Climate Change and Environmental Migration Case Studies that Indicate Potential Future Movements due to Climate Events: Austria, Greece, Spain, and the United States

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Abstract

Climate changes are becoming more and more noticable. The number and frequency of extreme climate events such as fires, floods, storms or earthquakes are rising. Many of them are related to the increase in the average global temperature. While direct ecological effects seem to be obvious, the impact on cultural, economic, and social patterns must also be considered. Based on Sustainable Development Goal 13 (SDG 13) “Climate Action” this paper therefore investigates the relationship between climate phenomena and migration. It explains the concept of climate migration and displacement. It takes a look at four Northern Countries (Austria, Greece, Spain, United States) and analyzes climate events that happened in 2021, and its effect on migration as well as their economic, social, and cultural ramifications and future trends. As data refers to events of 2021 statistics may not have recorded adequate migration patterns. Still, there is a trend towards internal and short-term migration visible. Taking a deeper look at commonalities among these countries, the paper emphasizes the comprehensive nature of this phenomenon and shows the intertwined nature of SDGs. The paper therefore tries to raise awareness on the topic of climate migration and the increasing urgency to take actions and to build future adaptation strategies.

Keywords : Climate, Environmental Migration, Climate Action, Climate Change, Climate Events, Sustainable Development Goals, and Migration

Introduction

Our planet has always experienced changes in the processes that take place both on the surface and within the Earth and in its atmosphere. However, with urbanization and the expansion of human activity, climate change has begun to become more noticeable over time. In recent years, the effects of climate change –increase in the average global temperature, extreme phenomena, ice melting, etc.– have become a front line issue that affects not only biodiversity, but also humans (Global Climate Change, 2022). Large-scale earthquakes, fires or floods are only some of the manifestations of climate change that have already shown its impact in forest land, residential areas, crops, businesses or property, leading to the so-called ‘environmental migration’. This phenomenon, although widely ignored among popular conscience, constitutes the first cause of world-wide internal displacements and it’s, thus, a major source of alteration of all humans’ living conditions (Internal Displacement Monitoring Center, 2021, 12).

Environmental migrants have been described as “persons or groups of persons who, predominantly for reasons of sudden or progressive change in the environment that adversely affects their lives or living conditions, are obliged to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their country or abroad” (IOM, 2007, 1). While sudden and extreme phenomena that produce macro-level displacements, especially in the Global South, seem to be perceived as the primary source of climate migration, the internal migratory consequences of gradual environmental changes appear to be overlooked in Northern Countries. On the contrary, far from being circumscribed to some remote Global South areas, current events suggest that climate phenomena arise and arouse the need for responses in the Global North.

Within the UN SDG 13 “Climate Action” framework, this paper focuses on raising awareness about the impact and implications of environmental migration in our cultural, economic, and social patterns, showing the intertwined nature of SDGs. In this spirit, the paper studies the extent to which climate migration is an issue of increasing saliency across the world. With this aim, the study seeks to evidence the increasing presence and prominence of climate migration in Northern countries, to observe the relationship between climate phenomena and migration, to identify the impact of climate change and climate migration on the socio-cultural and economic realm and, thus, on other SDGs, and to raise awareness about the comprehensive nature of the problem.

The first section of the paper focuses on the concept of climate migration, outstanding and remarking its different elements from a wide-ranging approach. The second section displays the situation in four different countries: Austria, Greece, Spain, and the United States. It analyses already occurred climate migration events and their economic, social, and cultural ramifications, as well as current climate trends embodying a potential risk to unleash similar consequences. This is followed by a reflection on the commonalities among the four countries that highlights the far-reaching nature of this phenomenon, as well as its comprehensive impact in SDGs, beyond number 13. Finally, the last part of the paper gathers the authors’ conclusions on climate migration, trying to highlight the need to raise awareness on the topic as a first step towards a solution of alerting and increasing the sense of urgency among current generations, as the basis for future education strategies.

Methodology

This research is based on the Sustainable Development Goal 13 “Climate Action”. Within this goal it focuses on the specific topic of climate migration. As already mentioned, this paper displays the situation in four countries in the Global North: Austria, Greece, Spain, and the United States. It analyses climate events that happened in those countries in the last two years and their economic, social, and cultural impacts including effects on migration and displacement.

Due to their respective nationalities, the choice of these countries as case studies results from the authors’ intimate knowledge about them and personal connection. Besides, these countries share as a common element the internal rather than external climate migration. It allows a

comparison to find commonalities and differences between these countries and enables a comprehensive view and an accurate answer to the research objectives. However, the focus on four countries of the Global North limits the scope of obtained information and, therefore. the chosen case studies cannot serve as an immediate representation of the whole of Europe, the United States, nor global perspectives.

The study´s data refers to events of the last year (2021) that may not have recorded adequate migration patterns (i. e. statistics), as internal migration appears to be more common and often short-term, or where direct migration patterns will only be visible in a few years. This accentuates the need for identifying current trends as well. In consequence, the paper looks not only at determined statistics or data, but also tries to detect relationships between them to get the required information.

All the information has been retrieved from a variety of sources which include institutional reports, national statistics and international databases. Facts have also been collected from different newspapers which, although they might not provide scientific and neutral evidence, have sufficiently served the purpose of this paper. Nonetheless, a disclaimer needs to be done in this regard, as the information retrieved from these sources might not be entirely accurate.

Climate Migration: A First-order Cause of World-wide Displacements

Climate migration is defined as the movement of individuals and groups of people who, either compelled or voluntarily, decide to leave their habitual residence, permanently or temporarily, as a consequence of sudden or progressive environmental changes that affect their living conditions (Chazalnoël and Randall, 2021, 21). As the authors exemplify, the definition of climate migration is wide and flexible, encompassing not only the most visible long-term displacements caused by extreme events, but also those provoked by the slow and progressive deterioration of living conditions due to environmental changes. In addition, the concept refers to relocations that occur both within the State and across international borders (2021, 21).

In 2020, 30.7 million people were displaced due to climate related phenomena, the highest number of its historical record. Indeed, in contrast with the popular belief, environmental issues are, by far, the main cause of human displacements, accounting for more than three quarters of them in 2020. Among the latter, only 2 % responded to geophysical factors, while the remaining 98 % were produced by weather-related hazards (Internal Displacement Monitoring Center, 2021, 12).

