023, p. 14).

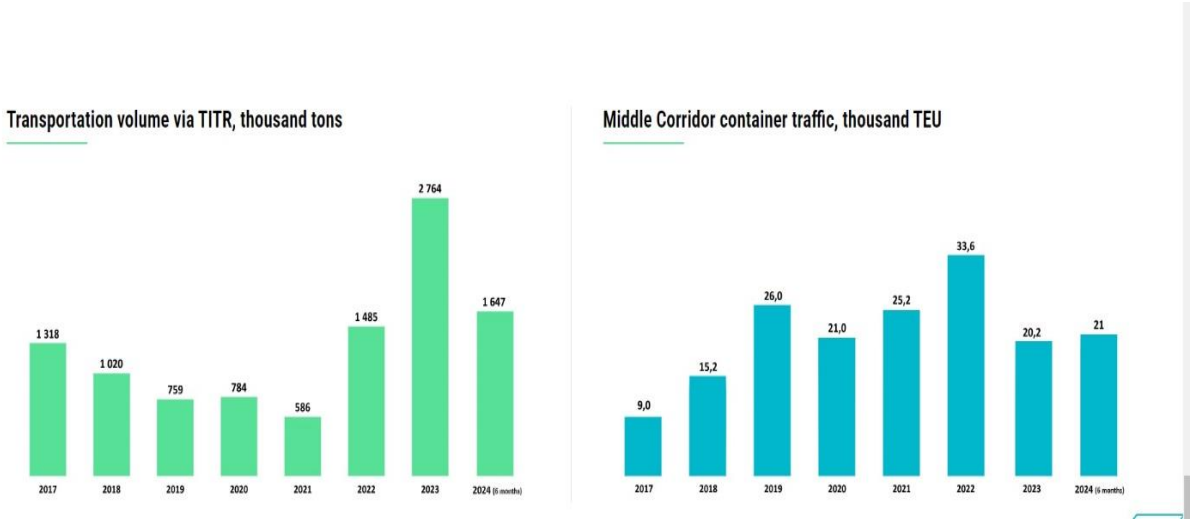
The Middle Corridor is a recent project launched by Kazakhstan in 2013 and commenced operations in 2017. As such, it remains a developing transport and trade route, in contrast to the well-established Northern Corridor. The most noticeable relative advantage of the Middle Corridor is its 7,000 km length compared to the 10,000-12,000 km-long Northern Corridor. However, hard and soft infrastructural problems, as well as bottlenecks along the route cause extensions and unpredictability of transit time and higher transit costs. It is reported that transport time along the Middle Corridor varies from 14 to 45 days, even up to 60 days (European Bank for Reconstruction and Development, 2023, p.11).[16]

[16] Please see footnote 1 for a disclaimer on different information about the transit times of the Northern, Middle, and Southern corridors in different sources.

4. The Middle Corridor: Its Current Status

As demonstrated in Figure 9, the container traffic on the Middle Corridor was 9.000 TEUs when in its first year of service in 2017. From then on, the cargo shipment saw a continuous increase until 2019, when the container traffic reached 26,000 TEUs, meaning in the first three years of the Middle Corridor, the container transport increased by 166.7%. In 2020, the shipment fell to 21,000 TEU amounting to a 19.2% decrease, mainly as a result of the negative effects of the Covid-19 pandemic on global trade. In 2021, the cargo volumes approximated to the 2019 level increasing to 25,200 TEUs. In 2022, following the Russian invasion of Ukraine and the resulting decline in the use of the Northern Corridor by Western logistics companies, attention shifted to the Middle Corridor. As a result, the Middle Corridor saw a record of 33,600 TEUs of container traffic. However, this upward trend did not last and in 2023 and the cargo volume on the Middle Corridor sharply fell to 20,200 TEUs, a level lower than that of 2020. In the first six months of 2024, the volume was recorded as 21,000 TEUs (Middle Corridor, 2024).

Figure 9.
Transportation volume in thousand tones and container traffic in thousand TEUs via the Middle Corridor between 2017 and the first six months of 2024



Source: Middle Corridor (2024)

As these figures demonstrate, the volume of cargo transport on the Middle Corridor fluctuates (see, Table 1). One major reason for the unevenness is variations in sea freight rates, which influence the decisions of logistics companies. However, besides this market dynamic, the Middle Corridor-specific reasons and the problems impair the expediency and competitiveness of the Middle Corridor.

Table 1.

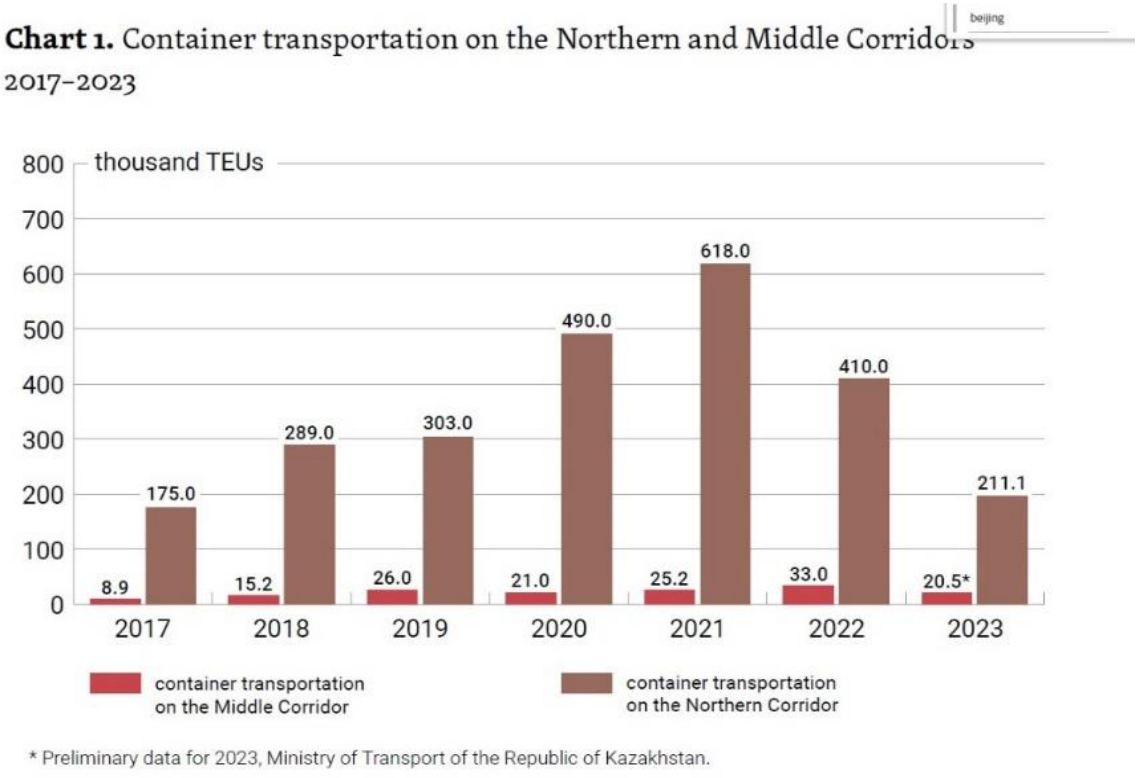
Increase/decrease in container transportation via Northern and Middle corridors in percentages compared to previous year

	Northern Corridor (%)	Middle Corridor (%)
2018	65.1	70.8
2019	4.8	71.1
2020	61.7	-19.2
2021	26.1	20
2022	- 33.7	30.9
2023	- 48.5	-37.9

Source: Own Elaboration

Figure 10.

Container transportation in thousand TEUs on the Northern and Middle corridors between 2017 and 2023



Source: Popławski et al. (2024, p.14)

Figure 10 shows the volumes of container transportation on the Northern Corridor and Middle Corridor. These figures demonstrate that in seven years between 2017 and 2023, the Middle Corridor carried only 6 % of the container volume that the Northern Corridor carried as (see, Table 2). This reveals that the Middle Corridor handles only a fracture of what the Northern Corridor handles.

Table 2.

Container transportation via Northern and Middle corridors in TEU between 2017 and 2023 and the comparison of the volume via the Middle Corridor with the volume via the Northern Corridor in percentages

	Northern Corridor (TEUs)	Middle Corridor (TEUs)	Container Transportation on Middle Corridor in comparison to the Northern Corridor (%)
2017	175,000	8,900	5.1%
2018	289,000	15,200	5.3%
2019	303,000	26,000	8.6%
2020	490,000	21,000	4.3%
2021	618,000	25,200	4.1%
2022	410,000	33,000	8%
2023	211,100	20,500	9.7%
Total between 2017 and 2023	2,496,100	149,800	6%
Avarage between 2017 and 2023	356,600	21,400	6%

Source: Own elaboration

Thus, it is clear that substantial improvements are necessary for the Middle Corridor to genuinely serve as an alternative to the Northern Corridor.

5. Prospects for the Development of the Middle Corridor

The European Bank for Reconstruction and Development report dated June 16, 2023, titled "Sustainable Transport Connections between Europe and Central Asia" offers insights into the potential development of the Middle Corridor. According to this report, in a "business-as-usual scenario," the volume of transit containers on the Central Trans-Caspian Corridor, the most promising track for the Caspian Sea passage, could rise from 18,000 TEUs in 2022[17] to 130,000 TEUs by 2040. The same report sustains that this volume could go up to 865,000 TEUs by the same year if investment projects and soft connectivity measures were implemented to achieve a free-flow transit time of 13 days. Additionally, increased traffic on the Northern and Southern Trans-Caspian Corridors could be expected, with volumes reaching 270,000 TEUs and 254,000 TEUs, respectively, due to spill-over effects. Consequently, by 2040, a total of 1.4 million containers could transit through Central Asia and connect to Europe, provided that all proposed improvements are implemented to boost the operational efficiency of the route.

