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Environmental Challenges as Catalysts for Regional Conflict and Cooperation in the Eastern Mediterranean

Edited by: Ziv Rubinovitz

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Maritime Policy & Strategy Research Center

The center is developing knowledge in maritime strategy, focusing on Israel's maritime surroundings: the Eastern Mediterranean and the Red Sea. The center does so in five core areas: (1) regional security and foreign policy, (2) the mobility of goods, people and ideas, (3) law, (4) energy, and (5) the environment.

The center was established in response to the of rising significance of the maritime domain both globally and in our region: the emerging strategic maritime competition between the United State and China, the expansion of exclusive economic zones (EEZ) and the crucial role of the seas in the international economic system both as a source of economic activity as well as serving as the world's main trade route. Our immediate environment saw a similar rise in the significance of the seas including the oil discoveries in the Eastern Mediterranean, the evolution of the Israeli Navy into a national strategic arm, Israel's total dependence on sea trade, and the growing realization that future development of national infrastructure may have to be done in the sea as land is becoming scarce.

The Konrad-Adenauer-Stiftung

The Konrad-Adenauer-Stiftung (KAS) is a political foundation of Germany, with the vision to promote international dialogue, sustainable development, good governance, capacity building, regional integration and enhance understanding of the key drivers of global developments. It is named after the first Chancellor of the Federal Republic of Germany, Konrad Adenauer who embodied Christian-social, conservative and liberal traditions. His name represents the democratic rebuilding of Germany, reconciliation with France, the anchoring of German foreign policy in a trans-Atlantic community of values, the establishment of the unique relationship between Israel and Germany as well as a vision of European unity and Germany's orientation toward a social market economy.

German political foundations are singular throughout the world. The Konrad-Adenauer-Stiftung is associated with Germany's Christian Democratic Union (CDU) party. Not many other organizations provide the same expertise in the field of democracy building and dialogue. Although each foundation is affiliated with a political party, they are organizationally, legally and financially independent and they are funded by the German Government. Their international work is closely aligned with Germany's foreign policy goals. Through its international activities and projects carried out in collaboration with local partners, KAS makes a substantial

contribution to international cooperation, ensuring that Germany lives up to its growing responsibility in the world. Particularly in development policy, the aim of our work is to motivate and enable (young) people to shape their own future by strengthening democracy and the rule of law and promoting the principles of a just social market economy. This includes capacity building in the areas of creating sustainable democratic structures, constitutional reform, as well as the support of human rights and peace processes. For this end, we collaborate with government institutions, policy-makers, political center parties, civil society organizations, academia and the media sector. A further pillar underpinning the political work is research and consultancy. This is more than just giving advice on current political affairs. We conduct research on the implications of political developments and seek to inform the policy-making process to contribute toward the development of far-sighted, sustainable policies that can help prevent crises.

Currently, KAS is present in around 120 countries, with over 100 offices on six continents. With our worldwide networks and long-term partner structures, we aim to contribute to knowledge exchange and policy development in line with our values and goals. The measures of KAS in the Middle East are aimed at structural changes as well as at strengthening and empowering social actors and, above all, institutions that advocate a change that not only contributes to the urgently needed stabilization of the region, but also advances truly sustainable development.

In its mission statement, KAS commits itself to preserving the close friendship between Israel and Germany. Therefore, KAS Israel mainly works on deepening and improving the relations between both countries on the one hand and between Israel and the EU on the other hand. In the field of foreign and security policy as well as social, economic and energy policy, the common interests between Israel and Germany are to be emphasised and deepened. A second important pillar of the work of KAS is the establishment of regional dialogue formats. Positive developments and regional normalizations are taken into account as well as regional power shifts and external threats posed to Israel. Finally, an important field of activity of KAS Israel is in the area of democratic resilience. KAS is particularly proud to have gained renowned partners, with whom phenomena such as populism and threats to democracy are analyzed and solution-oriented, alternative options for action are developed. All of KAS Israel's programs are dedicated to collaboration and knowledge-sharing to strengthen resilience and the ability to find solutions to the pressing problems of our time.

Content

FOREWORD

Beatrice Gorawantschy[1]

The Eastern Mediterranean region, located at the crossroads of Europe and the Middle East and an important nexus of cultural exchange, trade routes and energy transits, has in recent years gained additional geopolitical significance. A development which manifests itself in overlapping claims of sovereignty, great power competition (i.e. increased involvement of Russia and China) and gas discoveries, hence creating ample preconditions for further conflict. Today, however, the region is already in regular crisis mode and is home to multiple sites of failing sovereignty and state structures as well as long-standing political enmities.

Moreover, the International Panel on Climate Change (IPCC) defined the region in 2021 as a hotspot of climate change. Especially the densely populated coastal areas along the Mediterranean will be gravely impacted by its long-term implications in addition to environmental degradation. Populations and policy makers will have to deal with rising sea levels and extreme temperatures that will further exacerbate the region's water shortages and intensify droughts as well as forest fires. Further, water pollution, warming of the oceans and oxygen shortages, invasive species, energy exploitation at high seas as well as intensive shipping and fishing pose great challenges for the Mediterranean ecosystem at large. While the direct impact of climate and environmental challenges on the outbreak of violent conflicts remains ambiguous, climate change and environmental stress nevertheless can act as indirect crisis multipliers, especially in theaters of fragile statehood and long-standing political rivalries, and therefore pose significant security challenges for the Eastern Mediterranean and beyond.

The nature of these cross-border challenges however also requires transnational efforts ultimately increasing the prospects for increased cooperation and regionalism. After years of tension and bloc-building in the Eastern Mediterranean and the wider Middle East region, the last two years were already characterized by an uptick in dialogue and careful rapprochement. Especially Turkey made efforts to improve its regional bilateral relations, e.g., with Israel, Egypt and the UAE. Moreover, Israel and Lebanon reached a landmark maritime border deal in October 2022. These are encouraging trends towards de-escalation and dialogue. The region's gas resources as well as challenges like water shortages and the

[1] Dr. Beatrice Gorawantschy, Director Israel Office, Konrad-Adenauer-Stiftung

need for a renewable energy transition in line with the EUs climate policies could therefore become the drivers for new intra-regional dependencies and facilitate further cooperation.

As part of its mandate in the Middle East and North Africa, the Konrad-Adenauer-Stiftung is aiming to strengthen exchange and cooperation between countries of the region as well as between Germany and Europe on the one hand and the MENA region on the other. Our cooperation with the Maritime Policy and Strategy Research Center (HMS) forms part of this effort, this year examining climate change and environmental degradation – without doubt among the most pressing global challenges for generations to come. Against this backdrop the contributors provide valuable insights into their multifaceted region, outlining the various efforts and challenges associated with climate change and environmental degradation in the Eastern Mediterranean.

I would like to thank the authors cordially for their insightful contributions and the editor for his excellent cooperation and effort. It is our hope as the Konrad-Adenauer-Foundation in Israel that this publication will deepen the understanding of the Eastern Mediterranean region as well as its challenges and prospects for cooperation ahead.

Jerusalem, January 2023

INTRODUCTION

Ziv Rubinovitz

Since the 1990s, climate change has become the greatest long-term concern for the international community, dominating the international political discourse. This reflected the mounting evidence of global warming that has imminent effects and implications – rising temperatures, rapid melting of glaciers, increasing frequency of extreme weather events like droughts, wildfires, sandstorms, heavy rain that could cause flash floodings, as well as hurricanes, tornadoes, and typhoons. These extreme weather phenomena challenge and many times overwhelm the existing infrastructure that was planned and built to cope with much milder weather events. With what seemed in the earlier years of the post-Cold War era as a dramatic reduction of security threats, such issues as global warming and climate change could take the lead as a global concern. While later on, certainly after the September 11, 2001 terror attacks against the United States and the 2003 Iraq War, international security issues regained attention, climate change remained a major issue due to the growing severity of its consequences across the globe. The awareness to climate change's impact on national security of any country grew, for instance, when countries tormented by climate related disasters were unable to provide food for their population – leading to humanitarian crises and in the worse cases, destabilization of the countries and their political systems. The worst cases of dysfunctional countries turned into failed states, which then became security problems for their neighbors and the international system as a whole.

Climate change recognizes no border and affects not only the weather, but also the environment. Environmental challenges are on the rise due to climate change. They are becoming more frequent and more extreme, and are very likely to be trans-national and impact entire regions. The trajectory for some regions is that they will become uninhabitable in the coming decades, and given the predicted rise of sea level, living on the current coast lines will become impossible to maintain, certainly not without heavy infrastructure investment. Several island nations in the Pacific are already planning their permanent evacuation as their islands will be underwater in the coming years.

This alarming reality is the motivation for assembling this collection of chapters. The Konrad Adenauer Foundation (KAS) in Israel and the Maritime Policy and Strategy Research Center (HMS) at the University of Haifa decided to dedicate

their annual collaboration for 2022 to environmental challenges in the Eastern Mediterranean as catalysts for regional conflict and cooperation. The backdrop is that this region had a long history of conflict over political disagreements and nowadays the region's countries have economic interests in the sea – natural gas fields – that are vital for their respective energy markets and economies. This fueled past and contemporary conflicts, particularly because the Eastern Mediterranean basin is small and the countries' respective economic waters (Exclusive Economic Zones, EEZ) are limited. The proximity of the countries in the region to one another makes any environmental problem that one experiences everyone's concern. And the fact that the Mediterranean is a nearly closed sea – only the Gibraltar Straits in the west and the Suez Canal in the southeast allow any, very limited, circulation of water[1] – makes pollution and other environment related problems remain for a long time; thus, the region's countries cannot hope that such challenges would just move away with the sea currents. Buckpassing maritime environmental challenges to other countries is not a realistic option, therefore the regional countries must deal with them.

The economic interests in the Eastern Mediterranean focus the attention of the countries, and maritime environmental issues in the region potentially carry considerable financial and political costs, which require a state-level response, and very likely – a regional one. The question is whether environmental challenges that are non-political by nature could suggest a different trajectory for the regional states' reaction. There is evidence that over such challenges there is a better chance for international cooperation, as long as the issue at hand remains non-political. The most recent example is Israel's humanitarian aid to Turkey and even to Syria, although not directly, after the devastating earthquake in February 2023.[2] As reasonable as this seems to cooperate with neighboring countries in the face of an environmental challenge, it is important to note that the threshold between a purely environmental challenge and a possible political implication could be blurry. For example, a country that suffers the effects of an environmental event might reject aid offered by a neighboring country because of their enmity or due to concern over the real intentions behind the offer of humanitarian aid. Reluctance to accept aid or cooperate is in fact sensible in

1 Bella S. Galil, "A Sea, a Canal, a Disaster: The Suez Canal and the Transformation of the Mediterranean Biota", in Carmela Lutmar and Ziv Rubinovitz (eds.), *The Suez Canal: Past Lessons and Future Challenges* (Cham, Switzerland: Palgrave Macmillan, 2023), pp. 200–201.

2 Lazar Berman and Amy Spiro, "'Request was received': Israel to send earthquake relief to Syria as well as Turkey", *Times of Israel*, February 6, 2023.

regions like the Middle East and the Eastern Mediterranean because of their usual conflictual reality.

Environmental challenges can cause conflict between countries if they reduce access to natural resources that are vital to one or more of the involved nations, such as water or natural resources that are necessary for the economy like oil or gas. This is particularly true for the Eastern Mediterranean region, which is warming faster than any other region in the world thus suffering climate change-related challenges more intensely than other regions. This is happening while the region is also one of the powder kegs of the world on political and geopolitical bases, regardless of climate change and its effect. This mixture seems to raise tensions in the region and beyond, and can easily turn into armed conflict and hostile acts by various parties.

Nevertheless, environmental challenges can also ignite cooperation among neighboring countries, particularly if the event in question cannot be blamed on any one party but is indeed a natural occurrence. It is safe to assume that in the Eastern Mediterranean, the odds are that less cooperation and more conflict would occur. But this does not mean that conflict is inevitable in case of an environmental catastrophe. In fact, unlike the common tendency of the Middle East and the Eastern Mediterranean to conflict and violence over political disputes, environmental catastrophes – particularly those associated with climate change – are potential threats to many countries and therefore could catalyze cooperation among regional rivals. The most sensitive concern in this hot region is access to fresh water. Losing it due to an environmental or climate change reason would be a grave concern for any of the region's countries, but as much as it could cause conflict, it might as well create the conditions for cooperation with neighboring countries – either for short-term or for a long-term water supply. This could turn into a dependence of one country on another over an existential resource, which could be highly risky, but it could also turn into a high level of cooperation that both countries can benefit from, thus reducing existing tensions between them.

Yet, there is no escape from the political atmosphere in the region, which could easily foil any such cooperation. The deeper the rivalry is, the harder it would be to cooperate. This is where third parties could step in with the role of mediator or facilitator of cooperation. This third party should be accepted by all sides. In the Eastern Mediterranean, this role could probably fit the European Union better than to the United States because there is less animosity toward the EU, and because of its proximity to the region – two EU member state, Greece and

Cyprus, are part of the Eastern Mediterranean basin – it has a clear interest in environmental issues that might affect it. In addition, the EU would undoubtedly benefit from resolving environmental challenges in this region by reducing potential political tension on its south-east boundaries.

To reiterate, environmental and weather effects related to climate change have risen in the recent decades and the trajectory is that this will continue and intensify in the foreseeable future. This would be even more intense in the Eastern Mediterranean, therefore environmental challenges are and will remain an acute concern for all countries in the region and in its vicinity. The effects on the countries and their populations could and likely would be devastating. Therefore, the question of conflict and cooperation that this publication deals with is timely.

Structure of the book:

Given the regional nature of the topic, this publication has gathered scholars from Israel, Turkey, Greece, Cyprus, and Germany which represents Europe and its role in this issue. The first two chapters are conceptual discussions about different aspects of this topic – one about how to think about predicting climate change related issues, given the magnitude of the challenge, and the other on the concepts of regional conflict and cooperation. Three additional chapters discuss case studies in the region – in Syria amid the ongoing civil war, in the seas surrounding Greece, and in Cyprus, at the Limassol Bay. The final chapter discusses Germany's and the EU's perspective on environmental challenges in the Eastern Mediterranean and how it can be tackled successfully.

Moti Shattner and Uri Schattner discuss a significant issue related to the current challenges that emerge from climate change, which is the difficulty to predict given the magnitude of the challenge we are facing. They argue that the existing models cannot predict properly due to the current intensity of extreme events. These extreme events have a significant and direct impact on economic, geopolitical and strategic decision-making, and require decision-makers to prepare for the potential conflict these events might ignite. The chapter presents a new approach to extreme events and their scientific and political implications. It suggests developing a systemic approach that will refer to extreme events in an appropriate context. The new models will provide a broad basis for humanity dealing with the global phase transition and not just for individual countries.

Ziv Rubinovitz's chapter overviews key aspects of international relations literature on regional conflict and cooperation with a focus on environmental issues and humanitarian matters which are commonly the result of environmental catastrophes. He emphasizes that conflict and cooperation are not mutually exclusive, and could occur at the same time, i.e., cooperation could occur within a context of conflict and vice versa. An important issue is the nature of the phenomenon that countries are facing. If it is political, the likelihood of cooperation plummets, while the less political it is, the chances for cooperation grow, especially in a context of a natural disaster, including environmental calamity. This complex picture gets even more complicated in regions like the Middle East and the Eastern Mediterranean, which have a long history of conflict and enmity between virtually all regional players – thus mutual suspicion and distrust are the common rule. Yet, given the right circumstances combined with mutual interests, cooperation could certainly be on the table. For instance, in the Eastern Mediterranean, the gas fields and their safety and protection could be such an interest shared by all regional players.

Oğuzhan Akyener, Fatih Temiz, Levent Kenar, and Abdullah Altun discuss the grim situation in Syria in the recent decade with the high toll the civil war is taking on Syria's society and environment, as well as the challenges that arose there. They make the case that indeed environmental challenges trigger regional conflict, but also regional conflicts trigger environmental problems. They exemplify this by drawing a grim picture of the environmental effects of the crisis in Syria, including the immigration and refugees, the illegal oil sales, and the chemical, biological, radiological and nuclear agents. All of these issues originate in or are worsened by the civil war, and given the magnitude of the destruction in Syria, their resolution requires regional cooperation.

Eirini Asimina Stamatopoulou, Nikolaos P. Ventikos, Emmanouil Nikolaidis, Stavroula Delenta, and Dimitrios Drivas discuss an early warning system for marine pollution in the Adriatic-Ionian seas. Closed and semi-closed seas like the Mediterranean are more sensitive to marine pollution, such as litter, effluents, oil and eutrophication, and requires regional action. The European Union created a baseline for developing a macro-regional strategy for the Mediterranean basin to tackle the environmental challenges, which are related to extreme weather events, water scarcity, loss of biodiversity and food security. The chapter introduced the SEAVIEWS Project which is a transnational repository network of sensors monitoring water quality. The chapter presents the environmental issues

that arise in the selected area, the selection where the measurements are taking place, as well as the reference values for each of the monitored parameters.

Angelos Menelaou, Michalis Makrominas, and Carol Bailey deal with a local challenge at the Limassol Bay in Cyprus. They present the Blue Limassol Risk Assessment project that represents a government-academia collaboration that brings together maritime professionals, environmentalists, regulators, and academics to address the great challenges facing the city of Limassol and its coastal environment. It both assesses threats from industry and leisure and recommends the best practices to alleviate the threats and promote sustainable growth. The project focuses on the Limassol Bay due to the high concentration of diverse industries in the region and a steady increase of anthropogenic pressures in the area. The project addresses the growing concern of the residents of Limassol for their environment. The chapter presents the concept of Blue Economy and its importance to Limassol, discusses the risk assessment applied to the various industries in the Limassol Bay, and provides a holistic evaluation of risk assessment and the root causes.

Stefan Lukas presents a German/European view of environmental challenges in the East Mediterranean and suggests how they can be tackled successfully. Developments in the East Mediterranean have a direct impact on the European Union; therefore, Germany, France, Italy and Greece must deal with the climate policy situation in East Mediterranean countries such as Egypt, Israel, Lebanon or Syria. This chapter presents new approaches in European and regional climate and foreign policy and shows that only an international approach can lead to success. Although climate change has not yet been the source of conflicts in the region, but is mostly seen as an accelerant for already existing conflict hotspots, this circumstance may be reversed within the next decade. The tipping points for such a reversal are already visible wherever natural resources are running out and distribution struggles are growing in intensity - be it in the Iraqi marshes, the Nile Delta or along the Jordan Valley. To ensure that this does not happen, the European partners must also live up to their responsibility and support the actors in the Eastern Mediterranean in adapting to the new climatic circumstances and reducing fossil energies.

In conclusion, the chapters represent different perspectives of the topic of this volume. They cover theoretical and practical issues, some of the latter being optimistic while others pessimistic. This variety properly reflects the issue of environmental challenges in the contemporary Eastern Mediterranean basin. Obviously, the chapters do not cover all of the relevant issues, but they do highlight

key issues and representative cases that illustrate some notable environmental challenges the East Mediterranean faces. The need for cooperation of the regional players, with international players as well, is a theme that they all agree on.

EXTREME EVENTS IN EARTH SYSTEM – BUG OR FEATURE?

Moti Shatner and Uri Schattner

The significant increase in extreme events occurring in recent years challenges the predictability of existing models since they exceed the known prevalence and intensity. Recent studies redefine extreme events as part of a larger system, laying down a new scientific foundation for enhanced model predictability. This major and systematic shift in scientific approach has a significant and direct impact on economic, geopolitical, and strategic decision-making due to the growing need to prepare for the direct impact of extreme events and the potential conflicts they might initiate. This chapter presents a new approach to extreme events and their implications for scientific research and decision-makers.

Extreme Events

Extreme events are one of the more drastic expressions the climate crisis induces in our lives. Devastating storms, heavy rains, destructive floods, massive landslides, dam collapses, wildfires, infections and diseases, seem to have become more frequent in the last decade. Extreme temperature, which exceeds predictions (peak value and duration) lead to power and water crises. Frequent droughts cause acute water crises and, together with other factors, acutely change land uses faster than humanity can cope with. Meanwhile, we are flooded by scenarios for long-term trends such as seawater warming, rising ocean levels, and their uncertain effect on human and natural coastal systems. The frequency and intensity of extreme events are increasing along with their inter-correlations.

History shows that substantial long-term environmental changes and short events have caused significant changes in human societies. For example, earthquakes[1] and volcanism[2] destabilized societies, and resource depletion brought them to

[1] Nur, Amos. "The End of the Bronze Age by Large Earthquakes?" In Benny Peiser, Trevor Palmer and Mark S. Bailey (eds.), *Natural Catastrophes During Bronze Age Civilisations: Archaeological, Geological, Astronomical and Cultural Perspectives* (Oxford: Archaeopress, 1998), pp. 140–147.

[2] Driessen, Jan. "Towards an archaeology of crisis: Defining the long-term impact of the Bronze Age Santorini eruption", in Robin Torrence and John Grattan (eds.), *Natural disasters and cultural change* (London: Routledge, 2003. pp. 266–279.

collapse.[3] In modern times, countries tend to assist others after natural disasters, sometimes despite their rivalry, and not take advantage of weaknesses. This is possible when the damage is secluded to one region while the others remain stable. The climate crisis, however, poses global stress and affects several countries and societies at once. Its effect on the mode of cooperation between countries is still unknown. What will be the nature of the mutual support between countries in the face of increasing distress when world orders shift course and casualties rise (e.g., due to floods, fires, and economic and psychological crises)? On the other hand, a systemic crisis can result in economic and social pressure that manifests itself in political and military tension, leading to aggression and geopolitical changes.

Predictive models play a central role in guiding the preparedness of individuals, societies, and countries for long-term trends and abrupt extreme events. These models guide every aspect of state management, e.g., economic, security, and medical preparedness. The models are mainly based on observations that accumulate over time in the scientific record. Some of these observations were collected during monitoring, while others in dedicated surveys. The data collection is based on the induction approach, which claims that since natural behavior is universal, observations collected in similar environments worldwide represent the global occurrence of a phenomenon. For example, the nature of tsunamis is similar on a global scale and, therefore, could be sampled locally in different places worldwide to overcome sampling difficulties (since it is impossible to sample everywhere worldwide). However, when dealing with extreme events, the induction approach has one central problem since an event is not ubiquitous, it could be missed by sampling paleo (past) data or overlooked while analyzing observation. For example, if only a few samples out of several hundred show extreme values, they could be interpreted as outliers rather than representing extreme cases. Additionally, when a modern event, such as Hurricane Ian (late September 2022), strikes, it is presented as "a 500-year flood event" based on data records.[4] However, this presentation suggests that the likelihood of such an extreme case is low, while the reality may differ. This difference highlights the main gaps between the rapidly changing reality and scientific predictability. Despite the significant scientific advances in the last three decades, showing that climate undergoes a substantial change, our grasp of extreme events still

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3 Diamond, Jared. *Collapse: how societies choose to fail or succeed: revised edition* (New York: Penguin, 2011).

4 Hannah Nightingale, "DeSantis provides update on Hurricane Ian, says report of hundreds of deaths 'not confirmed'", *The Post Millennial* September 29, 2022.

relies on past records and inductions. The increased frequency and intensity of unexpected extreme events question the predictability of current datasets and the credibility of existing predictive models and strongly suggest they should be reevaluated (Figure 1).

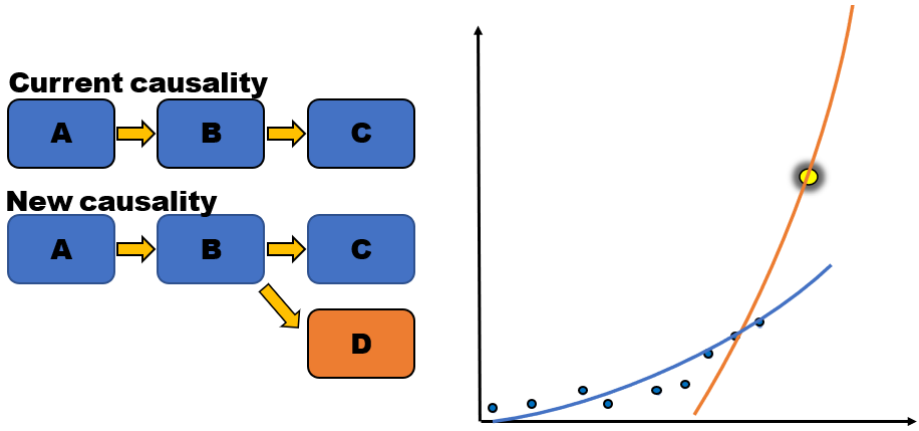

Figure 1: How should we interpret an extreme event (yellow dot)? Does it represent a measurement error, an unusual or extreme event, a fundamental shift in the existing system, or an entirely new set of rules?

