# Analysis, Feasibility, and Proposal of the Framework of the Na-tional Climate Change Adaptation Program

**Amin Padash[1,2]✉ 🄳 | Hamidreza Aghababaeian[1,3] | Alireza Khosropanah[1,4] | Mohammad Javad Mohammadizadeh[1,2]**

1. Center for Climate Change and Health Research (CCCHR), Dezful University of Medical Sciences, Dezful, Iran
2. Department of Environmental Planning, Faculty of Environment, University of Tehran, Tehran, Iran
3. Department of Health in Emergencies and Disasters, Dezful University of Medical Sciences, Dezful, Iran
4. Department of Internal Medicine, Dezful University of Medical Sciences, Dezful, Iran

| Article Info | ABSTRACT |
|---|---|
| | Climate change is a phenomenon that is caused by the increase in the concentration of green-house gases in the atmosphere and its effects on the meteorological and environmental patterns, and has caused things such as temperature increase, frequent droughts, decrease in rainfall, sudden floods, and changes in wind and humidity patterns. The importance of climate change for Iran is great; Because the country is facing problems such as continuous droughts, reduction of water reserves, and negative effects on agriculture and economy. The main challenges of these changes include the lack of specific plans and limited infrastructure to implement adaptation programs, political and administrative issues, and lack of community awareness about climate change. Coordinated decisions and cooperation with other countries and international institutions also create other challenges. In this research, based on the (Driving force-Pressure-State-Impact-Response) DPSIR framework, the existing situation has been analyzed, concrete examples related to it have been mentioned, and finally, the framework of the national climate change adaptation program has been presented. The framework of the proposed national climate change adaptation program titled Determining the position, Preparation and action, Implementation of strategies, and Monitoring, evaluation and rehabilitation (DPIM), includes 4 main parts: 1- Position determination, 2- Preparation and action, 3- Implementation of strategies, and 4- Monitoring, evaluation, and rehabilitation with a total of 16 executive steps. |

## INTRODUCTION

The energy crisis highlights global reliance on fossil fuels, but many nations have leveraged this as a chance to push for climate action through renewables (Fernández et al., 2024; Sinervo et al., 2024). Denmark leads in climate efforts, excelling in nearly all Climate Change Performance Index (CCPI) categories, though no country ranks high enough to meet the 1.5°C target. Figure 1 and Table 1, shows China and the U.S., the two largest GHG emitters, have been ranked "very low" at 51st and 52nd respectively. Nordic countries perform better overall, while the Persian Gulf region lacks updated data or favorable conditions (Burck et al., 2023).

Climate change has significantly impacted Iran, bringing challenges like droughts, floods, and rising temperatures, which threaten economic, social, and environmental sectors (Badrzadeh et al., 2022; Mirzaei Hassanlu et al., 2024). The health of citizens is increasingly at risk, leading

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to higher public costs, urging the need for a national plan to manage these risks (Amiraslani et al., 2024). Two key strategies include adapting to climate change and reducing greenhouse gas emissions (Karaşan et al., 2024; Liobikienė and Butkus, 2018). Over the past five decades, these changes have affected vital areas like energy, food security, and migration (Ghufran et al., 2024; Butler, 2024; Becker and Fanzo, 2023).

*Problem Statement*

Iran faces significant risks from climate change, with a 4% rise in air temperature per decade—double the global rate—intensifying heat-related illnesses and extreme weather events like floods and droughts (Doostan & Alijani, 2023; Saberifar, 2023). These events threaten public health, food security, and worsen air pollution, yet a comprehensive national strategy is lacking to address climate-related health risks (Mosadegh et al., 2024). According to the World Meteorological Organization (WMO) data extreme climate events have increased fivefold between 1970 and 2019, becoming more severe and unpredictable (Dong et al., 2023; Liang et al., 2023). Recent floods in Europe highlight the escalating damage caused by such crises (Saouter & Gibon, 2024).

The flood in China's Henan province that happened in 2021 led to dozens of deaths and displacement of more than 250,000 people, disruption in coal transportation and aluminum production, and disruption in the production chain of iPhone products (Hsu et al., 2023; Manandhar et al., 2023). While extreme events have increased more than fivefold over the past few decades, losses from extreme events have increased nearly eightfold globally, representing a nearly 77% increase in the cost per event over five decades (Figure 2) (Newman and Noy, 2023; Filazzola et al., 2020).

In Iran, climate change has worsened droughts and intensified floods, imposing significant social, environmental, and economic costs. Experts estimate damages of $160 billion over the next decade, with health risks increasing the strain on healthcare systems (Bayat-Afshary & Danesh-Yazdi, 2023; Mehdipour et al., 2022).

The World Health Organization predicts that climate change will cause 250,000 deaths annually between 2030 and 2050 due to malnutrition, disease, and heat stress (Fadda, 202, World Health Organization, 2014). Healthcare systems need better integration of climate-related data to increase resilience and protect vulnerable populations (Campbell-Lendrum et al., 2023). Examining the twenty-year average (2000-2019) of the climate risk index shows that the average CRI score and the twenty-year average ranking of Iran were 90 and 97, respectively (Nakano, 2021; Eckstein et al., 2021).
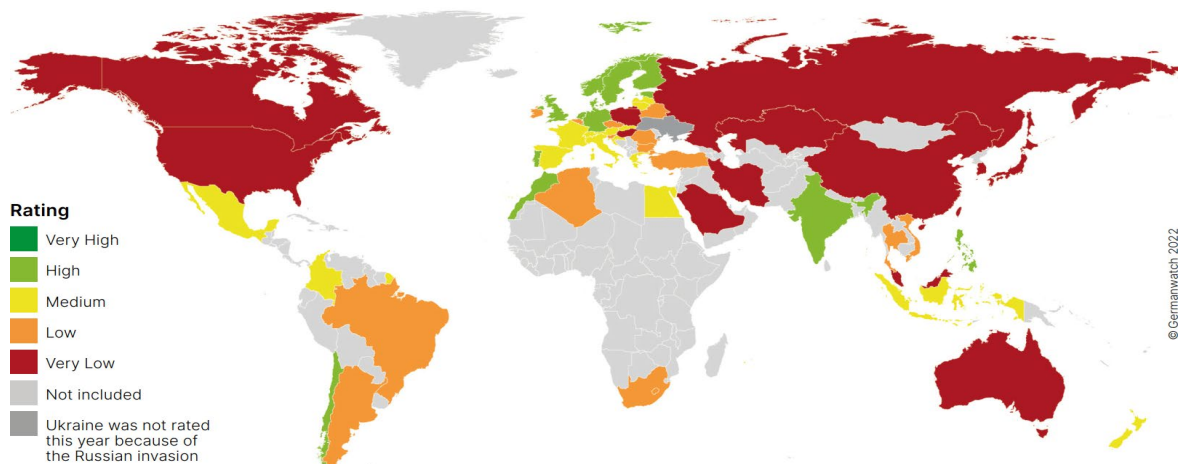


**Fig. 1.** World map based on CCPI overall performance results (Burck et al., 2023)

Research indicates that effective climate risk management requires prioritizing preventive strategies, adaptation measures, and disaster management, supported by laws aligned with climate change (Liu et al., 2024). Malinowska (2024) highlights the importance of a preventive approach in the insurance industry, emphasizing that adaptation plans are essential for managing climate risks effectively. These strategies are crucial for reducing disaster impacts and safeguarding the environment.

