

## A Study on the Application of Metaverse Diplomacy for Integrated Dust Storm Management from a Hydropolitical Perspective (Case Study: Tigris and Euphrates Watershed)

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### Abstract

Metaverse diplomacy, as an innovative and digitally oriented approach to tackling complex international challenges, offers a platform for virtual and meaningful interactions among stakeholders. The Tigris and Euphrates watershed, recognized globally as one of the most politically sensitive transboundary regions, is characterized by intricate political, social, and security interdependencies involving water resources. Extensive dam projects along the upper reaches of the Tigris and Euphrates rivers have had profound security and environmental ramifications for downstream nations, sparking contentious disputes over water rights. The reduction of water allocations and the failure to meet agreements for downstream countries have led to the desiccation of vital wetlands, turning them into major sources of wind erosion and intensifying dust storms in the region. This research, using a descriptive-analytical approach, examines the application of metaverse diplomacy from a hydropolitical perspective within the Tigris-Euphrates watershed. The findings of this study hold potential for informing the formulation of regional and international policies aimed at mitigating the adverse effects of dust storms. Moreover, metaverse diplomacy could serve as a tool for facilitating dialogue among the riparian nations of the Tigris-Euphrates watershed, enhancing cross-border cooperation and fostering conflict resolution. The integration of virtual simulations and scenario-based modeling could significantly improve the forecasting and management of dust storms, serving as a pivotal platform for the exchange of information, and enabling more rapid, informed decision-making in the context of reifying predictions and countering dust storm impacts.

**Keywords:** Visualization, Virtual Reality, Augmented Reality, Shared Benefits, Geopolitics.

### 1- Introduction

Dust storms are one of the significant environmental and socio-economic challenges in the Middle East region, especially in the Tigris and Euphrates watersheds. This phenomenon, which is caused by climate change, natural

resource degradation, and inefficient management of water and soil resources, has multiple impacts on human health, food security, and economic and social infrastructure. Dust, as one of the most important atmospheric phenomena in arid and semi-arid regions, is

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caused by a complex interaction of natural and human factors (Hafeznia et al., 2017). This phenomenon occurs as a result of wind erosion and the rise of suspended particles from the ground surface and has widespread impacts on environmental systems, human health, and economic activities. In areas without suitable vegetation cover, strong winds cause the transfer of a significant volume of fine soil particles to the atmosphere. In addition, human activities such as inappropriate exploitation of soil resources, excessive livestock grazing, and unsustainable agriculture increase the intensity and frequency of this phenomenon (Razviyan et al., 2014). The Tigris and Euphrates River Basin, due to its geographical location and specific climatic conditions, has become one of the main centers of dust storms in the Middle East. This basin, which includes parts of Turkey, Syria, Iraq, and Iran, plays a vital role in providing water resources and livelihoods of local communities. However, in recent decades, due to challenges such as decreasing water resources, climate change and destruction of natural habitats, the amount and intensity of dust in this region have increased sharply. The construction of large dams upstream of the rivers, especially in Turkey and Syria, has significantly reduced the flow of water entering the downstream areas. This decrease, along with successive droughts and rising temperatures, has caused widespread drying of agricultural lands and turned them into the main sources of dust production (Zaki et al., 2020). Dust in this region has detrimental effects on the quality of life and health of residents. Among the consequences of this phenomenon are the increased prevalence of respiratory diseases, asthma, and allergies, which severely affect vulnerable groups such as children and the elderly. Decreased air quality, decreased horizontal and vertical visibility and disruption in transportation, increased migration from areas affected by dust, decreased job opportunities and decreased income in urban and rural sectors, decreased agricultural production, stagnation in the field of industry and tourism, disruption in air transportation and flight safety, decreased