Several recent studies form the foundation for a new generation of models and redefine extreme events. In an observation-based study, McPhillips et al. (2018) classify extreme events as unexpected occurrences of acute impact, sudden onset, high intensity, and duration events.[5] In a comprehensive literature review (i.e., indirectly based on reports and observations), Stewart et al. (2022) found similarities between descriptions of extreme events across many disciplines, which refer to their time context and rate of change, as well as the risk, vulnerability, and impact they impose on human society.[6] These authors suggest that the abovementioned criteria could serve as a basis for a comparative study on extreme events. Another approach, by Broska et al. (2020), tries to redefine extreme events according to their reality-changing disruption.[7] These authors

5 McPhillips, Lauren E., et al. "Defining extreme events: A cross-disciplinary review". *Earth's Future* 6.3 (2018): 441–455.

6 Stewart, Mathew, W. Christopher Carleton, and Huw S. Groucutt. "Extreme events in biological, societal, and earth sciences: A systematic review of the literature". *Frontiers in Earth Science* (2022).

7 Broska, Lisa Hanna, Witold-Roger Poganietz, and Stefan Vögele. "Extreme events defined—A conceptual discussion applying a complex systems approach". *Futures* 115 (2020): 102490.

suggest that disruption is a requirement for defining extreme events. They discuss extreme events in the context of complex systems. Nonetheless, the approach to the extreme events remains a direct extension of the present-day events, part of a simple system describing a causality model (cause-and-effect).

Attempts to understand and anticipate extreme events have been a common practice in the financial world, where asset prices (e.g., stocks, bonds) are highly volatile and crashes in the stock markets can create huge losses. During the 1990s, the Value at Risk (VaR) approach was developed to calculate the risk of extreme losses in asset portfolios.[8] The first attempt to predict these losses was based on the assumption that prices move according to a normal distribution ("Bell curve"). When this perfect theory was found to be far from actual evidence, a second attempt was made to base predictions on historical data and induction. Nevertheless, the historical approach was more valuable in non-volatile periods, and was less adequate for highly volatile times. A third approach uses a Monte Carlo simulation to create "potential" future scenarios based on assumed correlations between the different assets. The hypothetical scenarios were then analyzed to create predictions on extreme events. Again, this approach was found to only partially capture extreme changes in the market, as it was highly dependent on semi-qualitative inputs (the correlation matrices), and was assuming a linear world with simple causality, which was not always the case in volatile periods. Calculating and reporting VaR numbers is currently a regulatory requirement for most financial institutions. However, many criticize the prevalent use of VaR due to its highly limited predictive power.[9] With the rapid introduction of non-linear models (e.g., neural networks) and big-data to the financial world in recent years, it is hoped that a new set of extreme-events models will emerge.

Aim

The accelerating changes in the Earth System processes require a paradigm shift to understand inter-disciplinary relations of processes, improve the predictability of continuous processes (e.g., sea level rise, glacier melting, slowing ocean circulation, and frequent droughts), and improve the preparedness for extreme events. Will extreme events be frequent? What will be their intensity, frequency,

8 Jorion, Philippe. *Value at Risk: The New Benchmark for Managing Financial Risk* (3rd ed.) (New York: McGraw-Hill, 2006).

9 Taleb, Nassim Nicholas. *The Black Swan: The Impact of the Highly Improbable* (2nd ed.) (London: Penguin, 2010).

duration, and distribution? Should we expect to witness unknown processes and events due to post-tipping point cascades? The scientific tools available today still cannot deal with these questions.

The current chapter has three main goals: (1) to explain why the empirical analysis and modeling method common today, based on simple systems, has difficulties in dealing with extreme events; (2) to propose initial directions for an analysis based on a complex systems approach; and (3) to offer insights to researchers and decision-makers at a time when the complex models are merely beginning their development, while the predictions of the existing models are losing their accuracy.

Our study suggests that when a complex system changes, induction models based on past events will have difficulties predicting extreme events, because these are not in the statistical range of past observations. Events now called extreme, since perceived as exceptions, may become the new norm. Since they have little or no documented history, simple models cannot deal with their occurrence. In order to discuss these issues, the chapter will define simple and complex systems and discuss the benefits arising from analyzing a system as complex.

Earth system

In recent decades, studies of the processes and events shaping the Earth are undergoing a revolution (Figure 2). A central part of the studies is published as research papers focusing on principles and case studies. These studies expand the knowledge by providing causal relationships between specific factors, the environment, and interrelationships between processes. For example, the effect of temperature rise on the melting of glaciers and consequently on the sea levels. In a simple system, accurate documentation of past records (e.g., climate, earthquakes, ocean temperature) enables one to draw conclusions about the system dynamics today and helps assess its future behavior, assuming the present conditions are maintained.[10]

The empirical analysis method can consist of several causal connections, together making a web of relationships. This web, presented in comprehensive review papers, provides the framework of rules and facilitates predicting super-processes. For example, deposits sampled from the ocean floor and its subsurface enable examining the oxygen content (among other parameters).

[10] Obreht, Igor, et al. "Last Interglacial decadal sea surface temperature variability in the eastern Mediterranean". *Nature Geoscience* 15 (2022): 812–818.

Together with the knowledge of the governing processes, these samples will enable the reconstruction of the aerobic conditions on the ocean floor in the past. The results also serve as a basis for constructing a timeline of condition changes, and reconstruction of their altering environment (e.g., ocean bottom currents and anoxic events). The timelines assist in the prediction of future conditions. Therefore, the review studies integrated many details and processes into a comprehensive and extensive understanding and may formulate new principles and processes.

Unique projects conducted in recent years aimed at mapping as many causal relationships as possible to find additional hidden connections, especially in the field of climate (e.g., causeme.uv.es).[11] Based on increasing computing power and growing databases, these studies and projects begin to uncover unknown interrelationships between seemingly separated disciplines. By that, they enable treating the Earth as one complex system, instead of a conglomerate of simple ones.

Still, it is impossible to evaluate the influence of one component relative to another with certainty,[12] especially if the components are from different systems and disciplines (Figure 2a). For example, what is the effect of pollution carried by ocean currents on the conduct of tourism, marine resources, and public health in downstream littoral countries? Or what is the long-term effect of the increasing microplastic pollution on ecological systems and public health? These questions cross several disciplines. Hence, a comprehensive and responsible answer requires a great deal of expertise in each of the disciplines and their interrelations. Moreover, even then, the element of uncertainty will remain significant.

From the 1980s, science began examining supposedly unrelated processes recorded in different disciplines, e.g., geological, biological, environmental, and climatic (Figure 2b). One known outcome is the linkage between increasing carbon dioxide fraction in the atmosphere and temperature. Papers such as Petit et al. (1999) paved the way for understanding the causal interrelationships

11 Runge, Jakob, et al. "Inferring causation from time series in Earth system sciences". *Nature communications* 10.1 (2019): 1–13; Runge, Jakob, et al. "Detecting and quantifying causal associations in large nonlinear time series datasets". *Science Advances* 5.11 (2019): eaau4996; J. Runge. "Causal Network Reconstruction from Time Series: From Theoretical Assumptions to Practical Estimation", *Chaos: An Interdisciplinary Journal of Nonlinear Science*, 28.7 (2018), 075310.

12 Taleb, Nassim Nicholas (2010).

between these systems,[13] beyond the circumstantial occurrence of phenomena in each discipline separately.[14] This generalization attempts to counter a common and justified criticism of scientific explanations that circumstantiality does not necessarily represent causation. If two events co-occur, they are not necessarily connected by a causal relationship, since correlation is not causation. The agglomeration of many disciplines (components and processes) into the Earth System concept is an essential step in developing thinking. However, the Earth System is still to be perceived as a complex system. Steffen et al. (2020) place the main challenge in fully integrating the human aspect (e.g., sociology and public health disciplines) in the overall Earth System to understand the interrelationships comprehensively. They suggest that fast computing will facilitate deciphering nonlinear relations, especially between humanity and the environment.[15]

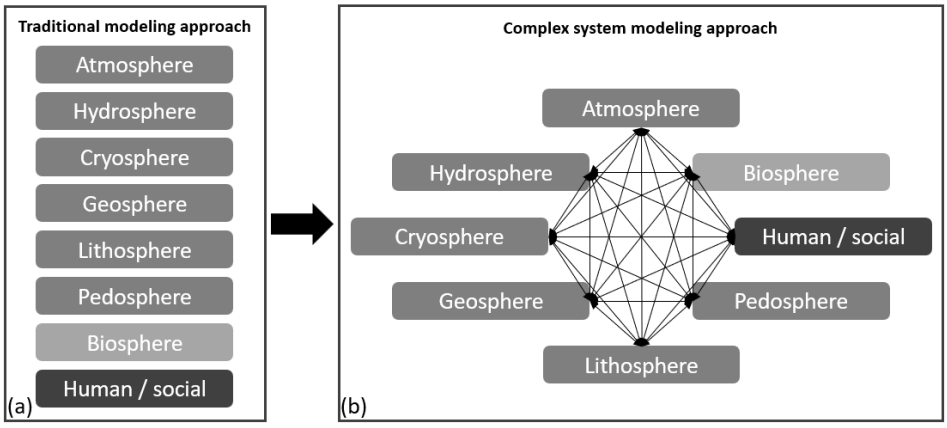

Figure 2: Shift from a silo to an inter-influence approach: (a) Some of the disciplines comprising Earth sciences and the human aspect. Traditional studies and most researchers work within one or two of these disciplines today; while cross-disciplinary studies are usually conducted through a collaboration between researchers from different fields. This disciplinary division has considerable influence on the modeling approach. (b) An example of a complex system approach to the same disciplines presented in 2a, emphasizes the processes within each discipline and between them. This comprehensive approach, which is only starting to develop today, underlies the Earth System concept.

13 Petit, Jean-Robert, et al. "Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica". *Nature* 399.6735 (1999): 429–436.

14 Stewart, Carleton, and Groucutt (2022).

15 Steffen, Will, et al. "The emergence and evolution of Earth System Science". *Nature Reviews Earth & Environment* 1.1 (2020): 54–63.

Today, the agglomeration of Earth processes into one system is gaining momentum since the realization that many of the processes related to Earth and humanity are on the verge of a tipping point. This approach developed in 2008 and became dominant.[16] Once the continuous processes reach a failure, a threshold, or a tipping point, the system shifts sharply into a new phase and begins to behave differently.[17] The current statistics cannot anticipate the timing, essence, and magnitude of these tipping points and certainly cannot deal with their consequent processes. The nature of individual events occurring after the tipping point can be described based on, for example, the laws of physics and thermodynamics. However, their overall course is unpredictable because the scientific record does not encompass a sufficiently long observational history of the post-tipping point phase.

Some studies attempt to address the likelihood of crossing tipping points. For example, McKay et al. (2022)[18] defined 16 different tipping points and examined their dynamics. They suggest that today the world rapidly approaches five such points, and four additional ones will be crossed shortly after if global warming exceeds the 1.5-degree Celsius threshold. They also stress the irreversible nature of crossing tipping points, and the unpredictable cascade of events that will follow. For example, melting permafrost in high latitudes may lead to increased greenhouse gas emissions contributing to global warming. Hence, a post-tipping point cascade may initiate secondary points and cascades.[19] These and other researchers emphasize the uncertainty element, which still does not allow for quantitative assessments of the threshold conditions (e.g., timing, extent, values) for a tipping point to occur. However, some statistical physics approaches stress the need to analyze the Earth as a complex system to reduce these uncertainties.[20]

Simple and complex systems

A phase transition describes an abrupt shift of a system and restructuring of one state into another. In physics, for example, ice may become water, water

16 Stewart, Carleton, and Groucutt (2022).

17 Lenton, Timothy M., et al. "Tipping elements in the Earth's climate system". *Proceedings of the National Academy of Sciences* 105.6 (2008): 1786–1793; Armstrong McKay, David I., et al. "Exceeding 1.5°C global warming could trigger multiple climate tipping points". *Science* 377.6611 (2022): eabn7950.

18 McKay et al. (2022).

19 Petit et al. (1999).

20 Fan, Jingfang, et al. "Statistical physics approaches to the complex Earth system". *Physics Reports* 896 (2021): 1–84.

shifts to gas, and graphite to diamond. In these cases, both states of the matter are well studied. The phase transition occurs when the system undergoes some restructuring – e.g., atoms are organized differently in solid and liquid – after which the system shows new statistical properties. Phase transition can happen relatively quickly when a complex system reaches a tipping point or a critical threshold. The term phase transition is also used for describing a transition between distinct states of a complex system, e.g., climate change or ocean currents. However, in this case, the transition is less clear – the timing and duration of restructuring and the conditions in the post-transition state.

The analysis and modeling method standard in science, commerce, and decision-making is based on a Simple System assumption. Monotonic and linear rules transform the system from state A to B while skipping nonlinear interactions between system components. Its predictions are based on datasets and statistical tools. Hence such a system has difficulties modeling phase transitions, such as extreme events, due to their abruptness and the emergence of new components and secondary cascades. In these cases, the simple system breaks down due to a significant change in its parameters or rules. The climate crisis brings up examples of such behavior – will future rise in seawater temperature be monotonous? Will the glacier melting rates match the linear laws known today? The answer is probably no because the existing rules break down and transition to new ones. These shortcomings of the simple system approach pose a major limitation in studying extreme events, which takes on central significance when preparing for them. The simple system approach comprises a component of a more extensive complex system.

A Complex System is composed of many interacting components and processes, thereby creating distinct macro-level properties. For example, purchase decisions of individuals at the micro level create price and inflation trends at the macro level. Earth's climate, the human brain, and the stock markets are all examples of complex systems that integrate nonlinear interactions between their components. The relationships between the system's components make the system "complex" and difficult to model along the narrow approach of a simple system. Components that are semi (or entirely) autonomous create typical complex systems properties such as phase transition (restructuring of the system, a tipping point), nonlinear behavior, emergence (properties that only show on the macro level), and feedback loops (the system feeds itself in inputs). Some complex systems include sub-systems that are also complex. For example, Earth is an integrated complex system that includes several complex

sub-systems, including the geosphere and the atmosphere (e.g., Steffen et al., 2020;[21] Figure 2).

Discussion

In the last few decades, understanding Earth-shaping processes has become necessary for making practical decisions. Explanations of short-span natural events such as earthquakes and tsunamis and long-lived storms, pollution, droughts, and ocean level changes are simplified to make professional jargon more accessible to the public. The simplifications enable decision-makers in various fields, such as economics, health, and security, to implement the knowledge. It also allows countries to conduct their matters separately. The question is whether this is the only correct, and most appropriate way to imply insights between supposedly unrelated disciplines.

The study of Earth processes, upon their various components, has improved significantly in recent decades, thanks to enhanced data acquisition tools, analytical methods (human and machine), knowledge appropriation, computing, instrumentation, and laboratories. The improvements helped us better understand known processes, recognize new ones, and define interrelationships between them. This substantial progress, which continues today, constitutes the core of science in mapping causal relationships (individual and multiple). During this causal mapping, cases that did not fit the statistical prediction and the application of scientific models (i.e., theories) also evolved. Initially, they challenged existing models by being exceptional. Their inclusion led to model modifications. With the development of statistics, they testified to abnormal or defective measurements or even to cases that deviate from the norm (i.e., outliers; Figure 3). Even in these cases, the outliers represented events that were indeed measured, measurement errors, or an outcome of superposition of more than one process (for example, the grain size distribution on the seabed where there is more than one transport system).[22] The increasing intensity and frequency of extreme events have led to a reevaluation of Earth's processes – are these events unusual and anomalous to the conventional models known today? In this case, the models and common analytical approaches are still valid. Alternatively, these events may stem from a superposition of several processes

21 Steffen et al. (2020).

22 Schattner, Uri, et al. "Sedimentary response of the deep eastern Mediterranean basin to the north African desertification, sea level variation and regional tectonics". *Basin Research* 34.2 (2022): 662–687.

and systems – and if so, what are the other systems? Or maybe the outliers represent the phase transition in the known processes? In this case, the models need to be modified.

In this framework, we highlight the main challenges in dealing with extreme events. First, we propose to refine the definition of extreme events to understand if they represent outliers in an existing model (Figure 3a), suggest a required calibration of an existing model (Figure 3b, 3c), or define a new model (Figure 3d). McPhillips et al. (2018) define extreme events according to their impact on ecological, social, and technological systems. They highlight the tight connectivity between human vulnerability and extreme events, for example, the increased frequency of extreme climatic events acting on growing urbanization, residential areas expansion, and reliance on technology. Stewart et al. (2022) defines extreme natural events according to their abruptness, unforeseen occurrence, and strength, e.g., tsunamis, floods, earthquakes, and volcanic eruptions.

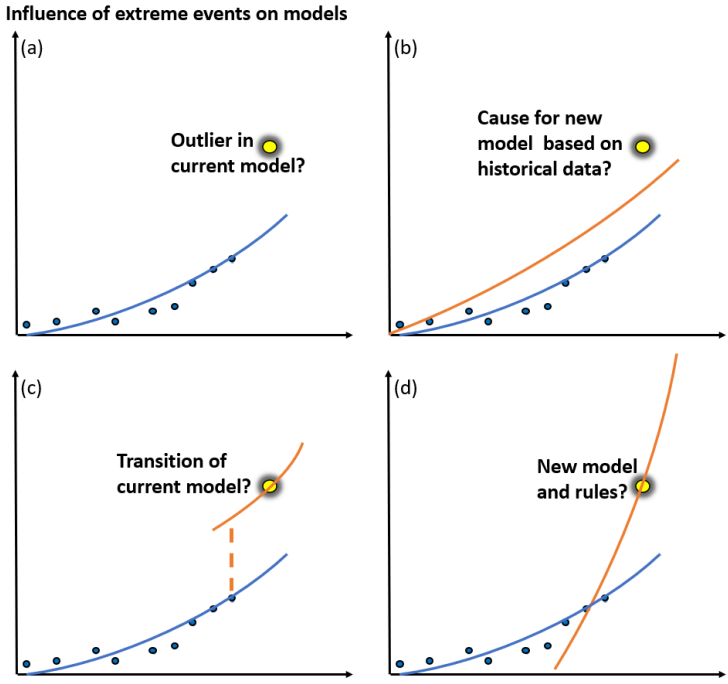

Figure 3: How should we interpret and manage an extreme event? There are four approaches: (a) the extreme event is marked as an outlier in an existing model, (b) extreme events are used as a basis for new models which still rely on historical records, (c) the extreme event is used as an anchor for shifting existing models to the new conditions represented by the event, (d) understanding of the extreme event is used for formulating a new model.

We propose to define an extreme event based on its association with a set of rules and degrees of predictability: an event predicted by an existing model cannot be considered extreme. In contrast, an event unpredictable by an existing model signifies a shift in the system state and raises the need to reform basic model rules will be considered extreme. We suggest adding the term Catalyst Event to the extreme events because they accelerate scientific leaps and establish new models and the Earth System approach (Figure 4). As mentioned, the main question examined today is whether we are witnessing a phase transition in the Earth processes that weaken the predictability of existing models. Therefore, distinguishing between an extreme event that belongs to the simple system and a catalyst event that represents a behavior within the complex system will help advance research efforts.

The second challenge is formulating a new model as part of a complex system. Including all processes shaping the Earth as one system is an essential starting point because the interrelationship between processes and disciplines is probably the central key to the new models. Even if we still do not know the new models and theories, we understand that they sum up to formulate a complex system since it allows growth beyond the individual and multiple causal relations toward the third challenge – finding the nature of mutual influence between disciplines and processes comprising the complex Earth system. Therefore, today's scientific world is experiencing one of the fascinating periods – the Earth's processes is most probably at a tipping point.

The frequent recurrence of extreme events (e.g., extreme heat waves) that shocked scientific thinking probably indicates that several systems are in a phase transition or several simultaneous ones. The fourth challenge is formulating new models during a phase transition, when the system has not yet stabilized, and sufficient historical information is lacking in the new state. In addition, the duration of the transition is unknown, and likewise, the range of the phenomena accompanying it, the domino effect they induce, and the new state that will develop after the transition. These events probably reflect the transition to a state with a different set of rules than the one we are familiar with (Figure 3d). Today, the importance of data acquisition and knowledge appropriation is significant, even if we are unsure if we are witnessing a phase shift or the beginning of the new state. In both cases, the appropriation cannot serve as a basis for the induction of a simple system since the mutual influences between disciplines have been proven beyond doubt (e.g., the influence humanity has on global warming). Humanity no longer has the privilege and time to rely on a

simple system approach. It has to emphasize and promote the complex, strategic and multi-complement approach.

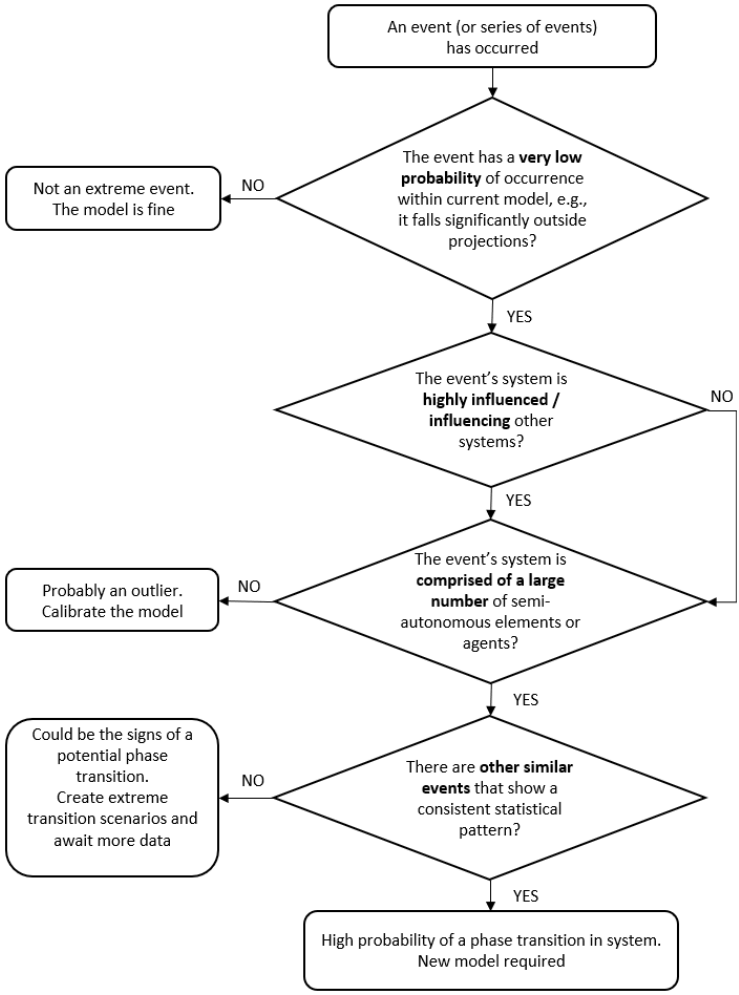

Figure 4: A flowchart representing the basic classification of extreme and catalyst events that accelerate the emergence of new scientific models (theories).

The scientific disciplines were defined and divided over the years – a division emphasized by increased specification during the millennia transition. However, after many connecting mutual influences between traditional disciplines were drawn, we need to redefine the boundaries and the approach to understanding Earth's processes. The magnitude of scientific and political responses to the extreme events described here is reflected, for example, in the establishment of

the UN's Intergovernmental Panel on Climate Change (IPCC) and the definition of the 17 Sustainable Development Goals (SDG). These practical environmental-oriented actions further emphasize the importance of a deep and systematic understanding of the Earth system (Figure 2b). The global COVID-19 pandemic that crossed geographic and political boundaries emphasized the importance of sharing knowledge and an integrated international scientific action to find practical solutions for the benefit of humanity. With global efforts as a background, each political entity could choose how to deal with the crisis. This concept should also be implemented facing the climate crisis and its extreme events, which also cross borders. The global scientific effort resulting from extensive cooperation will create a fertile ground for new knowledge and the basis for management models in all aspects of life, for example, the economy, insurance, environment, security, and public health. These models will reduce the uncertainty and future conflicts arising from shortages and disasters. Therefore, it is essential to advocate knowledge sharing and create new tools facilitating the scientific revolution to understand the Earth system better.

Along with increasing cooperation between research disciplines and between countries, it is necessary to increase the vigilance of decision-makers to the economic, military, and social consequences of the reformulated scientific models. A complex system can shift abruptly into a new state due to its nonlinear nature. Most scientific models (theories) and our psychology assume a linear and stable environment with simple causality. Decision-makers should, therefore, compensate for the stable forecasts by highlighting the least probable scenarios at each moment and prepare accordingly. In addition, they should expand the concept of causality to the systemic and complex levels.

Conclusion

The empirical analysis and modeling method commonly used today, based on simple system thinking, has difficulty dealing with frequent and powerful extreme events. These events are mostly interpreted as outliers within an existing model but they can also be identified as catalyst events that indicate a phase transition into a broader complex system. The increasing difficulty in providing predictions within the framework of the existing models led to the foundation of a new research approach (or a super-discipline) that refers to the nonlinear elements of a complex system. We are currently only at the beginning of this process because the new definitions and directions of the new models are debated and because data is scarce.