*Challenges of climate change in Iran*

In 2016, Iran's Department of Environment developed a national climate change strategy focusing on emission reduction, agriculture, food security, natural resources, biodiversity, and water management (Barati et al., 2024). While the plan outlines adaptation strategies for different sectors, it lacks the necessary executive guarantee as it was not fully approved by the Council of Ministers. A review of Iran's development plans highlights insufficient attention to climate change, which demands a more focused and operational approach (Debonne et al., 2022; Kowalska & Syrda, 2024). Effective implementation requires collaboration across government, health providers, researchers, and communities (Karamouzian et al., 2019).
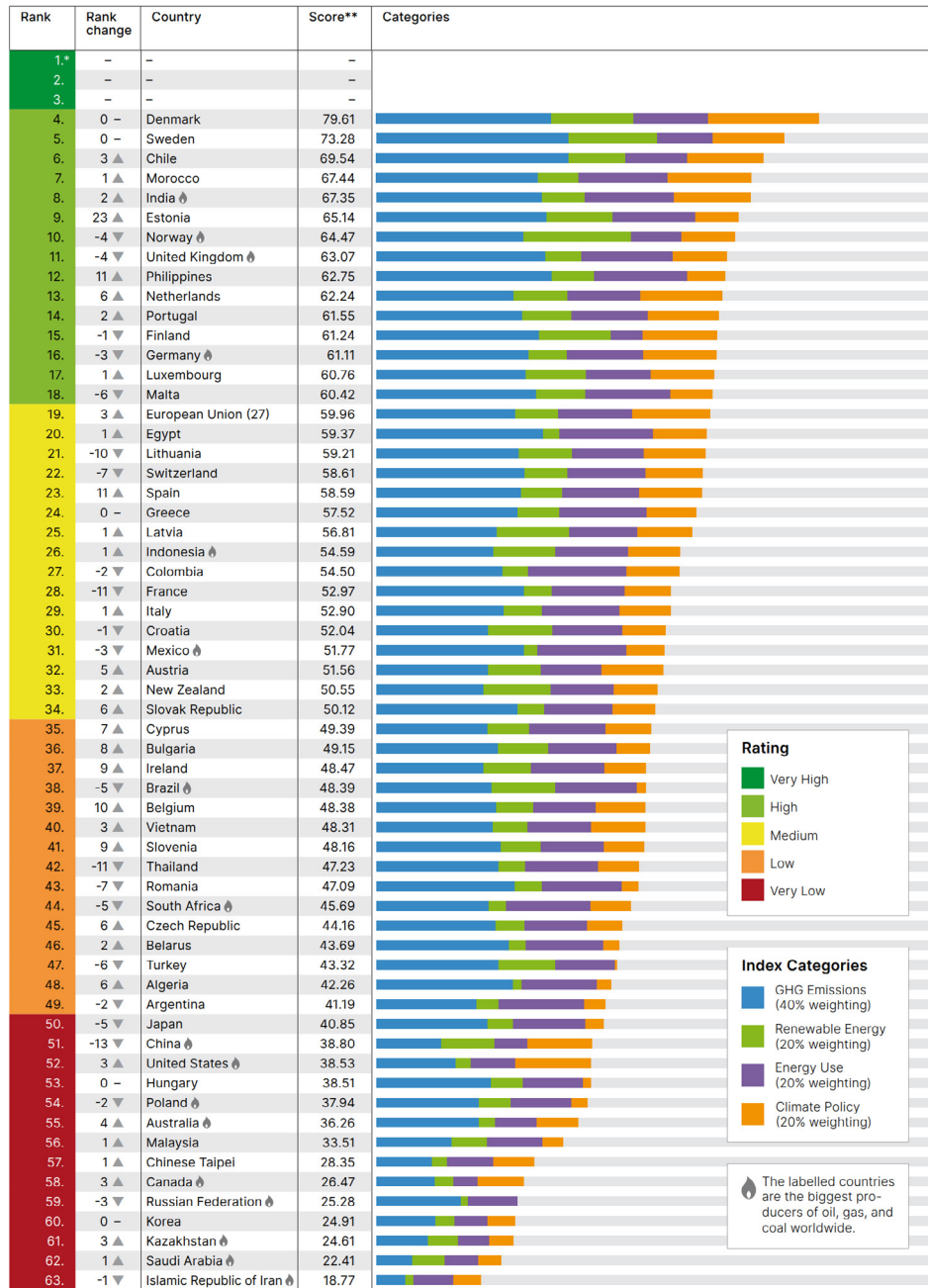
**MATERIALS AND METHODS**

The DPSIR framework (Driving force-Pressure-State-Impact-Response) analyzes environmental problems by linking human activities with environmental and socio-economic impacts (Padash et al., 2021). It follows a causal chain from driving forces, through pressures, to changes in ecosystem states, leading to impacts on human well-being and societal responses. Originally developed as the PSR model by the OECD, it was expanded by the European Environment Agency (EEA) to include driving forces and impacts (Cheng et al., 2022; Santos et al., 2024). The innovation of this research is in the analysis of the climate change trend with different environmental approaches, and social, health, and economic effects based on this model. This study applies the DPSIR model to analyze climate change, highlighting how human activities and resource consumption lead to environmental pressures, requiring appropriate societal responses (Li et al., 2024). The consumption of environmental resources has led to significant environmental challenges, with indiscriminate resource use creating pressure that alters environmental conditions, negatively impacting human well-being and ecosystems. Addressing these issues requires appropriate societal responses. As illustrated in Figure 3, responses encompass all elements of the DPSIR framework, with the most effective solutions targeting the initial driving forces in the cause-effect chain.