individual and social capital, and the closure of educational and recreational centers are other consequences of this crisis, which results in significant economic and social losses (Monjezi et al., 2024). In addition, the deposition of dust particles on agricultural lands has caused a decrease in soil fertility and a decrease in agricultural production, which ultimately puts more pressure on the regional economy (Soleimani et al., 2020). To contain and mitigate this crisis, it is essential to adopt comprehensive management approaches and strengthen regional cooperation. Dust in the Tigris-Euphrates basin is a multifaceted and complex issue with environmental, economic, and social consequences (Mahmoodzadeh et al., 2024), which requires urgent measures, investment in scientific research and new technologies, and strengthening regional and international cooperation (Darvishi-Bloorani et al., 2020). Without implementing comprehensive policies based on sustainability principles, this crisis could have irreparable consequences on ecosystems and the livelihoods of local communities. In this regard, Rashidinejad et al. (2024) assessed the impact of hydropolitical actions of upstream countries of the Tigris-Euphrates basin on Iran's security. Their findings showed that Türkiye's hydropolitical actions encompass other human, social, economic, and political dimensions, in addition to environmental threats to southwestern Iran. Mehrabi et al. (2023) studied the impact of Turkey's hydropolitical approaches on the microdust crisis in Iran. Their findings indicated that Iraq was the main source of microdust, but by comparing the source of microdust with the map of the Tigris and Euphrates watersheds, it was found that water shortages in these river basins due to Turkish dam construction activities have exacerbated microdust in this region. Zaki et al. (2020) studied the role of the Gap Project in the hydropolitics of the Tigris and Euphrates river basins. The results of their study showed that Turkey's role upstream of the two transboundary rivers, the Tigris and Euphrates, and by implementing a unilateral strategy with other countries in the region, has

created hydropolitical challenges in various social, economic, and environmental dimensions in downstream countries. In another study titled *Intertwining Water, Politics, and Environment in the Tigris-Euphrates River Basin*, Mianabadi and Amini (2020) concluded that the existing complexities have caused the connection of water and politics, such that military conflicts are not far off in the near future. Hafeznia et al. (2017) in their study examined the impact of political factors on the intensification of dust phenomena in the Tigris-Euphrates River Basin. The results obtained show that war and military conflict, weak political management, and security conditions are effective in the intensification of dust phenomena in the Tigris-Euphrates River Basin. From a review of various studies, it can be seen that so far, various studies have emphasized more on the political aspects of this phenomenon, and not many studies have been conducted on the geopolitical and hydropolitical aspects of transboundary and shared watersheds, as well as the reasons for the occurrence and spread of dust storms in these watersheds. Other studies have also not examined the impact of metaverse diplomacy and the use of metaverse industry technologies to reduce tensions and better manage, as well as to objectify the simulation and modeling of dust storms. Given the transboundary nature of this crisis and its connection to hydropolitical issues, its sustainable management requires cooperation and synergy among the countries with interests in this area. On the other hand, technological advances in the digital and cyberspace domains offer new tools to strengthen international cooperation, including metaverse diplomacy. Metaverse diplomacy, as one of the emerging tools in the digital age, uses virtual reality, augmented reality and 3D digital environments to facilitate international negotiations and cooperation. This approach allows for multidimensional communication and broad participation in an interactive and decentralized space. In the field of dust storm management, metaverse diplomacy can act as a bridge between governments, international organizations, and

local stakeholders, providing the basis for knowledge exchange, joint solution design and comprehensive program implementation. In the Tigris-Euphrates watershed, which provides vital resources for millions of people in Iran, Iraq, Turkey, and Syria, hydropolitical interactions play a key role in shaping policies and decision-making. The water resources of this region are important not only for agriculture and drinking water supply, but also for maintaining the balance of local ecosystems. However, increasing demand for water, decreasing rainfall, and climate change have placed unprecedented pressures on these resources, making their management a complex transboundary challenge. Therefore, the use of metaverse diplomacy in this area can be an effective tool to strengthen dialogue, reduce political tensions, and most importantly, objectify modeling in the field of dust forecasting. This research examines the role and application of metaverse diplomacy in the integrated management of dust storms from a hydropolitical perspective in the Tigris-Euphrates watershed. Therefore, in this regard, the key challenges, potentials in metaverse technologies and implementation solutions are identified. The main goal is to provide a comprehensive framework for utilizing new technologies to solve environmental problems and increase regional cooperation. This issue can provide a model for managing transboundary crises in other parts of the world, not only from a scientific perspective but also from an operational perspective. The results of this research can, in addition to improving the management of dust storms in the Tigris and Euphrates basins, act as a model for other regions with similar environmental and hydropolitical challenges and help strengthen international cooperation and create sustainable peace in these regions.