According to present-day changes, each component comprising the earth system may undergo a phase transition, along with the entire system. This is an unusual situation where theories based on evidence of a simple system may break down, new types of relations and positions must be described, and new types of data should be collected. Therefore, research is beginning to undergo a major transition due to the need to adapt the models (theories) and because the Earth's processes are changing their behavior as parts of a complex system. Consequently, decision-makers in the economy, society, and security arenas should also adapt and act as part of a complex system. In particular, it is worthwhile to treat induction-based predictions with greater skepticism (e.g., reoccurrence of major storms) and to increase the probability of rapid lateral changes and inter-systemic correlations.

The increasing catalyst events may indicate that we are on the verge of a scientific revolution. At its core – a shift from simple causal thinking to systemic thinking that relates to all factors and processes. Simple causal thinking can be applied to relatively stable and linear environments with few or no interacting components. Systemic thinking based on a complex Earth system will refer to broader interrelationships, put the extreme events in their appropriate context, and aspire to find new logic that will better define reality today and in the future. With the increasing frequency of extreme events and while the Earth is on the verge of several tipping points, we do not have the privilege to continue relying on simple causal models to predict future behaviors. The transition to comprehensive systemic thinking will provide a better basis for multidisciplinary policy models (social, political, security, and medical). The new models will provide a broad basis for humanity dealing with the global phase transition and not just for individual countries. Still, each country will choose its own path, as was manifested during the COVID-19 pandemic. We hope that the systemic Earth system thinking will provide a broad enough common denominator as a basis for international treaties, similar to the present-day attempts regarding carbon emissions and alternative energy.

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year he co-founded the College of Management's FinTech accelerator. In 2013 he co-founded Bluevine, a next-gen SME bank in the US. He also co-founded Risk Modules, a risk-management company, that was acquired by Taldor, and Balaganim, a youth NPO that already helped around 15,000 teenagers. Moti serves as board member in several companies, and as strategic advisor to leading banks, insurance companies, institutional and PE funds, large corporations, global consulting groups and the Israeli Ministry of Finance. His research focuses on complex system, risk management, entrepreneurship mindsets, far-future analysis and strategic decision making.

Prof. Uri Schattner is an associate professor in marine geosciences, co-founder and former head of the Dr. Moses Straus Department of Marine Geosciences, and head of the Seismic Interpretation Lab at the University of Haifa's Leon H. Charney School of Marine Sciences. Uri was elected president of the Israel Geological Society for 2023-2024. He obtained his BSc in Geology and Biology from the Hebrew University in 1998, both MSc (applied Geodesy, 2001) and Ph.D. (Tectonics, 2006) in Geophysics from Tel Aviv University, post-doc at the Geological Survey of Israel (2006) and the School of Earth and Environment at the University of Leeds, UK (2007). In 2007 he received the Bentor Award from the Fredy & Nadin Herrman Institue of Earth Sciences (Hebrew University, Jerusalem) for writing an excellent paper on the tectonic development of the eastern Mediterranean. In 2016 Uri received the Freund Award of the Israel Geological Society (the highest and most respected prize for Earth Sciences in Israel) for writing an original and innovative paper on sediment transport in the eastern Mediterranean. In 2016 Uri invented a simple and low-cost technique for collecting ground magnetic data on a bicycle that yielded new magnetic data over thousands of kilometers and five peer-review papers. His research focuses on plate and salt tectonics, seismic stratigraphy, Earth System analysis, acquisition processing and analysis of marine geophysical data, structural geology, gravity, magnetics, and seafloor morphology, mainly in the Mediterranean Sea and the southern Atlantic Ocean. His research and teaching promote comprehensive thinking for understanding inter-relating processes in the Earth System.

REGIONAL CONFLICT AND COOPERATION: A CONCEPTUAL FRAMEWORK

Ziv Rubinovitz

This chapter provides a conceptual framework for thinking about regional conflict and cooperation, which are among the most common terms in the political world and in particular, international relations. They imply that political entities – countries, political parties, individual politicians, interest groups, etc. – and economic enterprises like corporations all have interests and can protect or promote them in many ways, which can be either conflictual or cooperative, and there are several variants for each way. While the phenomena of conflict and cooperation are universal in nature, they can take different shapes in different regions. Some regions are more prone for conflict and violence than others, either due to social, historical, or cultural issues or due to scarcity of resources which causes disquiet.

There are numerous theories about the origins and conduct of, and prospects of success in international conflict and cooperation. But are conflict and cooperation mutually exclusive? Not quite. In fact, conflict might emerge within a generally cooperative environment, and cooperation could occur within a generally conflictual one.[1] The key issue is the cause and scope of either phenomenon. This is where environmental challenges could lead to either conflict or cooperation in a given region, even though the typical regional dynamics are opposite.

A conflict is a situation in which interests of two or more parties overlap, thus there is a dispute. It commonly occurs in a specific location either between the parties or in close proximity to them, but a conflict can also be ideological thus less associated with a specific location. A conflict between two countries can also occur when they struggle over their relative or absolute influence over a third country.[2] A conflict can be intense or moderate, violent or relatively calm,

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1 Robert Jervis, "Cooperation under the Security Dilemma", *World Politics* 30, no. 2 (1978): 167–214.

2 For instance, the Israeli-Syrian conflict over Lebanon during the 1970s–2000s, beyond their direct conflict. Eyal Zisser, "The Israeli-Syrian-Lebanese Triangle: The renewed Struggle over Lebanon", *Israel Affairs* 15, no. 4 (2009): 397–412; Hilde Henriksen Waage and Geir Bergersen Huse, "A Careful Minuet: The United States, Israel, Syria and the Lebanese Civil War, 1975–1976", *International History Review* 42, no. 5 (2020): 1081–1102; Zach Levey, "The United States, Israel and the 1976 Red Lines in Lebanon", *International History Review* 44, no. 4 (2022): 772–790; Simon Haddad, "The Christians of

short or long. Conflicts can also be on a single issue or multiple issues, one- or multi-dimensional, and as a rule, multi-layered conflicts are longer and harder to resolve. Usually, a protracted conflict would indicate that vital interests of the parties are at its heart. Resolving a conflict generally requires concessions and probably third-party assistance such as mediation or providing some form of compensation for the concessions one or more of the primary parties makes for a peaceful resolution of the conflict. But most important, resolving a conflict demands political will of the primary parties to do so. The longer the conflict exists, and the more it touches on vital interests of a party – security, economic, ideological, or other high-value interest – the harder it is to resolve the conflict peacefully.[3]

Conflicts can erupt over material matters such as territory or resources, or over non-tangible matters such as ideology, religion or emotions. The non-tangible issues could be the hardest to compensate for.[4] But conflict can also erupt as a result of environmental sources, such as pollution that severely harms one party, particularly if this pollution could have been prevented and its source is either human error or a deliberate action. Natural environmental challenges are harder to blame on someone, thus a conflict could erupt, but it would be less politically motivated, therefore potentially it could be easier to resolve with other regional players.[5] The key reason for this is that the environment does not recognize international borders, therefore any environmental challenge is potentially trans-national, and cooperation is not only reasonable but likely, even necessary.

Cooperation is a situation in which two or more parties work together on one issue or multiple issues. It can be done to promote their common interests or

Lebanon in the Context of a Syrian-Israeli Political Relations", *Journal of Social, Political, and Economic Studies* 26, no. 3 (2001): 589–624; Michael Kerr, "'A Positive Aspect to the Tragedy of Lebanon': The Convergence of US, Syrian and Israeli Interests at the Outset of Lebanon's Civil War", *Israel Affairs* 15, no. 4 (2009): 355–371.

3 Ho-Won Jeong, *Understanding Conflict and Conflict Analysis* (London: Sage, 2008); Edward E. Azar, Paul Jureidini and Ronald McLaurin, "Protracted Social Conflict: Theory and Practice in the Middle East", *Journal of Palestine Studies* 8, no. 1 (1978): 41–60; Jacob Bercovitch, *Social Conflicts and Third Parties: Strategies of Conflict* Resolution (New York: Routledge, 2019 [1984]); Charles-Philippe David and Jean-François Gagné, "Natural Resources: A Source of Conflict?" *International Journal* 62, no. 1 (2006/2007): 5–17.

4 Jonathan Leader Maynard, "Ideology and Armed Conflict", *Journal of Peace Research* 56, no. 5 (2019): 635–649. For various aspects of religion in conflicts see Jonathan Fox and Shmuel Sandler (eds.), *Religion in World Conflicts* (London: Routledge, 2006).

5 Nils Petter Gleditsch (ed.), *Conflict and the Environment* (Dordrecht: Springer, 1997).

resolve a mutual problem. Cooperation can be short-term or long-term, and could be done within a generally conflictual relationship. Cooperation can involve joint political action, or activation of military, police, firefighting or other relevant forces of the cooperating parties. But it can also involve division of labor, for instance if one party mobilizes its forces while the other party assists by other means, such as financially.

Cooperation could be based on long-term interests of the parties or on short-term or immediate needs, thus an ad hoc cooperation. It can be on a specific issue (like medical aid in a humanitarian crisis) or a variety of issues (such as medical aid, food supply, and aid for recovery well after the initial crisis ends), depending on the level of trust between the engaged parties or the need in the given situation. For instance, a natural disaster like an earthquake, flooding, or volcano eruption could mobilize countries to assist the tormented country with emergency aid on a humanitarian basis.[6] If such an event is rare, the cooperation could be ad hoc. But if the region is prone to experience such events quite often, the regional cooperation could be more habitual, even institutionalized.

A conflict can be managed or resolved, and in both cases, the level of cooperation can vary. Two parties can closely cooperate in order to manage but not resolve their conflict for any reason – for instance, the audience costs associated with the necessary concessions,[7] the leadership's ideological rejection of the concessions, or either side's anticipation to gain more in the future than at present – but they might as well loosely cooperate in the context of conflict management, assuming that they receive some degree of assistance from third parties. The point is that

6 Bimal Kanti Paul, *Disaster Relief Aid: Changes and Challenges* (Cham, Switzerland: Palgrave Macmillan, 2019); Ilan Kelman, *Disaster Diplomacy: How Disasters Affect Peace and Conflict* (New York: Routledge, 2012); Ilan Kelman, *Catastrophe and Conflict: Disaster Diplomacy and Its Foreign Policy Implications* (Leiden: Brill, 2016); Julia F. Irwin, "Disastrous Grand Strategy: US Humanitarian Assistance and Global Natural Catastrophe", in Elizabeth Borgwardt, Christopher McKnight Nichols, and Andrew Preston (eds.), *Rethinking American Grand Strategy* (New York: Oxford University Press, 2021), 366–383; Cathal O'Connor, "Foreign Humanitarian Assistance and Disaster-Relief Operations: Lessons Learned and Best Practices", *Naval War College Review* 65, no. 1 (2012): 152–160; David Capie, "The United States and Humanitarian Assistance and Disaster Relief (HADR) in East Asia: Connecting Coercive and Non-Coercive Uses of Military Power", *Journal of Strategic Studies* 38, no. 3 (2015): 309–331.

7 On audience cost see for instance Marc Trachtenberg, "Audience Costs: An Historical Analysis", *Security Studies* 21, no. 1 (2012): 3–42; Shuhei Kurizaki and Taehee Whang, "Detecting Audience Costs in International Disputes", *International Organization* 69, no. 3 (2015): 949–980.

conflict and cooperation can happen simultaneously and the degree of either conflict or cooperation could differ.[8]

Applying the global concepts to the regional level requires caution because some regions are more volatile than others – the Middle East being one of the most unstable in the world – thus regional dynamics are an important element to consider when discussing the dynamics of conflict and cooperation. Regions can be 'rough neighborhoods' in which conflict is custom, usually due to scarce resources and the lack of political resolution of border disputes or ideological conflicts, broadly defined. In such regions, there is a high level of sensitivity to unexpected occurrences, and almost anything can quite literally ignite a political firestorm. This reality can make the regional players develop mechanisms for monitoring and containing such events – particularly those caused by nature – to mitigate the concerns of the players. But this requires some degree of trust in other players, some of which could be rivals or enemies.

It is an axiom that in regions like the Middle East multilateral cooperation is nearly impossible due to the long-standing rivalries and lack of trust among most if not all regional players. But reality is more complex and nuanced. Many of the rivalries end up remaining in the rhetorical or political level – at the surface – while deeper interests of all sides prevent more serious confrontations from erupting. Moreover, there is plenty of evidence of tacit cooperation among Middle Eastern players, usually when vital interests are at risk, such as the security of the states that could be in peril from a common adversary.[9] This is the case in the Israel-Saudi Arabia relations that are warming in the recent ten to twenty years because of their mutual concern with Iran (and several additional issues over which they may have similar views), although they did not reach peace and

8 For theoretical discussions at the international level, see for instance Benjamin Miller, *When Opponents Cooperate: Great Power Conflict and Collaboration in World Politics, with a New Preface and Afterword* (Ann Arbor, MI: The University of Michigan Press, 2002); Charles L. Glaser, "Realists as Optimists: Cooperation as Self-Help", *Security Studies* 5, no. 3 (1996): 122–163.

9 See for instance Ian Black, *Just Below the Surface: Israel, the Arab Gulf States and the Limits of Cooperation* (London: LSE Middle East Centre, 2019); Uzi Rabi and Chelsi Mueller, "The Gulf Arab states and Israel since 1967: from 'no negotiation' to tacit cooperation", *British Journal of Middle Eastern Studies* 44, no. 4 (2017): 576–592; Yoel Guzansky, "Israel and the Arab Gulf States: From Tacit Cooperation to Reconciliation?" *Israel Affairs* 21, no. 1 (2015): 131–147.

normalization at the time of writing.[10] And since the early 1990s, there have been areas of regional cooperation that work well – most notable the Barcelona Process, renamed as Union for the Mediterranean – although admittedly, none of them are done exclusively by the regional parties. All involve external players such as the European Union, the United States, or the United Nations.[11]

Usually, regions are dominated by a regional power and could thus be quite benign, but there can also be two or more powers competing for regional dominance or hegemony, which ensures a political regional conflict as a permanent situation. Under these circumstances it becomes hard to cooperate at the regional level. Environmental or health issues like maritime pollution or pandemics are often trans-national and could be the exception in which cooperation is possible. Indeed, in recent years there is growing cooperation on non-political matters in the Middle East, particularly on environmental issues, for instance, a regional forum of ministers of environment.[12]

But not all regions are as volatile as the Middle East. There are peaceful regions like Europe, North America, or South America (all with noted exceptions to this peaceful exposition). In such regions, one could expect a high degree of cooperation in various fields. The existence of regional institutions or organizations like the European Union, Mercusor, Latin American Integration Association, and the United States-Mexico-Canada Agreement certainly hints to this. But there are cases where a challenge in such a region could in fact be hard to deal with. This is the case in Europe, where certain challenges like the refugee crisis could ignite conflicts because the regional institutions function well but only to a limit, while the challenge requires a much more extensive action.[13]

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10 Marta Furlan, "Israeli–Saudi Relations in a Changed and Changing Middle East: Growing Cooperation?" *Israel Journal of Foreign Affairs* 13, no. 2 (2019): 173–187; Jacob Abadi, "Saudi Arabia's rapprochement with Israel: the national security imperatives", *Middle Eastern Studies* 55, no. 3 (2019): 433–449; Jonathan Rynhold and Michal Yaari, "The transformation of Saudi-Israeli relations", *Israel Affairs* 26, no. 6 (2020): 799–818.

11 For instance, see Dalia Dassa Kaye, *Beyond the Handshake: Multilateral Cooperation in the Arab-Israeli Peace Process, 1991–1996* (New York: Columbia University Press, 2001).

12 In February 2022, Israel's then-minister of environmental protection Tamar Zandberg met with her colleagues at the initiative of Cyprus to coordinate climate change related actions in the Mediterranean. "Cyprus Government Initiative for Coordinating Climate Change Actions in the Eastern Mediterranean & Middle East", February 2, 2022.

13 Refugees from Africa, Syria and Ukraine, and previously from the disintegrating Yugoslavia, cause tensions that could spark into conflict among European countries. See Tiziana Caponio and Irene Ponzo (eds.), *Coping with Migrants and Refugees: Multilevel Governance across the EU* (Milton: Taylor and Francis, 2022); Jef Huysmans, "The European

After this brief conceptual discussion of the terms conflict, cooperation and their application to the regional level, we should consider the more specific context of this volume – environmental challenges in the Eastern Mediterranean. It is well established in research that the Eastern Mediterranean and the Middle East as a whole experience global warming and climate change at a higher rate than any other region. This is attributed to its unique natural characteristics, including large deserts and lower water levels. This means that it warms at a faster rate than other regions, which obviously has a more aggressive effect on the region's water and food supplies, leading to harsher living conditions. The region experiences more extreme weather events such as heatwaves, droughts, dust storms, and flash floodings following torrential rain.[14] This, in turn, makes the question of conflict and cooperation more acute and urgent in this region than elsewhere.

A key question is whether the environmental challenge originates in a long-term process like climate change or an immediate one like oil spillage that pollutes the sea and coasts of several countries. The answer to this question would suggest what type of cooperation (if any) would likely take place, or how severe would a conflict be. For instance, if there is a drought, how intense would the struggle over water in the region be.[15]

Climate change has been recognized by scholars and government officials as a national security concern,[16] although political attention to this concern, its magnitude, and urgency could vary, as occurred in the United States under the

Union and the Securitization of Migration", *Journal of Common Market Studies* 38, no. 5 (2000): 751–777; Philippe Fargues and Christine Fandrich, *The European Response to the Syrian Refugee Crisis: What Next?* MPC – Migration Policy Centre, Robert Schuman Centre for Advances Studies, European University Institute, 2012. There are arguments that flows of refugees are deliberately sent to Europe to destabilize it. On Ukrainian refugees in this role see Mark A. Grey, "Commentary: Ukraine's refugees are part of Putin's plan to destabilize Europe", *Channel News Asia*, May 29, 2022, and for Syrian refugees in this role see "Migrant Crisis: Russia and Syria 'weaponising' migration", *BBC*, March 2, 2016.

14 George Zittis et al., "Climate Change and Weather Extremes in the Eastern Mediterranean and Middle East", *Reviews of Geophysics* 60 (2022): e2021RG000762.

15 Marcus Dubois King (ed.), *Water and Conflict in the Middle East* (New York: Oxford University Press, 2020). An earlier analysis of water scarcity's role in Middle Eastern conflicts appears in Arnon Soffer, *Rivers of Fire: The Conflict over Water in the Middle East* (Lanham, MD: Littlefield Publishers, 1998).

16 Jeffrey Mazo, *Climate Conflict: How Global Warming Threatens Security and What to Do about it*, Adelphi Papers volume 49, issue 409 (2009), particularly chap. 5.

Obama and Biden administrations compared to the Trump administration.[17] Accepting that climate change has significant impact on a country's national security calls for some serious measures to prepare for the new reality and mitigate the consequences, as much as possible. The gradual but distinctive rising temperature will cause a rise of sea level in the coming years – sealing the fate of several island nations, such as Tuvalu and Kiribati – but is already changing the pattern of weather events, making them more extreme and intense, to a level that costs countries a fortune to recover from and could devastate regions. This could lead to direct and indirect security consequences. One of the greatest concerns is destabilizing countries due to effects of climate change and likely creating additional failed states that would become a serious source of concern for international peace and security.[18]

It is easier to cooperate in an environmental context than in a political context. The latter might bare ideological costs, while the former could much more easily be considered a natural disaster causing a humanitarian catastrophe, hence more manageable even if it could be more acutely severe than the latter type.

Another key question emerges from the history of conflict in the Middle East and its tendency to rapidly slip into conflict mode. The question would be whether

17 Marc Kodack, "Climate Change in U.S. National Security Strategies under Obama, Trump and Biden", *Center for Climate and Security*, March 23, 2021. The Department of Defense referred to climate change as a national security threat even under the Trump administration, in contrast to the White House position and policy. Alex Ward, "The Pentagon calls climate change a national security threat. Trump isn't listening", *Vox*, January 18, 2019. See also: Bathsheba Demuth, "Against the Tide: The Trump Administration and Climate Change," in Julian E. Zelizer (ed.), *The Presidency of Donald J. Trump: A First Historical Assessment* (Princeton, NJ: Princeton University Press, 2022), 181–197.

18 Mazo, *Climate Conflict*, chap. 4; Joshua W. Busby, *States and Nature: The Effects of Climate Change on Security* (Cambridge: Cambridge University Press, 2022); Joshua W. Busby, "Who Cares about the Weather? Climate Change and U.S. National Security", *Security Studies* 17, no. 3 (2008): 468–504; Maximilian Mayer, "Chaotic Climate Change and Security", *International Political Sociology* 6, no. 2 (2012): 165–185; Mark G. Stewart, "Climate Change and National Security: Balancing the Costs and Benefits", in Christopher A. Preble and John Mueller (eds.), *A Dangerous World? Threat Perception and U.S. National Security* (Washington, DC: CATO Institute, 2014); Ole Magnus Theisen, Helge Holtermann, and Halvard Buhaug, "Climate Wars? Assessing the Claim That Drought Breeds Conflict", *International Security* 36, no. 3 (2011–12): 79–106; Nina von Uexkull and Halvard Buhang, "Security Implications of Climate Change: A Decade of Scientific Progress", *Journal of Peace Research* 58, no. 1 (2021): 3–17; Marc Levy, "Is the Environment a National Security Issue?" *International Security* 20, no. 2 (1995): 35–62.

Middle Eastern countries can cooperate at all when facing a common challenge or is a third party necessary for any cooperation to take place. Assuming that the challenge is environmental, there is a good chance that there would be willingness to cooperate, at least ad hoc, to deal with the issue. A caveat could be that the countries don't have the means to face the challenge effectively, therefore they would need to ask for a third party's assistance.

Conflicts are common between two or more neighboring countries anywhere. Environmental events could make things worse by intensifying a conflict or starting one, if it makes the situation worse for one party (or more) – for instance by floodings, pollution, etc. Things could deteriorate even further if a tormented country suspects that its neighbors are responsible to its devastation in any way or that they might take advantage of the circumstances and physically turn against it. In a volatile region like the Middle East, such thoughts are not uncommon and many times, rightfully so.

Offers to cooperate in such a region under such circumstances could seem suspicious, for instance if one country offers its rival humanitarian assistance during a devastating environmental catastrophe. This happened more than once in the Middle East when Israel offered help to neighboring countries only to be rejected for either the mere appearances of getting help from Israel or due to suspicion of Israel's intentions.[19]

However, even in a normally hostile region, rivals can assist one another. For instance, in 2010 during the devastating Mount Carmel Forest Fire in Israel, Palestinian firefighters assisted their Israeli counterparts.[20] This repeated in other fires in the Jerusalem Mountains in recent years as well.[21] Later on, this led to Israeli-Palestinian joint firefighting drills.[22] One could speculate that such events in the small territory of Israel and the Palestinian Authority make it mutually beneficial to assist one another to control the given fire and end it

19 For instance, Israel's former Defense Minister Benny Gantz revealed in February 2022 that Israel offered aid to Lebanon's military amid the ongoing crisis in Lebanon but was declined. Amy Spiro, "Gantz: Israel offered aid to Lebanese military four times in past year", *Times of Israel*, February 2, 2022.

20 Hassan Shaalan, "Palestinian firefighters help battle Carmel blaze", *Ynetnews*, December 5, 2010.

21 Aaron Boxerman, "Palestinian Firefighters Help Israel Battle Jerusalem-area Blazes", *Times of Israel*, August 17, 2021.

22 Zachary Keyser, "Israeli and Palestinian firefighters practice saving lives together", *Jerusalem Post*, November 6, 2019.

quickly. Thus, there's a strong incentive to cooperate – and no less important – for both sides to welcome the offer of help. And again, assuming that the event is indeed environmental, it is easier to cooperate compared to an event that could be political in nature. A similar dynamic can be seen with pandemics, such as the Israeli–Palestinian cooperation during the COVID-19 pandemic,[23] as well as with humanitarian crises, such as Israel's medical help to Syrian citizens (and also quite a few anti-regime fighters) wounded during the Syrian civil war (since 2011).[24] These examples provide a glimmer of hope that there are issues that could be dealt with in a cooperative manner even if the broad pattern of the relations in the region is conflictual. The question is to what extent such cooperation could rekindle a political process toward conflict resolution and peace. But this is beyond the mandate of this volume.

In conclusion, conflict and cooperation can occur simultaneously, and could have both positive and negative effects on the relations in a given region. Environmental challenges have a better potential to ignite some level of cooperation even among fierce rivals and bitter enemies than a challenge that is political in nature. In the Middle East and specifically in the Eastern Mediterranean basin, there are quite a few countries with conflicting interests, rivalries, and concerns, which all boil down to a low level of mutual trust that is essential for cooperation. Nevertheless, some of these conflicting interests can in fact create mutual interests, such as the need to protect the natural gas fields and the rigs from terrorism on the one hand and environmental problems like pollution on the other hand. Any such challenge could project negatively on the perceived stability of the region, thus affect the energy trade for all parties. Hence, this would give them a strong incentive to cooperate. Israel, Egypt, Cyprus, Turkey, Greece, and perhaps in the

23 Lior Lehrs, "Conflict and Cooperation in the Age of COVID-19: The Israeli-Palestinian Case", *International Affairs* 97, no. 6 (2021): 1843–1862. For a broader discussion of conflict and cooperation amid the COVID-19 pandemic see Hal Brands and Francis J. Gavin, eds., *COVID-19 and World Order: The Future of Conflict, Competition, and Cooperation* (Baltimore, MD: Johns Hopkins University Press, 2020).