Figure 1: Number of Displacements in 2020 in the World (Internal Displacement Monitoring Center, 2021)

Unfortunately, climate migration is not simply about the displacement of citizens due to hurricanes, wildfires or tornados; it is also about abandoned territories, altered livings and uprooted human beings. Its consequences pose a challenging threat for the accomplishment of the universally agreed 2030 Agenda beyond SDG 10, whose seventh target points to facilitating "orderly, safe, regular and responsible migration and mobility of people" (United Nations, 2022). Although no explicit reference to migration is made in the remaining 16 global objectives, climate induced movements entail social, economic and cultural disruptions that reveal the "mutually supporting relationships" between this phenomena and SDGs and that, thus, hinder the advancement towards all the 17 goals (Migration Data Portal, n.d.).

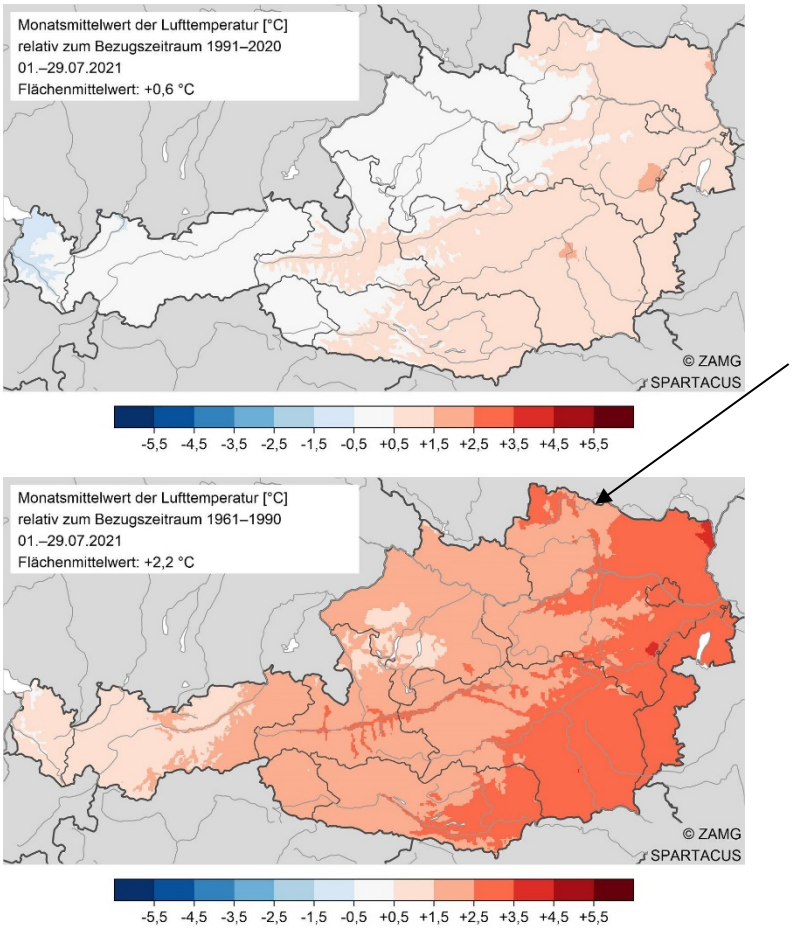
In this sense, even if massive displacements provoked by extreme phenomena in developing countries seem to be at the forefront of climate migration concerns, and even if, indeed, numbers point to countries in Sub-Saharan Africa and the Middle East and North Africa as the most affected by it (Internal Displacement Monitoring Center, 2021, 12), the internal low-scale movements produced by the progressive deterioration of environmental conditions in Northern countries are equally an alerting reality that bode ill for the achievement of the global agenda.

Climate Migration in Austria, Greece, Spain, and the U.S.

Austria: Flooded Lives

On July 30, 2021, huge floods occurred in Styria, in the Southeastern and central part of Austria, especially in and around the city of Graz. In that area, July 2021 was one of the warmest (3rd) in the history of measurements. In the south of Austria July was between 20 and 50 % too dry, with 10 to 40 % more heat days with temperatures over 30°C (ZAMG, 2021). This is also accentuated in Figure 2, where a comparison to the periods 1961-1991 and 1991-2020 is depicted. As the picture shows, the mean temperatures are nearly everywhere too high. The black arrow points at Styria, where the changes are extremely noticeable.

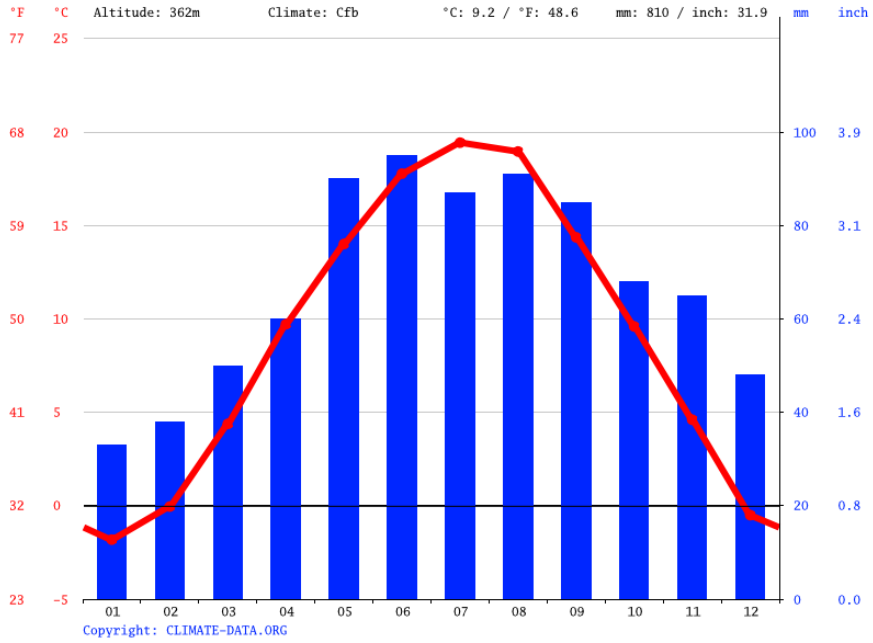
Figure 2: Mean Temperatures in °C in Austria - a Comparison of the Periods 1961-1991 and 1991-2020 (ZAMG, 2021)



By rising temperatures, especially after a long warm period, there is more steam causing more moist air and the development of big clouds, which in turn can lead to intense rainfalls and thunderstorms. Before this happens, the weather is mostly sticky (Malberg, 2007, 159). Furthermore, vertical movement of air also pushes thunderstorms to develop (Glaser et al., 2010, 82). Rainfalls with big drops and high intensity, affecting just a small area are also called convective precipitation (Glaser et al., 2010, 136). These short intense rainfalls are an increasing phenomenon, leading to small-scale floods (Science ORF, 2021). Additionally, due to the previous dry period, the water cannot seep away easily.

