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Equitable mitigation to achieve the 1.5 °C goal in the Mediterranean Basin

Olga Alcaraz[1] · Bàrbara Sureda[1] · Albert Turon[1] · Cindy Ramírez[1] · Marta Gebellí[1]

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Abstract
The mitigation required to achieve the 1.5 °C goal of the Paris Agreement entails drastic emissions reductions. The mentioned goal is of special interest for regions like the Mediterranean where the average temperature is rising above the world average with the consequential risk for the future viability of its different ecosystems. The objective of this work is to analyze if the commitments of the Mediterranean Basin countries submitted under the Paris Agreement framework are in line with the 1.5 °C goal. For this analysis, the cumulative emissions of the current Nationally Determined Contributions of these countries until 2030, are compared with the result obtained from distributing the cumulative greenhouse gas emissions compatible with the 1.5 °C global mitigation scenario between 2018 and 2100. This distribution is obtained using the Model of Climate Justice that allocates the global emissions by using equity criteria (equality and responsibility) that take into consideration the historical responsibility for each country, in the period from 1994 to 2017. There are two main conclusions from the analysis of the NDCs. Firstly, it is concluded that the Mediterranean Basin countries, as a whole, are not in line with the 1.5 °C goal, because by 2030, 77% of the emissions budget that should be available until 2100, based on the equity criteria aforementioned, will already have been emitted. And, secondly, when the NDCs for each one of the countries are compared, some significant differences in the degree of ambition can be seen.

Keywords Mitigation · Paris Agreement · NDCs · Cumulative emissions · Climate Justice · Mediterranean

1 Introduction

The Mediterranean Basin constitutes a geographic and climatic unit that spans three continents and is especially sensitive to the adverse effects of climate change. The increase in the average

✉ Olga Alcaraz
olga.alcaraz@upc.edu

[1] Universitat Politècnica de Catalunya, Barcelona, Spain

surface temperature of this region is above the observed global increase, and it has already exceeded 1.4 °C with respect to the pre-industrial period temperature (1880–1899) (Medecc Network 2019). Likewise, heat waves are more frequent, severely affecting urban areas, and drought intensity and frequency are also increasing, causing water availability problems in some regions (Cramer et al. 2018; Lange 2019). The socioeconomic impacts of climate stress have been described in a wide variety of areas. Recent studies have shown severe impacts on crop production and a decreasing wheat yield (Danzi et al. 2019). Rises in sea levels will alter the shape of coasts, seriously affecting coastal low-areas such as deltas and impacting strategic economic sectors (Ciscar et al. 2014; López-Dóriga and Jiménez 2020). Predictions indicate that even achieving the temperature goals of the Paris Agreement, the risk of drought is likely to increase, and precipitations and surface runoffs are likely to decrease (IPCC 2018a). These risks are significantly less in the 1.5 °C global scenario. This scenario would allow ecosystems to stay within the variability observed during the Holocene. In scenarios leading to 2 °C or more warming, Mediterranean terrestrial ecosystems would experience unprecedented changes never seen in the Holocene (Guiot and Cramer 2016).

Despite having a common historical legacy and cultural tradition, the 21 countries from the Mediterranean Basin present a significant socioeconomic diversity (Medecc Network 2019). Among this group, there are developing and developed countries, eight of which belong to the EU27. In terms of income level in the World Bank (WB) classification, Syria is classified as a low-income country; Egypt, Algeria, and Morocco are lower-middle-income countries; Albania, Bosnia and Herzegovina, Lebanon, Libya, Montenegro, and Turkey are upper-middle-income countries; the remaining 10, Croatia, Cyprus, France, Greece, Israel, Italy, Malta, Monaco, Slovenia, and Spain, are high-income countries (World Bank 2020). In addition to socioeconomic diversity, some of these countries have suffered or are suffering from severe armed conflicts, and there are humanitarian emergencies in the Mediterranean Sea, such as the current refugee crisis, that highlight the necessity to reinforce cooperation between both sides of the Mediterranean (Albahari 2015; Panebianco 2020).