24 Nir Boms, "Israel's Policy on the Syrian Civil War: Risks and Opportunities", *Israel Journal of Foreign Affairs* 11, no. 3 (2017): 323–336; Nir Boms and Stéphane Cohen, "Israel and Syria: A Decade of War, 2011–2021", *Israel Journal of Foreign Affairs* 16, no. 1 (2022): 31–51; Itamar Rabinovich and Carmit Valensi, *Syrian Requiem: The Civil War and Its Aftermath* (Princeton, NJ: Princeton University Press, 2021), 141; Eyal Zisser, "'Operation Good Neighbor' – Israel and the Rise and Fall of the 'Southern Syria Region' (SSR)", *Israel Studies* 26, no. 1 (2021): 1–23. See also Anthony Luder, "Treating the Enemy: Victims of the Syrian Civil War in Israel", in Maigul Nugmanova, Heimo Mikkola, Alexander Rozanov and Valentina Komleva (eds.), *Education, Human Rights and Peace in Sustainable Development* (London: IntechOpen, 2020), 10.5772/intechopen.87936.

future Lebanon and others could cooperate for the sake of their prosperous natural gas industries. The same logic can also be applied to the Mediterranean coasts of the countries in this basin which attract tourism and other sea related leisure activities that represent a significant share of these countries' income. Hence, there are plenty of incentives for Eastern Mediterranean countries to cooperate on environmental issues, despite their conflicts and disputes.

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ENVIRONMENTAL CHALLENGES AND POLITICAL CONFLICTS IN SYRIA AND THE EAST MED

Oğuzhan Akyener, Fatih Temiz, Levent Kenar, Abdullah Altun

Environmental challenges trigger regional conflicts, but also regional conflicts trigger environmental problems. They may even have a multiplier effect on each other in some cases. The only way to achieve successful results in conflict situations is effective and efficient regional cooperation. From this point of view, we focus on very significant fields which may deepen the environmental challenges and regional conflicts nexuses in the East Mediterranean, such as the negative environmental impacts of the political conflicts in Syria, the bilateral relationship between the immigration and the environmental challenges, the threats of the illegal oil sales on the regional peace and the environment in the Mediterranean, and the partly ignored but very significant issue of Chemical, Biological, Radiological and Nuclear (CBRN) agents.

Negative Environmental Impacts of the Political Conflicts in Syria and the Eastern Mediterranean Region

Looking back at the year 2011, before the conflict's start, the Arab Republic of Syria produced around 400,000 barrels of crude oil daily – naphtha, jet kerosene, diesel fuel, and fuel oil were produced in the country. The Deir ez-Zor and Hasakah fields produced oil and the Hama fields produced natural gas. Homs and Baniyas were the destinations of crude hydrocarbons to be refined (Zwijnenburg, 2019). Then, as the domestic struggle intensified, extensive attacks against hydrocarbon facilities took place across Syria. Infrastructure was destroyed in cities and towns, resulting in a massive amount of rubble, as shown in Figure 1. Industrial areas also took their share of the damage. All these events put Syria years back from what she was.

Afterward, the mass exodus of Syrians gave the burden of environmental stress to the neighboring countries of the war-torn state. The Syrian War cannot exclude the effects of global climate change and the heavy problems it brings to the area. The long-lasting drought in the Eastern Mediterranean gave birth to its own socio-economic consequences accelerated by the wrong environmental and agricultural policies of the Syrian government. For instance, people were leaving their villages to seek wealthier lives in the cities. Then, the drought that stretched between 2006 and 2010 led to the rebellion of 2011 which then caused dire immigrations, skirmishes and terrorist acts (Ülker et al., 2018). Nevertheless, citing these environmental causes does not turn a blind eye on the matters that lasted for many generations, of course. The Levant collects many languages,

religions and sects; the water scarcity and the political instability do not help any stabilization attempts in the region.

Figure 1: Syrian cities in rubbles (UN Habitat, July 2022)

Climate Change in Syria

Initially, meteorological and maritime registers demonstrate that droughts became more frequent, temperature of the sea surface rose, evaporation rate and temperatures augmented, and winter precipitation declined in the coastal Levant area. These climatic events are serious for the current and future generations. Population growth and lack of management put further stress on the bodies of water, also cause environmental worsening (Gleick, 2014).

Throughout the ages in the Middle East, it is a historically known phenomenon that the available water is scarce. To reduce the future consequences of this, an effective water management strategy is essential, of course not only for Syria but for all the nations in the area. As Syrians flee their homeland, their vacuum causes other water related problems. Also, where Syrians relocate abroad the influx of new people bring further stress to the water resources in the new abodes.

When the whole struggle is over and Syrian refugees once again populate their own country a keen water policy needs to be implemented. This new policy will need to focus on the growing population, climate change, altered precipitation routines, a renewed approach to farming, and animal husbandry. Once the limited resource of water is put into an upright use in a canny way the stability of the region will become more powerful. Sustainable water management for

above ground and underground waters is indispensable. Irrigation of fields will need to be done in a scientifically modern and efficient method. Choice of crops to be grown must be reviewed for the best possible outcomes both for financial and water-concerned paths. Water regulations should be implemented (Gleick, 2014).

The drought caused crop failures and the people in the country could not support themselves anymore, and thousands of farmers left their land to seek a better life in urban areas. Almost 90% of water was used in agriculture. Water overuse caused salinization of soil. About 75% of the farmers lost all of their crop that caused 800,000 farmers to lose their source of revenue. This resulted in one million people to be left in food scarcity. The displaced farmers flocked to the cities raising unemployment rates and poverty even further. Moving people diverted the water problems from one area to new ones bringing more stress to their new destinations (Ibrahim and Novotny, 2018).

The graphs below (Figures 2 and 3) show the aftermath of droughts and civil war: a famine. Syria is one of the countries that experience calamitous food insecurities. Half of the households in the country suffer from food shortages. Most of the top 10 countries listed below faced or are still living through civil unrest and internal struggles.

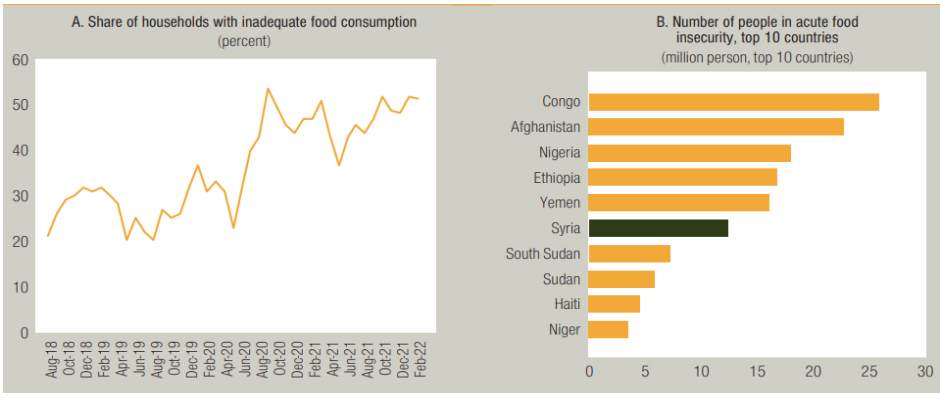

Figure 2: Food Insecurity in Syria (Syria Economic Monitor, Spring 2022)

The conflicts also broke the population structure. Now the male-to-female ratio has skewed. This will surely cause further problems in the next generation when they come to age to form families, and work force will need to adapt to an uneven gender distribution.

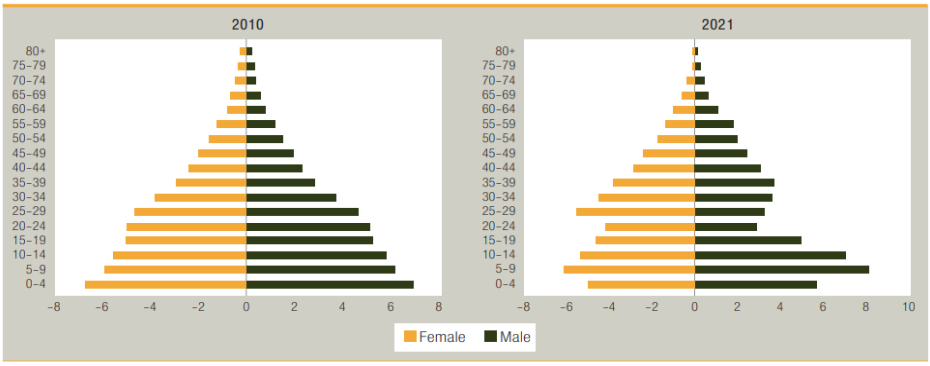

Figure 3: Syria Population Pyramid, 2010 and 2021, millions per age group (Syria Economic Monitor, Spring 2022)

The water supply and water treatment infrastructures in Syria are outdated. With the internal struggles, the facilities became run down, insufficient and damaged. Groundwater has been excessively used for irrigation, effects of climate change are faced as desertification, and pollution in response to failed infrastructure, and lack of sanitation due to scarce water are some major water-related problems. The failure of infrastructure (impaired or demolished) halts storage, treatment, distribution, and disposal of water. There is much stress on the aquifers due to overuse, as urban water pipes ceased to work. The UN-Habitat Thematic Paper on Environment and Climate Resilience summarized the problem as "Droughts, less rain and higher temperatures leading to increasing water scarcity, land degradation, desertification, and forest fires are some of the stressors that impact both rural and urban Syria with accelerating effects." It is also worth noting that the damages to the dams in the country are in the range of billions of US dollars (UN Habitat, July 2022).

Migration is possible when it is available as well. The graphs below (Figure 4) display immigration rates changing as the temperature varies. The poorer portion of the world cannot access means of transportation (just like people in Yemen or Somalia) and necessary means to immigrate to safer countries. Whereas, citizens of middle-income countries have a higher chance of making their way to their destination. People often immigrate to countries within 1,000 km from where they currently live (Cattaneo, 2015). The infographics explain why Syrian refugees take shelter in Jordan, Lebanon, and Türkiye; also, it is important to know that the wealthier class of Syrians took refuge in more distant countries.

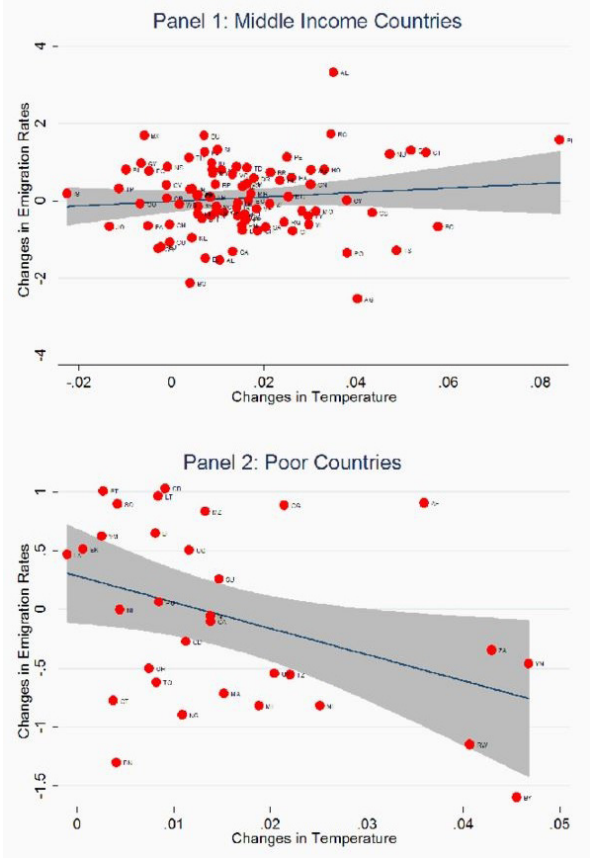

Figure 4: Changes in emigration rates versus changes in temperature (Cattaneo, 2015)

As a result, the Syrian exodus to neighboring countries and Europe took place. According to the Republic of Türkiye Ministry of Interior Directorate General of Migration Management, approximately 3.6 million Syrians live in Türkiye (goc.gov.tr, 2022).

Current Pollution in Syria

The failed infrastructure and all the debris in the near-demolished Syrian cities are the offspring of the current struggle. This conflict causes pollution in the area and the residents suffer from this havoc. Hazardous chemicals, crude oil and other forms of hydrocarbon are spilled and scattered throughout the conflicted areas. Sewers and water structures are hit, and people cannot easily reach safe drinking water. Basic sanitation is at risk. Houses are bombed and many are left

homeless in addition to millions of tons of debris all around the country. Human waste, household waste, hospital waste, and industrial waste accumulate at the moment since the infrastructure has totally collapsed. Diseases have emerged. Pollutants harm the people living nearby the contaminated areas. When the exodus ends and people of Syria return to their homes this contamination above and under the ground will harm them (Pax for Peace Report, 4.11.2015). A ceasefire will be a new beginning; however, there will be many problems awaiting resolving.

The deteriorating economy, ripples of the so-called Arab Spring, long-lasting droughts, and availability and easiness to access to fresh waters can be put into the roster of causes of the Syrian crisis. Noting that, the climate conditions took a key part in the worsening of the economy in the country (Gleick, 2014). Yet, it is not possible to reduce the causes to one single entry.

Uncontrollably and hastily urbanizing Syria faced new environmental challenges. The shortage of potable water is the main problem. Municipal waste grew. Garbage collection became problematic. Lack of properly working sewage systems brought another problem: discharge of human waste to the environment. Sanitary and environmental hygiene deteriorated (Ibrahim and Novotny, 2018). The collapsed municipal services gave a scene as it can be seen in the photo below (Figure 5). The garbage is piling up and there is no reason why it would not give birth to communicable diseases. Leakages from these piles pollute all components of the environment. Medical wastes are also found in these wild garbage areas. Lack of sanitation causes loss of citizens.

Figure 5: Garbage in the streets of Aleppo (Pax for Peace Report, October 2015)

People started refining their own oil products from crude oil. The makeshift structures pollute their surroundings. Those primitive refineries harm the people working in them and all the people living around the facilities. Air, water, and soil are all in danger of this form of pollution (Figure 6).

Figure 6: Make shift oil refining in Syria (Hamlo, 2016)

In a study on makeshift refineries, it was found that more than 300 groups of such facilities hosted thousands of primitive setups. As people learned how to operate these installations, the number grew exponentially. Of course, health, safety, and environment concerns are not sought for. Exploding machinery and barrels harm the health and quality of life of the workers and residents nearby. Even children were employed in these facilities as a cheap labor source. When the workers confessed, they earned around $15 per-day and they also added that they were aware that what they did was carcinogenic. Benzene, carbon monoxide, carbon dioxide, hydrogen sulfide polycyclic aromatic hydrocarbons, sulfuric acid, toluene, xylenes are among the hazardous and poisonous compounds that are formed in the refining processes (Zwijnenburg, 2020).

One of the many direct attacks on the infrastructure is caught by satellite images. The Baniyas oil terminal was struck by an underwater sabotage, according to news reports. The pipelines were the target. There is little information about the incident, nevertheless, satellite images show a clear pollution in the Mediterranean Sea (Zwijnenburg, 2019, Figure 7).

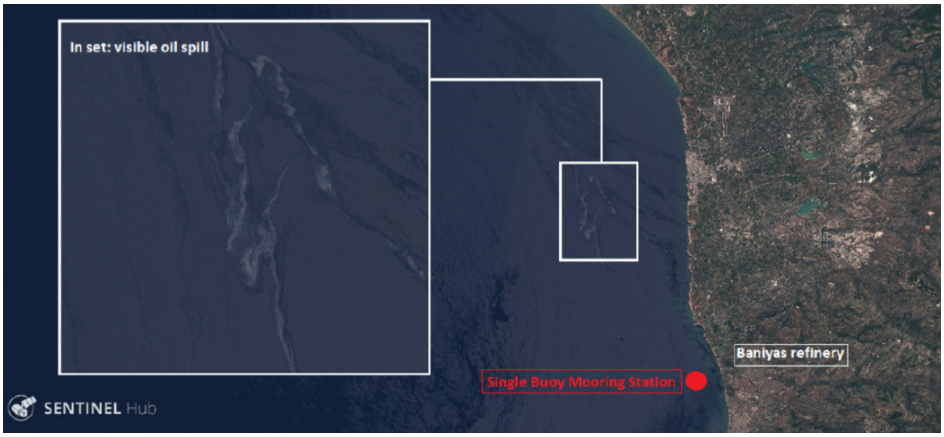

Figure 7: Oil spill in June 2019 off the coast of Syria (Zwijnenburg, 2019)

The image below (Figure 8) shows the aftermath of the attacks to the refinery in Homs. All hydrocarbon structures are key elements and strategic holdings of the power controlling the area. The Syrian regime, armed groups, the US-led coalition, and the Russian Air Force all took part in attacks on pipelines, refineries and other strategic locations.

Figure 8: Attacks to oil structures in Homs in February 2012 (Zwijnenburg, 2019)

Furthermore, there are various sources for the usage of weapons in Syria. Remnants of all the missiles, bombs, shells, bullets and other varieties of weapons and ammunition can be found all around the country. People scavenge these leftovers to find anything that can be used or sold for money; these people are in direct contact with whatever is used during the conflict. In addition, these people carry the agents they acquired from the leftovers of the war. The soil, underground waters, above ground water bodies, and the air all took their shares from the pollution generated by the war. The next generations will see the aftermath of these contaminations in their water, in their food, in their livelihoods, and in their very own bodies.

Illegal Oil Sales Threatens Regional Peace and the Environment

Increasing unrest on a regional and global scale causes many disruptions and alternative routes in international value chains. New threats continue to exist for the Eastern Mediterranean and related regions, which have been the scene of many wars, military coups, uprisings, terrorist attacks and conflicts since the early 1900s. When we focus on today, ongoing civil war in Syria, expansionist policy of Iran through the militia organizations (also known as the Shiite crescent), conflict in the island of Cyprus and the illegal structures that have emerged due to the instability in many countries (where the state authority is weak) continue to obstruct the regional peace and possible integrated breakthroughs.

While the conflicts may deepen the polarization (depending on their sociopolitical background), increasing risks may also cause some countries to get closer by putting their problems aside. In addition, while we can observe such a complex picture in the Eastern Mediterranean and related regions, the US-China tension, the Russia-Ukraine war, and the hardening sanctions packages negatively affected the due regional balances as well as the entire international system. The capacity of international struggle against terrorism and the illegal structures has naturally decreased. With the altering value chains, informal trade has been on the rise. While the energy crisis shook the whole world, the illegal trade process, which can be described as black oil, gained momentum.

Unfortunately, the ongoing instability and civil war in Syria paved the way for an illegal trade and unregistered sales system led by terrorist organizations (especially in the oil sector) since the very beginning. For instance, ISIS used to produce around 50,000 barrels per day (bbld) within its occupied areas in the region (Steve Raabe, 2014).

Currently, according to TESPAM's (local - technical Syrian) connections in the Deir ez-Zor and Hasakah provinces, the illegal oil production and sales, which started with ISIS (in these provinces), has reached volumes exceeding 150,000 bbld (barrels per day) under the control of Partiya Yekitiya Demokrat (PYD). Approximately 90,000 barrels of this volume are obtained from the fields in Hasaka province, and the remaining 60,000 barrels are obtained from the fields in the Deir ez-Zor region. All of the oil produced in the province of Hasakah is sold to buyers in Kurdistan Regional Government (KRG), at around $25 (per barrel) below market prices. This portion is legalized through the existing producing oil fields in KRG (usually by changing the production rates), then shipped to the international markets. A part of the production in the Deir ez-Zor region is again sent to the KRG. Some other portion is sold to the Assad administration (and processed within low technology mobile refineries) and usually this volume is exchanged for needs (such as medicine, equipment, oil products etc.). A significant portion is legalized in Basra and then through a similar process in KRG sales, legalized and then exported (*TESPAM's Technical Connections in Deir ez-Zor and Hasakah*, 2022).

The due oil fields in Deir ez-Zor and Hasakah provinces can be seen in the map below with green colors (Figure 9).

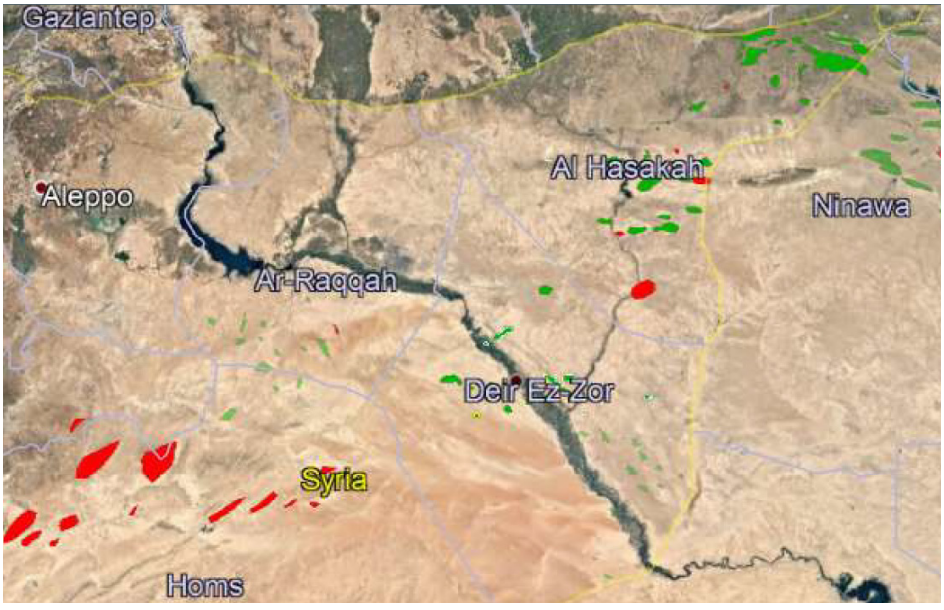

Figure 9: Oil and Gas Fields in Deir ez-Zor and Hasakah Provinces of Syria (Akyener, 2018)

When the relevant unregistered trade volume is calculated within today's figures, it reaches an economic volume of over $10 million per day.

Although this trade process is negligible, while considering the current volumes of the international black oil market, it is an important threat in terms of ensuring regional stability and preventing the financing of terrorism.

In addition, in this context, oil that is produced, shipped, stored and sold under very primitive conditions naturally has to be operated by causing great damage to the environment at every step in this context. In many producing fields, at rates up to 8% (of the total production) is estimated to be lost as leakages. This situation poses a great risk in terms of environmental safety. Moreover, it is estimated that since the Syrian civil war began, soil pollution has increased by 800% and water pollution has increased by 300% (due to oil spills) in areas where oil is produced, stored and transported (*TESPAM's Technical Connections in Deir ez-Zor and Hasakah*, 2022).

On the other hand, methane gas produced together with oil is naturally directly burned in some of those oil-producing fields. This can be accepted as another factor that increases the carbon emissions.

Possible Environmental Challenges Triggered Immigration in the Region

The possible role of the climate change in triggering migration has been discussed for decades (Hugo 1996 & Helbling and Meierrieks 2021). In fact, there are two main strands of the literature in analyzing the relationship between climate change and immigration: the impact of environmental challenges on immigration (Helbling and Meierrieks 2021) and the impact of immigration on the environment (Price and Feldmeyer 2012 & Ma 2020). To illustrate the seriousness of the issue, 26.4 million people around the world have been displaced annually as a result of the environmental challenges and the number of the climate migrants will rise to 1 billion until 2050 (The Lancet 2020).

According to Climate Change Vulnerability Index for the years between 2018 and 2035, the most vulnerable countries to climate change are African and Asian (Verisk Maplecroft, 2022). More specifically MENA countries, our neighbor countries are considerably vulnerable to climate change especially due to extremely high temperatures, scarcity of the groundwater and rainfall and scarcity in agricultural and arable land (Borghesi and Ticci 2020). Another important point is that the climate change-driven immigration is mainly a low-

skilled migration since different education levels (which may be associated with different income levels) do not have the same vulnerability levels to difficult environmental conditions (Helbling and Meierrieks 2021).

The crises of available and possible food and energy are also very big threats to the environment vulnerable populations in the region. Multilateralism and international trade enable water and food scarce regions to access required foods and other goods. Especially the role of the efforts such as the Black Sea Grain Initiative, (2022) brokered by Türkiye, in terms of reducing pressure on the environmental vulnerable populations is of great significance.

The host countries of possible migrations are vulnerable to various problems such as the provision of accommodation and food, security, health, education and arising cultural and social issues. To deal with these difficulties immigration host countries will have to undertake huge burdens.

An Overview on Recent CBRN Threat

CBRN weapons are chemical, biological, radiological and nuclear agents used in both military operations and terrorist activities in order to kill and injure the living populations and dysfunction the organisms. These are indirectly forwarding the military forces to the untargeted directions. Chemical, Biological, Radiological and Nuclear agents can possess some hazardous effects which can be categorized as follows:

- Chemical threat: These substances which include military chemical warfare agents, toxic industrial chemicals and household chemicals may cause poisoning or injury.
- Biological: Illnesses that are caused by a deliberate release of a hazardous bacteria, viruses, a biological toxin or even a genetically modified microorganism.
- Radiological: Illness caused by exposure to harmful radioactive materials.
- Nuclear: Extreme life-threatening health effects that are caused by exposure to harmful radiation, thermal, or blast arising from a nuclear deployment.