This study analyzes various documents, including Iran's national climate change strategy approved in 2016 by the Environmental Protection Organization, periodic reports from the World Health Organization, and the national action plan for climate adaptation (Piri, 2022). It also examines the national crisis management strategy from 2019, along with the Hyogo and Sendai frameworks (2015-2030). The analysis incorporates events and statistics from the last 20 years regarding natural disasters and climate risks (Wisner, 2020; Murray et al., 2018; Aitsi-Selmi et al., 2015).

**FINDINGS AND RESULTS**

The results of document review and their analysis in the form of driving force, impact, state, pressure, and response (DPSIR model) show the conditions of Iran managers, planners, policymakers, and analysts in Table 2.

**Table 1.** The ranking table shows the 2023 Climate Change Performance Index for countries worldwide (Burck et al., 2023).

| Rank | Rank change | Country | Score** | Categories |
|------|-------------|---------|---------|------------|
| 1.* | – | – | – | |
| 2. | – | – | – | |
| 3. | – | – | – | |
| 4. | 0 – | Denmark | 79.61 | |
| 5. | 0 – | Sweden | 73.28 | |
| 6. | 3 ▲ | Chile | 69.54 | |
| 7. | 1 ▲ | Morocco | 67.44 | |
| 8. | 2 ▲ | India ⬧ | 67.35 | |
| 9. | 23 ▲ | Estonia | 65.14 | |
| 10. | -4 ▼ | Norway ⬧ | 64.47 | |
| 11. | -4 ▼ | United Kingdom ⬧ | 63.07 | |
| 12. | 11 ▲ | Philippines | 62.75 | |
| 13. | 6 ▲ | Netherlands | 62.24 | |
| 14. | 2 ▲ | Portugal | 61.55 | |
| 15. | -1 ▼ | Finland | 61.24 | |
| 16. | -3 ▼ | Germany ⬧ | 61.11 | |
| 17. | 1 ▲ | Luxembourg | 60.76 | |
| 18. | -6 ▼ | Malta | 60.42 | |
| 19. | 3 ▲ | European Union (27) | 59.96 | |
| 20. | 1 ▲ | Egypt | 59.37 | |
| 21. | -10 ▼ | Lithuania | 59.21 | |
| 22. | -7 ▼ | Switzerland | 58.61 | |
| 23. | 11 ▲ | Spain | 58.59 | |
| 24. | 0 – | Greece | 57.52 | |
| 25. | 1 ▲ | Latvia | 56.81 | |
| 26. | 1 ▲ | Indonesia ⬧ | 54.59 | |
| 27. | -2 ▼ | Colombia | 54.50 | |
| 28. | -11 ▼ | France | 52.97 | |
| 29. | 1 ▲ | Italy | 52.90 | |
| 30. | -1 ▼ | Croatia | 52.04 | |
| 31. | -3 ▼ | Mexico ⬧ | 51.77 | |
| 32. | 5 ▲ | Austria | 51.56 | |
| 33. | 2 ▲ | New Zealand | 50.55 | |
| 34. | 6 ▲ | Slovak Republic | 50.12 | |
| 35. | 7 ▲ | Cyprus | 49.39 | |
| 36. | 8 ▲ | Bulgaria | 49.15 | |
| 37. | 9 ▲ | Ireland | 48.47 | |
| 38. | -5 ▼ | Brazil ⬧ | 48.39 | |
| 39. | 10 ▲ | Belgium | 48.38 | |
| 40. | 3 ▲ | Vietnam | 48.31 | |
| 41. | 9 ▲ | Slovenia | 48.16 | |
| 42. | -11 ▼ | Thailand | 47.23 | |
| 43. | -7 ▼ | Romania | 47.09 | |
| 44. | -5 ▼ | South Africa ⬧ | 45.69 | |
| 45. | 6 ▲ | Czech Republic | 44.16 | |
| 46. | 2 ▲ | Belarus | 43.69 | |
| 47. | -6 ▼ | Turkey | 43.32 | |
| 48. | 6 ▲ | Algeria | 42.26 | |
| 49. | -2 ▼ | Argentina | 41.19 | |
| 50. | -5 ▼ | Japan | 40.85 | |
| 51. | -13 ▼ | China ⬧ | 38.80 | |
| 52. | 3 ▲ | United States ⬧ | 38.53 | |
| 53. | 0 – | Hungary | 38.51 | |
| 54. | -2 ▼ | Poland ⬧ | 37.94 | |
| 55. | 4 ▲ | Australia ⬧ | 36.26 | |
| 56. | 1 ▲ | Malaysia | 33.51 | |
| 57. | 1 ▲ | Chinese Taipei | 28.35 | |
| 58. | 3 ▲ | Canada ⬧ | 26.47 | |
| 59. | -3 ▼ | Russian Federation ⬧ | 25.28 | |
| 60. | 0 – | Korea | 24.91 | |
| 61. | 3 ▲ | Kazakhstan ⬧ | 24.61 | |
| 62. | 1 ▲ | Saudi Arabia ⬧ | 22.41 | |
| 63. | -1 ▼ | Islamic Republic of Iran ⬧ | 18.77 | |

**Rating**

- Very High
- High
- Medium
- Low
- Very Low

**Index Categories**

- GHG Emissions (40% weighting)
- Renewable Energy (20% weighting)
- Energy Use (20% weighting)
- Climate Policy (20% weighting)

⬧ The labelled countries are the biggest producers of oil, gas, and coal worldwide.

* None of the countries achieved positions one to three. No country is doing enough to prevent dangerous climate change.
** rounded