## **2- Theoretical framework**

### **1-2- Geographical features of the Tigris and Euphrates watershed**

The Middle East is known as one of the driest regions in the world due to its location in the transition zone between the tropical climate and

the mid-latitudes. The Tigris-Euphrates watershed, with an area of 879,790 km<sup>2</sup>, is one of the transboundary and international watersheds shared by Iraq, Turkey, Iran, Syria, Saudi Arabia, and Jordan (Table 1). 28% of the Euphrates watershed is located in Turkey, 40% in Iraq, 15% in Saudi Arabia, 17% in Syria, and only 0.03% in Jordan. Of the total length of the Euphrates River, 1,230 km is located in Turkey, 1,060 km in Iraq, and 710 km in Syria. Turkey accounts for 89% of

the annual flow of this watershed, and Syria accounts for 11%, with the share of other countries being very small. The Tigris River is 1850 km long, of which 400 km flows in Turkey, 32 km on the border between Turkey and Syria, and 1418 km in Iraq (FAO, 2014). Therefore, the water needs of Iraq, Syria, and Saudi Arabia depend on rivers that originate in mountainous areas (Mohammadi et al., 2024).

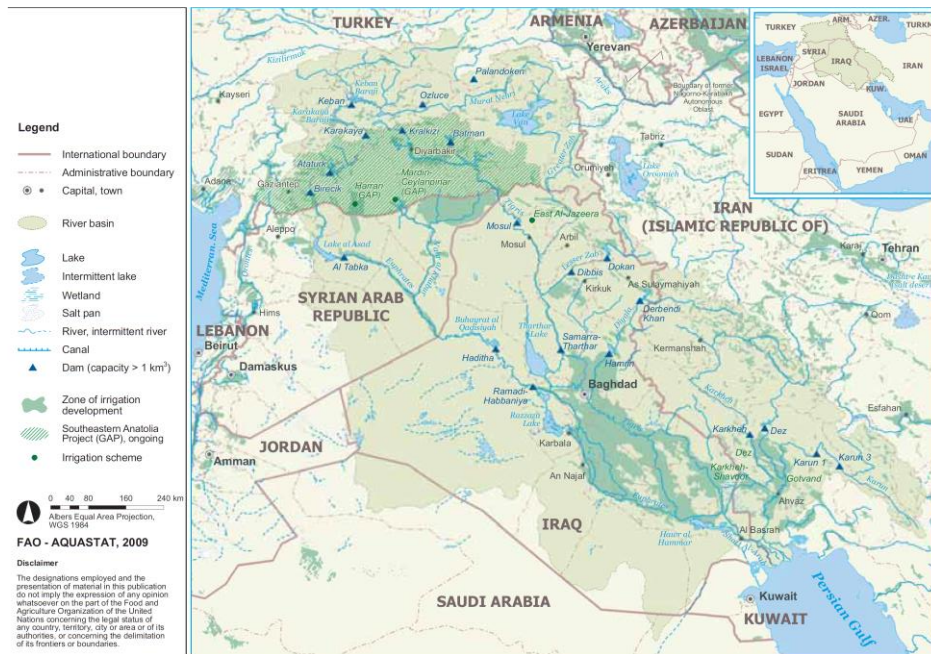


Figure 1 - Tigris and Euphrates River Basin (Franken, 2008)

Table 1- Tigris and Euphrates watershed (Mianabadi and Amini., 2020)

Euphrates River		Tigris River		Country
Percentage of total (/.) watershed	Area (square kilometers)	Percentage of total (/.) watershed	Area (square kilometers)	
-	-	19	41990	<b>Iran</b>
28/2	125000	24/5	54145	<b>Türkiye</b>
39/9	177000	56/1	123981	<b>Iraq</b>
14/9	66000	-	-	<b>Saudi Arabia, Jordan and Kuwait</b>
17/1	76000	0/4	884	<b>Syria</b>
100	444000	100	221000	<b>Total</b>