In July 2021, media reported extreme amounts of precipitation of more than 100 liters/qm (Kurier, 31/07/2021). The following graph in Figure 3 shows a climate diagram for Graz, the main city of Styria. It reveals that the average amount of precipitation in July is between 80 and 90 mm, which equals to 80 and 90 liters/qm. This means that, in the evening of July 30, 2021, the amount of rainfall largely exceeded the average amount of precipitation of the whole month.

Figure 3: Climate Diagram of Graz (Climate-Data.org, 2021)



The floods led to different problems in urban and rural areas, not only being of ecological nature, but also economic, social and cultural. Its relevance becomes apparent when looking at the news at that time: many newspapers and social media channels reported about failures in infrastructure, material and property damages. These impacts were rather short-term, but still of a high significance for the affected population.

One message was striking, as there are almost never messages of that kind in Austria. In Graz, the capital city of Styria, several main streets were flooded. The sewer system was overloaded and water could not be held anymore. This also led to flooded basements and ground floors. As a consequence, the Grazer security management called the population up to not leave their houses, to not drive their cars and to avoid flooded areas and sources of electricity. Additionally, many trees fell over and damaged caras and power lines. However, it is said that most damage could be avoided by the numerous retention basins around the city (Kurier, 2021).

While the above mentioned problems did occur in urban as well as in rural areas, the latter were also affected in agricultural terms. These intense floods and heavy rainfalls also caused huge damages in agricultural areas, which seem to be even of higher importance, as they do not only cause short disturbances but a seasonal impact in terms of decreasing yields, lower quality of the crops and also pest invasion (BMK, 2021).

Figure 4: Destroyed Pumpkin Fields (Reinbacher, 31st July 2021)

Looking at this kind of event, induced by the previously mentioned climatological trends, we can predict that the economic costs (damages in infrastructure, agriculture, etc.) are, and will be, rising in the future. For instance, it can be assumed that, in the long term, the number of insurances (crop and hail insurances, private health insurances, ..) will rise as a response to climate change or, rather, its impact.

Regarding migratory consequences, even though extreme climate phenomena like the described floods destroy houses and infrastructure, or have a negative impact on agriculture and its harvest, people in Austria tend neither to leave the country nor to leave the region they are living in. In other words, adaptation to these new circumstances and rebuilding their homes is preferred over migration.

Still, this kind of event is compulsory connected to short term, internal migration that does not usually seem to be present. This can be proved by the following statistics: in 2020, in all federal states in Austria, more immigration than emigration occurred. Concerning internal migration within Austria, statistics show that in 2021 (until now) there was more internal immigration than internal emigration in Styria, following nearly a balanced development (Statistik Austria, 2021).

However, an internal migration from cities to rural areas can be noticed. This is shown in the following Figure 5 (Statistik Austria, 2021). The same statistics also show that young people (age 18-26) tend to move to cities, whereas all other age groups prefer to leave cities. It can be assumed that heatwaves are one of the reasons why people in cities tend to migrate to surrounding regions, as they have an even greater impact in cities.

Figure 5: Internal Migration in Austria 2020 (Statistik Austria, 2021)

To sum up, climate events do not yet have an enormous impact on migration within Austria. At least, there have not been recorded adequate migration patterns. Apart from that, there is no clear connection to find between climate changes and migration within Austria.

This specific case study, however, is of local and regional impact and usually does not pose a risk at national, international or global scale. However, the solutions on a local level can also serve as a solution in other parts of the world. The implication of successful solutions may even lead to a reduction of climate change induced migration in poorer countries.

Greece: Running Away from Fire

In the summer of 2021, Greece experienced a devastating fire season with heat waves being the most intense in the last thirty years, and temperatures reaching 45°C (EFFIS, 2021). Specifically, the summer of 2021 was the hottest in the last 43 years. Between July 27 and August 6 the heatwave that occurred lasted 188 hours. As the scientists of the National Observatory of Athens explain:

“The cause of the intense and prolonged heatwave is the movement of the jet stream, a powerful air current located about 10 km above the earth's surface and moving from west to east. In recent days, the jet stream have been found to be displaced further south of their mean climatic position in the Western European region, which has also resulted in the development of a high pressure field over our region and a gradual rise in temperature (2021)”

The increased temperatures in combination with the heatwaves contributed to the outbreak and expansion of hundreds of mainly forest fires, ranking the summer of 2021 the most devastating summer of the last 13 years (National Observatory of Athens, 2021). Greece mapped 84 incidents of forest fires which burned a total area of more than 1.300.000 acres. This performance is the worst of the 2008-2021 period , as it approaches almost the sum of the burnt areas of the 2013-2020 period. It is worth noting that the average burned area per forest fire in Greece until 2020 was 500 acres, while in the summer of 2021 the average performance exceeded 1.500 acres (EFFIS, 2021).