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## A- Driving force

Climate change encompasses alterations in the entire weather system, influenced by both climatic and non-climatic factors resulting from human activities. The Earth's climate system reacts slowly to inputs, leading to delayed internal changes; for example, a single drought year may gradually lower lake levels, with subsequent years potentially causing decreased precipitation and longer dry spells. Research indicates that greenhouse gases, including carbon dioxide (CO2), methane (CH4), and nitrogen oxide (NO2), are primary contributors to climate change by trapping solar radiation and causing global warming, with a temperature rise exceeding 1.5 degrees Celsius increasing the risk of irreversible impacts (Hoegh-Guldberg et al., 2019; Seneviratne et al., 2018). The Iran Meteorological Organization reports a 1.1-degree
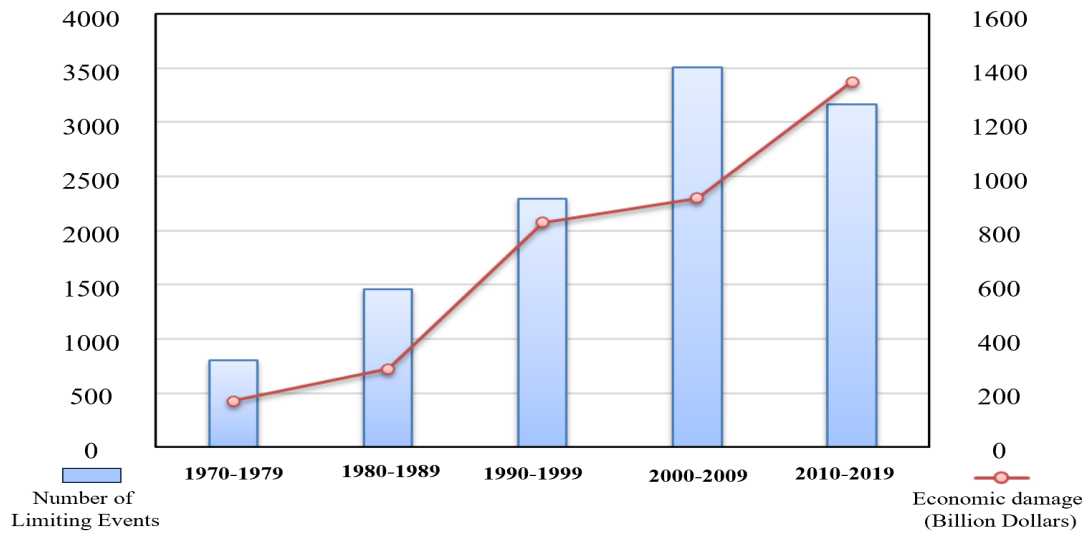
**Fig. 2.** The number of extreme climatic events and the damages caused by them in the world during the last 5 decades
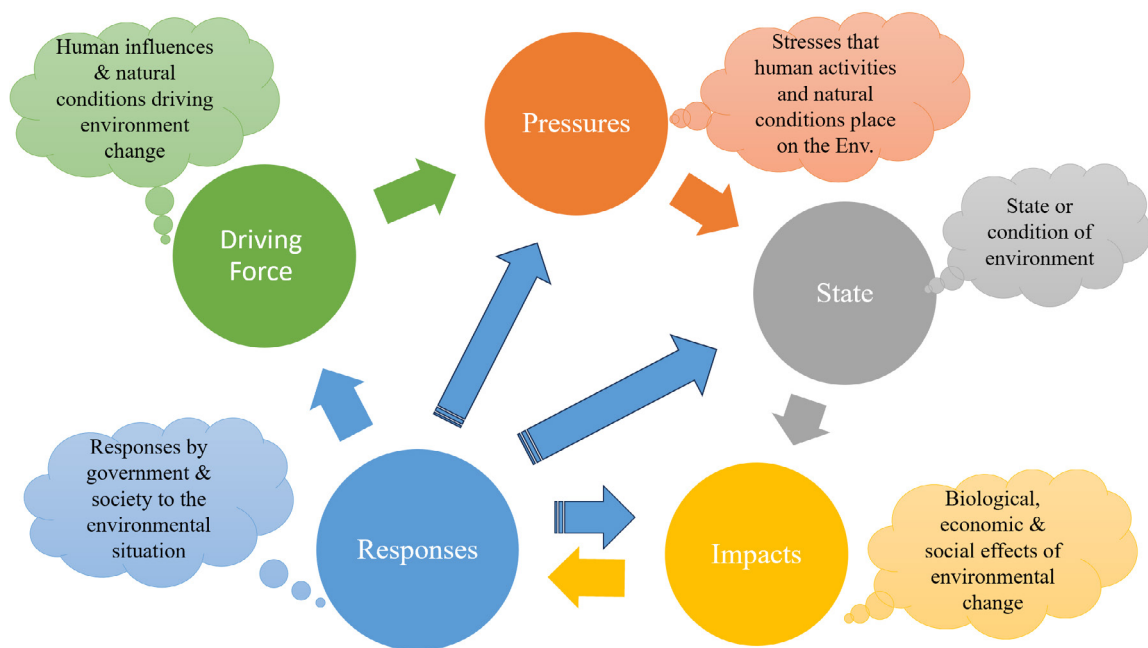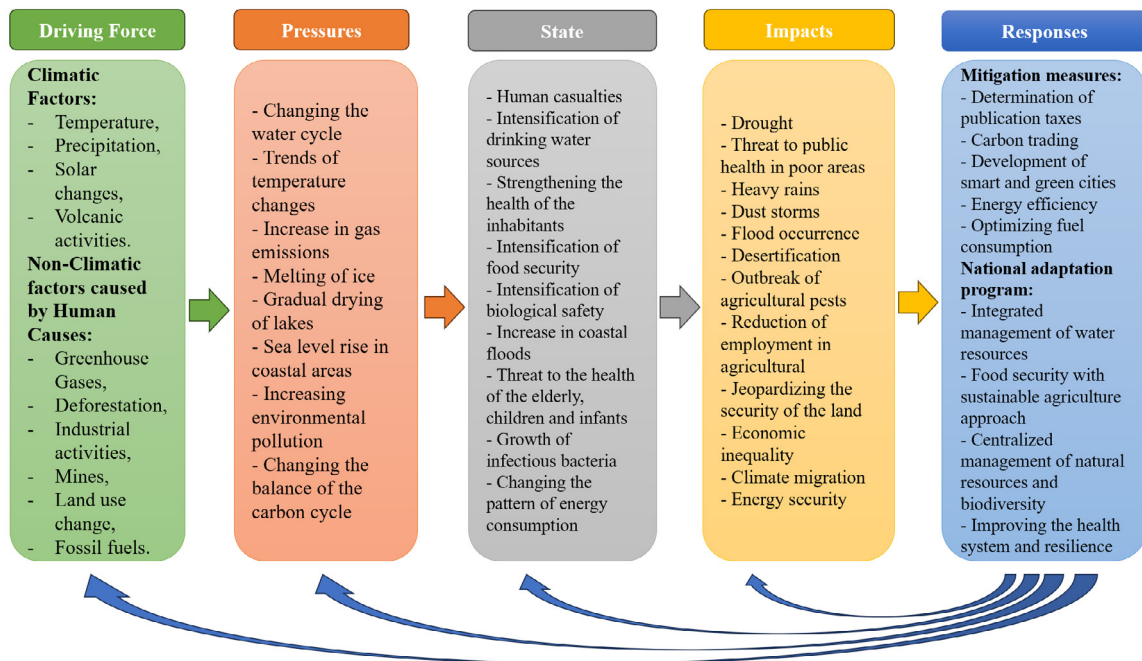