According to the same report, the required investments encompass the rehabilitation and modernization of railway and road networks, expansion of rolling stock, enhancement of port capacities, upgrades to border crossing points, and development of multimodal

[17] In 2022, the total amount of container traffic via the Middle Corridor was 33.000 TEUs. Hence, the Central Trans-Caspian Corridor handled 54.5% of the total container transportation through the Middle Corridor this year.

logistics centers and supplementary network connections across all five participating countries, which would amount to €18.5 billion of investment (European Bank for Reconstruction and Development, 2023, p.45-47). Overall, the European Bank for Reconstruction and Development report suggests that the Middle Corridor could reach and surpass the Northern Corridor's potential and become the primary land route between Asia and Europe if necessary investments and improvements are achieved.

The required investment is substantial and the improvements are likely to take serious effort. The recent developments, opportunely, highlight the growing interest of international stakeholders in investing in the Middle Corridor. For example, in July 2022, the European Bank for Reconstruction and Development committed over $100 million to upgrade Kazakh railways (Popławski et al., 2024, p. 21), which amounts to a contribution to the infrastructural development of the Middle Corridor. In May 2023, G7 leaders declared their commitment to support Central Asian countries in addressing regional challenges and fostering trade, energy connections, sustainable transport like the Middle Corridor, and related initiatives. G7 leaders also renewed their commitment to the G7 Partnership for Global Infrastructure and Investment (PGII), emphasizing their goal of collaborating to mobilize up to $600 billion by 2027 to strengthen global partnerships for public and private investments in sustainable, inclusive, resilient, and quality infrastructure with partner countries (The White House, 2023, May 20). In September 2023, at the Germany-Central Asia Summit, leaders from Central Asia and Germany expressed interest in developing the Middle Corridor and securing financing through the EU's Global Gateway initiative (Euronews, 2023, September 30). At the Global Gateway Investors Forum in January 2024, it was announced that European and international financial institutions would invest €10 billion to improve sustainable transport connectivity in Central Asia (European Commission). In addition to Western actors, China also shows interest in the Middle Corridor. As to that, during the Third Belt and Road Forum in October 2023, Chinese President Xi Jinping announced China's intention to participate in the Middle Corridor project (Xinhua, 2023, October 18). As importantly, in recent years, actors involved in the Trans-Caspian International Transport Route (TITR) association have demonstrated a stronger commitment to advancing the Middle Corridor. This includes the signing of various declarations and agreements between the TITR countries to enhance cooperation. Major global logistics and shipping companies, including Italy-Switzerland's MSC, Denmark's Maersk, France's CMA CGM, China's COSCO, and Israel's ZIM have launched services along the Middle Corridor. Finnish company Nurminen Logistics, CEVA Logistics, and DHL are also active on this route. Agreements have been signed involving German, Lithuanian, and Austrian companies to further boost the corridor's development (Carafano, 2022; Dupuy, 2024; Popławski et al. 2024, p. 6-7&14; Satubaldina, 2023, December 28). All these developments in recent years point to the possibility of the Middle Corridor to develop to become the principal intercontinental land transport and trade route between Asia and Europe.

6. Conclusion

China's growing manufacturing power and its trade with the EU amplifies the geoeconomic and geopolitical significance of Asia-Europe/China-EU transport and trade routes. In this context, consequent to Western sanctions and efforts to politically and economically isolate Russia as a response to the latter's invasion of Ukraine in February 2022, the Trans-Caspian International Transport Route (TITR) - the Middle Corridor - has become a focal point in strategic planning as it began to be considered as a potential alternative to the Northern Corridor which links China with Europe via Russia. In its current state, the Middle Corridor has certain disadvantages due to hard and soft infrastructural problems that impede it from assuming the role of the Northern Corridor as the primary land-based transport and trade route between Asia/China and Europe/EU. Yet, with enough investment and adequate improvements, the Middle Corridor has the potential to overtake the place of the Northern Corridor. The current geopolitical climate is favorable for this development. International actors including governments and the private sector show a rising interest in the development of the Middle Corridor. This interest can be translated into more investments in the route. Certainly, the conduct of the Middle Corridor countries, that is, the Central Asian countries, Azerbaijan, Georgia, and Türkiye, will be decisive for the future of the Middle Corridor. Adopting a regional perspective and taking steps towards further economic and political regionalization will be crucial for developing the Middle Corridor, which could offer substantial economic, political, and strategic advantages to these nations.

Reference List

Asian Development Bank. (2022). CAREC Middle Corridor Assessment: Transport Connectivity on the Eurasian transit routes. https://www.carecprogram.org/uploads/19th_TSSC_CAREC-Middle-Corridor-Assessment-Report.pdf

Carafano, J.J.. (2022, August 29, 2022). Central Asia's Middle Corridor gains traction at Russia's expense. Geopolitical Intelligence Services. https://www.gisreportsonline.com/r/middle-corridor/

Dupuy, A.C.. (2024, May 22). There's an alternative to Russian-based trade routes—but it needs support from the US, EU, and Turkey. Atlantic Council. https://www.atlanticcouncil.org/blogs/turkeysource/theres-an-alternative-to-russian-based-trade-routes-but-it-needs-support-from-the-us-eu-and-turkey/

Eurasian Rail Alliance Index. (2023a). *Transit time and possible transport corridors on the China — Europe — China route*. https://index1520.com/en/analytics/obzor-rynka-zheleznodorozhnykh-perevozok-2023/#:~:text=The%20route%20passes%20through%20China%20%E2%80%94%20Kazakhstan%20%E2%80%94%20the%20Caspian%20Sea%20%E2%80%94,Europe%20via%20the%20Suez%20Canal.

Eurasian Rail Alliance Index. (2023b). *Analysis and prospects for the Trans-Caspian international transport route*. https://index1520.com/upload/medialibrary/169/q8i6bxpap6f3f2tpih7xdpuor208lhdk/en_TITR.pdf.

Euronews. (2023, September 30). *Germany and Central Asian states voice support for closer cooperation via 'Middle Corridor'*. https://www.euronews.com/2023/09/30/germany-and-central-asian-states-voice-support-for-closer-cooperation-via-middle-corridor

European Bank for Reconstruction and Development. (2023). *Sustainable transport connections between Europe and Central Asia*. https://www.ebrd.com/news/publications/special-reports/sustainable-transport-connections-between-europe-and-central-asia.html

Eurostat. (2024, July 12). *International trade in goods by partner*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=International_trade_in_goods_by_partner#Focus_on_EU_trade_in_goods_-_an_overview

Eurostat. (2024, March 4). *China-EU - international trade in goods statistics*.

https://ec.europa.eu/eurostat/statistics-explained/index.php?title=China-EU_-_international_trade_in_goods_statistics.

European Commission. *Key Outcomes of the Global Gateway Investors Forum for EU-Central Asia Transport Connectivity*. https://international-partnerships.ec.europa.eu/document/download/e1c1b297-0d05-40a3-968c-cba1c77a48d9_en?filename=investors-forum-eu-central-asia-transport-connectivity-key-outcomes_en.pdf

OECD. (2023). *Realising the Potential of the Middle Corridor*. https://doi.org/10.1787/635ad854-en.

Middle Corridor. (2024). https://middlecorridor.com/en/.

Norton, B. (2024, January 31). *China is 'world's sole manufacturing superpower', with 35% of global output*. Geopolitical Economy Report. https://geopoliticaleconomy.com/2024/01/31/china-world-manufacturing-superpower-production/

Popławski, K. Baniak, S. Michalski, A. Popławski, M.. (2024). *The Middle Corridor: A Eurasian alternative to Russia*. Centre for Eastern Studies. https://www.osw.waw.pl/sites/default/files/OSW-Report_The-middle-corridor_net.pdf

Satubaldina, A. (2023, December 28). Cargo Transportation Along Middle Corridor Soars 88%, Reaches 2 Million Tons in 2023. The Astana Times. https://astanatimes.com/2023/12/cargo-transportation-along-middle-corridor-soars-88-reaches-2-million-tons-in-2023/

Seong, J. (2024, April 22). *The global economy is resetting, China is repositioning itself to export innovative technologies, and its trading partners are more diverse*. McKinsey Global Institute. https://www.mckinsey.com/mgi/overview/in-the-news/the-global-economy-is-resetting-china-is-repositioning-itself-to-export-innovative-technologies-and-its-trading-partners-are-more-diverse

Statista (2024, June 14). *Trade balance of the European Union with China from 2013 to 2023(in billion euros)*. https://www.statista.com/statistics/257155/eu-trade-with-china/

The State Council Information Office of China. (2024, March 11). *China's manufacturing sector strives to remain competitive amid headwinds*. http://english.scio.gov.cn/chinavoices/2024-03/11/content_117052667.htm#:~:text=In%202023%2C%20China's%20total%20value,31.7%20percent%20of%20its%20GDP