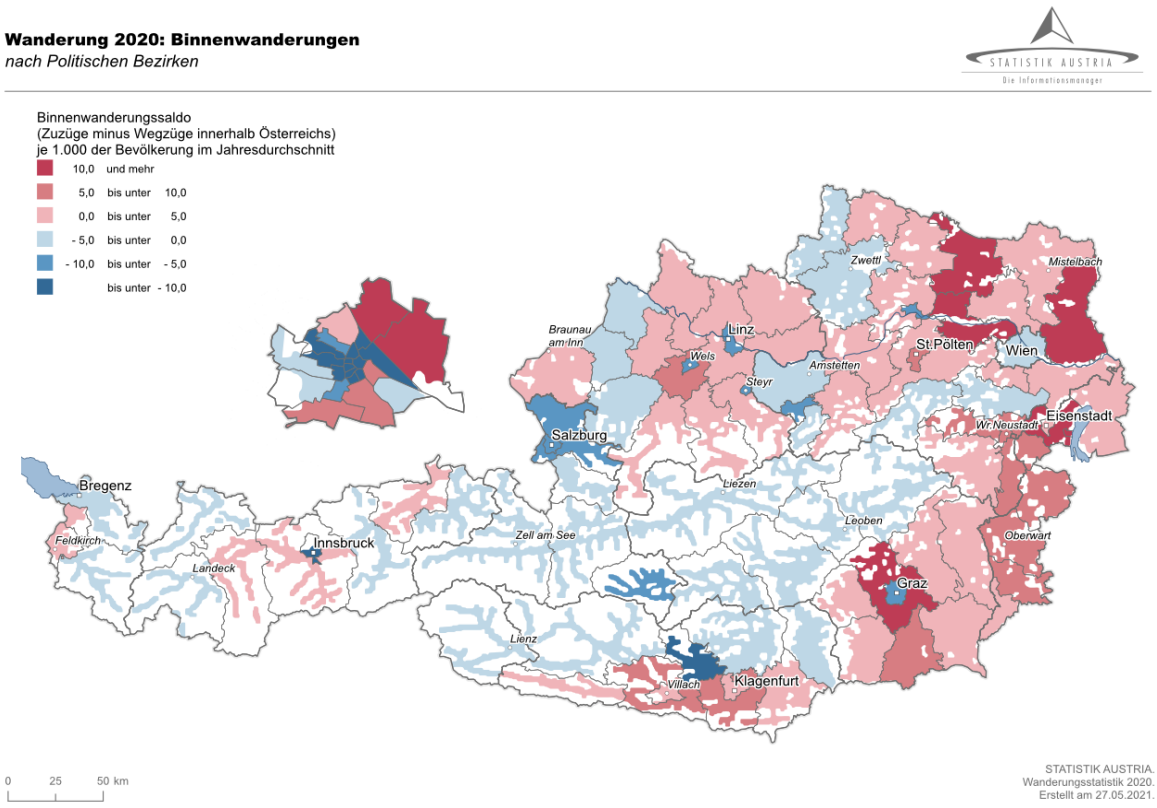
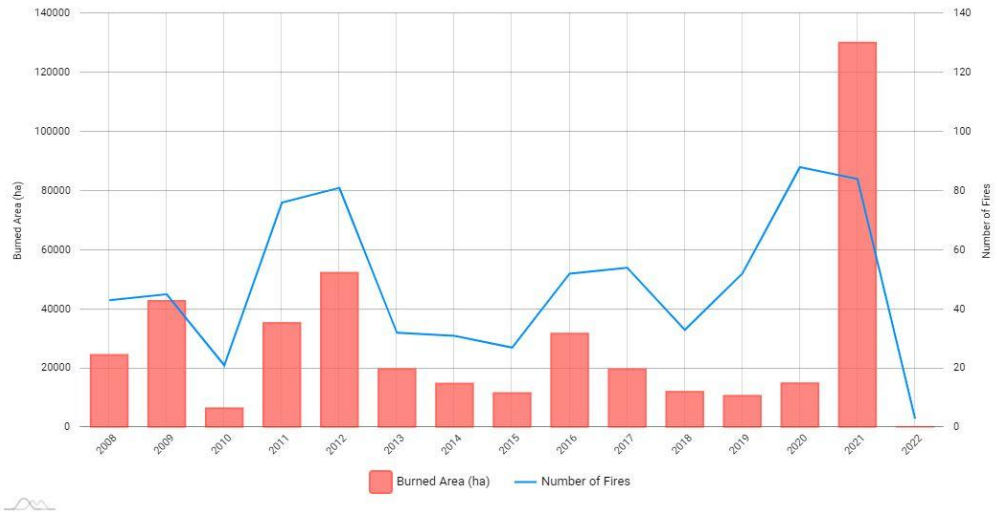


Figure 5: GWIS Annual Statistics for Greece (Copernicus Europe´s Eyes on Earth, 2022)



The fire brigade recorded fires in the Prefecture of Attica (Eastern Central Greece), in North Evia Island, in Ilia (Western Greece) –where the archaeological site of Olympia was also in danger–, in Messinia (Southwestern Greece), in Mani (South-Epirotic Greece), in Achaia (Peloponnese,

Southern Greece), in Grevena (Western Macedonia), in Salamis (island near Attica), in Fokida (Central Greece), as well as in the islands of Rhodes (see figure 6).

The most devastating fire that evolved into a mega fire was that of Northern Evia, with a total burned area of 66.000 acres (EFFIS, 2021). Evacuations were carried out in many areas and villages, as well as in Athens. In Northern Evia, hundreds of residents were even evacuated on ferries and fishing boats as the wildfire reached the sea (BBC News, 2021).
The fires burned forest areas, agricultural lands, residences, businesses, as well as many wild and domestic animals which either did not manage to be saved due to the rapid spread of the wildfire or were trapped in the estates of many livestock breeders who had to leave to save themselves.

Figure 6: Greece and the Fires of 2021 (Greek City Times, 2021)

Figure 7: Wildfires in Vilia, Attica (Charokopio University, 2021)

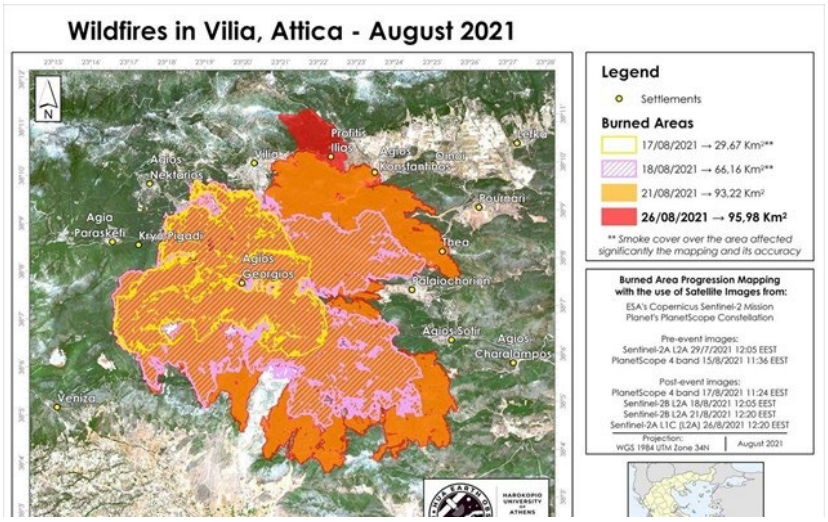
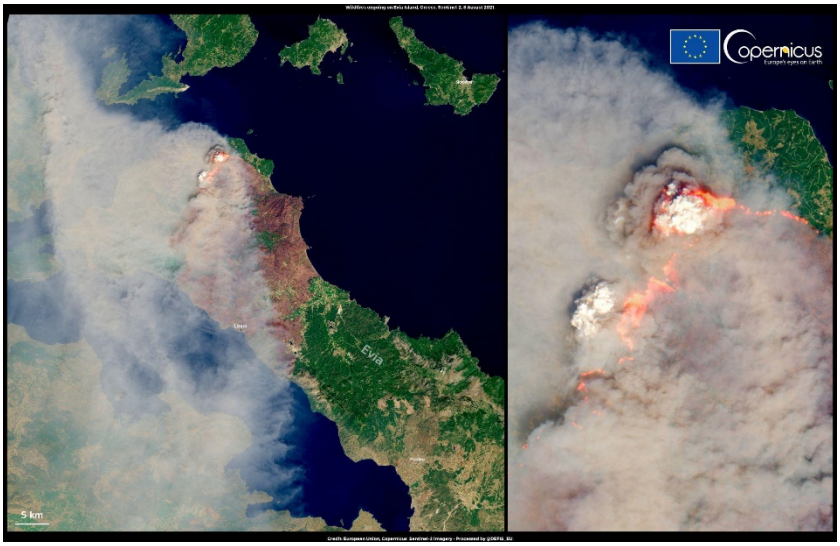