**Fig. 3.** Driving force, Pressure, State, Impact and Response (DPSIR) model

rise in average air temperature, with projections suggesting this trend will continue, altering precipitation patterns from snow to rain and increasing the likelihood of flooding (Mirdar Soltani, 2023; Sadeqi et al., 2022). Changes in precipitation patterns from snow to rain, coupled with increased runoff, can intensify rainfall and create conditions conducive to flooding. Solar oscillations, including the 11-year solar cycle, exhibit variations over different time scales, although the sunspot cycle is not distinctly observable in climatological data. These solar fluctuations have been linked to historical climate events, such as short ice ages and warming trends from 1900 to 1950 (Scafetta & Bianchini, 2023; Biswas et al., 2023; Sokoloff et al., 2020). Additionally, volcanic eruptions can significantly impact climate; for instance, the 1991 Mount Pinatubo eruption had subtle effects on global temperatures, while massive eruptions can alter Earth's climate for millions of years and lead to mass extinctions (Guillet et al., 2023;

**Table 2.** Analysis of climate change information with the DPSIR approach

| Driving Force | Pressures | State | Impacts | Responses |
|---|---|---|---|---|
| **Climatic Factors:**<br>- Temperature,<br>- Precipitation,<br>- Solar changes,<br>- Volcanic activities.<br>**Non-Climatic factors caused by Human Causes:**<br>- Greenhouse Gases,<br>- Deforestation,<br>- Industrial activities,<br>- Mines,<br>- Land use change,<br>- Fossil fuels. | - Changing the water cycle<br>- Trends of temperature changes<br>- Increase in gas emissions<br>- Melting of ice<br>- Gradual drying of lakes<br>- Sea level rise in coastal areas<br>- Increasing environmental pollution<br>- Changing the balance of the carbon cycle | - Human casualties<br>- Intensification of drinking water sources<br>- Strengthening the health of the inhabitants<br>- Intensification of food security<br>- Intensification of biological safety<br>- Increase in coastal floods<br>- Threat to the health of the elderly, children and infants<br>- Growth of infectious bacteria<br>- Changing the pattern of energy consumption | - Drought<br>- Threat to public health in poor areas<br>- Heavy rains<br>- Dust storms<br>- Flood occurrence<br>- Desertification<br>- Outbreak of agricultural pests<br>- Reduction of employment in agricultural<br>- Jeopardizing the security of the land<br>- Economic inequality<br>- Climate migration<br>- Energy security | **Mitigation measures:**<br>- Determination of publication taxes<br>- Carbon trading<br>- Development of smart and green cities<br>- Energy efficiency<br>- Optimizing fuel consumption<br>**National adaptation program:**<br>- Integrated management of water resources<br>- Food security with sustainable agriculture approach<br>- Centralized management of natural resources and biodiversity<br>- Improving the health system and resilience |

Yadav et al., 2022; Aubry et al., 2021).

*B- Pressures*

Climatic factors significantly impact the environment and its natural cycles, such as water and energy cycles, leading to fundamental changes in these trends. Researchers recognize that the potential catastrophic effects of climate change are determined by its magnitude, speed, and the vulnerability of affected systems, including the consequences of extreme temperature increases and cascading effects. However, there has been insufficient consideration of the factors influencing this capacity, as few estimates exist regarding the impacts of warming exceeding three degrees Celsius on a global scale. Additionally, studies on how climate change contributes to larger crises remain sparse.

*Changes in average evaporation-transpiration*

Rising temperatures lead to increased evaporation rates, which hinder the replenishment of underground water sources, a trend that has intensified over the past fifty years in Iran. The Iran National Center for Climate and Drought Crisis Management reports that this growing evaporation capacity has significantly reduced soil moisture and impacted water resources, including those for drinking and agriculture. This ongoing trend, combined with harmful human activities, contributes substantially to negative environmental outcomes in the country (Saemian et al., 2022).

*C- State*

Global climate change results in altered weather patterns, leading to both positive and negative economic and environmental impacts. Examples include increased human casualties, heightened pressure on drinking water supplies, food security challenges, and escalated health risks, particularly for vulnerable populations. For instance, the floods in Iran during the spring of 2016 resulted in economic damages ranging from $3 to $5 billion, along with significant health

losses. From 2000 to 2019, extreme climate events such as forest fires and heatwaves have cost the global economy hundreds of billions annually, with studies attributing approximately $143 billion of these costs to climate change, predominantly through human casualties and property destruction (Brakenridge et al., 2017; James, 2016; Akhtar, 2024; Jangi et al., 2024; Ding et al., 2024; Nyadera et al., 2024; Kogan & Kogan, 2019).

*Intensification of heat, health threat*

In 2023, the world experienced its hottest summer on record, marked by devastating floods and wildfires. The increasing frequency and intensity of heat waves are impacting global work capacity, resulting in an estimated loss of 45 billion working hours in 2018 compared to 2000 (Campbell et al., 2018). In 2003, climate change led to approximately 70,000 deaths in Europe, with projections indicating over 250,000 fatalities from 2030 to 2050 (Singer et al., 2022). Additionally, Iran saw a rise in disease outbreaks, escalating from 546 in 2010 to 4,143 in 2017, with 326 cases linked to water shortages, particularly in drought-affected regions (Marengo et al., 2022).

*Food security*

Nutritional health is essential for national development, social justice, and economic growth, making food security a critical issue requiring urgent attention (Hariram et al., 2023). Climate change adversely impacts agricultural production, threatening food security and economic stability (Lee et al., 2024; Behera et al., 2023). Studies show that 17-20% of agricultural products and about 30% of food are wasted (Singh et al., 2023). With the global population projected to reach around 9 billion by 2050, current crop yield trends for staples like wheat, corn, and rice are insufficient to meet future food demands, exacerbated by the challenges posed by climate change (da Cunha Dias et al., 2021; Mohammadi et al., 2023).

*D- Impact*

Current measures to address climate change are inadequate, resulting in long-term impacts on both human and natural ecosystems. In Iran, the primary concerns include drought, heat waves, health impacts, forest fires, and intensified flooding, all of which disrupt urban water management, agriculture, health systems, urban infrastructure, and biodiversity. The exacerbation of droughts and flooding imposes significant social, environmental, and economic costs, with no clear estimates of the financial damages due to ongoing climate change and mismanagement (Desmet et al., 2024). While climate change may enhance agricultural potential and reduce energy demands in colder regions, it primarily causes global warming and extreme weather events in most inhabited areas, particularly in dry and hot climates (Kumar et al., 2023).