The State Council Information Office of China. (2022, June 14). *China accounts for 30% of global manufacturing output: Official*. http://english.scio.gov.cn/pressroom/2022-06/14/content_78269516.htm

The White House. (2023, May 20). *G7 Hiroshima Leaders' Communiqué*. https://www.whitehouse.gov/briefing-room/statements-releases/2023/05/20/g7-hiroshima-leaders-communique/

World Bank Group. (2024). *Sustainable Development in Shipping and Ports*. https://www.worldbank.org/en/topic/transport/brief/sustainable-development-in-shipping-and-ports#:~:text=Maritime%20transport%20is%20the%20backbone,and%2061%20percent%20of%20imports

World Population Review. (2024). *Manufacturing by Country 2024*. https://worldpopulationreview.com/country-rankings/manufacturing-by-country

Xinhua. (2023, October, 18). *(BRF2023) Full text of Xi Jinping's keynote speech at 3rd Belt and Road Forum for Int'l Cooperation*. https://english.news.cn/20231018/7bfc16ac51d443c6a7a00ce25c972104/c.html

Zhu, L. (2024, February 2). *Experts: China still dominates manufacturing*. China Daily. https://www.chinadaily.com.cn/a/202402/21/WS65d56abaa31082fc043b8503.html#:~:text=Analyzing%20the%20Organization%20for%20Economic,times%20the%20US%20share%2C%20six

EVALUATION OF ECMWF DATA FOR IRAN'S CLIMATIC CONDITIONS

Arabi Yazdi

Arabiyazdi@gmail.com
Ph. D of Agricultural Meteorology,
South Khorasan Regional Water Authority Company

In this study, the validity of the European Centre for Medium-Range Weather Forecasts (ECMWF) for providing temperature parameters (minimum and maximum, mean and dew point temperature) and precipitation prediction in different regions of Iran between 2015 and 2017 with a spatial resolution of 0.5 * 0.5 degrees has been evaluated. In order to compare and evaluate ERA-Interim data, minimum and maximum, average, dew point temperature and monthly precipitation of five stations over Iran representing different climate zones have been used. The results showed that the ERA-Interim model predicted generally monthly scale better than the daily scales. For precipitation, the coefficient of determination at all stations were high and, in most stations, it was more than 0.6 and up to 0.99. The values of R^2 for the average values of temperature, minimum temperature, and maximum temperature of all stations were close to one, which indicated that the observed values explained the changes in the predicted values of the model. In general, the standard error of all temperature variables was low and acceptable on a monthly scale, which indicated that the model values were with a small distance from observations. Nash–Sutcliffe model efficiency coefficient varied between -2.4 and 0.9 at stations and variables. A correlation coefficient of average and maximum temperature was about 1 at all stations, which indicated a strong relationship between the observed values and the model. The equally assumption for the minimum temperature and the dew point was not true. In general, the model could well simulate the process of time variation of different variables at selected stations, and the accuracy of the model was acceptable.

Keywords: Reanalysis; ERA-Interim, statistical analysis, Iran, Gridded data.

1. Introduction

Precise monitoring of climate factors such as precipitation and temperature is important in various fields of hydrology, agriculture, and industry. The spatial variation of the meteorological stations has led to the lack of access to various climatic data in the non-stationed areas. Today, the development of centers for forecasting and modeling of climatic data has provided access to time-consuming data. The reanalyzed data is used in conjunction with station data, or sometimes in non-data locations, which have been investigated in various studies of the validity of these data such as the European Centre for Medium-Range Weather Forecasts (ECMWF) in Iran (Sharifi et al, 2016; Raziei and Sotoudeh, 2017; Darand and Zand Karimi, 2015). ERA-Interim is produced by ECMWF, which describes the forecast model, data assimilation method, and input datasets (Dee et al, 2011). ERA-Interim also provided an opportunity to improve the technical base for reanalysis production at ECMWF. This includes checking of input observations, methods for quality control, and bias

correction of the observations, as well as providing the tool for monitoring the data assimilation system and its all over efficiency. Each of these features has affected the quality of the reanalysis. Berrisford et al. (2009) prepared a detailed description of the ERA-Interim product archive. Near-real-time updates of various climate indicators derived from ERA-Interim data, can be found at http://www.ecmwf.int/research/era.

Reanalysis origins in the exploitation of meteorological data collected for the FGGE in 1979. These models assemble the data from meteorological stations around the globe (satellite stations, buoys, and upper air observing stations). The results obtained from international aviation and shipping lines and also taking into account the physical-dynamic relationship between the atmosphere and the ocean and the effect of the complex topography of the planet, and the distribution of seas, oceans and forests on it, predicts atmospheric movements and various variables such as pressure and wind. For production of reanalysis data, observational data combines with predictive models. Model predictions are derived from the input data into the model and the mathematical relation defined for the model (Dee et al., 2011; Balsamo et al., 2010). These data take into account the role and effect of observational data, and over time, the forecast errors will be less compared to observational data. (Dee et al., 2011).

The ECMWF first has been looking at atmospheric data since 1979 with high resolution power and for 31 levels (15-ERA). The second inspection of the center was referred to as 40-ERA and carried out during the period 2002-1957. for60 levels with the maximum use of satellite data. On the basis of the network, the data and predictions associated with ozone conditions and the state of the waves in the oceans are available. The data replication system used to generate ERA-Interim is based on the 2006 IFS version (Cy31r2). This system includes the analysis of 4D variations of the 4D-VAR with a 12-hour analysis window. The spatial resolution of the data set is about 80 km (T255 spectrum) at 60 vertical levels from the surface to 0.1 HPA. This database contains real-time rainfall data and its monthly data archives are updated every month.

Various researchers have studied on reanalysis data databases such as NCEP/NCAR, CRU, ECMWF, etc. in different regions and for different climate variables. Poli et al. (2010) described the details of using these data in the ERA-Interim version of the ECMWF database. Balsamo et al. (2010) evaluated the accuracy of estimated rainfall values of the ERA-Interim version on the United States at the daily, monthly, seasonal, and annual basis. The results of their research showed that there is an appropriate coordination between the estimated rainfall values and the precipitation of the GPCP v2.1 databases on the region mapped in the annual time scales. Belo Pereira et al (2011) evaluated global precipitation data sets over the Iberian Peninsula using ERA-Interim and ERA-40 versions of rainfall data and GPCC and CRU bases and compared the data with the values of the national base of IBO2 (Spanish and Portuguese national data). The results showed that estimated rainfall values of the ECMWF base were the best data for understanding the precipitation characteristics of this area. The results of MCEVOY et al. (2014) studies on 4 network databases with observations showed that the type of climate variable and the spatial resolution of network data has an impact on the results of statistical comparisons. Wang and Zeng (2012) compared observational rainfall data with the ECMWF analysis data on the Tibetan plateau (China), and found that there is a high correlation between these data. Pena-Arancibia et al. (2013) studied on precipitation data of NCEP / DOE, ERA-Interim and JRA-

25, and three remote sensing databases (TRMM, CMORPH, PERSIANN) in Australia and South East Asia. They found that ERA- Interim has the most accuracy for estimating precipitation in these areas. Kishore et al. (2015) examined the precipitation data of four databases with India's national data from 1989 to 2007, and found that ERA-Interim data was better than other databases. In another study, the precipitation values of eight databases were investigated with 46 in situ stations in the Sind River basin and Hindu Kush-Karakoram-Himalaya at different altitudes, which are more similar to those of the NCEP / NCAR and ERA-Interim bases compared to other land databases (Khan et al. 2015). A high correlation was found between the ERA-Interim rainfall data and observational data on monthly and daily scales in England and Wales (DeLeeuw et al., 2014). In addition, the potential of ERA-Interim was evaluated in predicting extreme precipitation characteristics for 1 to 7 days in England and Wales, and the results showed a very strong correlation between observational daily precipitation and ERA-Interim estimations (Rhodes et al. 2015). Szczypta et al. (2008) evaluated the data of precipitation, temperature, humidity, irradiance, and wind speed of the ERA-Interim version with the values of the national database of France and obtained a very good correlation between these two bases.

Iran with an area of 1,640,195 square kilometers is located in the southern half of the temperate northern region between 03 °, 25 ° and 47 °, 39 ° north latitude from the equator and 14 °, 44 ° and 20 °, 63 °the eastern part of the Greenwich Meridian. In Iran, researchers have studied the accuracy of ECMWF reanalysis database. Darand and Zand Karimi (2015), evaluated the spatial-temporal accuracy of precipitation of ECMWF over Iran. The results showed that not only the time coordination, but also the amount, are very similar between estimated values of ECMWF precipitation database and observed values of rainfall. Raziei and Sotoudeh (2017) studied on the error rate of the ECMWF in predicting rainfall in different regions of Iran, The results showed that ERA-Interim has a very high accuracy in prediction of rainfall in many parts of the country and its error rate is negligible. Sodoudi et al. (2010) compared the daily precipitation predicted by ECMWF with the daily precipitation of Iran's rainwater grid for the base year 2010. The results showed that the ECMWF provides reliable forecasts of daily rainfall throughout the country. Considering the expansive use of reanalysis data in different areas, and more need for further consideration to use it, this study evaluates the accuracy of the (ERA-Interim) reanalysis data for estimating precipitation and temperature in regions with diverse climates in Iran.