The threat of terrorism is a potentially dangerous crisis for large populations. The development and use of CBRN weapons has proven a lethal threat that one must be prepared for in advance. The full extent of the potential CBRN threats cannot be estimated since they can appear in unanticipated routes depending on a number of external factors. The unpredictability and uncertainty of these

threats can create a challenge in preparing for a possible CBRN threat. Also, before a CBRN threat occurs, there are no warnings that are initiated prior to the threat being realized, so being alert of potential indicators that may appear is critical. Indicators can appear suddenly and seem out of place such as powders, liquids, or strange smells.

Some general indicators of a chemical attack are:

- Unusual numbers of patients with very similar symptoms seeking care virtually simultaneously (especially with respiratory, ocular, cutaneous or neurological symptoms, e.g., nausea, headache, eye pain or irritation, disorientation, difficulty with breathing, convulsions and even sudden death)
- Clusters of patients arriving from a single locality
- Definite pattern of symptoms clearly evident
- Existence of sick or dying animals
- Devices, unusual liquid spray or vapor (suspicious devices or packages, droplets, oily film, unexplained odor, low clouds, or fog unrelated to weather)

Potential indicators of a bioterror/bioweapon attack:

- A highly unusual event with large numbers of casualties
- Higher morbidity or mortality than is expected
- Unnatural spread of a disease outbreak which is uncommon for a certain geographical area
- Multiple epidemics or multiple perpetrators that could release single or multiple agents at different locations
- Lower attack rates in protected individuals which have some type of respiratory protection, such as mission-oriented protective posture gear or high-efficiency particulate air-filtered masks (indicates that a biological agent has been released via aerosol)
- Dead animals (because many biological agents that could be used for BW/BT are zoonoses, which indicate a biological agent release that may also infect humans)
- Unusual disease manifestation (For example, more than 95% of worldwide anthrax cases are cutaneous illness. Therefore, a single case of inhalational anthrax should be considered highly suspicious for BW/BT until proven otherwise).

Some indicators of a radiological dispersal device/radio-nuclear agent attack include:

- Thefts, transactions or seizures of radioactive materials from related companies, organizations or laboratories
- Inappropriate inquiries regarding radiological material usage, storage or transportation
- Tampering with facilities that store radioactive materials or radioactive wastes
- Multiple, unexplained human or animal radiation burns or radiation sickness.

It is a fact confirmed by various sources that there are neighboring countries and terrorist groups which possess the CBRN weapons and have the potential to use them at any time in this region. Although prohibited by international conventions, these elements continue their efforts to improve their existing facilities and capabilities in the means of producing CBRN weapons. It is understood that these efforts pose a potential threat to the region. Furthermore, the possibility that these weapons can be used by terrorist groups on the civilian population is another fact that should always be considered. In the face of such possible mass-casualty chemical incidents, it is essential to put forward the necessary measures and activities against such attacks throughout the region. This requires giving high priority to the establishment of a Multinational CBRN Defense System (focused on our region) and its implementation when necessary. Just an example to the seriousness of the issue, chemical weapons have been used in Syria and at least 15,000 Syrians have suffered from exposure to chemical agents since the beginning of the conflict. Attacks using chemical weapons have been taking place in Syria since 2012. As of April 2018, official reports put the number of chemical attacks at 163. Some intelligence analyses reported that Syria had an important chemical weapon capability, which included blister agents, like sulfur mustard, and nerve agents, like sarin and Vx.

Conclusion

Climate and shifts in climatic conditions shaped history in many cases causing conflicts, migrations, battles, and chaos. In the case of Syria, weapons were introduced into the clash. Farming communities flocked into the cities when their crops failed. Additionally, they could not make a living from animal husbandry. These failures in return bring a vacuum effect when a huge population leaves their abode and their former society. The failed state in Somalia saw a “Balkanization” period and many pirating activities in her coastal waters after

years of drought. Sudan frequently suffers from harsh droughts which give birth to further instability in the area and in 2011, a new country was carved from it, South Sudan, which also had her own civil war between 2013 and 2020. Syria is an addition to list of examples.

There is a diversion between scientists whether global climate change actually causes armed struggles (Ülker et al., 2018). Yet, it is obvious that global climate change contributes to the building up of the problem. The de facto internal fragmentation of the State of Syria generated a vacuum which notorious groups wanted to fill. Terrorist attacks on civilians and military personnel at home and across the borders continued.

Resettling Syrian refugees would not only require new houses. There is much more to be done. Sanitary infrastructure needs to be rebuilt; it is also essential that the contamination from years-long pollution is treated.

Water mismanagement which caused an economic drawback that then turned into internal migration and an international crisis has its roots in global climate change and anthropogenic causes. Food shortages followed. Unemployment grew. These all added up to a political havoc. Climate simulations foresee a worse scenario arriving in the coming decades, and alarmingly, locally and internationally water management issues should be prioritized and measures should be brought into global agenda as soon as possible to avoid recurring failures and human tragedies (Gleick, 2014).

All in all, after eliminating the internal struggle in Syria and getting rid of all the separatist and terrorist groups, the people of Syria need to rebuild their country. New and improved infrastructure is essential. An effective water management policy and a sustainable approach to all natural resources are essential. All these require huge efforts of collaboration by neighboring countries. A wealthier and peaceful Syria will see a prosperous future as long as the people living in Syria are nonviolent toward each other and the neighboring states.

As to illegal oil sales, the volume of such sales continues to rise in Syria. Unfortunately, this situation helps financing the regional instability and terrorism and also comprehends a huge risk for the environment. In this context, it would be appropriate for Turkey and Israel, which have started a normalization process again, to put forward common goals and practices for the solution of regional problems within the framework of a common macro policy (regardless of the effects of government changes).

While dealing with the current migration problem in the region, the seriousness and the future possible burden of the climate change triggered migration may not be perceived effectively. Two collaborative steps must be taken before it is too late: (1) the detailed simulations of the possible climate change impacts in the region and their various impacts including immigration, and (2) the actions plan towards reduce these negative impacts and solve possible inevitable problems.

As to CBRN, this issue is also not considered enough. However, current realities require us to take urgent actions. Healthcare providers and first responders must be prepared to recognize military or civilian casualties of CBRN warfare or terrorism. They must be able to clearly recognize agent-exposure symptoms against a varying background of typical injury and CBRN exposure stress behaviors and must also be informed, to the fullest extent possible, about anticipated CBRN attacks by hostile forces or terrorist activities. This intelligence requires consideration of an adversary's political factors and motivation, CBRN agent or any related substances possession or access, CBRN warfare offensive and defensive capabilities, and any strategic advantage to be realized through agent use. As a healthcare provider or first responder manages individuals suspected to have been exposed to chemical warfare agents, initial recognition of the type of agent used may be facilitated through an understanding of tactics, modes of agent dissemination, likely routes of casualty exposure, physical agent properties, and other factors determining the persistence of these toxicants in the environment.

To sum up, the world is in a very big transformation process after the 1990s in a way that conflicts and wars affect all dimensions from development to energy, from global value chains (GVCs) to consumption patterns. This situation prevents the global community from focusing on environmental and emission issues. With this awareness, the whole world should focus on its long-term future by pushing aside the existing conflicts. While the northern world (Europe) is experiencing a war (Russia-Ukraine war) without a winner, it is very important for the East Med to commence a more comprehensive and integrated cooperation as soon as possible.

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SEAVIEWS TRANSNATIONAL REPOSITORY NETWORK: A SECTOR ADAPTIVE VIRTUAL EARLY WARNING SYSTEM FOR MARINE POLLUTION IN THE ADRIATIC-IONIAN SEA

Eirini Asimina Stamatopoulou, Nikolaos P. Ventikos, Emmanouil Nikolaidis, Stavroula Delenta, Dimitrios Drivas

One of the major concerns about marine environment and coastal areas is the prevention of diffusion of marine pollution caused by several pollutants such as marine litter as well as effluents, oil pollution and eutrophication. This challenge applies to all seas but especially applies in closed or semi-closed seas like the Mediterranean Sea while a special concern has been increasingly highlighted at the macro-regional level during the last decade. The European Union (EU) has set up the baseline for the development of a macro-regional strategy for the Mediterranean Sea basin that could jointly tackle the barriers towards the green and digital transition, as well as climate change, environmental deterioration, the proliferation of extreme weather events, water scarcity, loss of biodiversity and food security. In that context, SEAVIEWS Project has been established as a transnational repository network of sensors monitoring the water quality. This chapter presents the environmental issues that arise in the selected area, the selection where the measurements are taking place, as well as the reference values for each of the monitored parameters.

Key words: Marine pollution; water quality; big data analytics; real-time data; multiparameter sensors.

One of the major concerns about marine environment and coastal areas is the prevention of diffusion of marine pollution caused by several pollutants such as marine litter as well as effluents, oil pollution and eutrophication. This challenge applies to all seas but especially to closed or semi-closed seas like the Mediterranean Sea. Mediterranean countries share a common historical and cultural heritage. Currently there are disparities in economic prosperity, environmental awareness as well as societal stability and security. Thus, an increasing concern about those challenges is highlighted at the macro-regional level and is expressed by regional policies and initiatives aiming at reduction of environmental risks and mitigation of the consequences caused by marine pollution and climate change. In parallel, the Mediterranean Sea:

- accounts a significant value for the neighboring countries. According to the European Commission, Mediterranean Sea blue growth value is considered about 32,552 million euros (European Commission, Infographics - Blue Growth - Maritime Affairs);

- is especially affected by the consequences of climate change (extreme heat waves, forest fires, floods). Researchers estimate that it is warming at a rate 20% higher than global average (European Commission)
- Represents 50% of the global water-poor population

The European Union (EU) has set up the baseline for the development of a macro-regional strategy for the Mediterranean Sea basin that could jointly tackle the barriers toward the green and digital transition, as well as climate change, environmental deterioration, the proliferation of extreme weather events, water scarcity, loss of biodiversity and food security. (Regions and cities call for a macro-regional strategy for the Mediterranean (europa.eu)) Profoundly, those challenges cannot be addressed only at the national level as they represent threats for all three shores of the Mediterranean, north, east and south. Thus, action is needed at the regional level. Therefore, the European Committee strategically supports joint projects addressing the aforementioned challenges in a macro-regional perspective, aiming to bring greater coherence between the initiatives implemented by different government levels.

Therefore, the European Committee has identified four macro-regional strategies that cover similar thematic areas including connectivity, environment, prosperity, and cross-cutting areas, such as climate change, spatial planning and good governance. However, there are differences between the thematic areas (each one emphasizes specific challenges) as a result of the available resources according to the different needs and potentials of the different regions. Figure 1 shows the four thematic areas as well as the participating countries.

Apart from the macro-regional areas there are also other initiatives that cover the south and east shores of the Mediterranean Sea. Union for the Mediterranean (UfM) includes 42 member countries from southern and eastern Mediterranean, representing one of the largest memberships of any territorial cooperation in the region (Lierop, 2021). It mainly addresses strategic objectives of human development and regional sustainable development. Mediterranean Sea Basin ENI CBC Programme is a neighborhood instrument covering 14 countries (Cyprus, Greece, Israel, Jordan, Lebanon, Malta, Palestine and San Marino, as well as selected regions from Egypt, France, Italy, Portugal, Spain, and Tunisia). This initiative aims at promoting fair and sustainable economic, social and territorial development and fostering cross-border integration. Eleven priorities have been identified, including, among others, sustainable tourism, water management, integrated coastal zone management, etc.

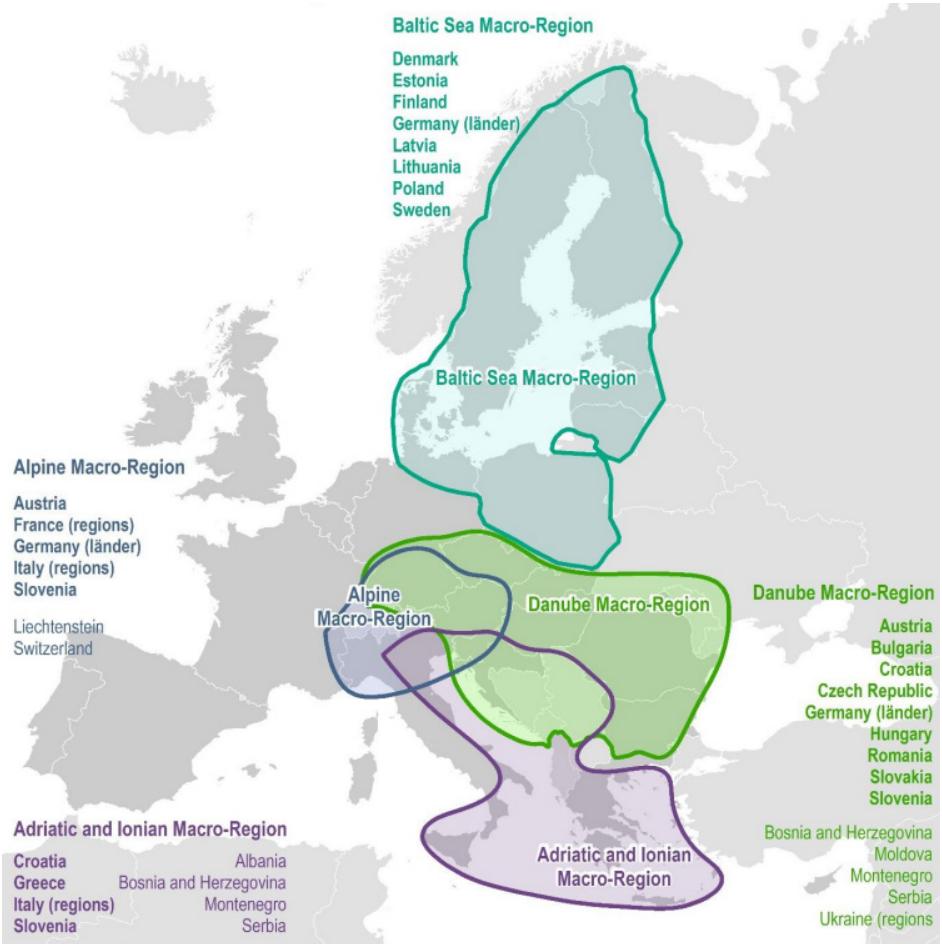

Figure 1: EU- Macro-Regional Areas, Source: https://waterquality.danube-region.eu

Interreg ADRION Programme is a transnational cooperation program that covers 9 countries from the European Union (Croatia, Greece, Italy and Slovenia) and western Balkans (Albania, Bosnia-Herzegovina, Montenegro, North Macedonia and Serbia). Adrion Interreg current programming period supports the following priorities: innovative and smart region; sustainable region; connected region; and supporting the governance of EUSAIR. The general objective of the EUSAIR is to promote economic and social prosperity and growth in the region by improving its attractiveness, competitiveness and connectivity. EUSAIR will contribute to the further integration of the Western Balkans. (https://www.adriatic-ionian.eu/about-eusair/, 2023) In this chapter, we mainly focus on the Mediterranean Sea and the Adriatic and Ionian Macro Region and specifically

discuss the environmental risks to water and the marine environment. According to the EUSAIR, these risks are being addressed by the following actions:

1. Increasing marine knowledge
2. Transnational terrestrial habitats and biodiversity
3. Development of joint management plans for cross-border habitats and ecosystems
4. Joint population level management plans for large carnivores and awareness-raising activities
5. Protection and restoration of coastal wetland areas and karst fields
6. Awareness-raising activities on implementation and financial aspects of environmentally-friendly farming practices
7. Fisheries and aquaculture

In order to implement the above actions, the EU has supported numerous research projects at the national, regional, and European level. Among these projects, we selected to present the transnational repository network developed by the SEAVIEWS Adrion-Interreg Project that will receive, store, and analyze data about the quality of sea water from a network of smart sensors allocated in critical points. Individuals will also be able to post real time observations regarding marine pollution using an application. Big data analytics tools will be incorporated making this an innovative virtual early warning system for preventing and managing the marine pollution from various sources. The ultimate goal of this output is to promote through the network the people's understanding and sensitivity and therefore, engage them in the prevention of marine pollution.

The network of smart sensors consists of 17 probes installed in the Adriatic Ionian Sea. The distribution of sensors follows:

- 5 probes in Greece (4 stationary, 1 onboard a tugboat vessel)
- 2 probes in Italy (1 stationary, 1 onboard a research vessel)
- 1 probe in Croatia
- 1 probe in Slovenia
- 3 probes in Albania
- 5 probes in Montenegro

The rest of the chapter is structured as follows: section 2 represents the selection of the points for installing the probes, section 3 focuses on the case study of Greece and more specifically with the identification of the accepted values and

link to the marine pollution incidents while section 4 describes the environmental issues that are relevant to the area of interest.

Environmental Issues in the Adriatic – Ionian Sea

Greece

The Ionian Sea is the archipelago of western Greece that spans from the north to its mid-south. It is connected to the Adriatic Sea to the north and is bounded by Southern Italy, southern Albania to the north, and Greece's west coast, including the Peloponnese. This region is a hotspot of biodiversity and hosts natural protected areas, sites of conservation interest of global importance (National Marine Protected Areas, NATURA 2000 sites), and other areas with different protection regimes according to the IUCN categorization. The Ionian Islands were always on trade routes between the eastern and the western Mediterranean Sea and between the southern and the northern Mediterranean cultures.

Additionally, thanks to their beauty, they are famous holiday destinations having a big contribution to the country's "heavy industry", tourism. The problems that came up with the increased human use of the marine and coastal space, particularly for fishing, maritime transport, tourism, and construction, cannot be ignored as they have intensified pressures on coastal and marine ecosystems. Furthermore, the foreseen growth in offshore oil and gas extraction poses serious pollution risks from hazardous substances.

The main environmental sustainability problems and threats are:

- Oil spills at sea. Although accidental oil spills are becoming rarer, ships and fishing boats still deliberately release some oil into the sea as part of their operation.
- Marine litter is a major environmental problem. Some 33-39% of the relatively high amounts of litter found on beaches, the sea surface and the seafloor originate from shoreline sources, including poor waste management practices, tourism and recreational activities.
- Agricultural effluents and particularly nitrates (nitrate pollution) which cause eutrophication, with consequently the difficulty of reproduction and survival of the organisms that live in aquatic environments.
- Overfishing has a devastating impact on Ionian Sea as it destabilizes the food chain and destroys the natural habitats of many aquatic species.

Italy

The Marine Protected Area (MPA) of Porto Cesareo is in the south of Italy, and it includes the municipality of Porto Cesareo, and partially the municipality of Nardò (Lecce, Puglia) in their entirety. This area is characterized by a wide heterogeneity of environmental habitats on the coast as in the sea. However, similar to many other areas, it also faces several anthropogenic pressures that could undermine its integrity, function, and services. The MPA falls within an average populated area (about 171 inhabitants per km^2), for a total number of residents equal to 37,715, of which 5,930 in the Municipality of Porto Cesareo and 31.785 in that of Nardò. These numbers, however, increase significantly during the summer months, being subject to a very intense tourist flow, up to about 100,000 tourists per year registered in hotel and non-hotel businesses; this number increases to 1,374,000 if tourists from second homes are also included.

Many of these tourists remain and enjoy the beaches while others perform diving activity, with six diving centers actively operating in the area throughout the summer and hundreds of divers every year. Many tourists and locals have boats, so 3,000 naval units moored and thousands of sport fishermen fish in the Marine Protected Area in zone C where the activity is allowed. The Porto Cesareo MPA is located in a territorial context economically based on small professional fishing, sport and tourism, generating socio-economic needs often in conflict with each other and in contrast with the priority purpose of the establishment of the area, i.e., environmental protection. This situation makes the management of human activities by the manager particularly complicated and the creation of concrete tools for the governance of the area is essential.

A flux of plastic of about 0.8 kg $(km\ day)^{-1}$ is reported as plastic pollution in the Specially Protected Area of Porto Cesareo and the shipping was identified as the main contributor (76.7%), followed by the city of Gallipoli (5.8%), the River of Crati (2.7%), and the city of Taranto (2.2%), which is located at the perimeter of the Taranto Gulf.

Additionally, the port of Taranto is located in the Gulf of Taranto with 18 million tons of cargo capacity/year (Autorità di Sistema Portuale del Mar Ionio, data for the year 2019).

Croatia

The Croatian part of the Adriatic Sea states is a clean and well-preserved sea, attracting tourists to its shores, which makes it an important part of the Croatian

economy. Traces of oil spilled from ships can appear on the Adriatic, but they are not characteristic of the Croatian coast. Major environmental problems cause:

1. The concentration of copper. Parts of a ship that are immersed in the sea are coated with anti-fouling coatings to protect it from algae and other organisms. The coatings melt in water and emit heavy metals such as copper. Higher concentrations of heavy metals accumulate in the marine environment, affecting the health and development of fish, shellfish and other organisms.
2. Nutrients and sediments load. The environment is affected by the emission of substances from aquaculture farm, which occurs as a by-product of feeding and the dissolution of substances in seawater.
3. Chemical anomalies. Different sediments and greater inflow of freshwater can cause changes in oxygen concentration, salinity level and pH values. This problem is crucial in shellfish farming.

Albania

The Albanian coast extends for a length of 429 km, with about 273 km of coast in the West facing the Adriatic Sea and 154 km of coast in the South West on the Ionian Sea. The coast is made up of long sandy beaches, deltaic river mouths and lagoons. There are several lagoons with a total surface of 150 km^2. This forms a highly diverse ecosystem with great natural and tourist values. These areas are sensitive ecological systems and are economically important as they are used for tourism, fishing, aquaculture, and recreation.

The main threats to the coastal marine environment are listed hereafter:

1. Discharge of urban and industrial wastewater. Four major urban areas (Durres, Vlora, Lezha and Saranda) are positioned along coastal area that discharge the untreated urban and industrial waste-water directly into the sea. Most industrial activities are situated close to Ishem, Shkumbini. Semani and Mati rivers, causing a long-term pollution effect to marine environment.
2. Extensive use of chemical fertilizers and pesticides in agriculture. The central and northern coastal regions remain the country's most important agricultural areas. Different chemicals are transported from surrounding fields run-off, as well as from all rivers' network.
3. Nutrients and sediments load that ultimately reach the coast and the sea through river flow.
4. Uncontrolled solid/plastic waste disposal. One of the key problems in the area is solid waste, which is largely generated from local communities

(both construction and municipal waste), but also from tourist and marine transport activities.

5. Hydrocarbon pollution. The hydrocarbon pollution from oil spills is related to commercial shipping and sailing boats, especially in two major Adriatic Harbors of Durres and Vlora.
6. Deforestation and erosion. The coastal erosion and deforestation are a significant problem in the northern and central coastal regions in Albania, caused by natural and anthropogenic factors.

Slovenia

Slovenian waters and the 46 kilometers of the Slovenian coast are situated within and along the Gulf of Trieste at the northernmost part of the Adriatic Sea. Shallowness, small water volume and weak currents in the Slovenian part of the Gulf of Trieste are manifested in environmental sensitivity.

Major environmental problems in Slovenian sea are:

- Plastic waste and microplastics
- Decrease of biodiversity
- Pollution due to intentional or unintentional discharges
- Underwater noise
- Introduction of nonindigenous species
- Overfishing
- Increased probability of occurrence of floods

A large part of the area of Koper Bay is occupied by Luka Koper, which has become an important international port in Central Europe. The main part of the released amount of ballast water in the Slovenian sea is associated with the release of ballast water from ships in Luka Koper and its berths, and only a small quantity in the Izola shipyard. The Gulf of Trieste area is also influenced by the activities of Italian ports, especially ports in Trieste and Monfalcone. Marine traffic is causing pollution due to intentional or unintentional discharges, introduction of nonindigenous species, waste pollution, underwater noise.

When it comes to microplastics and plastic waste, results obtained by the Institute for Water in Ljubljana show a lot of microplastics floating in the sea. It's also connected to the conditions in the Bay of Trieste with a closed circulation of water. The exchange of water with the open sea in the northern Adriatic is limited, and it leads to the piling up of substances in the area – pollutants and

microplastics. Currents from the southern parts of the Adriatic Sea also bring plastic, which then floats on the surface of the sea in Slovenia. As a result, the concentration of plastic in Slovenia is much higher than in other parts of the Adriatic.