*Long-term consequences*
*Health*

Rising temperatures and escalating food costs pose significant risks to infants, making them vulnerable to malnutrition-related issues such as stunted growth and weakened immune systems. Over the last 30 years, the days conducive to Vibrio bacteria growth, which causes cholera, have doubled, particularly affecting regions like the Baltic Sea and the Northeast United States. Children are especially at risk for infectious diseases linked to climate-induced changes in temperature and rainfall (van Daalen et al., 2022). The choices made today will shape the future, with predictions estimating over 250,000 climate-related deaths annually between 2030 and 2050 (Singer et al., 2022).

*Air pollution and health*

If current carbon emissions and climate change trends persist, a child born today will

experience a world that is 4 degrees warmer by their 71st birthday, jeopardizing their health throughout life (Perera, 2022). In 2016, air pollution from fine particulate matter led to 2.9 million premature deaths, with coal-related PM2.5 contributing to 440,000 of these fatalities; when considering all coal pollutants, the total reaches one million deaths. Alarmingly, global coal energy supply rose by 1.7% from 2016 to 2018, reversing a previous decline (Romanello et al., 2022).

*Agriculture and food security*

Rising temperatures are projected to reduce agricultural yields, threatening food security and driving up prices; over the past 30 years, corn, winter wheat, soy, and rice production has declined by 4%, 6%, 3%, and 4%, respectively. During the 2007-2008 grain price surge, Egypt saw a 37% increase in bread prices (Watts et al., 2021).

*Climate change and biodiversity threats*

Climate change poses a significant threat to habitats, diminishing the tolerance and resilience of species, particularly in Iran's Alborz and Zagros mountains, where reduced rainfall and rising temperatures will impact wetland water volume. This shift may decrease animal and bird reproduction, increase migration, alter plant and animal production cycles, and lead to more agricultural pests and diseases (Sadrianzadeh et al., 2023; Khajoei Nasab et al., 2022).

*Climate change, intensification of drought, and small storms*

Climate change influences fine dust by altering temperature, humidity, and precipitation patterns, leading to increased dryness and decreased soil moisture, which accelerates dust production and contributes to dust storms (Kok et al., 2023; Alahmad et al., 2023). Conversely, some researchers argue that fine dust may also drive climate change by affecting atmospheric temperatures and cloud functionality, impacting ecosystems in flat areas with strong winds, particularly in the Middle East and southwestern Iran (Salmabadi et al., 2023).

*Climate change and climate migrations*

Climate change drives internal migration through factors like drought and floods, complicating adaptation efforts and increasing economic strain, with the IPCC estimating millions will migrate due to habitat loss (Schewel et al., 2024; Cardarelli & Pomper, 2024). In Iran, the drying of wetlands, particularly Hamoun, links to water resource nationalization in Afghanistan and creates climate refugees who lack legal protection under international law (Modirzadeh et al., 2021; Choe et al., 2020; Wu et al., 2023).

*Climate change and future water tensions*

While global changes in water supply and demand are inevitable, their precise predictions remain uncertain (Benavides-Muñoz et al., 2024). A preliminary analysis by the WRI projects increased water stress by 2040 for 167 countries, notably in Chile, Estonia, Namibia, and Botswana, indicating heightened vulnerability to shortages in these regions, similar to conditions in Iran and parts of the Middle East, Australia, and the Americas (Crochemore et al., 2024; Mueller et al., 2021; Luo et al., 2015).

*E- Response*

The answer is actually a measure to reform the system, which is often proposed in the form of laws and regulations or national action plans. To address climate change, reform measures are often proposed through laws and national action plans, focusing on two main types of actions: reduction measures and adaptation strategies (Lyster, 2024; Remling & Meijer, 2024). While over 84% of UNFCCC members have developed adaptation plans, funding remains

significantly below the estimated needs, with compliance costs projected at $160-340 billion annually by 2030 and $565-315 billion by 2050 (Leiter, 2022).

*The proposed framework of the National Climate Change Adaptation Program (DPIM)*

Adaptation to climate change is becoming a common and necessary part of all levels of planning worldwide. In the 17th CUP meeting of the Climate Change Convention, it was emphasized that national adaptation planning can enable all developing countries (especially less developed) to assess their vulnerabilities and climate change risks. In this meeting, it was also emphasized that in less developed countries, the risks of climate change make development challenges more complicated, which means that these countries need to deal with

Smallness is compatibility. Considering this issue, the CUP meeting discussed the National Adaptation Plan process as a way to facilitate adaptation planning

effective in less developed countries and other developing countries. Adaptation planning at the national level is an ongoing process.

It is progressive and repeated, and its implementation should be based on national priorities.

Compilation of the adaptation plan according to the different aspects of the problem and the extent of the beneficiaries requires the formulation of a collaborative process between different levels of governance including parliament, government, ministries, private sector, and public sector.

In this regard, the following sentence is proposed for the formulation of the National Climate Change Adaptation Program in Iran's 7th Development Plan: "To strengthen adaptation and reduce the damage caused by climate change, the Environmental Protection Organization is obliged to cooperate with the Ministries of Oil, Country, Defense, and Agricultural Jihad., energy, industry, mining and trade, roads and urban development, and health, treatment and medical education to develop a national program for adaptation to climate change during the first year of the program and get it approved by the Cabinet of Ministers.

The framework of the proposed national climate change adaptation program titled (DPIM) Determining the position, Preparation, and action, Implementation of strategies, and Monitoring, evaluation, and rehabilitation, includes 4 main parts (Figure 4):

1- Determining the position
2- Preparation and action
3- Implementation of strategies
4- Monitoring, evaluation, and rehabilitation

One of the main features of this program is its rotational approach, which means that periodic reviews and evaluation results in stage 4 create the necessary inputs for stages 1 to 3.