2. Method and Materials

a. ERA-Interim Data:

The daily rainfall data and average temperature, maximum and minimum daily temperature, and dew point temperature from the ERA-Interim ECMWF database with synoptic station data at corresponding geographic locations for 3 years from 1 January 2015 through 31 December 2017 was used and compared with a spatial resolution of 0.5 * 0.5 degrees. The ERA-Interim data were downloaded in February 2018 from the ECMWF Public Datasets web interface (http://apps.ecmwf.int/datasets/data/interim-full-daily/levtype=sfc/). Collection activities, quality control, selection, unification, and display of network data from various sources have been done. ERA-Interim products typically

appear once a month with a two-month delay to ensure quality and to improve the technical issues of production.

Since there are variations in climatic conditions and topography in Iran, the study areas were selected in such a way that they could have a comprehensive coverage of climatic and topographic diversity. As shown in Fig. 1, according to the proposal of Sharifi et al. 2016, the Synoptic Station of Kermanshah (Zone 5), Synoptic Station of Rasht (Zone 8), Synoptic Station of Bushehr (Zone 4), Synoptic Station of Mashhad (Zone 2), and The synoptic station of Birjand (Zone 1) has been investigated. Table (1) presents the geographic and climatic characteristics of the stations mentioned above and their elevations.

Figure 1.

Spatial distribution of rainfall variation in Iran Reference Modarres 2006

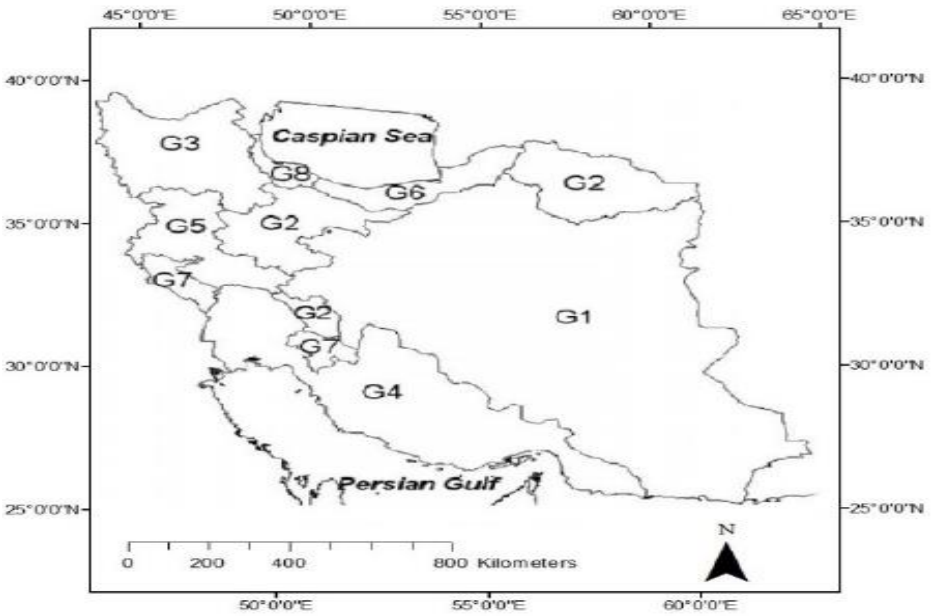


Table 1.

Specifications of synoptic stations studied

Synoptic Station	Longitude	Latitude	Elevation (m)	Climatic zone	Climatic Properties	Area of Iran (%)
Mashhad	59 38	36 16	999.2	Eastern climber	Moderate-mild precipitation, dry	17.1
Kermanshah	47 9	34 21	1318.6	Highlands	Cold good precipitation, dry	15.2
Bushehr	50 49	28 58	9	The climate of the Omani coast	Very hot, low rainfall, very wet	7.7
Rasht	49 37	37 19	-8.6	The Caspian Sea Region	Moderate, well rainfall, wet weather	1.5
Birjand	59 12	32 52	1491	Eastern Shelf Climate	Warm, very low rainfall, dry	39.7

Ref: Masoudian, 2012

For comparison, the correlation coefficients (R^2), RMSE and NRMSE, the mean bias error (MBE), Nash–Sutcliffe model efficiency coefficient (N_S) and residual coefficient (CRM) were used. The normalized root mean squared error (NRMSE) is used to evaluate the accuracy of model predictions against observations and compare them in different regions as shown by equation no.1.

$$NRMSE = \frac{RMSE}{O\,max - Omin} = \frac{\sqrt{\frac{\sum_{i=1}^{N}(Oi - Pi)^2}{N}}}{O\,max - Omin} \quad (1)$$

The N_S is used to compare the predictive power of a model with observational values and to describe the output accuracy of the model in accordance to equation no.2.

$$EF = 1 - \frac{\sum_{i=1}^{N}(Oi - Pi)^2}{\sum_{i=1}^{N}\left(Oi - \underline{O}\right)^2} \quad (2)$$

$$MBE = \frac{1}{N}\sum_{i=1}^{N}(Pi - Oi) \quad (3)$$

$$CRM = \frac{\sum_{i=i}^{N} Oi - \sum_{i=1}^{N} Pi}{\sum_{i=1}^{N} Oi} \quad (4)$$

In which, Pi and Oi values represent predicted and observable values, and N is the number of data or time series lengths and $\bar{O}i$ is the average of observational data. O_{max} and O_{min} are the maximum and the minimum of observations, respectively.

3. Results

One of the important dimensions in comparative studies between measured and predicted data is the knowledge of the status of measured data. In addition to climatic factors, station location, altitude, vegetation around the station, exposure to wind and prevailing wind direction, and type of rain gauges were utilized at each station (Sieck et al., 2007). They may also affect measured climatic variables. These factors make it possible to record different measurement values from a rain event and cause uncertainty in the observations. These factors make it possible to obtain more uncertainties in the evaluation of observational data with a model such as ERA-Interim.

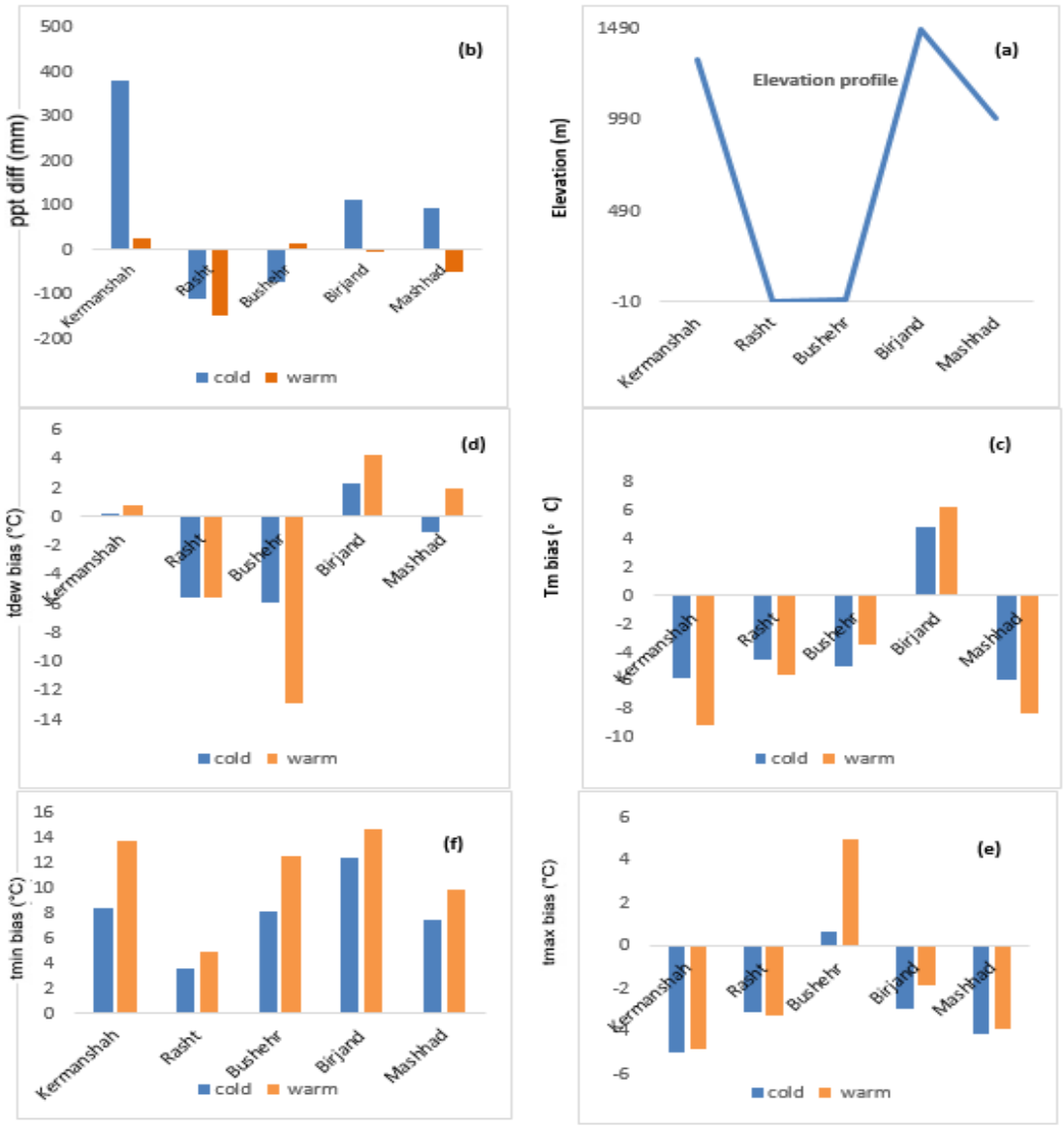
On a monthly scale, the elevation range of the stations and the bias comparison between the cumulative/average cold and warm season with the observations in the studied period are shown in Fig. 2. The difference between the sum of rainfall of different months (January, February, etc.) from model with observations in years 2015 to 2017 are demonstrated in Fig. 2. In the case of temperature variables, it is different from the average