**2-2- Hydropolitics**

Hydropolitics, as an interdisciplinary field of study in political science, geopolitics, and water

resources management, analyzes political and diplomatic interactions related to water resources, especially in shared watersheds. This concept is particularly important in areas where rivers, lakes, or aquifers cross national borders and are significantly affected by complex factors such as climate change, increasing water demand due to population growth, and economic development programs. In addition to examining conflicts, hydrogeopolitics also focuses on the study of governance mechanisms and cooperation between countries for the sustainable management of water resources and is considered as a tool for understanding power relations and competition in the exploitation of these vital resources (Harris, 2010). The Tigris-Euphrates watershed is a prominent example of hydrogeopolitical tensions in the Middle East region, involving the countries of Iran, Iraq, Syria, and Turkey. As an upstream country, Turkey has significant control over the water resources of this watershed through the implementation of the Southeastern Anatolia Development Project (GAP), which includes the construction of dozens of dams and extensive irrigation networks. The idea was first proposed in 1936. The Turkish government has stated that the project aims to reduce regional deprivation through agricultural development, increase incomes and improve living standards, as well as enhance social stability and economic growth, create employment and generate electricity. The project covers nine Turkish provinces, including Adiyaman, Batman, Diyarbakir, Gaziantep, Kilis, Siirt, Şanlıurfa, Mardin and Şırnak, and is located in the Tigris and Euphrates river basins and in the northern Mesopotamia region. Approximately one-fifth of Turkey's irrigable land and one-third of its energy capacity are located in this region (Zarger et al., 2023). These measures have reduced the inflow to downstream countries, namely Iraq and Syria, and have led to ongoing tensions between these countries (Kibaraoglu et al., 2011). Iraq, which is heavily dependent on the water resources of the Tigris and Euphrates, has faced several crises in the field of agriculture and food security. Also, Iran, due to its geographical

location in the border parts of this watershed and the exploitation of shared rivers such as Sirvan and Alvand, plays a role in some of these interactions (UNESCO, 2013). Disagreements between these countries mainly focus on the amount of water allocation, the way in which resources are managed, and the environmental consequences of Turkish water projects. These challenges demonstrate the strategic importance of hydrogeopolitics in the sustainability of water resources, regional security, and international diplomacy (Naderi et al., 2022).

### **3-2- Metaverse**

The word metaverse is composed of two parts: meta and verse. Meta means superior and verse is derived from the word universe meaning world. Thus, metaverse means a world superior or beyond the world. The concept of metaverse emphasizes the elements of presence, interactivity, and standardization. Accordingly, it is a three-dimensional interconnected and connected virtual world in which users can interact with each other instantly and in real time by creating their own digital avatars (Dionisio, 2013; Mansouri et al., 2024). As an emerging and new technology of the current world, metaverse is built by augmented reality, virtual reality, and mixed reality (Yadav et al., 2024). Metaverse has created a unique opportunity for companies to exploit innovative methods. This world makes it easier than ever to organize events, facilitate interactions with different capabilities, and effectively communicate with users. Such a capability allows companies to connect with consumers in new ways that were not possible before. The extensive developments in cyberspace after the transition from agricultural and industrial periods have opened new horizons towards the postmodern era. These developments have caused transformation in all aspects of individual and social life and paved the way for the formation of a new civilization. In such circumstances, governance in cyberspace has become one of the most important and challenging issues facing government systems (Ning et al., 2022). As one of the most advanced

forms of virtual reality, the metaverse offers a digital and simulated environment in which users can have diverse experiences and their behaviors are remarkably similar to real-world activities. This virtual space, due to the advanced interactions it provides, will have tangible and real impacts on the physical lives of users (Mystakidis, 2022). The metaverse can be considered the intersection of scientific and technological achievements in fields such as computer science, artificial intelligence, and social sciences, which, beyond a commercial brand, is a response to the need to rearrange scattered digital realities. Previous initiatives in the field of virtual interactions, such as projects such as “Second Life”, have now reached integration and evolution in the form of the metaverse. This development has made activities such as education, shopping, virtual visits, and health services digitally possible. As a world beyond physical reality, the metaverse allows for the presence of individuals with an independent identity to experience their daily activities in a virtual environment (Woods et al., 2022). In recent years, the metaverse has been able to eliminate geographical and temporal limitations and create new platforms for virtual interactions, interactive learning, and the expansion of social and economic activities. By simulating 3D environments, this technology enables virtual presence in events and meetings without the need for physical travel, and not only reduces time and costs, but also has positive environmental impacts, including reducing greenhouse gas emissions (Zhou et al., 2024). Holding business meetings and international events is one of the practical benefits of the metaverse. This technology allows for interactive meetings with the presence of 3D avatars, which not only induces a sense of real presence, but also improves interpersonal communication. International companies and organizations can hold their meetings without time and place restrictions and benefit from faster and more productive interactions (Damodaran, 2023). In addition to all these benefits, the metaverse has positive impacts on the environment. Reducing