*The main goals of the National Adaptation Plan to Climate Change*

The main goals of the national plan to adapt to climate change generally seek to achieve the following goals:

1. Identifying and evaluating the effects of climate change:
- Investigating and analyzing the effects of climate change on different regions, ecosystems, and economic and social sectors.
2. Development of adaptation strategies and measures:
- Providing solutions and practical plans to reduce vulnerabilities and increase the resistance of communities and infrastructures against climate change.
3. Increasing awareness and capacity building:
- Educating and informing people and institutions about climate change and ways to adapt to it.
- Improving skills and technical knowledge in the field of climate change and adaptation measures.
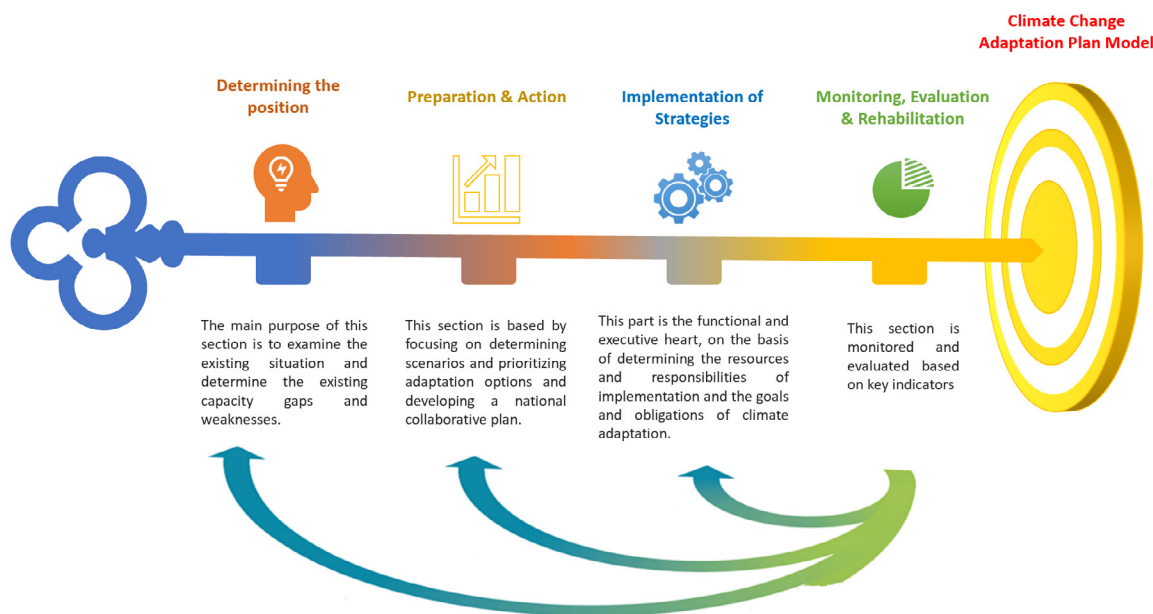
**Fig. 4.** The proposed framework of the National Climate Change Adaptation Program

4. Strengthening international coordination and cooperation:
   - Cooperation with international institutions and other countries to exchange information, experiences, and technologies related to adaptation to climate change.

5. Policy and decision support:
   - Providing detailed information and analysis to decision-makers to formulate and implement effective policies and laws in the field of adapting to climate change.

6. Promotion of investment and financing:
   - Attracting financial resources and investment to implement projects and measures related to adapting to climate change.

7. Protection of natural resources and biodiversity:
   - Implementation of programs and projects for the protection of natural resources and ecosystems to preserve biodiversity and reduce the effects of climate change on them.

These goals can be efficient and effective to reduce vulnerabilities and increase the resilience of communities and the environment against the challenges caused by climate change.

*The principles of the National Adaptation Program to Climate Change*
The principles of the National Climate Change Adaptation Program include a set of strategies and foundations that help guide and effectively implement adaptation programs and measures. These principles are:

1. Participation of society and stakeholders:
   - Involving local communities, non-governmental organizations, the private sector and other stakeholders in the decision-making process and program implementation.
2. Science-oriented and evidence-based information:
   - Using data, models, and scientific studies to formulate and implement adaptation measures.
3. Integration and interdepartmental cooperation:
   - Creating coordination and cooperation between different departments and institutions (such as agriculture, water, health, and infrastructure) to implement comprehensive and coherent

programs.

4. Flexibility and adaptability:
- Designing programs and actions in such a way that they can respond to changes and new conditions and be updated.

5. Justice and equality:
- Ensuring equal access of all groups to adaptation resources and facilities, with special attention to vulnerable and low-income groups.

6. Risk management and resilience:
- Assessing and managing the risks caused by climate change and increasing the resilience of communities and infrastructures against these changes.

7. Preserving and promoting biodiversity and ecosystems:
- Protecting ecosystems and biodiversity as part of climate change adaptation strategies.

8. Continuous monitoring and evaluation:
- Creating continuous monitoring and evaluation systems to check the progress of programs and make necessary changes based on the results.

9. Productivity and optimal use of resources:
- Optimizing the use of natural and financial resources to implement adaptation measures.

10. Training and capacity building:
- Training and empowering people and institutions to better understand climate change and develop the necessary capabilities to adapt to it.

These principles have been considered as a guiding framework for developing and implementing climate change adaptation programs in developing the proposed framework, and their goal is to increase the efficiency and effectiveness of these programs.

*Description of the steps of the proposed framework*
*1- Determining the position:*
The main purpose of this section is to examine the existing situation and determine the existing capacity gaps and weaknesses; See Figure 5, "Determining the position" section.
The main steps of this section include the following 4 steps:
- Checking the current situation,
- Determining capacity gaps and weaknesses,
- Assessing the prerequisites for action and development,
- Formation of infrastructure of databases and statistical data.

*2- Preparation and action:*
This section is based by focusing on determining scenarios and prioritizing adaptation options and developing a national collaborative plan. The output of this section provides the necessary approaches for the third section, the implementation of strategies; See Figure 5, "Preparation and action" section. The 4 steps of this section include the following:
- Determination of future climate change scenarios,
- Evaluating future scenarios, risks and opportunities,
- Compilation and prioritization of compatibility options,
- Compilation and prioritization of compatibility options.