Figure 8: The Ongoing Wildfire on the Island of Evia in Eastern Greece (Copernicus Sentinel-2 satellites, 8th August 2021)



During the fires, Greece provided 71 firefighting equipments, while due to the uncontrolled and critical situation it activated the European Civil Protection Mechanism and received emergency reinforcements from 11 member countries of the European Union (Austria, France, Germany, Spain, Croatia, Cyprus, Poland, Romania, Slovakia, Czech Republic and Sweden), as well as from 13 other countries (Egypt, Switzerland, U.S., United Kingdom, United Arab Emirates, Israel, Qatar, Kuwait, Moldova, Ukraine, Russia, Serbia and Turkey) (Kathimerini newsroom, 2021).

Figure 9: The Coastguard Moved 650 People from Limni, in the North of the Island of Evia (BBC News, 7th August 2021)

Figure 10: Firefighting (REUTERS/Alexandros Avramidis, 2021)

The increased temperature, soil moisture conditions and the presence of trees and shrubs were catalytic factors for the creation and reinforcement of fires. In addition, changes in the climate with

hot and dry conditions led to the drought of organic matter in the forests, resulting in the fires spreading faster and becoming even more powerful. Another factor that led the spread of fires, mainly in forest areas, was forest management by the inhabitants of those neighborhoods, as the accumulation of huge amounts of vegetation, houses and other infrastructures in risky areas resulted in the increase of fuels and the reinforcement of fires, making them powerful and destructive in their path (C2ES, 2021).

Mediterranean countries such as Greece may be adapted to fires (rapid recovery of forests and vegetation), but the continuous increase in the intensity of fires due to climate change points to a huge threat and danger for its economy, society and culture. The devastating effects of wildfires are found in the flora and fauna of the ecosystem, in human property and infrastructure, in agricultural and livestock income as well as in health (both physical and mental) (WWF, 2022).

In this sense, the high temperatures caused by fires lead to soil erosion. As there is no vegetation, the absorption of water becomes increasingly difficult and, as a result, there risk of flooding increases in case of rain. On the other hand, a large percentage of animals benefit from vegetation and, once it is burned, there is a lack of food to feed them (2022). It is worth noting that as mega fires destroy the vegetation of an ecosystem, it has terrible effects on farmers and ranchers, since agricultural and livestock income is directly dependent on the breeding of animals, as well as the cultivation of land. As a consequence, it can be stated that the Greek economy gets completely affected by the fires, as the exports of agricultural products account for one third of the country's total exports, while this sector contributes to 4.1% of Greece's GDP (SelectUSA, 2019). The local production system (timber, apiaries), as well as tourism, are also largely affected by this phenomenon, as most of the burnt forest areas were natural landscapes of high aesthetics with a huge biodiversity of wild animals and birds.

In parallel, the devastating effects of fires affect people's physical and mental health in the short and long term. The increase in the levels of CO_2 (carbon dioxide), PM_{10} (particulate matter) and O_2 burden in the atmosphere cause health issues, being mainly of respiratory nature. In this concrete case study, the psychology of the people of both, those who immediately experienced the disaster, and of the volunteers who contributed by any means to the extinguishing of the fires and the support of the affected residents (medical care, hospitality, provision of food and necessities) was affected to a huge extent, causing traumas that are difficult to recover. The moments they experienced will remain etched forever in their souls, especially in the vulnerable groups (the elderly) as they suffered a mental shock seeing their property covered by flames.

When it comes to wildfires, control and treatment is difficult and especially in Northern Evia it was impossible. The flames with the help of the heat wave on the days of August and the high temperatures became uncontrollable. The important thing in such cases is proper prevention. Unfortunately, in Northern Evia and Attica there was no proper and comprehensive prevention in case of a mega fire. There was a lack of fire lanes, there were not enough patrols and water tanks so that the fire authorities did not have time to reach all the fires that broke out at the same time. "We were waiting for the fire brigade, which never arrived and as a result I drove my family away

and saved my house from the flames on my own along with three other residents", testifies a resident of the village Kiparissi (North Evia).

Despite all the difficulties experienced by the affected areas, the struggle of the volunteer groups that were set up during and after the fires and that still persists is very important.

Apart from the weaknesses and mistakes made, the actions that were taken in the following days after the fires were extinguished should be noted. The main ones are the following:

A) 6th September 2021: creation of the first Ministry of Climate Crisis and Civil Protection in Greece by the government of Kyriakos Mitsotakis, the Civil Protection, and the Fire Brigade. The purpose of the General Plan of Civil Protection is the effective confrontation of destructive phenomena for the protection of citizens and the natural environment (Ministry of Climate Crisis and Civil Protection, 2021)

B) 10th August 2021: establishment of the "Special Committee for the Reconstruction of Northern Evia" headed by Mr. Stavros Benos in collaboration with the non-profit Association "DIAZOMA". The aim of the Committee is the restoration of the burnt North Evia through a holistic and anthropocentric program. Specifically, its actions focus on environmental regeneration (reforestation, creation of a forest nursery, opening of paths), infrastructure (construction of a new road axis), support for residents so that they do not have to migrate, entrepreneurship, urban plans, culture, tourism, and the governance system (Reconstruction Program of Northern Evia, DIAZOMA, 2021).

Figure 11: Eftixia Papoulia (ALPHA Free Press, 6th August 2021)

Figure 12: Satellite Image from NASA, Wildfires from Greece (8th August 2021)

Spain: A Warming Economy

The Spanish Commission for Refugee Aid (CEAR) and Greenpeace warn that Spain is not either exempt from the impact of climate change; rather, its socioeconomic and geographic characteristics make it highly vulnerable to this phenomenon (CEAR and Greenpeace Spain, 2021, 24). According to National Geographic, due to its location in the Mediterranean basin, Spain is likely to be one of the most affected countries, especially in regards to the increase of temperatures (Crespo Garay, 2021).