the need for air and ground travel significantly reduces greenhouse gas emissions and plays an important role in combating climate change by contributing to the Sustainable Development Goals. Also, saving time and financial costs has made this technology a suitable option for many organizations and individuals (Scurati et al., 2021). Overall, the metaverse, as a transformative technology, has great potential to change the way human, educational, commercial, and environmental interactions occur. By removing spatial and temporal constraints, creating interactive simulated environments, and reducing costs and environmental impacts, this technology can be used as a powerful tool to facilitate international interactions, improve educational experiences, and enhance the quality of life (Allam, 2022). Despite the metaverse’s potential to facilitate diplomacy and crisis management, it faces numerous technical, legal, and security challenges. From a technical perspective, dependence on cloud computing, artificial intelligence, and high-speed internet, coupled with infrastructure limitations in some countries, hinder the widespread use of this technology. From a legal perspective, the lack of specific frameworks for regulating diplomatic interactions challenges issues related to the validity of treaties, data ownership, and digital governance. From a security perspective, threats such as cyberattacks, theft of sensitive data, and identity theft pose serious risks to the use of this technology. Therefore, before promoting metaverse diplomacy, it is necessary to develop legal and security standards and improve technological infrastructure at the international level (Darabpour, 2023).

### **3- Discussion**

#### **1-3- Türkiye's hegemonic pattern in the upper reaches of the Tigris and Euphrates watershed**

According to studies by Zeitun and Warner (2006), hydrohegemony is actually hegemony in a river basin based on the control of water resources. Thus, in this strategy, contracts and construction of facilities are implemented by applying pressure and threats, and given the

weaknesses of management and water management policies in the downstream countries of the water basin (Yashar Zaki et al., 1402), the stronger country upstream of the river is able to use more water resources. In contrast, in the downstream countries of these transboundary rivers, such as Iraq, concerns arise based on cutting off the flow and turning off the tap by upstream countries (Mohammadi et al., 2013; Mehrabi et al., 2023). Thus, conflicts and alliances occur between countries (Zeitun and Warner, 2006). Accordingly, Turkey has tried to establish hegemony by launching and developing the Gap Project, and this project is a symbol of this country's hegemony at the watershed level and in the Middle East region. The Southeastern Anatolia Development Project (GAP) includes 22 large dams, among which the Ataturk, Keban, Qarqiye, Burjil and Qom Qiyam dams are of particular importance. The project also includes water storage projects, hydroelectric power plants and extensive irrigation networks. The hydroelectric power plants of this project are capable of producing about 23 billion megawatt hours of electricity annually, most of which is used for agriculture and the production of strategic products. The storage capacity of this project reaches 100 billion cubic meters, which is three times the capacity of the dams in Iraq and Syria (Zakaria, 2019). It is predicted that after the completion of the project, Turkey will be able to control 80% of the water resources of the Euphrates River and 47% of the flow of the Tigris River (Malaki, 2022). On the other hand, although Turkish development projects, especially the GAP project (Southeast Anatolian Development Project), have had a major impact on the reduction of water resources in downstream countries (Iran, Iraq and Syria), the role of other factors and downstream countries should not be overlooked. Iran and Iraq, with their water policies and projects in managing the common resources of this basin, have indirectly contributed to the exacerbation of the water crisis. In Iraq in particular, mismanagement of water resources and increasing agricultural needs, coupled with internal challenges such as

persistent droughts and reduced water flow from Turkey, have exacerbated the water crisis in this country (Al-Ansari, 2013). Also, in Iran, excessive consumption of water resources and reduction of groundwater reserves have added to the water crisis, which, together with the effects of Turkish projects, has further complicated the critical conditions (Fathi et al., 2020).