monthly temperature (January, February etc.) of the model with observations. In the Fig. (2b) during the cold season (autumn and winter), the bias range of precipitation is positive for stations in Kermanshah, Birjand, and Mashhad. The most difference between model and observed values is at Kermanshah station, which is due to model prediction in December. In Rasht and Bushehr, this difference is negative (model minus observation). The lowest difference in the cold season is at Bushehr station (-72 mm), which shows the total difference in cold seasons (18 months of cold) between model and observations. The difference in elevation between stations does not reflect the difference in rainfall, which indicates that the model's performance is not uniform in some regions with specific climatic and geographical conditions. The average temperature difference (Fig. 2c) is negative for the four stations in Kermanshah, Rasht, Bushehr, and Mashhad in the cold and warm seasons, and is positive only for the Birjand station, which has the highest elevation. In other words, the model predicts a higher average temperature (+4°C) for a warm, dry, and high climate region. The largest difference is negative (cooler than observations) at the stations of Mashhad and Kermanshah. The dew point temperature bias (Fig. 2d) is positive for warm and cold seasons for stations in Kermanshah and Birjand and is negative for Rasht and Bushehr. At Mashhad station, it is negative in cold season and positive in warm season. In general, many of these biases can be attributed to the network point and station location. At cold and warm seasons, the maximum temperature bias (Fig. 2e) is negative for 4 stations and only positive for the Bushehr station, which is in the range of 0.67 to -5 ° C. The minimum temperature difference (Fig. 2f) is positive for all stations in the cold and warm seasons. The minimum temperature difference changed in the range of 3.5 (Rasht) to 12.3 ° C (Birjand) in the cool season and 4.8 (Rasht) to 14.6 ° C (Birjand) in the warm season.

The dew point temperature of the model is calculated using the specific humidity parameters and surface pressure, and in the case of temperature below the minimum at 2 meters, the dew point temperature is assumed to be minimum temperature at 2 meters (Tmin = Tdew) (IFS documentation). Dew point temperature at Rasht and Bushehr stations with low altitude is negative in warm and cold seasons and is high in other stations that are located in high altitude, while the dew point temperature decreases at high elevation.

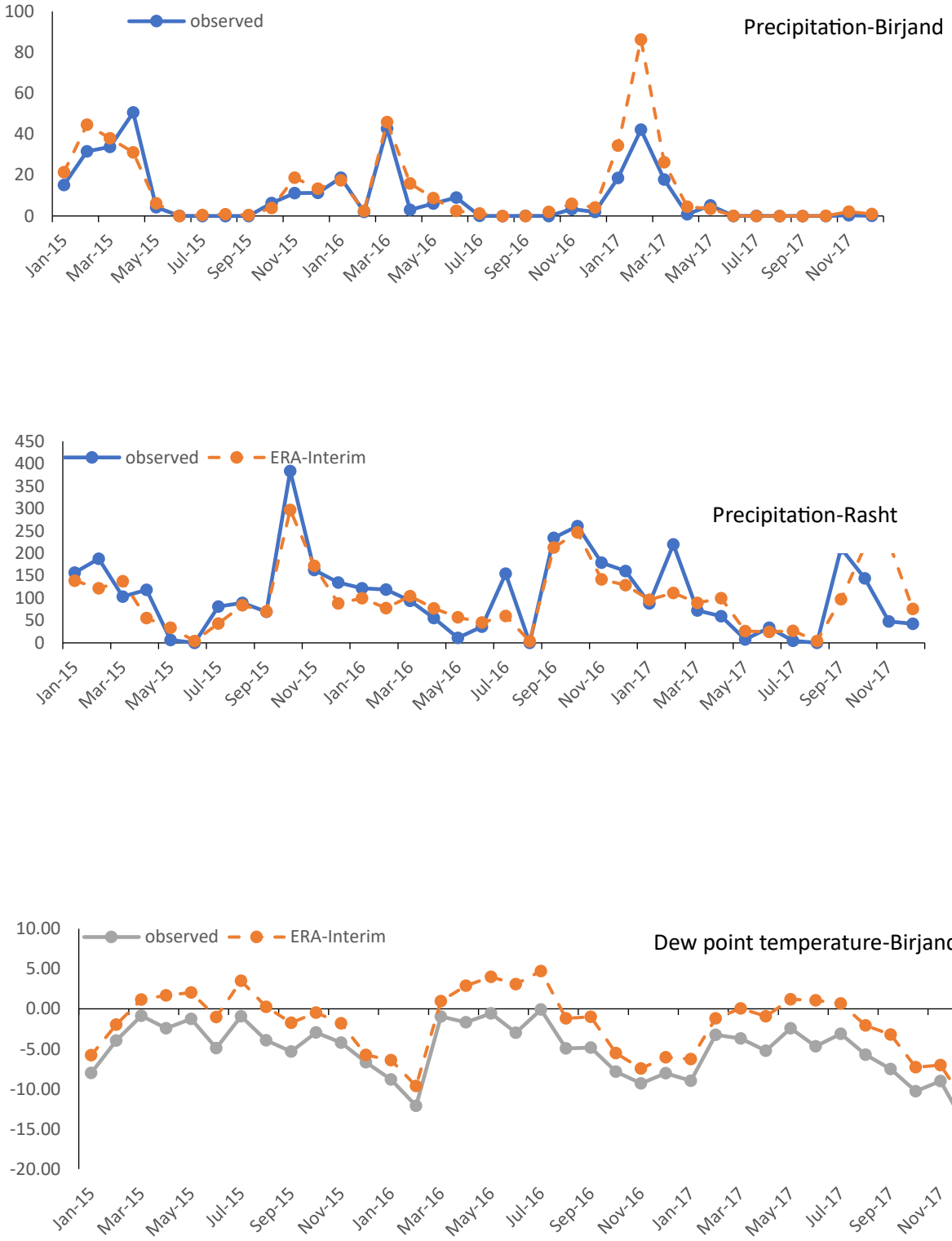
Figure 2.

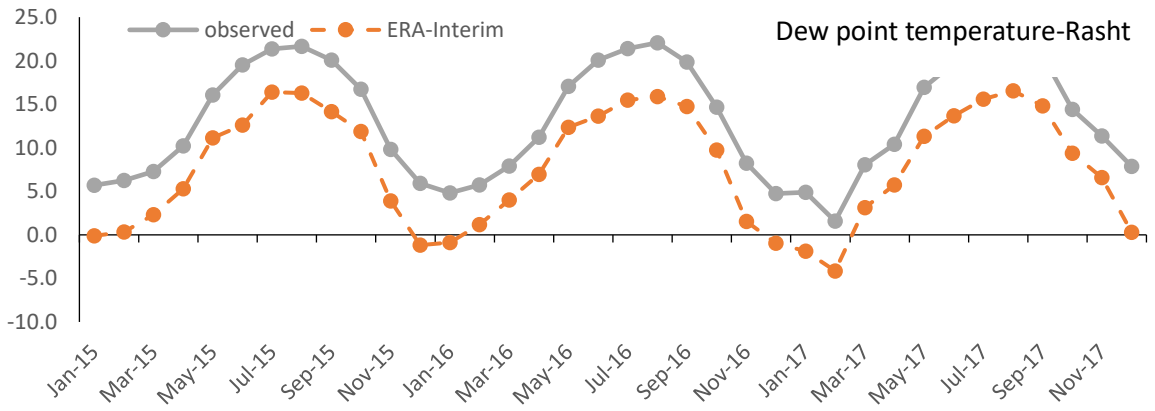
The elevation profile of the stations (A), the biases (model minus observations) at warm and cold season, (B) the precipitation bias, (C) the average temperature bias, (D) the dew point temperature bias, and (E) the maximum temperature bias in the 2015-2017.



In order to evaluate the ability of the ERA-interim model to predict weather variables in special atmospheric conditions in different regions of the country, comparison between precipitation and dew point temperature values from model for Birjand and Rasht stations are done monthly. The choice of the two stations was based on the lowest and the highest rainfall rates among the selected stations. The model was able to predict rainfall on most months studied in Birjand and was only over-estimated in February of 2015 and 2017, and has been under-estimated in April 2015. The model's ability to predict Rasht precipitation is also shown in Fig. 3. The model has been over-estimated the moderate dew point temperature in Birjand (+3.27 ° C) and has been under-estimated at -5.6 °C in Rasht station for all months.

Figure 3.
Rainfall and dew point temperature comparison between model and observed in Birjand and Rasht stations monthly





The difference between model and observed data from monthly mean temperature sum of rainfall are presented in Table (2). The model overestimated in Mashhad, Kermanshah and Birjand and underestimated in Bushehr and Rasht in precipitation. These conditions also apply for dew point temperature of these stations. The minimum temperature overestimated at all stations, ranging from 4 to 13.5 ° C, with the least positive difference in Rasht and the highest positive difference in Birjand. The model underestimated maximum temperature in 80 percent of stations, which varied from -2.4 to -4.9 ° C that observed in Birjand and Kermanshah, respectively.