Mediterranean countries also share a sense of identity, the Mediterranean, and a willingness to cooperate on environmental issues that seek to preserve the integrity of the different ecosystems and to underpin sustainable development. Since 1975 this willingness to cooperate is articulated under the Mediterranean Action Plan – Barcelona Convention and its related protocols (UNEP 2005). Likewise, the Mediterranean Strategy for Sustainable Development 2016–2025 (MSSD) aims to promote regional and national plans, by improving to achieve the Sustainable Development Goals (UNEP/MAP 2016). Among other objectives, the MSSD sets out that addressing climate change must be a priority for the Mediterranean and recognizes that climate change constitutes a severe risk for economic growth and development in this area. Moreover, since 2008, the Union for the Mediterranean (UfM) promotes cooperation among countries from the European Union and 15 countries from the South and East of the Mediterranean. Among other things, the UfM mandate is to support and advise its member countries on the elaboration, review, and implementation of their climate action commitments within the Paris Agreement context (Union for the Mediterranean 2020).

The Paris Agreement (PA) will be the multilateral framework for climate change global policy from now on. The justice and equity discussion has always been present in the United Nations Framework Convention for Climate Change (UNFCCC), often articulated under the "common, but differentiated, responsibilities and respective capabilities (CBDR&RC)" (United Nations 1992). The text of the PA, Article 2.2, establishes that the agreement will

be implemented to reflect equity and the CBDR&RC principle. The mitigation section, in Article 4.1, clearly states that the long-term temperature goal should be achieved on the basis of equity (United Nations 2015).

The bottom-up nature of the PA leaves the elaboration of their mitigation commitments, which are then incorporated into their nationally determined contributions (NDC), in the hands of each country that belongs to the agreement. This implies, to a large extent, that the states are also responsible for implementing the PA equitably. Throughout 2020, 2021, and up until the COP26 that will be held in Glasgow, parties belonging to the PA must communicate or update their commitments; and it will be imperative they do this task looking towards achieving the 1.5 °C global goal, constructing their contributions with an equity vision in a global context. Furthermore, countries are strongly encouraged, when communicating or updating their first NDC, to provide the necessary information for the clarity, transparency, and comprehension contained in the Annex I of the additional orientations regarding the mitigation section 1/CP.21, approved in decision 4/CMA.1 during COP24 (UNFCCC 2015, 2018).

Paragraph 6 in the previously cited Annex I explicitly requests that parties justify how their NDC is fair and ambitious in the light of their national circumstances. Paragraph 7 requires parties to explain how their NDC contributes to the achievement of the global average temperature stabilization goal defined in the UNFCCC and more precisely in the PA. Based on these requirements, it is necessary to establish references that can be used by parties to define their specific contribution in order to achieve the global temperature goals and, at the same time, that can be used to measure the degree of justice and ambition of their contributions.

In the literature, there are models that aim to globally achieve the temperature goal of the PA by distributing the greenhouse gas (GHG) emissions among the countries fairly (Baer et al. 2009; Kanitkar et al. 2013; Winkler et al. 2013; Raupach et al. 2014; Alcaraz et al. 2018). All of these models use as distribution criteria some of the equity principles found in the Fifth Assessment Report (AR5): equality, responsibility, capacity, and the right to sustainable development (IPCC 2014). Some models have been used as a benchmark to evaluate equity and the degree of ambition in the NDCs submitted by countries leading the global emissions ranking (Robiou du Pont et al. 2016; Robiou Du Pont et al. 2017; Robiou du Pont and Meinshausen 2018; Winkler et al. 2018). Nevertheless, to date, there are no published studies with a focus on the Mediterranean geographical area.

Considering both that the Mediterranean Basin is a hot spot for climate change and also the socioeconomic risks that the whole area faces, it is very urgent to look beyond every country's individualism and the European Union's limits and promoting cooperation between countries. The fact that there already exist multilateral cooperation entities working on climate action, the authors consider it may be of special interest for policy-makers to analyze the ambition of the mitigation component from the NDCs of the 21 Mediterranean arch countries under the climate justice prism. This analysis shows whether or not countries' commitments, individually and as a group, are in line with the 1.5 °C global mitigation goal. The analysis is performed by comparing the cumulative emissions that current NDCs would imply by 2030, with the result obtained from the distribution among all countries of the cumulative GHG emission compatible with the 1.5°C temperature scenario. The model used for this distribution is the Model of Climate Justice (MCJ) described by Alcaraz et al. (2018), which distributes the global emissions using equality and responsibility criteria considering the historical responsibility from each country.