### **2-3- Hydropolitical challenges of the Gap project in the Tigris and Euphrates watershed**

The Gap project has caused numerous hydropolitical challenges in social, political, economic, security and environmental dimensions, which have been formed as a result of tensions arising from water shortages in the region (Yashar Zaki et al., 1402). The destructive environmental effects of dust in Iraq and Syria due to the construction of the Ilisu Dam and the consequent reduction in the water flow of the Tigris River in Iraq are an example of these challenges. As a result of the construction of this dam, many wetlands, especially the Hur al-Huwayz wetland in Iraq, have dried up, which has itself caused dust production. In addition, other main sources of dust generation in Iraq include the destruction and degradation of the Hur al-Hamara, Hur Markazi, and Hur al-Azim wetlands (Navari, 2019). Following the decrease in the flow of the Tigris River, the wetlands of Iraq are also increasingly at risk of drying out and destruction, and Iraq has become one of the active dust centers in the region. As a result of the drying up of these wetlands, the dust production centers in Iraq have increased from 6 centers to more than 200 centers over the past years. Meanwhile, droughts and reduced rainfall due to climate change, increased exploitation of groundwater resources, numerous wars in the region, and grazing of livestock are other factors affecting the occurrence of dust storms in Iraq. Thus, fine particles (clay-sized) in the bottom and bed of rivers and wetlands are easily placed in the path of northern winds, and their range of effect has also extended to the western and southwestern regions of Iran (Roshani, 2016).

Dust storms in Iraq also affect the western and southwestern regions of Iran (Zaki et al., 2020). The West Asian region, with its dry and desert climate characteristics, is exposed to serious environmental challenges and climate change. This situation causes numerous crises in these areas, including long-term droughts. Among the environmental crises, desertification and wind erosion are among the most important threats that cause dust storms. In the last decade, dust storms in Iraq and Saudi Arabia have had significant negative effects on Iran. In addition to environmental effects, these crises have also acquired political and security dimensions and can pose a serious threat to national and regional security. These changes can have short-term and long-term negative impacts on environmental and human security, especially at local and national levels in the countries of the Tigris and Euphrates River Basins (Abdi et al., 2020).

The dust sources that have affected Iran are 27 percent domestic and 73 percent foreign, of which 67 percent are from Iraq and 7 percent from Saudi Arabia (Roshni, 2017). Considering these cases, it can be stated that dam construction in the upstream of the Tigris and Euphrates has left an erodible bed along the course of the rivers of this watershed by affecting the volume of surface flows and barren agricultural lands. In fact, the reduction in water intake from downstream dams, especially during droughts due to water storage in upstream dams, has reduced the area of lakes behind the dam and converted part of it into dry and erosion-prone lands. As a result of these factors, dust centers are created and expanded (Golendam, 2018). With the change in the inflow of flood flows into the hors due to dam construction upstream of the Tigris and Euphrates rivers and the lack of water rights for the wetlands, and considering the sharing of the Great Hor-e-Azim Wetland by Iran and Iraq, the outflow of the wetlands towards Arvand-rud has also decreased significantly (Abbasi, 2022). Climate change is especially felt in the Middle East and is changing the climate patterns of this region. According to reports from

the Intergovernmental Panel on Climate Change, the Middle East is experiencing a future with higher temperatures and more severe drought. These reports predict that the average temperature in this region will increase by 2 degrees Celsius by 2050, which could cause climate and water resource crises. According to these reports, reduced rainfall, increased evaporation, and increased frequency of droughts are among the characteristics of climate change in the Middle East. In addition to environmental impacts, these climate changes will also affect water security and agriculture in the region. Rising temperatures and decreasing water resources can lead to serious problems in the supply of drinking water and agriculture, which in turn exacerbates social and economic crises (Intergovernmental Panel on Climate Change, 2021).

### **3.3- Metaverse Diplomacy**

By reviewing the dust storm crisis in some of the countries located in the Tigris and Euphrates watersheds, we can acknowledge the importance of integrated and comprehensive management of this climate phenomenon. Metaverse diplomacy, as an emerging field in international relations, examines diplomatic interactions in the context of the metaverse. A virtual space that combines virtual reality and augmented reality to provide an environment for social, economic, and political communications and activities. This concept has gained greater importance with the advancement of digital technologies and the increasing importance of cyberspace in everyday life, especially in the field of diplomacy (Okllily, 2022). One of the important aspects of metaverse diplomacy is its impact on public diplomacy. By using the metaverse, countries can showcase their culture, art, and values virtually and communicate with different communities around the world. This approach can lead to strengthening the international image of countries and increasing their cultural influence. In addition, the metaverse can be used as a platform for diplomatic negotiations and interactions. Holding virtual meetings and conferences in the