By the middle of the year 2021, the country had already doubled the number of major fires[1] recorded in 2020 (Greenpeace, 2021), and even if the balance of the year resulted positive compared to the average of the last decade, Spain witnessed one of the largest wildfires of its history (Ministry for Ecological Transition and Demographic Challenge (MITECO), 2021). On August 14, a car wreck in the road of Navalacruz, in the Province of Ávila, led to a twelve day long wildfire that burnt over 22.000 hectares, causing the displacement of around a thousand people (The World News, 2020). Despite the main cause of the event being a car accident, the events that followed were nothing but a manifestation of the impact of climate change in Spain.

Experts state that the rise of temperatures, the enlargement of the climatological summer and other phenomena like torrential rains or dry winds caused by climate change are a first order agent in wildfires in the country. Concretely, instead of the root triggering cause, they rather embody an aggravating factor. In other words, as also shown in the case of Greece, what scientists foresee is that, there will not be more wildfires due to climate change, but worse ones

[1] Understanding major fires as those that affect more than 500 hectares.

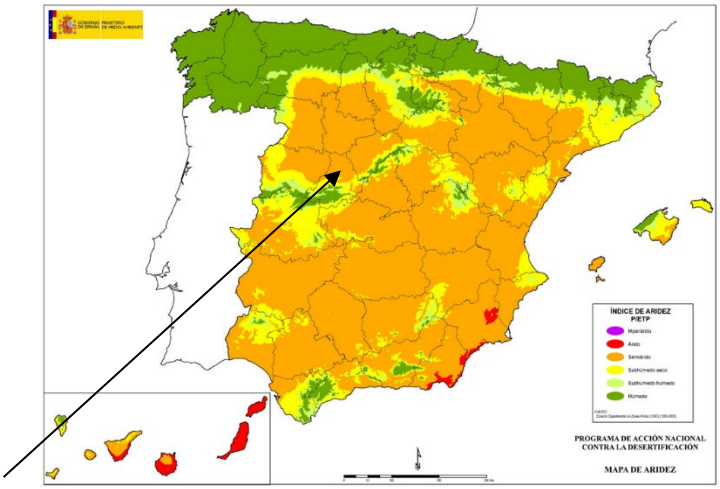
(Romero, 2021, 65). Indeed, going back to Navalacruz's case, on August 14, 2021 the municipality registered a record temperature of 38,8ºC at day time and 38ºC at night, accompanied by a moisture content of 2 % and wind gusts of 70 km/h (Europapress, 2020).

The events of the last decades show that the rise of temperatures is an already tangible reality in Spain, where temperatures are 1,5ºC over preindustrial times (Greenpeace, 2021). Data reveals that eight out of the ten warmest years in the country since 1961 occurred in the XXIst century, seven of them being in the 2011-2021 decade. Indeed, 2020 was the warmest year of the historical record after 2017, when the average temperature was 1ºC above the average between 1981-2010. Accordingly, the number of record heat waves is currently around eleven times higher than that of cold waves (State Meteorological Agency, 2020, 5).

Nonetheless, the impact of climate change is beyond the already realized manifestations; experts' predictions for the upcoming years highlight that this phenomenon constitutes a risk both in the present, and mostly in the near future. It is expected that if emissions continue at an intermediate level, the temperature will rise around 2ºC by the end of the century, and if these reach higher rates, the increase will be that of 5ºC (2020, 1). In the light of these considerations, it seems accurate to claim that the threat of climate change for Spain is not only climatological, but that it also extends to its social, economic, and cultural dimensions. As the case of Navalacruz shows, people will be forced to move to escape from the damages caused by climatological episodes, such as those of extreme events. However, these will not be the only source of displacements; the progressive and unconscious alterations produced by the increase of temperatures will, indeed, be a pivotal cause of internal migration in Spain.

For instance, the risk of desertification, soil degradation, floods or droughts caused by the increase of temperatures pose a significant threat for the agricultural and ranching industries in the country. The prolongation of summer temperatures, which leads to earlier flowering and harvests, is expected to cause a redistribution of crops in the long term, displacing most of the affected harvest to Northern areas (Sanz and Galán, 2021, 79). At the same time, higher temperatures will be followed by a higher demand of water resources, which, linked to the expected lower availability of the latter, is likely to provoke water deficits in the crops, decreases in production, and losses of harvests (2021, 80). For example, regarding the cultivation of olives, the predictions are that in the 2030-2050 period the productivity of watered and dry land groves will decrease by 3,5 % and 7 %, respectively, compared to the 1980-2009 timeframe (2021, 82). In parallel, extreme events and the rise of minimum temperatures in summer are also likely to produce episodes of thermic stress to animals, reducing their comfort, feeding and production. At the same time, the decrease of water availability will hinder their ability to relieve such stress, which adds to the foreseen variations in disease patterns and plagues (2021b, 85).

Figure 13: Map of Aridity in Spain(Ministry for Ecological Transition and Demographic Challenge, 2022)



Ávila

In Spain, over 23 million hectares – *i.e.* almost half of its territory– is destined to agricultural activities, of which around 17 million are occupied by crops. Regarding the ranching industry, data reveals there are over 25 million heads of pig and over 16 million heads of cattle (MITECO, n.d.). Although the share of the Spanish GDP occupied by this sector does not reach the 3 %, it is the largest share among the members of the European Union, and it employs over 749.700 people in the country. It is a "deeply rooted activity in the economy, society and territory [of Spain] that fosters wealth not only through its practice, but also in the rest of the economy through its interrelation and capacity to influence other sectors" (PwC and AEPLA, 2019, 9). Altogether, adding the interrelated activities, the agri-food system constitutes one of the prime industries of the country, contributing to the 10,6 % of the GDP and 14,2 % of the employment (2019, 14). This means that if, as manifested, the increase in temperatures alters the distribution of crops, makes territories unfertile and reduces the farming production, such a large share of the population devoted to these activities will have to be equally redistributed. Migration of people to the North will follow the foreseen displacements of crops to these areas; farmers with elevated expenses to maintain appropriate living conditions for their cattle will have to either move to where temperatures are lower or search for a different job; accordingly, fresher areas in the country will experience the arrival of the exodus from other villages; and, ultimately, abandoned territories will be left with no economic activity, no population and no culture.

Climate change will also impact other important sectors of the Spanish economy, such as that of tourism, which employed almost 2.5 million people before the COVID-19 pandemic (Statista, 2022). Good weather conditions and large sandy beaches are a determining factor for Spanish tourism, especially in the Mediterranean basin. Thus, the rise of temperatures, the erosion of beach areas, the alteration of sea temperatures and the increase of its levels and swell can all contribute to the discomfort of tourists that resort to Spanish costs during summer (Sanz and Galán, 2021, 169). This, added to the impact on other touristic attractions like the disappearance

of ski stations due to insufficient snow, or the risk of many turistic infrastructures to lose their economic rentability due to a possible absence of hydric resources in the future, leave no positive prospects for Spanish towns and cities that are highly dependent on tourism. It goes without saying that the consequent prediction would be that a large part of the population will have to find new locations for their businesses, activities and living.