Based on the description above, the layout of this article is as follows: Section 2 will describe the methodology followed and the data set used for the analysis. Next, Section 3 will present the results and discussion for the distribution of the cumulative emission allocated by the MCJ for Mediterranean countries until the end of the century, and based on the results of this distribution, the degree of ambition of the NDCs presented by countries will be evaluated. Finally, in Section 4, the main conclusions of this study will be summarized.

2 Methodology

2.1 Studied countries

The countries studied in this article include those with a coastline in the Mediterranean Sea and that constitute the geographic entity of the Mediterranean Basin (UNEP-MAP 2012). Monaco remains excluded from the study since the emissions from energy production in this country are included in the French accounting and its weight in global Mediterranean emissions is negligible (0.0051% of the GHG emissions in 2017) (IEA 2019a).

Table 1 shows a set of indicators from Mediterranean countries that enable the assessment of notable differences between them. On the one hand, we can find countries with a GDP per capita and historical emissions per capita that are relatively low compared with the world average. One of these countries is Morocco, which has a relatively low energy consumption per capita. However, its emissions intensity is high, which indicates that regardless of its low energy consumption, its economy relies on fossil-origin energy resources. On the other hand, there are countries like France, which has a high ranking GDP per capita, with emissions per capita that are above the world average and a high energy consumption. However, because France is a world power in nuclear technology, its emissions intensity is one of the lowest in the region. The comparison of EU27 member and non-member countries is especially interesting. Altogether, the EU27 countries have a higher level of emissions, energy consumption, and GDP per capita, but lower emissions intensity levels.

2.2 The model of climate justice

Despite a broad consensus within the UNFCCC that climate action should be developed based on equity, which is one of the pillars of climate justice, there is no consensus about how equity should be operationalized when sharing emissions reduction efforts among countries. This is a highly controversial and nonconsensual topic between the parties, hence its enormous complexity. For this reason, the Model of Climate Justice (MCJ) should be understood only as a reference in order to be able to assess under the same metric the mitigation commitments established in the NDCs.

The Model of Climate Justice (MCJ) is used to distribute the cumulative GHG emissions for the 2018–2100 period corresponding to each one of the studied countries (Alcaraz et al. 2018). This distribution is compatible with the 1.5 °C global temperature increase scenario with respect to pre-industrial temperature. The global scenario used is the RCP1.9 IMAGE 3.0.1 SSP1–19 for Kyoto Gases (excluding CO_2 from land uses) obtained from IIASA (van Vuuren et al. 2017; IIASA and IAMC 2019). Despite the 66% likelihood of holding the global mean temperature below 1.5 °C that this scenario implies, it is worth mentioning that

Table 1 Indicators from Mediterranean countries, Mediterranean total and subgroups of Annex I UNFCCC member countries and non-Annex I countries, EU27 members and non-members and world aggregate. Population data from UNDESA (UNDESA 2019), emissions from PRIMAP-hist dataset (Gütschow et al. 2019), GDP from World Bank (World Bank DataBank | The World Bank 2020), and TPES from IEA (2020) (IEA)