metaverse allows for wider participation and reduces costs. This can help facilitate diplomatic processes and increase their efficiency (Gupta, 2023). However, metaverse diplomacy also faces challenges. Issues such as cybersecurity, privacy, and data governance are among the fundamental concerns in this area that can limit its effectiveness in managing dust storms and regional negotiations. The most important of these challenges include the strong dependence on advanced communication infrastructure, the need to process large amounts of data, and the high costs of hardware and software equipment. In addition, the limitations of virtual and augmented reality technologies, the complex integration of remote sensing data, and the lack of technical standards for platform interoperability are key obstacles to the development of this technology. Cybersecurity issues, including cyberattacks, identity theft, and privacy violations, are considered serious threats to the widespread adoption of the metaverse. Finally, the lack of clear legal frameworks and governance considerations in the areas of data ownership and digital document validity can prevent the formal use of the metaverse in environmental diplomacy and environmental crisis management (Mystakidis, 2022; Dionisio, 2013). Therefore, developing legal and ethical frameworks for diplomatic activities in the metaverse seems essential to prevent potential abuses and threats (Shoker, 2022). The Tigris-Euphrates watershed is one of the most important hydropolitical regions in the world, which is always exposed to political and environmental tensions due to shared water resources and the high dependence of local communities on these resources. Dust storms, which are caused by the destruction of natural resources, climate change, and inefficient management of water resources, have detrimental effects on public health, agriculture, and the economy of the region. Due to their transboundary nature, these crises require comprehensive, participatory, and diplomacy-based approaches (Zirdat et al., 2023). New technologies have always played an important role in solving complex transboundary

challenges. One of these technologies that has recently attracted the attention of many researchers and decision-makers is the metaverse. As a simulated digital platform, the metaverse provides unique opportunities for multilateral interactions and strategic decision-making (Dima, 2022). Given the specific characteristics and special conditions of the Tigris-Euphrates watershed, the use of metaverse diplomacy can be an innovative and effective solution in managing crises such as dust storms that have seriously affected the lives of millions of people in this region. By creating 3D and interactive environments, the metaverse provides the conditions for holding virtual diplomatic meetings in which representatives of different countries can exchange views and discuss without the need for long trips and in-person gatherings. These meetings are held in simulated environments that accurately and realistically display the state of water resources, the paths of dust storms and their effects. In addition to reducing costs and time constraints, such an environment provides a suitable platform for making effective decisions by facilitating access to transparent information and creating a common understanding. The existing differences between the countries of the Tigris and Euphrates region, especially regarding water rights and the dust storm crisis, are among the main factors of regional tensions. In this regard, the metaverse can play an effective role in reducing these tensions by providing a documented and transparent platform for dialogue. Virtual reality enables accurate and interactive simulation of dust storms in a virtual space. Virtual reality (VR) is used to simulate dust storm scenarios, examine their effects on infrastructure, and plan for crisis management. In this environment, users can directly observe and evaluate the storms from different angles by being directly at the site of the storms. This provides users with a better and deeper understanding of the destructive effects of this phenomenon. This transparency not only facilitates the process of trust-building between countries in the region, but also enables them to reach sustainable agreements based on common

interests. Metaverse diplomacy provides a unique opportunity to manage environmental and political challenges in the Tigris-Euphrates region by eliminating geographical restrictions, reducing costs, and creating constructive interactions. By simulating different scenarios, this technology facilitates the transfer of knowledge and technology, and creates a transparent space for negotiations. It can help countries manage transboundary crises through regional cooperation and the use of new approaches. The use of metaverse in this context not only helps to improve environmental conditions and reduce hydropolitical tensions, but also demonstrates the capacity of new technologies to create positive changes at the international level. On the other hand, one of the main challenges in using metaverse for water resource management and environmental crises is the lack of specific international agreements on the joint use of water resources. This can seriously hinder the achievement of the goals of metaverse projects in these areas. In addition, the lack of effective coordination and cooperation among downstream countries, especially Iraq, Syria, and Iran, in the face of water crises caused by large dam projects such as the Gap, is one of the major obstacles to the use of this technology. On the other hand, technical challenges arising from the need for complex infrastructure and the ability to process big data can pose serious problems in the development and implementation of the metaverse. Also, the conflict of political and economic interests between different countries in the exploitation of new technologies is another obstacle to the progress of this field. Finally, the lack of unified global standards and appropriate legal frameworks for monitoring and evaluating metaverse projects can negatively affect the speed of adoption and efficiency of this technology (Heriamsal, 2024).