*3- Implementation of strategies:*
This part is the functional and executive heart of the national climate change adaptation program framework; that functional and executive strategies are planned and implemented based on the determination of resources and implementation responsibilities and climate adaptation goals and obligations; See Figure 5, "Implementation of strategies" section.
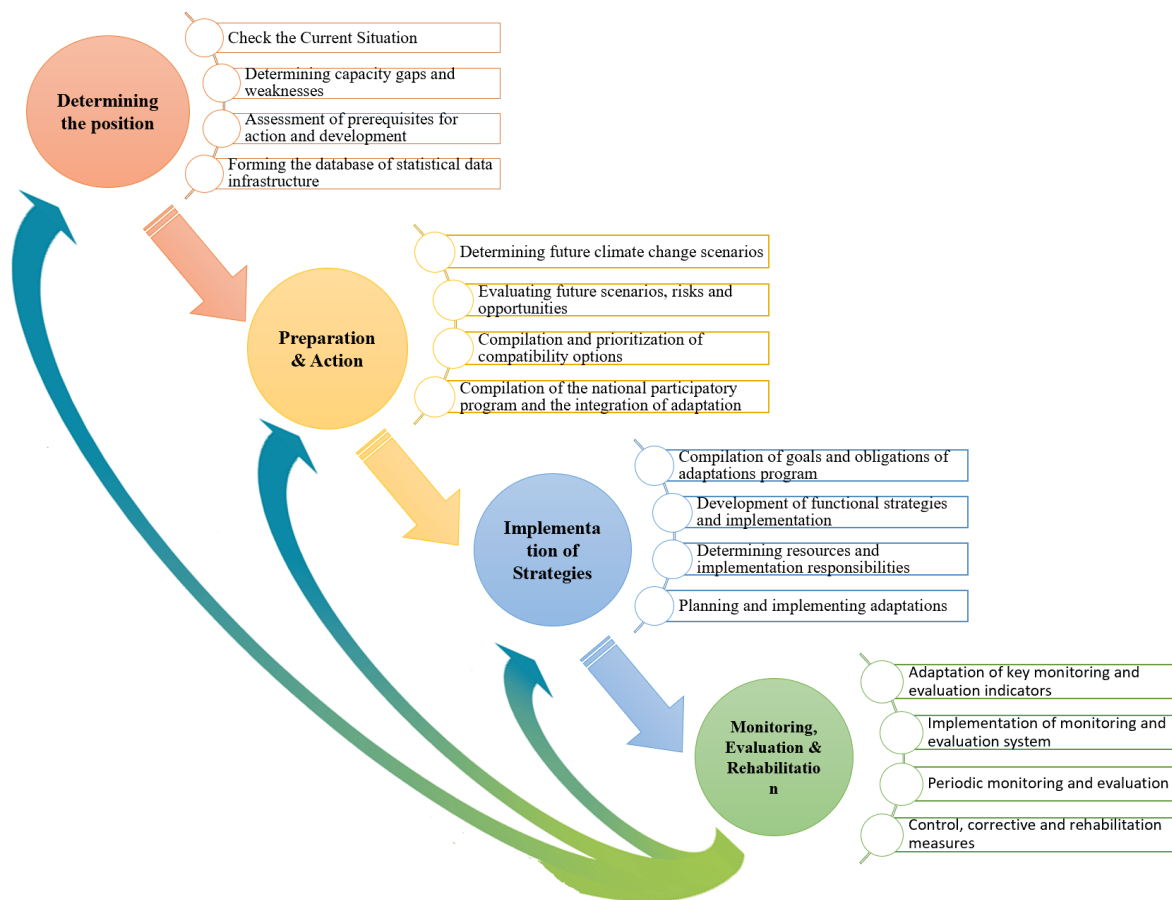
**Fig. 5.** The proposed framework of the National Climate Change Adaptation Program along with the implementation steps at a glance

The implementation steps of this section include the following:
- Compilation and prioritization of compatibility options,
- Development of functional strategies and implementation,
- Determining resources and implementation responsibilities,
- Planning and implementing adaptations.

*4- Monitoring, evaluation and renewal:*

Every system needs periodic monitoring and evaluation, this part is monitored and evaluated based on key indicators, and the required corrective and control measures are issued based on the results. The output of this section can be the input of any other section of the proposed framework; See Figure 5, "Monitoring, evaluation and renewal" section.

The basic steps of this section are as follows:
- Adaptation of key monitoring and evaluation indicators
- Implementation of monitoring and evaluation system
- Periodic monitoring and evaluation
- Control, corrective and rehabilitation measures

The proposed framework of the National Climate Change Adaptation Program along with the implementation steps are shown at a glance in Figure 5.

*Challenges facing the implementation of the National Climate Change Adaptation Program*

Iran's national climate change adaptation program faces several key challenges:

- Financial Constraints: Securing adequate funding and resources for climate adaptation initiatives is critical; insufficient financing may delay implementation and diminish program quality.

- Interdepartmental Coordination: Effective implementation requires seamless collaboration among various government departments and institutions; a lack of coordination can lead to inefficiencies and increased costs.

- Water Management: Decreased rainfall and rising temperatures are straining water resources, impacting agriculture, industry, and daily life.

- Environmental Protection: Climate change threatens natural resources like forests and biodiversity, necessitating adaptation programs focused on environmental conservation.

- Vulnerability of At-Risk Groups: Populations such as women, children, the elderly, and disabled individuals are particularly susceptible to climate impacts; adaptation efforts should prioritize their needs.

- Security Concerns: Climate change may exacerbate tensions and conflicts among local communities, especially in water-scarce regions.

- Technical and Managerial Limitations: Effective adaptation requires specialized technical skills and management capabilities, which are currently limited in many institutions.

Addressing these challenges demands extensive cooperation among institutions and adequate financial and technical support for successful climate adaptation in Iran.

## CONCLUSION

Climate change, as one of the biggest environmental challenges of the current century, has had wide-ranging effects on various countries, including Iran. Due to its special geographical location, Iran faces risks such as frequent droughts, temperature increase, rainfall decrease, and sudden floods, which directly and indirectly affect various economic, social, and environmental sectors. Benefiting from the climate change policy, energy consumption control policies, greenhouse gas reduction policies and clean development strategies based on renewable energies can provide a better perspective for the climate change roadmap while increasing the resilience of countries in these special conditions. put on decision makers and politicians. One of the most important elements that should be considered in planning the framework of the climate change program at the national level is the way organizations participate and how to share information for periodic and annual reports. The proposed framework of the national climate change adaptation program in Iran has been developed with the aim of reducing vulnerabilities and increasing the resilience of society and the environment against the effects of climate change. This proposed framework is based on the principles of participation, integration, use of scientific knowledge, flexibility, attention to local needs, sustainability, capacity building, informed decision support, justice and fairness, and adherence to international commitments. Considering the challenges ahead, the proposed framework of the National Climate Change Adaptation Program in Iran plays a vital role in dealing with the negative effects of climate change. This program seeks to create a resistant and resilient society against climate change by emphasizing comprehensive participation, using scientific knowledge and strengthening capacities. The effective implementation of this program requires extensive cooperation of all stakeholders and continuous commitment to the principles of sustainability and justice. By achieving these goals, Iran can take effective steps to reduce damages and improve people's quality of life.

## GRANT SUPPORT DETAILS

## CONFLICT OF INTEREST

The authors declare that there is not any conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy has been completely observed by the authors.

## LIFE SCIENCE REPORTING

No life science threat was practiced in this research.

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