Development of a transnational repository network of probes

The SEAVIEWS project is dedicated to the prevention of the diffusion of marine pollution of the Adriatic-Ionian Sea, which requires the development of a network consisted by multiparametric probes. The selected probes will be able to record nine (9) different parameters and help develop a transnational repository network that will receive, store, and analyze data about the quality of sea water. The probes will be installed in critical stationary and moving points. The aim is to create an innovative virtual early warning system for preventing and managing the marine pollution from various sources. The technical specification of the probes is presented in the following table:

Table 1: Probe technical specifications

	Parameters	Range of measurement	Accuracy
1	Temperature	-5 to 50°C	±0.01°C
2	Salinity	0 to 70 psu	±0.1 psu
3	pH	0 to 14 pH	±0.2 pH
4	Conductivity	0 to 200 mS/cm	±0.5% of reading + 0.001 mS/cm
5	Dissolved oxygen	0 to 50 mg/L	±0.1 mg/L for 0–8 mg/L ±0.2 mg/L for more than 8 mg/L ±10% reading for more than 20mg/L
6	Turbidity	0 to 4000 NTU	0 to 100 NTU: ±0.3 100 to 400 NTU: ±0.3 400 to 3000 NTU: ±5%
7	ORP	-999 to 999 mV	±20 mV
8	TDS (Total Dissolved Solids)	0 to 64 g/L	N/A
9	Depth	0 to 250m	±0.1 meters

Sea currents in the Ionian Sea

The prevention of the diffusion of marine pollution is a complex problem to be solved as it is affected by several parameters, some of those are difficult to be assessed. One of the major parameters in simulation for marine pollution is the sea currents. While assessing a potential marine pollution scenario (spread, affected areas, collaboration on a national level etc.) specific points should be selected based on the direction of the sea currents. In this paper we mainly

focus on the Ionian Sea where three main water masses have been identified (Malanotte-Rizzoli, 1997):

- The Modified Atlantic Water, MAW. It enters the Ionian Sea from the Strait of Sicily. It is then carried into the basin interior in the surface layer by the Atlantic-Ionian Stream (AIS) that reaches the Cretan Passage to become the Mid-Mediterranean Jet (MMJ).
- The Levantine Intermediate Water, LIW. It is formed by the intense evaporation and mixing processes of the MAW that occurs in the Levantine Basin. The LIW enters the Ionian Sea through the Cretan Passage.
- The Adriatic Deep Water, ADW. The Adriatic Sea exports relatively fresh water to the adjacent Ionian Sea.

Studies show that the Ionian Sea's dominant low-frequency dynamic over the last twenty years is characterized by a decadal oscillation of its circulation, with two rather different states associated with a circulation reversal in the Northern part of the Sea. The "anticyclonic" state is characterized by an anticyclonic gyre in the Ionian basin's Northern part. It is associated with a weak quasi-zonal jet crossing the Ionian Sea from West to East. The "cyclonic" state is related to a reversal of this Northern gyre. It is associated with an intense current crossing the basin at its center (Borzelli, 2009).

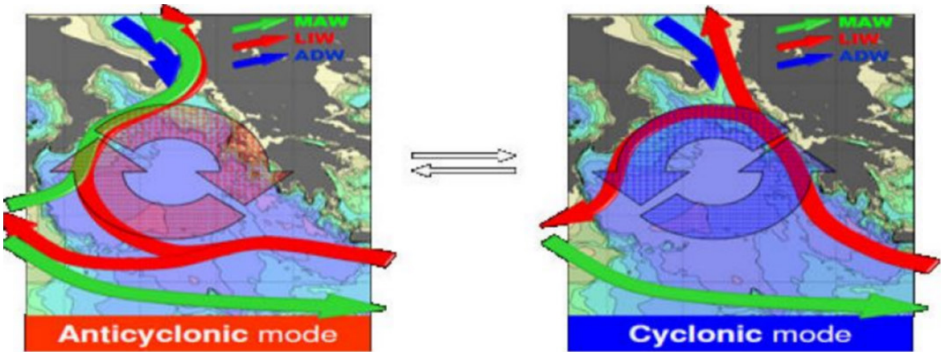

Figure 2: Anticyclonic and Cyclonic state Source: Gacic, 2010 (Gacic, 2010)

LIW is the current for both circulations, which determines the course of the waters in the Ionian Sea, as shown in Figure 3.

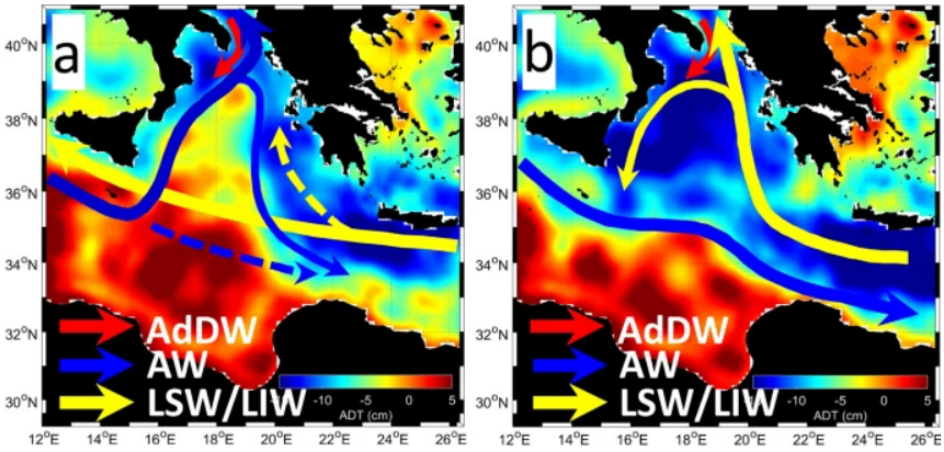

Figure 3: Schematic representation of the geostrophic circulation in the North Ionian Gyre region Source: Rubino, 2020

Sensor's Location Selection

The course of LIW, in combination with Natura 2000 regions and areas with intensive industrial activity, was the selection criteria for the points where the sensors were installed.

The order of presentation of the sensors' installation points will follow the course of LIW, from the south to the north, the current which determines the course of the waters in the Ionian Sea:

Patras Port. The selection criteria of this point, with geographic coordinates 38.222535°, 21.718504°, are:

1. being in the southern part of the LIW stream, we can monitor the entry of possible pollution in the Ionian Sea through the sea current
2. the study of the interaction of the Gulf of Patras as well as the Gulf of Corinth, with the main Ionian Sea
3. the monitoring of a busy port in the marine environment
4. the monitoring of an industrially developed area in the marine environment
5. its interaction with Aigio, as we will present below

Aigio. The selection criteria of this point, with geographic coordinates 38.256983°, 22.076565°, are:

1. the monitoring of an industrially developed area in the marine environment

2. the study of the interaction of the Gulf of Corinth with the main Ionian Sea
3. its interaction with Patras

Preveza Port & Cleopatra Marina in Aktio. The selection criteria, with geographic coordinates 38.958961°, 20.756437° (Preveza Port), and 38.948366°, 20.762949° (Cleopatra Marina in Aktio) of these points, are:

1. Due to its location, the inflow of pollution into Ambrakikos Gulf, the bay from the Ionian Sea, can be monitored. Ambrakikos Gulf is part of the Natura 2000 site (AMVRAKIKOS KOLPOS, LIMNOTHALASSA KATAFOURKO KAI KORAKONISIA - SiteCode: GR2110004) ((N.E.C.C.A.), 2022).
2. Its location in the central area of the Ionian Sea makes it an excellent point for monitoring the evolution of possible pollution in the Ionian Sea through the LIW stream.
3. We can study the interaction between the Ambrakikos Gulf and the Ionian Sea in general.
4. The impact of Preveza city, which is not industrial, on the marine environment given the comparison that can be made by monitoring the sensors of the Cleopatra Marina.

Corfu. Unlike the above, here this sensor will be mobile. In particular, the sensor is mounted on a tugboat whose operation is in the port of the city of Corfu. The selection criteria for this point are:

1. Its location at the northern tip of the Ionian Sea and at the end of LIW current offers us a complete overview of the spread of possible pollution as well as the interaction between the Ionian and the Adriatic Sea.
2. It is an area of high tourist interest.

Water Quality Reference value: The case of Greece

Water quality plays a significant role in the wellbeing of humans, animals and plants inhabiting an area. Surface water quality within a region is influenced by both natural processes and anthropogenic activities. Marine water quality has become a matter of serious concern because of its effects on human health and aquatic ecosystems including marine life. Physical, chemical, and biological characteristics are vital water quality parameters for monitoring as their values are an indication of the quality of water resources. Parameters that are frequently sampled or monitored for water quality include temperature, dissolved oxygen (DO), pH, electrical conductivity (EC), oxidation reduction potential (ORP)

and turbidity. However, water monitoring may also include measuring total algae, ammonia, ammonium, nitrate, chloride and chlorophyll, or laboratory parameters such as BOD (Biochemical Oxygen Demand) or TOC (Total Organic Carbon) [(Marko Tosic, 2013), (Manual, 2009) (Xylem.Inc, 2022).

In situ water quality sampling is the measurement of physical and chemical parameters in a water body at the time of sampling. The most common method of measuring in situ water quality is with a multi-parameter water quality instrument (sensor). The sonde of a multi-parameter water quality instrument is a collection probes that measure individual parameters. Whilst the configurations of probes vary with each instrument, the most common are DO, temperature, pH, EC, turbidity and depth. Probes are available that measure other parameters such as chlorophyll, ORP, nutrients and chlorophyll (Manual, 2009).

This chapter examines the parameters that are measured, by means of a multisensory, to indicate the quality of water: water temperature, pH, electrical conductivity (CON), turbidity, dissolved oxygen (DO), salinity (SAL), total dissolved solids (TDS), ORP in a depth of about two meters from the sea surface. The correlations and interactions between the different variables are studied, and then through those correlations the identification of different types of marine pollution can be carried out. The four types of marine pollutants that are being studied are oil spill, eutrophication, effluent, and thermal pollution.

Based on the literature, the normal value range of the parameters in a marine environment is shown in the table below.

Table 2 Sea water normal values

PARAMETERS MEASUREMENT	SEA WATER NORMAL VALUES	OIL SPILL	EUTROPHICATION	EFFLUENT	THERMAL POLLUTION
WATER TEMPERATURE	12°C-25°C (it depends on the season) [1]	(N/A)	(N/A)	(N/A)	(+)
pH	7.5 to 8.4 [2]	(N/A)	(+)	(+)/(-)	(+)
CONDUCTIVITY	30-60 mS/cm [3]	(-)	(+)	(+)	(+)
SALINITY	30-40 ppt [4]	(-)	(+)	(+)	(+)
DISSOLVED OXYGEN	5-15 mg/L [5]	(-)	(-)	(-)	(-)
TURBIDITY	5-10 NTU [6]	(+)	(+)	(+)	(+)
TDS	35 g/L [8]	(-)	(+)	(+)	(+)
ORP	<350 mV [7], [9]	(-)	(-)	(-)	(-)

As shown in table 2, an increase or decrease in the values of the parameters, or an interaction of the parameters in a particular way, indicates the existence of

some type of pollution. Dissolved oxygen (DO), for instance, is considered as one of the parameters most sensitive to pollution. Rapid increase in biomass caused by algae (eutrophication) creates an anoxic or hypoxic environment which is indicated with a decrease in this parameter value.

The above limits also vary from one region to another as each area has its own specific geomorphologic features. Especially the Adriatic Sea, although it is part of the wider Mediterranean region, is for many reasons considered a marine sub-region in its own right, and correctly so.

As a first step, on the basis of the diversity between the marine regions of the Adriatic Sea, each country has adjusted the above limits to its own special characteristics. The normal value range for each country is set as follows.

Table 3: Sea water normal values in Greece

PARAMETERS MEASUREMENT	SEA WATER NORMAL VALUES in Greece
WATER TEMPERATURE (°C)	12°C–25
pH	7.5 to 8.5
CONDUCTIVITY (mS/cm)	50–55
SALINITY (ppt)	33–36
DISSOLVED OXYGEN (mg/L)	6–10
TURBIDITY (NTU)	0–15
TDS (g/L)	32–35
ORP (mV)	300–500

Table 4: Sea water normal values in Italy

PARAMETERS MEASUREMENT	SEA WATER NORMAL VALUES in Italy
WATER TEMPERATURE (°C)	12°C–28.5
pH	7.5 to 8.5
CONDUCTIVITY (mS/cm)	50–55
SALINITY (ppt)	37.5–39.5
DISSOLVED OXYGEN (mg/L)	6–8.5
TURBIDITY (NTU)	<50
TDS (g/L)	30–41
ORP (mV)	80–370

Table 5: Sea water normal values in Croatia

PARAMETERS MEASUREMENT	SEA WATER NORMAL VALUES in Croatia
WATER TEMPERATURE (°C)	11°C–26
pH	7.9 to 8.3
CONDUCTIVITY (mS/cm)	20–58.5
SALINITY (ppt)	15–39.5
DISSOLVED OXYGEN (mg/L)	4.5–10
TURBIDITY (NTU)	0–2
TDS (g/L)	14–38.5
ORP (mV)	50–250

Greece case study

In this study, the authors focused on the case study of Greece. Greece has been selected as the most suitable candidate because 5 of the 17 sensors were installed in Greek territorial waters. In addition, sensors have been installed in sensitive areas such as Amvrakikos Gulf which is a NATURA 2000 protected area. Until the publication of this study, not all other probes were able to transmit reliable data. Therefore, it would be impossible to validate the rules generated.

For the stations under study in Greece (Aktio, Preveza, Aigio and Patra) the value range that was set at the beginning was the same for all four stations.

As a second step, the aforementioned rules were re-regulated with minor changes on the basis of the first results. Some minor differences were observed between the four stations. Especially in Amvrakikos Gulf (Preveza and Aktio) together with Patras port, both influenced by anthropogenic and industrial activities, the pH, TDS, CON and SAL values that were recorded were slightly higher than what was originally set.

On the basis of these remarks, the new rules were formulated as follows:

Table 6: Sea water normal values in Greece

PARAMETERS MEASUREMENT	SEA WATER NORMAL VALUES in Greece			
Greek Stations	Patra	Preveza	Aktio	Aigio
pH	≤8.64	≤8.53	≤8.53	≤8.53
CONDUCTIVITY (mS/cm)	≤56	≤55	≤60	≤55
SALINITY (ppt)	≤36.5	≤36.5	≤36	≤36
TDS (g/L)	≤36.1	≤36.0	≤38.5	≤36.0

The temperature measurements, during October 2022, showed the typical values of the parameter found in the coastal marine environment in Greece for this period. Temperature ranged approximately from 20 to 24°C, confirming the fact that water of Ionian origin flowing along the eastern coast are slightly colder (23°C) than the rest of Adriatic surface water (M. Lipizer, 2014). The DO values ranged from the minimum of 5.8–6 mg/L in Amvrakikos Gulf (close to the value of 5 mg/L that has been recorded previously (A. Pavlidou, unknown)) to 6.8–7 mg/L in Aigio and Patra. Surface salinity shows a strong variability (from less than 30.00 to 39.00 ppt). The SAL values that were recorded during this time period are slightly lower in comparison with other literature findings with SAL > 39.00 ppt covering the surface layer in the southern Adriatic (M. Lipizer, 2014) or >38.5 ppt in the Ionian surface water more specifically (Paola Rivaro, 2004).

Conclusion

The SEAVIEWS project is dedicated to the prevention of the diffusion of marine pollution of the Adriatic-Ionian Sea, which requires the implementation of a multiparametric probe. The probe will be able to record nine different parameters and help develop a transnational repository network that will receive, store, and analyze data about the sea water quality. The probes monitoring the sea water quality are installed in critical stationary and moving points. The aim is to create an innovative virtual early warning system for preventing and managing the marine pollution from various sources. This system analyses the measurements of the probes and historic data and then compares it with the logical rules that have been created based on the literature.

The data and the accepted values are stored in the same database and are accessible to subscribers in the SEAVIEWS web-based platform (SEAVIEWS, 2022). If a value exceeds the defined margin (based on the literature, specific area needs and historic data) the user gets a notification that marine pollution might occur. This innovative system aims to identify a marine pollution incident and prevent diffusion of marine pollution by informing stakeholders well in advance. Therefore, by acting on time the consequences of marine pollution are significantly decreased resulting in lower risk for marine pollution. However, the system needs to be trained with real data in order to avoid false alarms. Given that the probes are very sensitive equipment there is a high need for maintenance (cleaning and calibration) in order to ensure that clean data are being stored and used by the algorithm.

The overall evaluation of the "Sector Adaptive Virtual Early Warning System for Marine Pollution in the Adriatic-Ionian" is positive and is contributing to the implementation of the top priorities for the Mediterranean Sea especially in the Adriatic Ionian Sea which is the area where multisensors have been installed. This transnational repository network could be further expanded in order to cover also countries from the south and the east coast in order to foster cross-border collaboration and tackle the challenges of coastal management, water quality and protection of marine environment and life below the sea.

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BLUE LIMASSOL RISK ASSESSMENT

Angelos Menelaou, Michalis Makrominas and Carol Bailey

The Blue Limassol Risk Assessment Project (hence forth "BLRA") falls under the auspice of the Blue Limassol Forum, a strategic collaboration between the Limassol Municipality and Frederick University. The Forum aims at bringing together maritime professionals, environmentalists, regulators, and academics to address the great challenges facing the city of Limassol and its coastal environment. Under this mandate, the BLRA was conducted with two objectives: a) To assess potential threats to the sea and coastal environment of Limassol, arising from industrial activity including Commercial Shipping (Port), Marinas and Yachting, Fisheries and Aquaculture, Oil and Gas exploration, Coastal Construction and Litter and Sewage, b) To provide recommendations regarding best practices to alleviate these threats and promote sustainable growth. It is noted that the project focuses on the Limassol Bay due to the high concentration of diverse industries in the region and a steady increase of anthropogenic pressures in the area. The increasing concern of the citizens of Limassol regarding the state of their surrounding coastal environment was documented in an extensive opinion survey that took place under the first Blue Limassol Forum event in May 2020. As such, the BLRA can also be viewed as a direct response to the expressed opinions and perceptions of the people most closely affected.

To realize the project, a consortium of seven reputable institutions and a research team of more than 30 specialists had been established. These include the Limassol Municipality, Frederick University, Department of Maritime Studies and Department of Architecture, DNV-Greece, the Marine and Environmental Research Lab (MER), the Cyprus Marine and Maritime Institute (CMMI) and the Development Agency of Limassol (ANELEM). An important element of the study is a holistic approach to various sources of risk which are both interactive and aggregative. At the same time, the regulatory framework is largely fragmented based on different areas of focus or geographical reach. As such, several regulatory and monitoring bodies including the Shipping Deputy Ministry Cyprus Foundation of the Sea (Cy-FOS), the Department of Environment, the Department of Fisheries and Marine Research, the Cyprus Port Authority, the Department of Energy, and the P&O Maritime Limassol were directly involved.

A key aspect of BLRA was to undertake a consolidation of risk factors assessing the synergistic effects of various threats applied. While each sector has occasionally

provided its own risk assessment in isolation, the BLRA project was the first study, to our knowledge, to apply a holistic approach of risk assessment for the assessing environmental threats looking at all present industries at the same time rather than one and each on its own. This is important since the Limassol Bay and its coast is a unified space where the environmental pressures of the activities of each sector interact and aggregate. The spillover of the activities of one sector to another suggests that the overall impact on the sea and coastal environment of the various activities can be more than the sum of the its parts.

The chapter unfolds as follows: Section 2 outlines the concept of Blue Economy and its importance for the city of Limassol. Section 3 provides sectoral risk assessment as applied to the various industries present in the bay of Limassol. Section 4 consolidates sectoral threats and provides a holistic evaluation of risk assessment and root causes. Section 5 concludes.

Blue economy and the city of Limassol

As defined by the EU (European Commission, 2022, p. 2), the Blue Economy includes: (a) marine-based activities undertaken in the ocean, sea and coastal areas, such as living and non-living resources, renewable energies, desalination, maritime transport and coastal tourism, and (b) marine related activities which use or produce products and services, such as shipbuilding and repair, port activities, technology or digital services.

According to the EU Blue Economy Report (European Commission, 2022, p. VI), the 2019 annual turnover for the Blue Economy Sectors in all member states was estimated at €667.2 billion, with a Gross Profit of €72.9bn, employing 4.45 million people.

The natural beauty and the infrastructure of the coastal zones of Greece, Israel, Turkey and Cyprus provide significant income derived from the Blue Economy Sectors, which consequently has a major role in the general wellbeing for their citizens.

According to the Cyprus Statistical Service (2019), Coastal Tourism accounted for 12% of national GDP, while port activities, shipbuilding and repair contributed 7% national GDP (Cyprus DMS Milestones, 2022). In Cyprus, 74 beaches have been awarded Blue Flags (Blue Flag, 2022); the highest number per capita and the most Blue Flag Beaches per 100 km coastline in the world (The SOCLIMPACT Project, 2020). The 13km Limassol coastal promenade is considered one of the longest in the world. With approximately 1,000 ocean going vessels, Cyprus has

the 11th largest merchant fleet globally and 3rd largest in the EU (Cyprus DMS Maritime, 2022).

Limassol, one of 6 districts in Cyprus and the second largest city with 32km of coastline along Limassol Bay, houses the most important tourism, trading and service providing centers of the island. The population of Limassol district was recorded in 2021 as 258,900, an increase of 10% since the 2011 census, with 20.5% of residents being foreigners (Cyprus Press & Information Office, 2021). Limassol is the second largest urban area in Cyprus with an urban population of approximately 180,000. In addition to the permanent residents, Limassol also welcomes many tourists throughout the year, about 12% of the over 2 million tourists that visit Cyprus stay in Limassol (Cyprus Statistical Service, 2019). With strong cultural heritage in juxtaposition with sky-rise hotels and residential towers, the city of Limassol is considered to be an up-and-coming world travel destination (World Population Review, 2022) and place to live.

Limassol is the heart of the Cyprus maritime cluster, hosting more than 200 companies offering shipping and shipping-related services. Managing approximately 20% of the world's third-party management fleet, Limassol is the largest third-party ship management center in the EU and amongst the top three worldwide (Cyprus DMS Maritime, 2022). Hosting the main port of Cyprus and a modern marina to the west, a burgeoning energy center and fuel storage to the east, aquaculture and fisheries throughout, the Limassol Bay is home to Posidonia seagrasses and various protected species.

Whilst such development and operational activity bring economic benefit to Limassolians, this concentration of population and industrial activity also presents risks to the environment that must be sustained for all to flourish.

Therefore, as with many coastal cities, Limassol faces great challenges, ranging from the ecological protection of the sea, coastal and waterfront areas, to achieving growth by taking advantage of the potential of the seas and coasts, and ensuring a dynamic marine and maritime agenda for development, competitiveness, and job creation. It is noted, especially among citizens, that environmental pressures from human activity in the bay of Limassol have dramatically risen in the last 10 years due to the proliferation of coastal construction including high-rise buildings, as well as the expansion of marinas accommodating now over 1,000 yachts. Geopolitical events have also contributed gravely toward the over-concentration of industries. Following the 1974 events, the Limassol port was designated as the main merchant port of the country in place of the port of Famagusta.

Figure 1: 32km coastline of Limassol Bay, Cyprus

Recent environmental incidents (a) pollution by tar from unknown marine source in Israeli waters (Lloyds List Intelligence, 2021) and (b) a coastal accident in Lebanon caused by a continuous spillage from the Baniyas refinery plant (Cyprus Mail, 2021), have spread their effects beyond the countries' boundaries, indicating that marine pollution hazards and incidents can have cross-sector and cross-border impact and consequences.

In 2020, recognising growing citizen concerns regarding decision making in social-economic growth and the need for effective environmental risk management, the Limassol Municipality in partnership with Frederick University formed the Blue Limassol Forum as a means of engagement between citizens and stakeholders in the Blue Economy. A hybrid event, to launch the Forum was conducted in May 2020 with more than 700 participants.

The first task identified areas of highest concern to citizens. A survey was conducted, with more than 500 respondents. In the analysis of the results (BLF2020 Survey, 2020), the citizens clearly indicated their wish to improve the quality of coastal waters and beaches. A secondary question identified their beliefs that the main causes of pollution arose from activity in Waste & Sewage Management, Port & Shipping, Construction, Oil & Gas, Aquaculture & Fisheries and Recreational Water Sports.

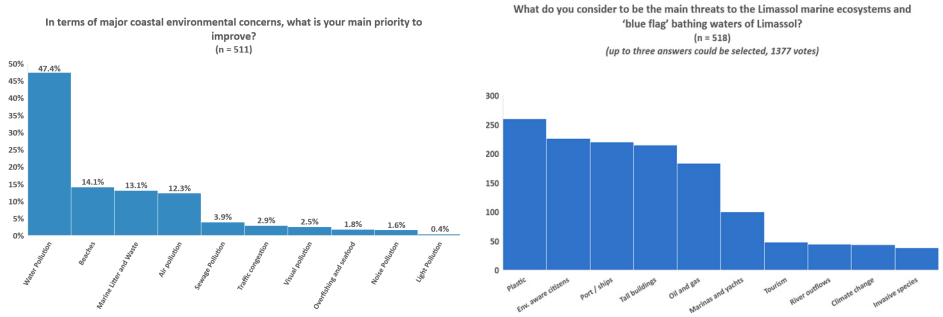

Figure 2: Responses from Citizen Survey (2020)

In order to investigate the environmental risk in these sectors, the Blue Limassol Forum partners commissioned an Environmental Risk Assessment. The objectives were to (a) provide a single source, factual description of the activities of the sectors operating in the coastal zone; (b) identify the environmental pressures exerted; (c) conduct a risk assessment that addressed the holistic environmental, social and economic impact of an incident; (d) make recommendations for mitigation and response practices that could be actioned by policy makers and stakeholders.