#### **4- Conclusion**

The Middle East's location in the arid and semi-arid belt of the world and the lack of rainfall in this region have led to widespread restrictions on the use of water resources. The fact that more

than half of the population of this region resides in transboundary watersheds and the joint use and exploitation of limited water resources has led to numerous tensions and conflicts in the Tigris and Euphrates River basins, as one of the transboundary watersheds in this region. Dam construction by Turkey, Syria and Iraq on the Euphrates River, as well as the construction of dams by Turkey and Iraq on the Tigris and Iran on the Karkheh, has led to a significant reduction in the natural flows of these rivers and negative impacts on the aquatic ecosystems of the region. Meanwhile, the negative impacts of dam construction in Turkey are significantly greater than in other countries in the region, and the damage to the country's water resources and environment is incomparable, especially compared to Syria, Iraq and Iran. These developments have left significant negative impacts, especially in Iraq and Syria. The drying up of rivers, lakes, and wetlands, the destruction of vegetation and forests, desertification, soil erosion, and the increase in active dust centers are among the consequences of these dams. Climate change and wind in the dried wetlands of southern Iraq, lands prone to wind erosion in southern Syria, and the deserts of Arabia have paved the way for the spread of dust and its transport to vast areas of West Asia. Due to the wide range of its consequences, the environmental threats resulting from the drying up of the Hur al-Azim wetland have also had significant economic, social, security, and health impacts on vast areas of Iran. As one of the most transformative new technologies in recent years, the metaverse has been able to eliminate many geographical and temporal limitations and provide a platform for real-world virtual interactions, interactive learning, and the expansion of economic and social activities. The augmented reality and virtual reality technologies of the metaverse industry, along with interactive 3D models, allow citizens and users to experience the risks and consequences of dust storms in a simulated real environment. These technologies help decision-makers and policymakers to present complex dust-related outcomes in a

simpler and more understandable format. Therefore, a better understanding of the severity and consequences of the spread of these storms is created. Such an approach, in addition to increasing the public awareness of stakeholders in shared and transboundary watersheds, also improves the decision-making processes of managers and policymakers in order to improve crisis management infrastructure. Given the ability of the metaverse to eliminate geographical restrictions and facilitate social interactions, it not only significantly reduces time and costs, but also reduces greenhouse gas emissions, which has an important and positive environmental impact. In this way, managers, policymakers, and statesmen can, without spending any money and in the shortest possible time, study crises and assess possible scenarios for the spread of future dust storms in this region, and by being aware of the consequences and outcomes of the damaging actions taken, in addition to reducing the scope of their effects, they can also prevent their occurrence. Achieving this will not be possible except through achieving a form of diplomacy and metaverse governance in order to advance goals and provide innovative solutions for disaster management and create more opportunities for cooperation and interaction among stakeholders in transboundary watersheds. To effectively deal with the challenges arising from water resource crises and dust storms in the Middle East, it is essential that policymakers and international institutions strengthen multilateral cooperation and joint mechanisms based on sustainable management of transboundary water resources. The use of new metaverse technologies, such as augmented and virtual reality, can greatly help simulate crises and facilitate decision-making processes based on advanced models. Also, the development and strengthening of crisis management infrastructures through forecasting models and simulation scenarios will allow for a more accurate and effective assessment of the consequences of dust storms. In addition, raising awareness and educating local communities in order to increase their resilience and ability to

adapt to these crises is of particular importance. Finally, promoting metaverse diplomacy can create a unique opportunity to facilitate international cooperation, promote shared governance, and achieve innovative solutions in disaster management and mitigation.

### Suggestions

Given the enormous potential of augmented reality and virtual reality technologies in the metaverse industry, it is suggested that in future studies, these technologies be used as new and efficient tools in the management of environmental crises, especially dust storms. The use of AR and VR can help to better analyze critical situations, simulate various consequences, and predict future scenarios. By creating virtual and interactive environments, these technologies not only allow for the reduction of time and space constraints, but also allow decision-makers to have a better understanding of the severity and scope of crises and take more effective measures. In addition, by facilitating education and information processes, the level of preparedness of communities and stakeholders against crises can be improved.

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