The United States: Increased Severity of Hurricanes

On August 29, 2021, Hurricane Ida hit the Louisiana coast with upwards of 241 kilometers per hour (kph) winds, going down as the most powerful and rapidly intensifying storm in United States history. Ripping across more than 2.400 km, Ida proved destructive while entering the United States near Louisiana and exiting near New York. Most tropical storms weaken rapidly after landfall as they lose access to the ocean; however, Ida maintained her Category 4 strength for up to six hours after landfall (Adamo, 2010).

The immediate impact of Hurricane Ida was over eight East coast states. Tornados touched down in six states. Storm surge heights reached between two and five meters, with offshore waves measured by satellite reaching up to 12 meters high (US Department of Commerce, 2022). Ida resulted in 43-cm of rain in New Orleans, with up to 20 cm as it moved across states (US Department of Commerce, 2022). 1.5 million people lost power in Louisiana alone as a primary transmission line was downed. Leaving residents without power for weeks, this was Louisiana's most significant power outage since 2000 (Hillburn, 2021). There were approximately 115 deaths and over $75 Billion worth of damage.

Hurricanes form from disturbances in the atmosphere over warm, tropical ocean water (US Department of Commerce, 2022). They continue to grow as the storm travels over areas with warm water, low winds outside the storm, and high moisture levels in the atmosphere. In the center of a hurricane is a calm channel of calm weather called the "eye" of the storm.

The National Weather Service defines a hurricane as a "tropical cyclone with a maximum sustained winds of 119 kph or higher" (NOAA, 2022). Using the Saffir-Simpson Scale, hurricane-strength tropical cyclones are classified into five based on maximum sustained wind speeds (Table 1). Major hurricanes fall into categories 3, 4, and 5, while super-typhoons reach categories 4 and 5 on the Saffir-Simpson Scale (NOAA, 2022).

Table 1: The Saffir-Simpson Scale (NOAA, 2022)

Category	Miles Per Hour (MPH)	Meters Per Second (MPS)	Knots
1	119 - 153	33 - 42	64 - 82

2	154 - 177	42 - 49	83 - 95
3	178 - 208	49 - 57	96 - 112
4	209 - 251	58 - 69	113 - 135
5	252	> 70	> 136

According to NOAA analyses, a 241 kph Category 4 storm has more than 250 times the damage potential of a Category 1 storm. As seen from Ida, hurricanes result in strong waves, high winds, and intense rainfall that destroy coastal towns and flood areas further inland. Most flooding from hurricanes is caused by storm surges, a temporary rise in sea level that occurs when storm winds push water towards the coast (UCAR, 2022). The low pressure of the storm impacts the strength of the storm surge (UCAR, 2022).

But, how does climate change influence the power of hurricanes? Climate scientists understand that humanity's carbon footprint has changed the baseline conditions of the climate, influencing every weather event across the globe. Hurricanes are driven by the transfer of heat from the sea to the air through evaporation. The storm's wind speed, or the potential intensity, depends significantly on the temperature of the ocean water. Climate scientists agree the Earth and our oceans are warming due to human activities. Sea surface temperature increased during the 20th century and continues to rise at an average rate of -17.7°C per decade (IPCC, 2013). Sea surface temperature has been consistently higher during the past three decades than at any other time since reliable observations began (IPCC, 2013).

This way, researchers agree that more intense hurricanes and tropical cyclones will occur as sea temperatures rise. The Intergovernmental Panel on Climate Change special report on Global Warming of 1.5°C has detected trends of the occurrence of very intense tropical cyclones (category 4 and 5 hurricanes on the Saffir-Simpson scale) over recent decades (IPCC, 2013). Indeed, climate change and warming oceans allowed Hurricane Ida to gain strength at landfall. In as little as 24 hours, Ida moved from a Category 1 to a Category 4 storm as it moved over abnormally hot water in the Gulf of Mexico. According to the National Oceanic and Atmospheric Administration measurements, the water in the Gulf of Mexico was 30° C, a few degrees hotter than average (NOAA, 2022).

Such increased levels of intense hurricane activity will produce storm surge flooding, landslides, saltwater intrusion in soils and surface water, resulting in loss of human life and livelihoods, impacts on buildings and environment, and salinity impacts on crops (US White House, 2021).

However, it is essential to note that, as seen in the case of wildfires, hurricanes and tropical cyclones will not increase in frequency but rather intensity (IPCC, 2013). Stronger and slower hurricanes will result in increased precipitation levels, both in coastal areas and areas inland. As the climate continues to warm, the atmosphere can hold more water, encouraging hurricanes to become "wetter." Increased heavy precipitation events will encourage flooding, erosion, channel modification, and debris flows that will result in loss of life, impact homes and infrastructure, damage crops and increase flood insecurity across the eastern United States (US White House, 2021).

At the same time, global climate change and increased intensity of hurricanes, precipitation, coastal flooding, rising sea levels, and general scarcity of natural resources could, directly and indirectly, affect movements (Laczko and Aghazarm, 2009, 15). Cities regularly exposed to climatic events can trigger environmental migration to other cities and states. Coastal cities, like Louisiana, where Hurricane Ida hit, are often confronted with sudden events like hurricanes and flash flooding that trigger massive evacuation and population displacement. This displacement is generally to nearby areas and is short-term (Smith and McCarty, 2009). However, as populations return to their homes, they find deterioration of the city appeal due to erosion of beaches and destruction of property. Deterioration of cities results in permanent displacement and increased internal migration flows. Significant and sudden increases in the inflow of migrants can lead to accelerated urbanization —particularly the expansion of slums or neighborhoods in vulnerable areas— which may overwhelm the city's capacity to deliver services (education, health, public safety, etc.) and increase the population at risk, particularly in small urban centers (Tacoli, 2009).

As for Hurricane Ida, it is too soon to tell how much impact it will have on environmental migration. However, there are parallels between Hurricane Ida and Hurricane Katrina that devastated the same in 2005. To compare, New Orleans, Louisiana shrank from 485.000 to 230.000 people after Hurricane Katrina. However, according to the Census Bureau, New Orleans regained 80 % of those losses by recovering 390.000 people by 2020 (Cusick, 2021). Equally as devastating as Hurricane Katrina in 2005, Hurricane Ida will see the same economic impact. People trying to escape the destruction and water, cities on the East Coast and beyond were inundated by people. As climate change continues to influence the weather, we can predict that we will see more people attempting to escape areas where flooding, coastal erosion, and infrastructure loss are rampant.