The current condition of the marine environment in Limassol Bay was established through determining the practices and gathering data for monitoring water quality, reporting and responding to environmental incidents.

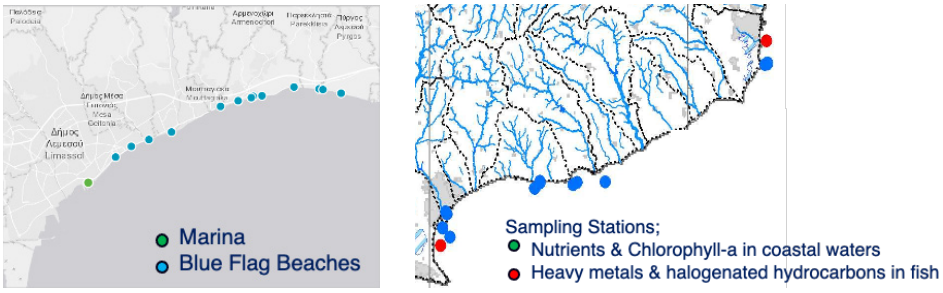

Figure 3: Location and nature of water sampling stations

This was achieved through literature review and interviews with the relevant organizations; authorities, companies and citizen action associations. Subsequently, these organizations provided comprehensive data in the form of pre-prepared spreadsheets, describing the procedures, frequency and mode of monitoring, reporting, recording and response to reported incidents. The

analysis provided a Fact Check for the sector studies which followed (Ellinas, et al., 2022, Appendix A).

Sectoral risk assessment

for each of the sectors identified in the citizen survey, focused study teams were tasked with describing the regulatory and operating conditions, main players, nature and level of activity.

In total, 122 relevant stakeholders (authorities, companies, associations) were identified as sources of primary data and opinion based on personal observation of unrecorded incidents. A structured questionnaire was provided for initial data collection, followed by interviews, to deepen the understanding of the responses.

The resulting data was analyzed based on three fundamental questions: (a) what might go wrong? (b) how often, how likely? (c) how bad? The likelihood of a hazardous event occurring was assessed using historic incident records from industrial activity elsewhere, of comparable scale. Using common metrics across the sectors, the consequence of an incident was categorized from Negligible to Extreme.

Commercial Ports & Shipping (Georgopoulou, Christensen, Rogers, Constantinou, & Josephides, 2022, Appendix C).

Limassol Port is a multipurpose port and the main port of Cyprus.

Figure 4: Limassol port and anchorage

The main activities include port anchorage services, port traffic and navigation, ship-shore interaction, cargo and bunker operations, waste management, repairs and maintenance. In terms of tonnage, 50% of the volume is containers and 23% general cargo.

Major risks were identified as (a) Collisions/Impacts, Leakages and Fire/Explosion, arising from port traffic, (b) Leakages, arising from cargo and bunker operations, (c) Control Loss, arising from Repairs and Maintenance operations, (d) Illegal Releases, arising from waste management.

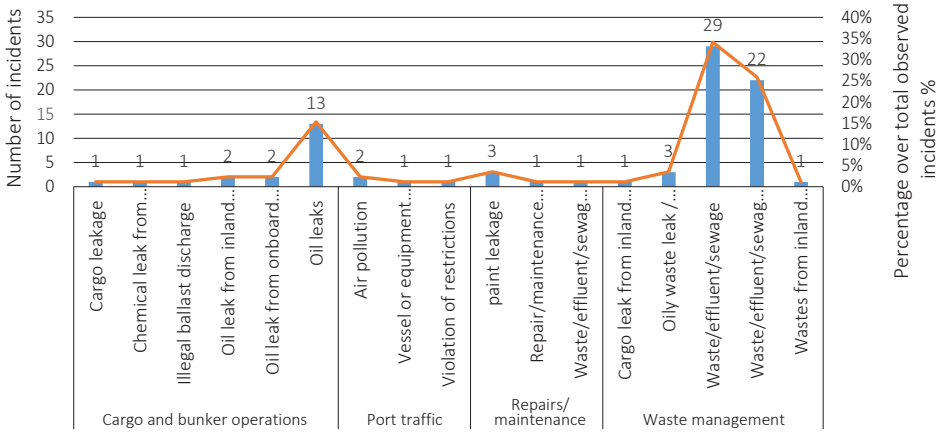

Figure 5: Categorisation of incidents in Limassol area

Although port operations are already heavily regulated and controlled, should an incident occur the impact is evaluated as significant in either environmental, economic and social terms. Specific recommendations covered (a) organizational planning and collaboration, (b) equipment and infrastructure, (c) development of procedures and personnel.

Oil & Gas (Lisciotto, et al., 2022, Appendix D)

Upstream oil and gas activity in Cyprus is limited. Several offshore exploration licenses have been granted to reputable international operators. Exploratory wells have been drilled approximately 180km off the southern shore of Cyprus. Gas discoveries have been made and the wells capped as there are presently no plans to develop.

Midstream activities such as delivery and storage of crude oil and LPG are concentrated in the Vasilikos energy terminal at the eastern point of Limassol Bay.

Whilst it is the intention to import natural gas to replace the use of heavy fuel oil (HFO) at the main Vasilikos power station, the construction of the necessary infrastructure is underway and expected to be completed by end 2023. Fuel storage includes safety fuel stock as per EU directives of 90 days, which for the period 2019-2020 amounted to 575,000 metric tons.

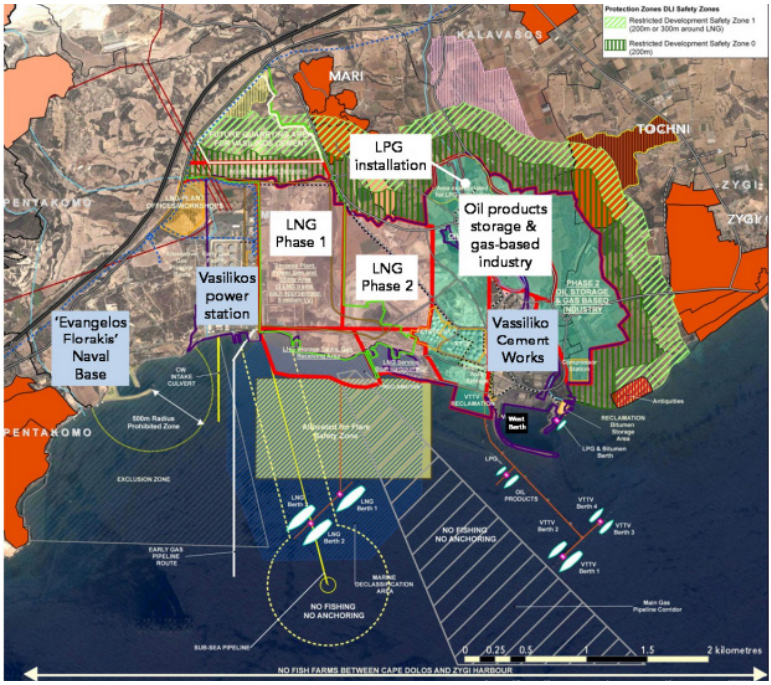

Figure 6: Vasilikos Energy Centre

Downstream retailers, such as Petrolina, BP and Shell store various liquid fuels. Distribution to retail outlets is by tanker truck travelling along the coastal highway. Private Dutch energy trader VTTI owns and operates a deep-water marine jetty and an oil terminal with 28 tanks with a maximum storage capacity of 545,000 m^3 (storing gasoline, crude oil, diesel, biodiesel, jet fuel and many chemicals such as MTBE).

The high risks are considered to be (a) leakage of oil products, leakage or discharge of oily waste from vessels delivering product at the energy center, (b)

GHG emissions arising from the continued use of HFO in power generation, (c) fire, explosions, and terrorist attacks.

Recommendations include (a) specific assessment and evaluation of mitigation measures in the areas of high risk, (b) identifying adaptation measures and mitigations for extreme events such as climate change, (c) enhanced preparedness and planning for cyber and terrorist attacks, (d) increased use of technology and introduction of a 24h monitoring program through satellite images for the identification of oil pollution.

Construction (Ioannou, et al., 2022, Appendix E)

Research focused on urban development, tourist and hotel sectors. While population density is considered low and expected to remain so, urban development is sprawling while residential towers and hotel complexes are expanding along the coastline changing the perspective.

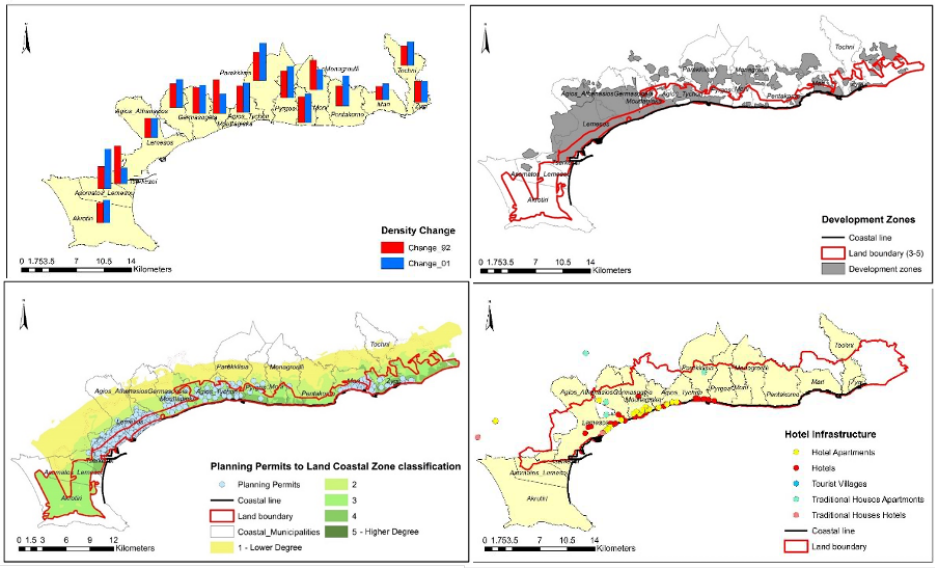

Figure 7: Field GIS data

The identified risks were considered low to medium and included (a) Marine water pollution from construction and hotels' activity. (b) Congestion from over development since coastal zones are very attractive and concentrate population and economic activities. (c) Underdevelopment and building vacancy are

sometimes a result of a vast overdevelopment period that causes urban decay when a coastal area is no more attractive to people and investments.

Specific recommendations for Marine water pollution included (a) regular and meticulous inspections of construction sites (b) establishing a focus group for updating health and safety regulations for construction and hotel operation, in the coastal environment context.

Similarly, recommendations for Overdevelopment or Overoccupancy and Underdevelopment included (a) a Climate Change Adaptation Plan to provide insights for a resilient and evidence based urban planning, (b) Urban Density Assessment Study supported by 3D simulations, (c) Effective affordable housing policy: Housing policy for Limassol roadmap, (d) Fast implementation of Limassol Sustainable Urban Mobility Plan (SUMP), (e) Incentives for refurbishing large abandoned or delayed construction projects.

Marinas & Recreational Yachting (Agrotis, et al., 2022, Appendix F)

The coastal and maritime tourism in Cyprus is considered one of the basic pillars of the country's economy. Nautical tourism, including activities such as recreational boating, marinas, cruises, water sports has expanded over the last 15 years.

St. Raphael marina, built in 1986 with 237 berths and Limassol marina, which was launched in 2010 with 650 berths, together have established Limassol as the island's yachting capital and created a model in Cyprus for the development of Nautical Tourism and Cyprus in general, as a promising Eastern Mediterranean Island destination.

Limassol marina, considered the main marina of entry to Cyprus, can have traffic of up to 9000 local visitors at the premises per week. In the summer, the marina operates at full capacity, while in the winter it is at 75% capacity. Approximately 80% of recreational vessels in Limassol marina are in the small to medium range (10 – 25 m), while larger yachts over 25 m and in the superyacht category consist of <10% of the total and small boats <10 m make up the rest of the >10%.

In a survey of yacht owners in both marinas, the majority of yacht owners make use of their vessel only occasionally. However, almost half of the yacht owners use their yachts between 50 and 70 days per year.

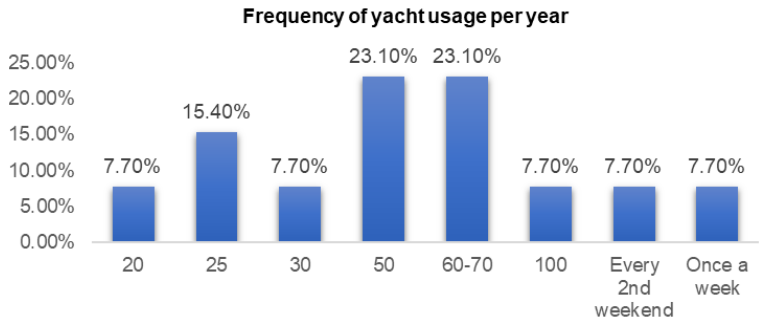

Figure 8: 2021 survey of yacht owners in Limassol

Bigger vessels adhere to different sets of legislations compared to the smaller recreational vessels and are also more frequently checked in comparison. These vessels are more obedient to reporting (i.e., holding tank activity/date/time/ location) and are also obliged to keep log books.

Both marinas have centralized waste collection systems. Nevertheless, the growth of the yachting sector in the region has led to an increased public concern over potential hazards that could impact the local environment and economy, such as sewage bacteria - anchoring, boat speeding and bilge water discharges.

Main risks include (a) Over fragmentation of responsibilities of government bodies (indirect) (b) Litter (plastics, wood, metals, glass, rubber, clothing, paper, etc.) (c) Invasive & alien species – Fouling (d) Collision with static/moving objects or marine animals (e) Disturbances above and below the surface - i.e. Marina/ Yacht operations & maintenance (exposure to noise, light, visual disturbance, or changes in water/air quality, etc.) (f) Abrasion/Disturbance of the seabed (g) Sewage disposal (h) Nutrient enrichment & subsequent ecological effects via sewage and other disposal actions (i) Potential for disease through precipitating bacteria/viruses (direct & bioaccumulation) (j) Bio - accumulative toxic & persistent components like heavy metals (i.e. antifouling & holding tank chemicals).

Recommendations include (a) establishing a Government entity, responsible for all aspects of the recreational yachting industry and environmental measurements in the marinas (b) Increased patrolling and checking of boating licences/certificates (c) more mandatory training/educational programs for recreational yacht owners and education of the younger generation regarding sustainable boating activities (d) Legally require owners of recreational boats in Cyprus marinas to have automatically updatable electronic log books.

Whilst water sports is a relatively unregulated industry at the international, regional, and local levels, a survey was conducted of 11 enterprises offering a variety of water sports: Speedboat, Waterski, Parasailing-parachuting, Windsurf, Canoe, Sea bike, Sailing, Towable inflatable tube, Sea spi single and twin carries, Stand up paddling (sup), Power surf xs, Catamaran, Flyboard, Oxoon new generation.

It is encouraging that the analysis determined that equipment is modern, relatively new, regularly serviced and in most cases still within warranty. Whilst the probability of fuel or oil spill from propelled equipment such as jet skis are considered likely, it is also assessed as infrequent and therefore of minimal impact. Risk of malfunction and therefore risk was assessed as low likelihood with negligible environmental impact.

Sewerage Management (Kletou, et al., 2022, Appendix G)

The Sewerage Board of Limassol (SBLA) is solely responsible for sewerage management. Sewage (sanitary) wastewater and storm drains are separated. The expanding sewerage network covers ten municipalities in the Limassol district. It consists of 820 km of pipelines and nine pumping stations, pumping 0.5-2 tonnes of sewerage per hour. The biological waste water treatment plant, situated in Moni near the Vasilikos energy terminal treats 30 tonnes of water per day, equating to ~10,000 tonnes of treated water and 11,000 tonnes of sludge per year.

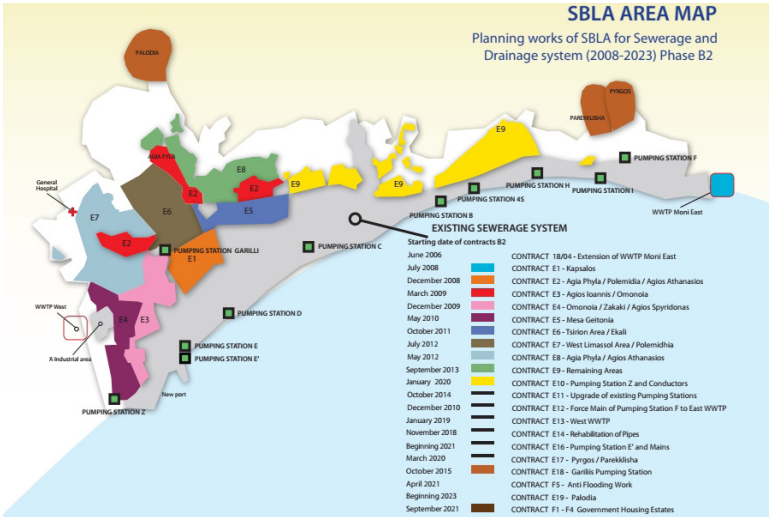

Figure 9: Limassol sewage system managed by SBLA

Responsibility for storm drains within Limassol are divided between SBLA, each municipality and the Public Works Department (PWD). All stormwater collected in the system is discharged in nearby water bodies (river or sea). The pipes are superficial and exit on the beach front, not in the sea or in the rivers.

Despite waste and storm systems being separate, on 3-5 occasions during periods of heavy rainfall each year, the volume of wastewater exceeds the capacity of the drainage system or the pumping stations and 1,000 m^3 excess wastewater (combined sewer) is discharged directly into nearby water bodies (sea or river) per occasion.

High risks are identified as (a) Synthetic compound contamination (inc. pesticides, antifoulants, pharmaceuticals) (b) Transition elements & organo-metals contamination (c) Hydrocarbon & PAH contamination (d) Nutrient & Organic enrichment.

In support of the action plans in place by SBLA, recommendations include: (a) Reinforcing current pipelines (b) Second treatment plant to the west of Limassol (c) Diverting most stormwater flowing in the city center (d) Sustainable Urban Drainage systems (retention reservoirs, porous surfaces, channels etc.). More generally, (a) Management of storm drains should be under one body (b) Replace covers of the drainage system to minimise run-off inputs into the network (c) Establish microplastic filters at the processing facilities.

Solid Waste Management (Kletou , et al., 2022, Appendix H)

The Cypriot policy on waste is structured by both national and European Union's regulations and Directives, guided by a hierarchical waste management strategic manner: 1) Prevention, 2) Reuse, 3) Recycling, 4) Recovery, and 5) Disposal.

The management of the Municipal solid waste is implemented by the sum of efforts from various actors and stakeholders at national and local levels.

In 2019 the urban population of Limassol district was estimated close to 180,000. Each citizen produces around 0.38-0.64 tonnes of garbage per year. Each household between 1.06-1.65 tonnes per year.

Green Dot Cyprus is a non-profit organization and the first collective recycling system approved in Cyprus, which serves more than 80% of the population of Cyprus.

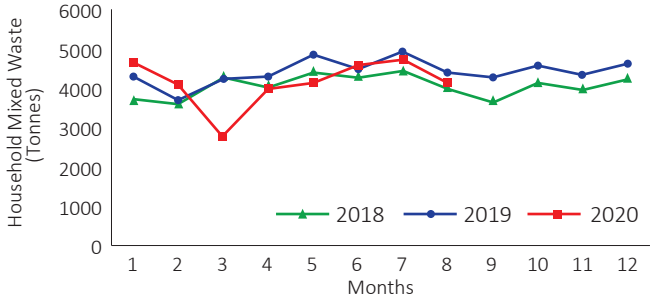

Figure 10: Mix Solid Waste Generation from households in Limassol district by Municipality for 2018-2020

Other non-profit enterprises have been established for Waste Management of Electrical and Electronic Equipment and dry cell Batteries up to 2kg and Accumulators, clothes for the purposes of reuse.

For general waste, the municipalities and communities hire a waste collection contractor to carry out the waste collection in all urban premises (household and work). Mixed waste and recyclable materials (municipal and commercial waste) are processed at the facilities established to manage and treat the municipal Mixed Household Waste of the District of Limassol.

Whilst the legislative framework is in place, with many management activities being implemented to achieve its goals; some of these activities are still a work in progress, hence questioning if these are sufficient and how far the solid waste management efforts prevent solid waste leakage in the natural environment. Littering is inevitable and is evident to a great extent in Limassol's urban areas, highway sides, land plots, rivers, river mouths and beaches.

Major risks associated with irresponsible dumping are (a) Ingestions by Marine Biota and (b) Physical Interactions (entanglement, smothering). Medium risks are (a) Social – Public health (bioaccumulation, microplastic ingestion) and (b) Economic – Tourism and Marine commercial industries.

Recommendations for mitigation include (a) Regulations for banning of single-use plastic and Improved quality control, e.g., traceability and management of ship owners (b) Reduce the inputs through Intensifying clean-ups of marine litter land-based pathways (i.e., river drainage basins), Installing trash-capture technologies in stormwater drainage systems and marine waste hotspots, i.e., ports and marinas, organized beach clean-ups. More generally, education

is needed to increase public awareness, and behavior change and increased attention to the circular economy.

Aquaculture & Fisheries (Kletou, et al., 2022, Appendices I & J)

In 2021, the handful of aquaculture companies operating in Limassol Bay produced ~8,000 tonnes, worth € 43.8 million. This figure almost doubled from 2012 and quadrupled from 2005. The summer feed for each farm is ~2-3 tonnes per day, resulting in a mean Feed Conversion Ratio of 2.3.

As this industry is expanding, so too are the identified risks, such as

(a) Smothering and Siltation

(b) Eutrophication on benthos

(c) Sensitive marine habitat alterations

(d) Nutrient and organic enrichment in the water column

(e) Escaped fish predation on local fauna

(f) Negative interactions with uncaged animals

(g) Deoxygenation of underlying sediments (h) Litter

(i) Synthetic compound treatment contamination.

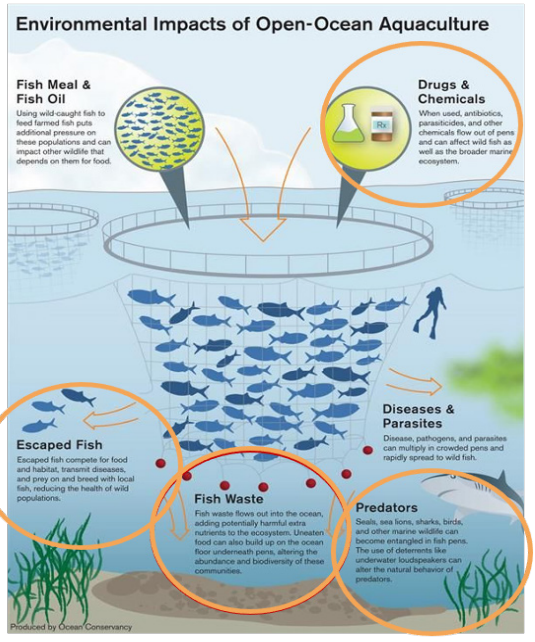

Figure 11: Environmental Impacts of Open-Ocean Aquaculture

The operating companies are investing in environmentally responsible practices.

Specific recommendations to reduce fish feed losses and mitigate environmental impacts include (a) Utilize technological advancements and innovate/diversify (b) Grow extractive species (c) Use nets without anti-fouling paints (d) Minimize littering by raising awareness of employees.

Similarly, at management level (a) Improve the environmental monitoring program (b) Synergistic approach to assess impacts (c) Move farms deeper and at least 1 km away from seagrass (d) Intensify controls/inspections.

The fisheries sector is in steady decline due to overfishing, invasive species, intensive trawling and low profitability. As a consequence, the contribution to GDP is relatively low. In 2021, Limassol shelters hosted: 57 full-time (A-B licences) small-scale vessels, 90 part-time small-scale vessels (C licence), nine polyvalent and two trawlers. In addition, there is estimated to be approximately 40,000 recreational fishers.

Activity is concentrated on the south-eastern coast, predominantly in and around Limassol Bay. The key risks are identified as (a) Removal of target species (b) Disruption to benthos (c) Removal of vulnerable, endangered, threatened and protected (ETP) species, (d) Unwanted landings and discards (other than ETP) (e) Litter and ghost gear.

Recommendations include (a) Reduce fishery pressure (b) Modifications of fishing gears (c) Compulsory education and training lectures (d) Enhance MPAs and protect keystone species (e) Cease trawling activities (f) Increase enforcement and penalties (g) Improved monitoring and data knowledge.

A Holistic Risk Assessment (Makrominas, 2022, Research Summary)

Typically, Environmental Impact Assessments (EIA) are conducted by projects and sectors within the process of securing the necessary licences for development. Each EIA considers the synergistic impacts together with other pressures occurring in the proposed area. Approvals are given by different authorities. This approach limits the ability to recognize and assess the complete picture of collective and total risk.