Table 2.

Differences of monthly average of model predictive values with observational variables

Station	Kermanshah	Rasht	Bushehr	Birjand	Mashhad
Precipitation	11	-7	-1.63	3	1.2
Average temperature	-7.5	-5.1	-4.2	5.6	-7.1
Dew point temperature	0.5	-5.6	-9.4	3.3	0.5
Minimum temperature	11	4.2	10.3	13.5	8.6
Maximum temperature	-4.9	-3.2	2.8	-2.4	-4

Determination coefficient and standard error for prediction values of model with observational values of the variables studied has shown in Table (3). The explanation or detection coefficient (R^2) indicates the ratio of the dispersion expressed from the regression model to the total dispersion. R^2 specifies that, according to the regression model, what proportion of the variation or dispersion of the model's prediction is related to the observed values. The closer the R^2 is to one, the more reliable a model can be. R^2 values are high (0.6 and up to 0.99) at all stations. The values of R^2 for mean temperature, minimum temperature and maximum temperature of all stations are close to one, which indicates that the observed values explain the changes in the predicted values of the model. In addition, the range of R^2 is for the maximum daily temperature variables and the average temperature is over 90% at daily scale. The coefficient of precipitation determination in the studied stations varies from 16 to 51 percent, of which the lowest is Bushehr station. Also, at Rasht

station, 85% of variation and dispersion in dew point temperature variable predicted by ERA-interim model depend on observational values. On the other hand, it is observed that this coefficient for dew point temperature at Kermanshah station is less than 10 percent, but exceptionally low at high altitudes.

In general, the standard error of all temperature variables is low and acceptable on a monthly scale. The standard error of estimation specifies that, according to the regression model, the predicted value of the (ERA-interim) model is, on average, as far as the actual (observable). On a daily scale, on average, the lowest and highest standard errors of precipitation prediction are at Birjand and Rasht, respectively. On average, it seems that model to have less error in estimating average temperature and maximum temperature.

Table 3.

Determination coefficient and standard error for prediction values of model with observational values of the variables studied at relevant stations on the monthly scale during the period of 2017-2015

Parameter	Statistic	Kermanshah	Rasht	Bushehr	Birjand	Mashhad
Precipitation	R^2	0.74	0.62	0.44	0.99	0.85
	(std. E. E)	23.63	44.47	20.93	0.80	9.30
Average temperature	R^2	0.99	0.99	0.97	0.99	0.99
	(std. E. E)	19.99	0.71	1.26	0.80	0.61
Dew point temperature	R^2	0.17	0.98	0.48	0.93	0.82
	(std. E. E)	2.94	0.84	2.17	1.10	1.97
Minimum temperature	R^2	0.97	0.97	0.99	0.95	0.98
	(std. E. E)	1.90	1.43	1.11	1.94	1.36
Maximum temperature	R^2	1.00	0.99	0.98	1.00	1.00
	(std. E. E)	0.71	0.85	1.21	0.37	0.57

In Table 4, the results of the ERA-interim prediction accuracy against observed values are presented using RMSE and NRMSE statistics for selected stations at monthly scale. The higher the magnitude of this statistic is closer to zero, the less model error is in the prediction of the observed values. The RMSE range of precipitation in selected stations is 9.44 to 53.7 mm.The higher number is value at Rasht station due to the higher precipitation rate. The range of RMSE for mean temperature is 4.41 to 7.8 which are related to Bushehr stations and Kermanshah, respectively. The lowest RMSE of dew point temperature is for Mashhad station and the highest RMSE of dew point is for Bushehr station. In general, RMSE of maximum temperature of all stations are less than their minimum temperature. Comparison of standardized root mean square error by intervals of observational values between different stations shows that the model accuracy in precipitation forecast in all stations is high and error rates range from 5 to 10 percent. On a daily scale, the RMSE range of

precipitation is at the selected stations is 7.3-4.1 mm. The higher amount at Rasht station is due to higher amount of precipitation at this station. Among the temperature variables, the lowest and highest RMSE values are for dew point temperature and minimum temperature at stations in Mashhad and Birjand, respectively. By looking at the NRMSE values of the various variables in the stations, the lowest NRMSE values are for the minimum temperature prediction at the Birjand station and precipitation at Mashhad station. The low values of NRMSE indicate model deviation of precipitation is less than one and represents an acceptable estimation of the model in all regions. Generally, NRMSE values in all precipitation and temperature variables are lower than 0.63 in all stations and is 1.11 in only one case. The highest NRMSE value is for the minimum temperature prediction at the Birjand station. The low NRMSE values indicate that precipitation model deviation is less than 1 and represents an acceptable model estimate in all areas. At this comparative level, the NRMSE model has been associated with a greater error in estimating the minimum temperature than other temperature variables. In general, the NRMSE values for all temperature and precipitation variables and at all stations are less than 0.4. On a daily scale, the highest NRMSE value is for the minimum temperature prediction at the Birjand station. The low NRMSE values indicate that precipitation model deviation is less than 1 and represents an acceptable model estimate in all areas. At this comparative level, the NRMSE model has been associated with a greater error in estimating the minimum temperature than other temperature variables. In general, the NRMSE values for all temperature and precipitation variables and at all stations are less than 0.4.

Table 4.

Root mean Square Error (RMSE) and Standardized (NRMSE) Model predictive values with observational values of the studied variables at relevant stations at monthly scale

Parameter	Statistic	Kermanshah	Rasht	Bushehr	Birjand	Mashhad
Precipitation	RMSE	25.97	53.69	24.00	9.43	9.44
	NRMSE	0.16	0.14	0.19	0.19	0.10
Average temperature	RMSE	7.80	5.17	4.41	5.67	7.27
	NRMSE	0.27	0.21	0.22	0.25	0.27
Dew point temperature	RMSE	4.48	5.62	10.45	3.48	2.05
	NRMSE	0.23	0.27	0.54	0.24	1.11
Minimum temperature	RMSE	11.58	4.45	10.61	13.68	8.85
	NRMSE	0.63	0.19	0.53	0.56	0.36
Maximum temperature	RMSE	4.95	4.45	3.75	2.49	4.02
	NRMSE	0.16	0.18	0.18	0.10	0.14

Table 5 shows the N_S between observational values and model prediction. N_S can vary from infinity to 1. EF = 1 means that the model has a perfect match with the observations. EF = 0 shows that the model predictions are accurately the mean of observational data, while the efficiency coefficient is less than zero, indicating that the average of the observations is better than the model and the accuracy of the model is very low. The range of N_S and variables at stations varies between -2.4 and 0.9. In comparison, the model has a low accuracy of dew point temperature in Birjand and Bushehr. The model also has a low accuracy of minimum temperatures in Mashhad, Birjand, Bushehr, and

Kermanshah stations. On the other hand, model have been high in predicting maximum temperature at all stations, as well as the rainfall and dew point temperature in Mashhad. The model in Birjand's dew point temperature estimate has operated with the average of observations and the efficiency coefficient is zero. On a daily scale, N_S changes at stations and various variables are between -0.3 and 0.9. The model underestimated the forecast of Bushehr precipitation, the minimum temperature in Mashhad, Birjand, Bushehr, and Kermanshah, and the maximum temperature at Kermanshah station. On the other hand, the dew point temperature in Mashhad, maximum temperature in Birjand, Rasht, and Mashhad were high.

The estimation of the mean bias error in this study shows that the model overestimated precipitation in Mashhad and Birjand stations, and underestimated rainfall of Bushehr, Rasht, and Kermanshah. Also, the model underestimated average temperature and overestimated the minimum temperature in most stations. On a daily scale, the mean bias error in this study shows that the model well done for forecasting rainfall in Mashhad station. The model underestimated the average temperature and overestimated the minimum temperature. Positive values of biases were shown for dew point temperature in Mashhad, Birjand and Kermanshah and its negative values were in Bushehr and Rasht. The positive values of biases for maximum temperature in Bushehr and Kermanshah and its negative values were seen in Mashhad, Birjand, and Rasht.

Table 5.
Nash–Sutcliffe model efficiency coefficient and mean bias error of the predicted model with the observed values of the variables studied at the stations in the monthly scale

Parameter	Statistic	Kermanshah	Rasht	Bushehr	Birjand	Mashhad
Precipitation	EF	0.6	0.6	0.4	0.5	0.8
	bias	11.2	-7.2	-1.6	3.0	1.2
Average temperature	EF	0.3	0.5	0.6	0.4	0.3
	bias	-7.5	-5.1	-4.2	5.6	-7.1
Dew point temperature	EF	0.1	0.2	-1.9	0.0	0.7
	bias	0.5	-5.6	-9.4	3.3	0.5
Minimum temperature	EF	-1.5	0.6	-1.5	-2.4	-0.3
	bias	11.0	4.2	10.3	13.5	8.6
Maximum temperature	EF	0.8	0.7	0.7	0.9	0.8
	bias	-4.9	4.2	2.8	-2.4	-4.0

The mean bias error (MBE) is the average of the model's tendency for over-estimating (positive values) or underestimating (negative values) of the model relative to the observed values (Table 6). The zero value of the statistic indicates the good ability of the model in predicting observational values. The study of the mean bias error in this study shows that the model predicted the observed values well for dew point temperature of Mashhad and Kermanshah stations. The bias error of the model in the prediction of minimum temperature in Birjand is the most overestimated and Bushehr dew point temperature is the least

underestimated. The Coefficient of Residual Mass (CRM) also confirms MBE results. In an ideal model, CRM is zero. In the case where the residual coefficient is positive, the model's tendency to estimate predictive values is less than observational values, and if the residual coefficient is negative, then the prediction values of the model are larger than observational values.