Climate Migration as a Challenge for Global Goals

As shown in the four case studies, climate change will undeniably impact all sectors of our society. It is now understood by scientists that climate related events might increase in frequency and, mostly in severity. In this case, all of the 17 global goals will be impacted in some capacity.

The case studies reflected in this paper showcase the interconnected nature of the impact of global environmental change as well as the impact to human population as a result. Although the overarching theme for examining these case studies is SDG 13 “Climate Action”, the results and predictions point to multiple commonalities and overlaps among the global goals. For instance,

long term impacts of catastrophes like fires, flooding, and other extreme events exacerbated by climate change may result in temporary or permanent migration that cannot allow for the existence of sustainable cities and communities –SDG 11–. In this sense, each case study has shown that the number of displacements and deaths will increase, and this will significantly increase the "direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations" (United Nations, 2022). In parallel, unsustainable communities will exacerbate poverty and food insecurity, directly correlating with global goals 1 and 2. If the highlighted trends continue, it will be impossible to achieve the target 1.5 of building "resilience of the poor and those in vulnerable situations and reducing their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters" (United Nations, 2022).

The phenomenon of climate migration, as outlined in the case studies, is also interlinked with SDG 15. Life on Land will be greatly impacted as areas such as Greece and Spain continue to experience hotter than usual conditions, whereas countries like Austria and the United States will continue to see more inland flooding. Both heat, fires, and flooding will result in desertification, degraded soils, erosion, and saltwater intrusion, all of it leading to abandoned areas and unlivable lands. Similarly, industry, innovation, and infrastructure will be impacted if cities are unable to prioritize sustainable communities –SDG 9–.

All in all, climate change and its migratory impacts can be connected to each of the 17 global goals. It is indeed a force that impacts society at every level. Therefore, it is not a solitary issue that can be easily or readily solved. Society has also now surpassed mitigation and must focus on awareness and resiliency building with the global goals in mind. A global partnership, exchanging knowledge and technology etc., which is also discussed in SDG 17 "Partnerships for the Goal", may serve as one of the most important bases of sustainable development.

Conclusions

As a whole, the cases of Austria, Greece, Spain and the U.S. depict a challenging future for large sections of the countries' citizens. The land's eroding ability to seep the water away easily in Austria will most likely lead to intense floodings, like the one occurred on July 30, 2021, in Styria. The Mediterranean basin's vulnerability to increased temperatures will presumably result in ever-more destructive wildfires, like the ones developed in Greece and Spain during the summer of 2021. And, finally, the rising sea temperatures in the Pacific and Atlantic oceans will predictably facilitate the occurrence of hurricanes, like Ida in Louisiana on August 29, 2021.

All the above-mentioned events reveal that climate change will be a first-order issue in the four countries, accentuating the impact of each climatological event. Indeed, despite in different manners, the information provided in the four cases shows that the alterations in our climate conditions lie behind the severity of all the cited events, not as much as a root cause, but rather as an aggravating factor. In this line, the intensity of the phenomena and its impact on communities led to the displacement of people in the four cases. Although mostly internal and

short-term, the movements that follow these events are a manifestation of climate migration in Austria, Greece, Spain and the U.S., with its consequent social, economic and cultural implications.

However, the aim of this paper is not to point to past events, but rather to alert about the upcoming future. By looking at current trends, the analysis made in the four states allows us to predict that climate migration will also be an increasingly noticeable reality in Northern countries. The alteration of our living conditions, caused not only by sudden extreme phenomena, but also as a consequence of the deterioration of our lands due to climate change, will force citizens to look either for a different job, for a more comfortable climate for living or even for a new touristic destination. All these changes convey further implications than those of a simple everyday decision: they involve a rearrangement of human settlements, a transformation of our current societies, an alteration of economic structures and, inherently, a modulation of one's culture.

With this in mind, climate migration cannot be understood only as a climate-related issue, nor as a territorially divided problem dominant in the global South; it is rather a global challenge and reality that concerns all countries and all SDGs. The four case studies developed in this paper reveal that, despite its particularities, they all already had and have manifestations of this phenomenon. In fact, even if these four countries do not, and cannot, directly explain the situation in every other state, nor even in the North, their joint consideration allows to identify common patterns and the existence of a global range problem which needs comprehensive solutions, regardless of each one's location on the planet. Precisely, the evidenced interconnectedness of the Sustainable Development Goals, as well as the global presence and reach of the climate migration issue, reveal the need for tackling it through increased intentional, accessible, and comprehensive global engagement that involves both the climate issue itself and its economic, cultural and social consequences.

Indeed, although the authors' goal was to identify the concrete goals related to the particular diagnosis made in each case study, the authors have found that climate migration and SDG 13 are so deeply interconnected to the remaining 16 targets, that a distinction of affected SDGs among countries would fail to understand its comprehensive nature. The effects from movements exacerbated by climate change will influence progress towards SDG 1, 2, 11, 13 or 15, among others. As highlighted by the United Nations, "climate change, [and its consequent migration], is affecting every country on every continent: it is disrupting national economies and affecting lives, altering cultures, communities and countries dearly today and even more tomorrow (United Nations, 2022). Understanding SDG 13 and focusing on global scalable solutions will inevitably reduce inequalities, poverty, food and water insecurity and drastically improve education, economic growth, infrastructure, resiliency building, and peace.

In this sense, there is a need to raise awareness about the countries and SDGs interconnection. Understanding the interrelations between SDGS is key to improving coherence, decision-making and the application of public policies in order to achieve sustainable development. Awareness about climate migration also means stressing the multiple spheres of our lives simultaneously

affected by it, the interconnectedness of both problems and solutions and the need for a comprehensive answer. By looking at past events, present patterns, and resulting predictions, the paper has seeked to draw the first step towards a solution of alerting and increasing the sense of urgency among current generations as the basis for future education strategies.

With SDG 13 and its subgoals in mind, the authors refrain at this point from giving further solutions, but rather focus on what it has been stressed as the essential first step: to raise awareness, which may be concreted in some recommendations:

1) raise climate change ambitions worldwide

2) prevention (reinvest) - priority to prevention, not repression

3) coordinate policies - clarify governance

4) priority in addressing the causes of extreme phenomenons by understanding and tackling climate role in them

5) access to more information - learn from the science (education)

6) raising awareness of the private sector - not only governance

7) last but not least, raising awareness of every individual.

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