The risks identified in the sector studies of the Blue Limassol Environmental Risk Assessment were analyzed to identify the collective impact of an incident in one sector on each of the other sectors and Limassol Bay as a whole. Thus, through

researching industry good practice, recommendations for risk mitigation at a strategic level were determined for review by the key decision makers, to set priorities for subsequent cost/benefit analysis. Consequently, the major risks and sector interaction were highlighted.

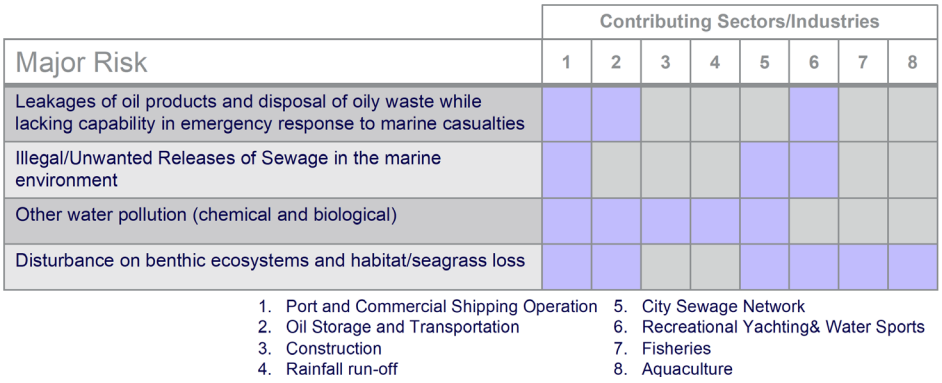

Figure 12: Collective major risks identified by the Blue Limassol Environmental Risk Assessment

The main contributory factors were identified as follows:

(a) Fragmentation of responsibility among many overseeing bodies.

The sheer number of regulatory and monitoring bodies identified in the study is a testament to the complexity of the current nexus of accountability. For example, while the Cyprus Port Authority, the Department of Fisheries and Marine Research and the Port Police are assigned the bulk of responsibility, all three institutions report to different Governmental Ministries. As a result, the partition of overseeing according to different activities and/or geographical areas inhibits coordination, transparency and awareness.

(b) Incomplete enforcement of extant regulations.

While a large number of polluting incidents have been recorded in the last 5 years, only a fraction of those (less than 20%) were deemed penalizable. Anecdotal evidence, from more than 350 additional citizens' complaints, indicate that even in cases where extant regulation is sufficient to alleviate pollution incidents the incomplete enforcement of the rules of play allows these incidents to persist and increase.

(c) Insufficient application of technology to reinforce areas of deficiency.

Enhancing the technologies employed to increase monitoring and enforcement is a necessary and potentially cost-effective way forward. The use of electronic logs for yachts entering/exiting the marinas, or the use of surveillance drones are such examples.

(d) Insufficient sampling capabilities to establish type of incident.

In line with technology gaps and a lack of conventional resources (i.e., sampling boats) the current inability to identify an incident, let alone provide an accurate measurement that establishes the type and source of pollution makes it difficult to enforce corrective actions.

(e) Absence of long-term planning.

Reactive legislation and ad-hoc decision making in periods of rapid growth has deprived the coastal area from carefully crafted long-term planning. The consequences of myopic policies are now beginning to show. The advent of High-Rise Buildings, compounded by additional coastal construction has not been subject to the local plan. The dispersion of High-Rises to non-preferential locations increases the uncertainty of the final impact of these buildings on the quality of life for ordinary Limassolians.

(f) Narrow focus on individual industries with externalities or spill overs.

Throughout our engagement with various stakeholders, it became apparent that although these stakeholders were, expectantly, knowledgeable about the pressures their industries exerted on the environment, there was little consideration or awareness about externalities, synergistic effects or spill overs on other industries.

(g) Limited environmental consciousness and education.

From beach littering, domestic waste disposal, abandoning fishing equipment, releasing sewage from recreational yachts, to dumping construction water or poor ballast water management, ordinary citizens and professionals alike have failed to develop a true environmental consciousness.

Conclusions

The Blue Limassol Risk Assessment Study offers a holistic identification and synergistic assessment of risk of all sectors operating across a common coast, a unique and innovative approach, implemented for the first time in Cyprus and

probably in Europe. This approach provides an opportunity to effectively manage the increased environmental risk of collective activity, to prioritise allocation of resources and improve capacity in implementing and executing mitigation solutions and practices.

A key benefit of the study was the engagement of stakeholders at all levels. The supporting narrative was positive and aimed toward working together on common issues, to achieve the best solution for the benefit of all. The intent and approach were well received and helped establish an invested stakeholder capital. Recommendations to policy makers and key stakeholders were presented in a series of dissemination events, followed by a public Blue Limassol Forum event in March 2022. Subsequently, the Ministry of Energy, Commerce & Industry and Deputy Ministry of Shipping who sponsored the Risk Assessment, agreed that an ad-hoc committee of relevant authorities and stakeholders be established, to assess the efficacy of the risk assessment recommendations and that the findings of the study will be considered during the development of the Cyprus Maritime Spatial Plan and 2030 Strategic Vision for Cyprus Shipping. Similarly, the Mayor of Limassol committed to addressing the findings in management and planning of developments in the coastal zone.

Throughout the investigation, the lack of integrated data proved to be a major obstacle in compilation of sector data and the completion of the risk assessment. The fragmentation of responsibilities in the water quality monitoring practices was also a constraint. Accordingly, a key recommendation of the researchers is a review of the relevant responsibilities and organizational structure to enable connectivity, supported by the creation of a new digital platform for the maintenance of related coastal environmental data. Whilst the research was driven by citizens concerns and findings shared with the public through conferences, media events and publication on the Municipality website, there is opportunity to improve active citizen engagement. Approaches and mechanisms to hear citizen views on identity, vision for their wellbeing in a coastal port city and active citizen decision making and stewardship are areas for further research.

Recognizing that environmental incidents do not respect maritime borders, the ongoing aim is to attract interest in this topic and create synergies. Presenting the findings at various events has resulted in neighboring countries in the Eastern Mediterranean collaborating to further the research. The intent is to confirm environmental performance indicators for robust sector comparison and replicate the risk assessment in other coastal cities. Sharing the new digital platform for this purpose will facilitate the integration with neighboring countries, offering

significant advantages through sharing of data, information and knowledge, leading to proactive and synergistic response to incidents impacting the region, such as the Syrian oil spill from Baniyas Power Plant.

Limassol Municipality has launched a center focused on the Blue Economy to drive innovation in areas of common priority, such as oil spill prevention, emissions reduction, digitalisation and the energy transition. By establishing a knowledge sharing network focused on risk assessment and leveraging the inclusion of Limassol in the EU 100 Cities mission, international collaboration can affect economies of scale in the implementation of known and new risk mitigation practices.

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THE IMPACTS OF CLIMATE CHANGE IN THE EASTERN MEDITERRANEAN – APPROACHES FOR ACTION BY EUROPEAN ACTORS

Stefan Lukas

When on November 3, 2022 a German delegation of business representatives led by the Federal Minister of Economics and Climate Change Robert Habeck concluded a deal with a number of Egyptian companies, this was hardly highlighted in the national or international press. This deal seemed too mundane. On closer inspection, however, it becomes clear that the German agenda on energy security issues is once again becoming a bit more detached from Russia – to the advantage of the new players on the international gas market in the Eastern Mediterranean. But it is not only the supply of LNG that Germany agreed on with its Egyptian partners. In particular, the investment of German companies such as Siemens in new hydrogen technologies in several Egyptian projects indicates that progress is also being made with regard to low-carbon alternatives and that the European partners are paving new and more climate-friendly paths for the future.[1]

That this is urgently needed and also in the interest of the actors in the Eastern Mediterranean is shown here, too, by events in Egypt – less than 200 km from the place where the treaty was signed. What the German-Egyptian journalist Karim el-Gawhary outlines in a series of articles about the coastal metropolis of Alexandria gives us a glimpse of a new dimension of advancing climate change. In the course of the climate-induced rise in sea level, large parts of the formerly wide beaches have been lost, forcing crowds of people to squeeze onto only a few square meters of sand.[2] At the same time, seawater seepage and a man-made subsidence effect are increasingly flooding urban areas near the sea, leading to the paralysis of the infrastructure there. Although the Egyptian government is now working on more effective coastal protection along the urban areas in the

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1 Dominic Ellis, Egypt and Germany strengthen LNG and green hydrogen links, *Gasworld*, November 7, 2022.

2 Karim El-Gawhary, Climate Change in Egypt: Alexandria or the sea?, *Qantara*, November 3, 2021.

Nile Delta, it is becoming increasingly obvious that the threat to the metropolis of Alexandria is much greater than the government in Cairo has long perceived.[3]

Both scenes from the same country show how ambivalent the relationship of many states in the region of the Eastern Mediterranean is in dealing with the now massive onset of climate change. On the one hand, many state actors are only now realizing the importance of promoting a more sustainable style of doing business. Although new studies and agendas for energy transformation have been developed in many places, also with the help of European partners, implementation in almost all riparian states falls short of what is necessary. On the other hand, climate change is making itself felt in ever greater dimensions - be it through rising sea levels, increasing salinization of soils, massive evaporation of surface waters, lack of rainfall or emerging water scarcity.

It is this combination of too late rethinking in the governments of the respective states and the faster than expected development of climate change that will also have a lasting impact on the state security structures on the ground. But it is not only for the local and regional partners that a rapid rethink is needed. Developments in the southern periphery also have a direct impact on the European community of states, which is why Berlin, Paris, Rome or Athens must also deal with the climate policy situation in Egypt, Israel, Lebanon or Syria. This chapter is therefore intended to provide food for thought for new approaches in European and regional climate and foreign policy and to show that only an international approach can lead to success.

Climate change as a gamechanger in the Eastern Mediterranean

In a region that is largely dotted with arid areas that have historically struggled with a constant lack of water, it is quickly apparent that access to water in particular is becoming increasingly critical as climate change accelerates. For example, the Washington-based World Resources Institute, which regularly collects a water stress test for almost all regions of the world, classifies all states in the Eastern Mediterranean in the water stress category "High" or "Extremely High".[4]

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3 Julie Emmrich, Koffi A. Koumassi, et al., Climate Governance: An assessment of the government's ability and readiness to transform Egypt into a zero emissions society, *Climate Action Tracker*, 2022, 6–7.

4 Rutger Willem Hofste, Paul Reig, and Leah Schleifer, 17 Countries, Home to One-Quarter of the World's Population, Face Extremely High Water Stress, *WRI*, August 6, 2019.

Nevertheless, the consequences and causes of this water shortage must be shown differently from country to country. Countries such as Syria, Egypt and Jordan are heavily dependent on fresh water from rivers. In addition to the Euphrates or the Nile, this also includes a whole series of smaller rivers, such as the Jordan or the Yarmouk. At the same time, all of these rivers harbor conflicts with neighboring states, as the sources are not located in their own countries, which means that water is increasingly being used as a political weapon. Turkey vis-à-vis Syria, as well as Ethiopia vis-à-vis Egypt and Sudan, have already used this political leverage in the past, which significantly worsened the situation in Syria in particular. In other states of the region, the interplay of enormous heat and the resulting evaporation influences an increasing shortage of water. For example, Egypt alone loses more than 10 billion m^3 of water per year due to higher solar radiation and poor irrigation systems evaporation. The situation is similar in Syria, where currently more than 2.2 billion m^3 of water per year simply evaporate.[5]

At the same time, the human-induced subsidence effect influences the fact that the currently still manageable sea level rise causes significantly greater damage in urban coastal regions than expected. The subsidence effect describes the subsidence of soils due to the pumping out of groundwater under cities until the 1980s. As a result, cities worldwide are sinking by several millimetres per year, which also affects Alexandria and Beirut.[6] Due to the increased water pressure as a result of sea-level rise and the subsidence of land masses near the coast, the probability of large-scale flooding has increased significantly.

But for regions such as the Nile Delta, where more than 40 million people live, many of whom are dependent on agriculture as a source of employment and supplies, sea-level rise poses a further problem: the rising water pressure from the direction of the Mediterranean Sea causes more saltwater to seep into the agriculturally valuable marshes of the Nile Delta. In combination with increased evaporation, the Nile Delta, which has been fertile for thousands of years, is suffering from increasing salinisation of the soil – with consequences for nature, the population and the economy. If the water flow of the Nile decreases even

5 Aurora Sottimano and Nabil Samman, Syria has a water crisis. And it's not going away, *Atlantic Council*, February 4, 2022.

6 Jana Kandarr and Mahdi Motagh, Coastal cities are sinking dramatically, *Earth System Knowledge Platform*, 2018.

further as a result of the new dam project in Ethiopia (GERD), this development is likely to accelerate significantly.[7]

For many regions of the Eastern Mediterranean, the decline of water as a resource goes hand in hand with a loss of economic and livelihood resources. Initially visible in the rural areas, the already strong rural exodus in the affected states eventually also affects the urban areas, where the arriving people are housed in mostly undignified conditions and often slip into unemployment. One of the first conflicts that can be attributed in large part to climate change is the war in Syria. Starting with a massive drought in the years 2001–2009, the Sunni rural population in particular had to move to urban centers such as Homs, Aleppo, Hama or Deir er-Zor, where they mostly encountered adverse living conditions and a repressive regime. At the same time, the drought that affected large parts of the Middle East led to an increase in local and regional food prices, which created additional pressure in society that ultimately resulted in the unrest of 2011 and the subsequent civil war.[8]

This effect is fuelled by a strong increase in population, which is accompanied by a higher demand for water and derived products for agriculture. While Egypt had just 34 million inhabitants in 1970, it had become the most populous state in the Arab world in 2021 with more than 104 million inhabitants. In states such as Israel, Lebanon, Syria or Jordan, population trends have also developed rapidly since 1970, often at the expense of national food and health systems.[9] The seriousness with which the authorities take this problem is shown by the statements of Egyptian President Abdel Fatah al-Sisi, who called in November 2022 for families to have no more than two children. Although population growth is gradually approaching a peak, it can be assumed that the combination of significant water shortages, a rising rural exodus and a worsening social situation in most urban areas will lead to an increase in distribution struggles. A similar situation can already be seen in Karachi, Pakistan, where, due to a dilapidated water infrastructure and a lack of rainfall, 60% of the urban population regularly suffer from water poverty and fight over the existing well systems, which in turn

7 El-Quilish, M., El-Ashquer, M., Dawod, G. et al. Development of an Inundation Model for the Northern Coastal Zone of the Nile Delta Region, Egypt Using High-Resolution DEM. *Arab Journal of Sciences,* 2022, 5.

8 Jan Selby, and Omar S. Dahi, Christiane Fröhlich, Climate change and the Syrian civil war revisited, *Political Geography*, 60, 2017, 232–234.

9 Data by United Nations Population Fund [accessed 13.11.2022].

has led to a significant increase in violent clashes – often fuelled by organized crime.[10]

But beyond water, the effects of climate change are also putting new pressures on societies in the Eastern Mediterranean. For example, regular hot spells with new highs of over 50°C create additional tensions in the respective health systems, which can be seen in the rising numbers of heat deaths, which particularly affect older, poorer and vulnerable population groups. As the human body exponentially loses working capacity at temperatures above 37°C and 60% humidity, the labor force in a country decreases with every heat wave, as various studies have already shown.[11]

The sharp increase in desert storms is also likely to fuel this trend. To explain: although sandstorms are not new to the region, according to the United Nations, the frequency and intensity of these sandstorms have already increased significantly and are expected to triple by 2050. Caused by damaged buildings and infrastructure, destroyed crops and high damages in the health sector, according to the World Bank, this resulted in damages of 13 billion US dollars in the Middle East in 2019 alone. And here, too, the future is clouded until 2050. Especially in the states of Jordan, Syria and Iraq, the number of days with sandstorms is likely to increase to up to 300 days a year due to climate change and intensive agriculture.

In a region that will heat up twice as fast as the rest of the world within the next 80 years and, according to current calculations, can expect an average temperature increase of 5°C, sustainable solutions must therefore be found urgently that are above all adapted to the new climatic conditions on the ground and avoid worsening the situation due to purely economic interests.[12]

Challenges and opportunities for European actors in the region

Due to the fact that hardly any large-scale investments have been made in energy transformation in Europe, but also in many countries of the Middle East,

10 Stefan Lukas, The Fight for water – Pakistan and the Consequences of Climate Change, *SIRIUS-Journal for Strategic Analyses*, 5(1), 2021, 57.

11 Damian Grimshaw, and Vic van Vuuren, *Working on a warmer planet – The impact of heat stress on labour productivity and decent work*, International Labour Organisation 2019, 17–18.

12 Zittis, G., Almazroui, M., Alpert, P. et al., Climate change and weather extremes in the Eastern Mediterranean and Middle East, *Reviews of Geophysics*, 60(3), 2022.

over the last 30 years, the pressure to act has grown immensely with regard to compliance with the Paris climate goals. At the same time, states on both sides of the Mediterranean are subsidising fossil fuels. Although the oil and gas-rich states in the Middle East are criticized particularly loudly in Europe, European actors should also first push ahead with the transformation in their own countries. Germany alone subsidises fossil fuels with more than 60 billion euros annually, while at the same time only a fraction of this money flows into the expansion of renewable energies.[13]

The data from the respective countries show that there is a great need for action to advance the energy transition, especially in the region of the Eastern Mediterranean. Countries such as Egypt, Syria, Jordan and Lebanon do not even obtain 10% of their energy from renewable sources. Even Israel, a high-tech country, supplied only 5.1% of its energy needs from renewables on an annual average in 2020.[14] The main reason for the stagnating expansion is the continued cheap gas and oil, especially since the exploration of new gas deposits in Egypt, Lebanon and Israel is likely to exacerbate this trend. At the same time, the conclusion of new gas contracts by European partners with the riparian states in the Eastern Mediterranean is encouraging the actors on the ground to continue exploiting their own gas deposits.

Against the backdrop of the aforementioned threat of advancing climate change in the region, regional and international actors must therefore ask themselves how an energy transformation towards greater resilience and sustainability can be achieved under the current framework conditions. This is a mammoth task that can only be solved internationally. Initial approaches to answering this question have already been made in the past. Large-scale projects, such as DESERTEC,[15] have already set the tone for joint cooperation in the expansion of renewable energies. A similar approach is now being taken in the hydrogen industry by European and regional partners. Germany in particular, under the leadership of the Green-led Ministry of Economics, but also France and Italy have

13 Gero Rueter, Gigantische Subventionen für fossile Energien, *Deutsche Welle*, May 25, 2015.

14 Hannah Ritchie, Max Roser, Pablo Rosado, Renewable Energy – Based on BP Statistical Review of World Energy, *Our World in Data*, 2022.

15 DESERTEC was a large-scale project launched by European and North African actors with the aim of strengthening the European and North African energy market with the help of renewable energies from North Africa. Thomas M. Schmitt, (Why) did Desertec fail? An interim analysis of a large-scale renewable energy infrastructure project from a Social Studies of Technology perspective, *Local Environment*, 23(7), 2018, 749–750.

initiated the first economic and research projects for the development of a joint hydrogen infrastructure. From a Middle Eastern perspective, Egypt, Israel and the Gulf States, which have the necessary infrastructure and financial resources, have already benefited from this. The main idea here is that European partners provide the know-how and scientific capacities, while the production of blue and later green hydrogen is carried out in the Middle East. Via the infrastructure, which is still to be developed, by ship or pipelines, such as the planned EastMed pipeline, the hydrogen will finally reach the European markets as a sustainable energy source.[16]

However, it must be mentioned that all of these projects are still in their infancy and, according to calculations, will probably only be economically viable in 15-20 years. The availability of water, which is needed in large quantities for the production of hydrogen in hydrogen electrolysis, is also a huge problem. Likewise, the massive expansion of desalination plants in Israel, Egypt or the GCC states cannot be a solution for this so far, as they are extremely energy-intensive. The operation has so far relied on fossil fuels and the disposal of the waste products in the process has still not been solved. Here, the Middle Eastern partners are hoping very much for technological solutions from Europe, which is why this is a great opportunity for scientific institutions. So it becomes clear that waiting for a profitable hydrogen industry would take too much time – a luxury we no longer have in the meantime.[17]

If one wants to reduce CO2 emissions in the countries of the Eastern Mediterranean and at the same time create an effective incentive system for the governments in these countries, only the conventional renewable energy sources of wind and sun can be considered. Not only do almost all states in the region have sufficient expansion capacities in this area, but all the technological prerequisites are already available. By expanding wind and solar energy, Egypt alone could produce more than 83 MW of electricity by 2027, which would cover 53% of its own energy needs.[18] At the same time, it would be possible to export energy via grids, which could create a new market in the region similar to the European energy grid, which could strengthen energy resilience in the entire

16 Laurent Ruseckas, Europe and the Eastern Mediterranean: the Potential for Hydrogen Partnership, *SWP-Comment*, Vol. 50, German Institute for International and Security Affairs (SWP), 2022, 4–6.

17 Ibid. pp. 7–8.

18 US-International Trade Administration, Egypt – Electricity and Renewable Energy, August 08, 2022.

region. Countries such as Saudi Arabia and Israel have been trying to build such a grid for several years, but with only moderate success so far. Since a large part of the components for renewable energies now come from China, it would therefore be necessary for Europe to significantly expand its own manufacturing capacities here as well, and not only in its own interest, to seek new cooperation with the actors in the Eastern Mediterranean.

Since the consequences of climate change are already omnipresent in the region, governments on the ground must also adapt to the new conditions and create new resilience as best they can. Here, too, European institutions and actors can provide support. Programmes such as the EU-funded Cascades programme can serve as a model here. Through risk screening and risk management, fire brigades, urban planners and disaster relief can be more quickly and effectively deployed in the respective risk areas and upcoming climate-induced hazards can be recognized at an early stage. Since this requires a networked approach of regional expertise, high computing power and climatological knowledge, the security-relevant framework conditions for European scientists must be guaranteed, especially in countries such as Egypt and Syria.[19]

If the current developments in the global CO_2 budget continue as they have and we are heading for a 3°C warmer region in the Eastern Mediterranean in 2050, the weather extremes described above will become much more intense. Since any system is only capable of adapting to a limited extent over such a short period of time, the states of Europe in particular will be obliged, again for their own interest, to provide financial support to particularly damaged states. Not only because of the historical responsibility of states like Germany, which have cumulatively contributed a very high share to the global CO_2 budget, the European Union and other nation states must have an interest in ensuring that states like Egypt, with its more than 100 million inhabitants, remain stable. Funds for compensation and disaster relief, such as those recently agreed at the UN Climate Change Conference in Sharm el-Sheikh in November 2022, can only be a first approach here.

Outlook

As much as efforts at the local and regional level can provide a basis for further projects and trigger future investment funding, the following premise still applies: If we do not also succeed at the international level in agreeing on globally

[19] For more information on effective screening mechanisms, view the joint project Cascades [accessed November 14, 2022].

effective measures to reduce CO_2 emissions, it will be almost impossible for us to adapt sufficiently to runaway climate change in the coming decades. This includes pursuing a more ambitious agenda at the next UN climate conference in the United Arab Emirates than the one recently held in Sharm el-Sheikh, so that at least the 2°C target set in Paris can still be met.

Since the global climate system is extremely inert (CO2 remains in the atmosphere for more than 1000 years), all options for action must also be designed for long-term application. As a result, societal and economic change is also needed in the countries of the Eastern Mediterranean, which should be socially acceptable, but as a consequence should make societies and state structures in particular more resilient and resource-efficient. New irrigation methods such as drip irrigation, which was developed in Israel in the mid-1970s, should therefore not only lead to an increase in economic efficiency, but also to a more responsible use of water as a resource.[20]

Although climate change has not yet been the source of conflicts in the region, but is mostly seen as an accelerant for already existing conflict hotspots, this circumstance may be reversed within the next decade. The tipping points for such a reversal are already visible wherever natural resources are running out and distribution struggles are growing in intensity - be it in the Iraqi marshes, the Nile Delta or along the Jordan Valley. To ensure that this does not happen, the European partners must also live up to their responsibility and support the actors in the Eastern Mediterranean in adapting to the new climatic circumstances and reducing fossil energies.

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20 Lorenzo Rosa, Davide Danilo Chiarelli, and Matteo Sangiorgio, Potential for sustainable irrigation expansion in a 3°C warmer climate, *PNAS*, 117(47), 2020.

This joint publication by the Maritime Policy & Strategy Research Center (HMS) and the Konrad Adenauer Foundation (KAS) examines how environmental challenges in the Eastern Mediterranean could catalyze either conflict or cooperation in the region. The chapters discuss the theoretical challenge of climate change to the existing models, the concepts of regional cooperation and conflict, the devastation created by the Syrian civil war, monitoring pollution in the Aegean and Ionian seas, challenges at the Limassol Bay that initiated government-academic cooperation, and European actors' actions facing climate change in the Eastern Mediterranean. The articles emphasize the need for cooperation at different levels - intranational, regional, and international - to cope with environmental challenges.

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