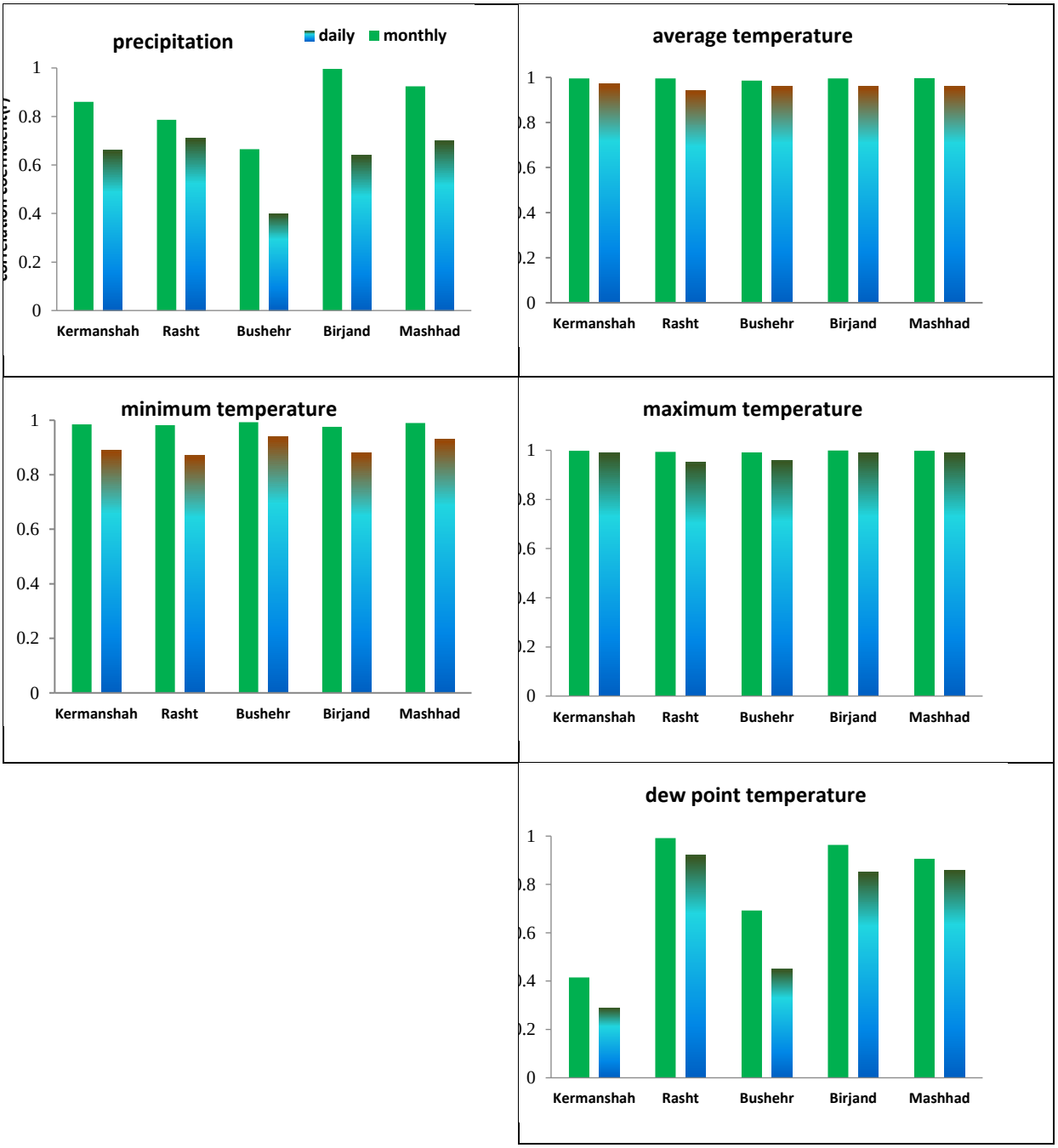
Table 6.
MBE and CRM of the predicted model with the observed values of the variables studied at the stations in the monthly scale

Parameter	Statistic	Kermanshah	Rasht	Bushehr	Birjand	Mashhad
Precipitation	MBE	11.2	-7.2	-1.6	3.0	1.2
	CRM	-0.3	0.1	0.1	-0.3	-0.1
Average temperature	MBE	-7.5	-5.1	-4.2	5.6	-7.1
	CRM	0.5	0.3	0.2	-0.5	0.4
Dew point temperature	MBE	0.5	-5.6	-9.4	3.3	0.5
	CRM	1.1	0.4	0.5	0.6	-0.4
Minimum temperature	MBE	11.0	4.2	10.3	13.5	8.6
	CRM	-1.5	-0.3	-0.5	-1.5	-0.9
Maximum temperature	MBE	-4.9	4.2	2.8	-2.4	-4.0
	CRM	0.2	0.1	-0.1	0.1	0.2

Figure 4 shows the correlation coefficient between the daily and monthly values of the studied variables in selected stations in the 2015-2017 period. The value of r on average temperature and maximum temperature is near 1 at all stations on monthly scale, which indicates a strong relationship between the observed values and the model. Thus, the model can be used to predict this climatic variables more successful in monthly scale and is consistent with Darand and Karimi (2015), Raziee and Sotoudeh (2016) and Sharifi et al, 2016. On a daily scale. pearson correlation coefficients vary from 0.7 to 0.99 and indicate a strong positive linear relationship between observational values and the ERA-interim model in various variables.

Figure 4.

Correlation Coefficients (r) Daily and monthly values of the studied variables at selected stations in 2015-2017



Conclusion

Due to the spatial and temporal constraints of in situ data, it is important to use grid data consist of a variety of ground databases, radars, and satellites in conducting hydrology, climate and, agricultural research. In this study, the accuracy of monthly values of temperature and precipitation variables of the ERA-interim model from the ECMWF base with five synoptic stations in different climatic regions of the country during 2015-2017 with a spatial resolution of 0.5 * 0.5 degrees has been evaluated. Notable achievements in modelling and data assimilation actualized at ECMWF in recent years. The results showed that the variability of the studied variables in the model with the observational data has a very high time synchronization. Due to the spatial distribution of selected stations, there is a strong and significant daily time series correlation between observational and model prediction in all variables. The ERA-Interim model predicts monthly data better than daily scale. In accordance to the N_S efficiency coefficient, the model predicted maximum temperature, mean temperature, and precipitation better than dew point and minimum temperature. The assumption of the model that the dew point temperature average equals the minimum temperature at daily scale is not true. In general, the model can well simulate the process of time variation for different variables at selected stations, with and acceptable accuracy. According to the results of this research, the data of this model can be used along with the station data.

Network data users should be aware of the existence of larger uncertainties in less density station areas. Observed difference may be due to factors such as the accuracy of the databases used in the model, the model's resolution, and the methods for interpolating the model in the corresponding coordinates of the stations. Also, the density of the terrestrial data network in the region and the study of the dynamics and physical relations governing the model, run steps etc. in predicting rainfall and dew point temperature and other temperature variables are the factors that should be considered in the application of models.

This study highlights the importance of conducting spatial analysis of observations and potential measurement errors in order to obtain an understanding of the potential deviations of network data before being used in hydro-climatic applications.

Reference lists

Balsamo, G., Boussetta, S., Lopez, P. and Ferranti, L. (2010). "Evaluation of ERA-Interim and ERA-Interim-GPCPrescaled precipitation over the U.S.A.". ERA Report Series. No. 5. ECMWF. Reading. UK. 10 pp.

Belo Pereira, M., Dutra, E. and Viterbo, P. (2011). "Evaluation of global precipitation data sets over the Iberian Peninsula". Journal of Geophysical Research: Atmospheres (1984–2012). 116 (D20).

Berrisford, P., Dee, D.P., Fielding, M., Manuel Fuentes, Kållberg, P.W., Kobayashi, S., Uppala, S. 2009. ERA report seriesThe ERA-Interim archive Version 1.0. available on http://www.ecmwf.int/publications/

Darand, M., Z. K, S. 2015. Evaluation of Spatio-Temporal Accuracy of Precipitation of European Center for Medium-Range Weather Forecasts (ECMWF) over Iran. Physical Geography Research Quarterly.V 47. Page 651-675(In Persian with English Summary).

Dee, D.P., Uppala, S.M., Simmons, A.J., Berrisford, P., Poli, P., Kobayashi, S., Andrae, U., Balmaseda, M.A.,Balsamo, G., Bauer, P., Bechtold, P., Beljaars, A., Van de Berg, L., Bidlot, J., Bormann, N., Delsol, C.,Dragani, R., Fuentes, M., Geer, A.J., Haimberger, L., Healy, S.B., Hersbach, H., Hólm, E.V., Isaksen, L.,Kallberg, P., Köhler, M., Matricardi, M., McNally, A.P., Monge-Sanz, B.M., Morcrette, J.J., Park, B.K.,Peubey, C., de Rosnay, P., Tavolato, C., Thépaut, J. N. and Vitart, F. (2011). "The ERA-Interim reanalysis: configuration and performance of the data assimilation system". Q. J. Roy. Meteorol. Soc.. No. 137: 553–597.

DeLeeuw, J., Methven, J., Blackburn, M., 2014, Evaluation of ERA-Interim reanalysis precipitation products using England and Wales observations, Q. J. R. Meteorol. Soc, 141, 798-806.

IFS DOCUMENTATION Cy41r1 Operational implementation 12 May 2015 PART IV: PHYSICAL PROCESS

Khan, A., Richards, K.S., Parker, G.T., McRobie, A., Booij, M.J., Duan, Z. and Khan, M. (2015). "Spatial and altitudinal variation of precipitation and the correction of gridded precipitation datasets for the Upper Indus Basin and the Hindukush-Karakoram-Himalaya".Geophysical Research Abstracts. Vol. 17. EGU 2015-7770-2.

Kishore, P., Jyothi, S., Basha, G., Rao, S.V. B., Rajeevan, M., Velicogna, I. and Sutterley, T.C. (2015). "Precipitation climatology over India: validation with observations and reanalysis datasets and spatial trends". Climate Dynamics: 1-16.

Massoudian, a. 2012. Weather in Iran. Shariah Toos Publications. P. 208.

MCEVOY, D.J., MEJIA, J.F., AND HUNTINGTON, J.L. 2014. Use of an Observation Network in the Great Basin to Evaluate Gridded Climate Data. JOURNAL OF HYDROMETEOROLOGY.15, 1913-1931.

Modarres, R. Regional precipitation climates of Iran. J. Hydrol. (NZ) 2006, 45, 13–27.

Pena-Arancibia, J.L., Van dijk, A.I.J.M., Renzullo, L.J., Mulligan, M., 2013, Evaluation of Precipitation Estimation Accuracy in Re-analyses, Satellite Products, and an Ensemble

Method for Regions in Australia and South and East Asia, Jour Hydromet, 14, 1323-1333.

Poli, P., Healy, S.B. and Dee, D.P. (2010). "Assimilation of Global Positioning System radio occultation data in the ECMWF ERA-Interim reanalysis". Q. J. R. Meteorol. Soc.. No. 136: 1972–1990.

Raziei, T., Sotoudeh, F.2017, Investigation of the accuracy of the European Center for Medium Range Weather Forecast (ECMWF) in forecasting observed precipitation in different climates of Iran, 43(1), 133-147(In Persian with English Summary).

Rhodes, R. I., Shaffrey, L. C., and Gray, S. L., 2015, Can reanalyses represent extreme precipitation over England and Wales?, Q. J. R. Meteorol. Soc, 141, 1114–1120.

Sharifi, E., Steinacker, R., and Saghafian, B., 2016, Assessment of GPM-IMERG and Other Precipitation Products against Gauge Data under Different Topographic and Climatic Conditions in Iran: Preliminary Results, Remote Sens, 8, 134-158.

Sieck, L. C., S. J. Burges, and M. Steiner, 2007: Challenges in obtaining reliable measurements of point rainfall. Water Resour. Res., 43, W01420, doi:10.1029/2005WR004519.

Sodoudi, S., Noorian, A.M., Manfred, G., Eberhard, R., 2010, Daily precipitation forecast of ECMWF verified over Iran, TheorApplClimatol, 99, 39–51.

Szczypta, C., Calvet, J.C., Albergel, C., Balsamo, G., Boussetta, S., Carrer, D., Lafont, S. and Meurey, C. (2011)."Verification of the new ECMWF ERA-Interim reanalysis over France". Hydrol. Earth Syst. Sci. No. 15: 647–666.

Wang, A., and Zeng, X., 2012, Evaluation of multi reanalysis products with in situ observations over the Tibetan Plateau, Jour G

Submission Terms

Authors presenting articles agree to comply with the following terms:

1. The journal should be published in an electronic format.
2. Articles should be submitted through the electronic platform and follow the instructions.
3. By submitting an article, the author confirms that the article has not been published in any other journal.
4. Only original and completed research papers are accepted.
5. Articles must be written in the format given in the “Author Guidelines”.
6. All articles should be submitted in English.
7. Before the review, the editor examines whether the article complies with the requirements. Non-complying articles will be immediately rejected and the authors will be informed about the reasons for rejection. The final deadline for the submission of the new version will be communicated to them.
8. Each article submitted to the journal will be checked by 2 reviewers.
9. The authors should take into account all the comments of the reviewers and make corrections. The third reviewer gives a reference to the objections of the author. The final decision on the publication of the article will be made by the editor-in-chief.
10. The published articles are copyrighted by the Editorial Board.
11. Modified or revised versions are not accepted after the deadline determined by the editor-in-chief. Any adjustments made after that date are not taken into account.
12. Articles, accepted for publication, will be checked by special anti-plagiarism software.
13. By submitting an article, the author confirms that he/she has obtained permission from the co-authors mentioned in the article.
14. All the used sources should be cited and the authors should guarantee that each and every reference is complete and accurate.
15. By uploading the article, the author gives the publishers the right to publish and retain the article.
16. Requests to withdraw an article are considered by the editor-in-chief. He/she may accept or reject the request.
17. Articles will be published under a Creative Commons Attribution License 4.0. This means that the journal is open to the public in electronic form, anyone can download and read the article for free. Besides, the article may be reprinted and quoted, provided that there is a reference to the originally published version.

Author Guidelines

Layout: Articles must be written following the guidelines in the 7th edition of the Publication Manual of the American Psychological Association. Articles must be in Microsoft Word format (21 cm x 29.7 cm), using 12-point Georgia font, with 2.5 cm margins, paragraphs left-aligned, pages numbered in the upper right, and double-spaced (except for tables and figures which may use single spacing).

First Page: It contains the title of the paper, the author's name, email address, organization and country, the abstract, keywords, and the introduction part of your article.

1. Title

The title should be in 14pt Georgia font (capital letters), bold and centered. After leaving one clear line space, the names, surnames and emails of the authors should be indicated in 12pt. After further omitting a line, the name, address (city) and country of the author's organization must be written in italics font size 12pt.

2. Abstract

The abstract must be no longer than 200 words, written in simple font size 12pt, and must cover the essential elements of the article such as the research topic, the methods used, and the main results and conclusions. It must be accurate, concise, and encompass the key points of the study.

3. Keywords

After the abstract, the author should provide a list of up to 6 keywords, separated by semicolon, that indicate the most important topics, methods and/or frameworks used in the article. Keywords must be written in a simple font size of 12pt.

Content: The main body of the article should be written in font size of 12pt following APA style.

1. Headings

Headings should be numbered with Arabic numerals, bold, left-aligned, and set in 12pt font size. There should be one complete line space between the sections and between the title and the main text. Paragraphs within the section should be indented 5-character spaces.

2. Subheadings

The subheadings (if any) should be bold, left-aligned, set in 12pt font size, and numbered with Arabic numerals (first indicating the section to which it belongs, then the sequence number) (for example: 2.1 or 2.1.1).

3. Equations

All equations must be clearly set and numbered consecutively from the beginning of the paper. They should be numbered simply (1), (2), (3), etc. Equations are centered on the page and labeled with Arabic numerals, right-aligned, in parentheses, and referred to only by those numbers in the text.

4. Tables and Figures

Tables and figures should be numbered with Arabic numerals consecutively from the beginning of the paper. Numbers are assigned based on the order in which tables/figures appear in the text and are bolded and left-aligned. All tables/figures must have a title, which should be written in 12-point Georgia font, left-aligned (over the table/figure), in italicized title case below the table/figure number, with a blank line between the number and the title.

All the tables and figures must be referred to in the text. The tables and figures should be inserted in the first appropriate place after being referred to. PNG and JPEG formats are considered suitable for figures.

We kindly request you to provide the original figures and tables that were extracted from the program/software used for its creation.

References: The APA style should be used for in-text citations and the reference list.

1. In-text Citations

In-text citations must be given in parentheses, indicating the author and the year of the publication.

Examples:

- A work by one author – (Nielsen, 2017)
- A work by two authors – (Sadigzade & Nasibov, 2022)
- A work by three or more authors – (Huseynova et al., 2019)
- Two or more works by the same author in the same year – (Berndt 1981a; Berndt 1981b)
- Organization as an author – (Food and Drug Administration [FDA], 2019)
- For quotations – (Yanmaz, 2018, p. 12)

2. Reference List

Each source cited in the article must appear in the reference list. All lines after the first line of each entry in your reference list should be indented 1.27 cm from the left margin. The references should be arranged in alphabetical order and comply with the APA 7th edition style.

Note

Articles in the journal are first arranged in alphabetical order by the primary author's country of origin. If there are several articles from the same country, they are then listed alphabetically by the primary authors' surnames.

Disclaimer

The opinions and views expressed in this publication belong solely to the authors of the articles and do not necessarily reflect the opinions, views or the official position of the ESRI, the ECO or the ECO Trade and Development Bank (ECO TDB). As the ECO Economic Journal strives to promote knowledge sharing and scholarly dialogue, we acknowledge the value and importance of open discussions on economic and institutional matters. In doing so, we recognize that disagreements may arise, and contentious topics may be explored. The ESRI, the ECO and the ECO TDB do not hold any responsibility for the political statements or contentious issues reflected in the articles of this publication.