	Population (2017) Millions	Cumulative GHG em. per capita (1994–2017) tCO_{2eq}	GHG em. per capita (2017) tCO_{2eq}	GDP per capita (2017) USD_{2011}	TPES per capita (2017) $\cdot 10^{-3}$ toe	Energy intensity (2017) $\cdot 10^{-6}$ toe/ USD_{2011}	Emission intensity (2017) tCO_{2eq}/ USD_{2011}
Albania	2.9	2.73	3.54	11,759	816	69	301
Algeria	41.4	5.79	5.53	13,876	1341	97	399
Bosnia and Herzeg.	3.4	6.15	8.47	12,275	2016	164	690
Croatia[1,2]	4.2	6.32	6.29	22,517	2091	93	279
Cyprus[1,2]	1.2	8.53	7.76	24,133	1880	78	321
Egypt	96.4	3.07	3.21	10,673	962	90	301
France[1,2]	64.8	8.69	7.31	40,171	3811	95	182
Greece[1,2]	10.6	10.83	9.06	25,033	2199	88	362
Israel	8.2	11.41	10.58	35,112	2793	80	301
Italy[1,2]	60.7	8.94	7.14	35,293	2529	72	202
Lebanon	6.8	4.57	3.36	11,634	1325	114	289
Libya	6.6	14.75	12.52	17,321	2028	117	723
Malta[1,2]	0.4	6.90	5.05	39,528	1553	39	128
Montenegro	0.6	8.00	7.36	16,341	1622	99	451
Morocco	35.6	2.65	3.23	7625	577	76	424
Slovenia[1,2]	2.1	9.92	8.72	31,200	3326	107	279
Spain[1,2]	46.6	8.54	7.37	34,229	2701	79	215
Syrian Arab Republic	17.1	4.15	3.54		520		
Tunisia	11.4	3.27	3.29	10,950	989	90	300
Turkey[1]	81.1	5.33	6.58	25,020	1810	72	263
Mediterranean	502	6.32	5.82	22,721	1911	84	256
Mediterranean Annex I	272	7.86	7.13	32,539	2632	81	219
Mediterranean non-Annex I	230	4.33	4.29	11,145	1061	95	385
Mediterranean from EU27	191	8.81	7.36	35,739	2982	83	206
Mediterranean non-EU27	311	4.59	4.88	14,757	1256	85	331
World	7550	6.04	6.30	15,463	1851	120	408

[1] Annex I countries; [2] countries from EU27

the impacts of such an increase are not minor, as is shown in the SR1.5 IPCC SR published in 2018 (IPCC 2018b).

The other data needed to calculate the MCJ are the historical GHG emissions data obtained from the PRIMAP-hist dataset (Gütschow et al. 2019); and the historical data and future projections of the population are taken from the UNDESA medium variant scenario (UNDESA 2019).

The MCJ distributes the emissions on the basis of equality and historical responsibility criteria. It tends to an equalization of the future per capita emissions taking into account the future population projections and applies a correction considering historical responsibility. The model allocates more emissions to countries that were historically below the world average per capita emissions and penalizes those who were above. For further insights on the mathematical

details of the MCJ, the authors recommend the reading of Annex I contained in the supplementary electronic material of Alcaraz et al.'s (2018) paper.

The year from which historical responsibility is considered influences the resulting emissions distribution and cannot be exempted from discussion (Müller et al. 2009; Rocha et al. 2015). Some authors suggest that historical responsibility should be considered from the beginning of the industrial revolution since developed countries' progress has been tightly linked to their increase in emissions (Cao 2008; Kanitkar et al. 2013). Some others propose that historical responsibility can only be demanded from the moment the international community became conscious of the climate change problem and this would place the date in the early 1990s (Ott et al. 2004; Baer et al. 2009; Gignac and Matthews 2015). The first IPCC report was published in 1990, and this is when the negotiations that would be taken to the approval of the UNFCCC in Rio-92 were started. After the ratification process, the UNFCCC entered into force in 1994. This date, 1994, marks a point of no return in the multilateral fight against climate change and is the one used in this article when starting to account for historical responsibility.

The results of the MCJ are the cumulative GHG emissions for the 2018–2100 period for each one of the countries studied. In this article, the MCJ results for the Mediterranean countries are compared with the cumulative emissions that their NDCs imply in the period 2018–2030.

2.3 The NDCs

The most recent version of the NDC submitted by each country by July 2020 is considered (UNFCCC). Turkey and Libya have not ratified the PA. In the case of Turkey, its Intended Nationally Determined Contribution (INDC) (UNFCCC) has been studied. In the case of Libya, which has not submitted an INDC, an estimation based on a trend scenario has been made.

In relation to the Mediterranean EU27 countries, the internal emissions distribution among countries is considered as follows: for the emissions that fall under the EU Emissions Trading System (EU ETS), it is assumed that the overall target coincides with each country's target (43% of ETS reduction in 2030 with respect to 2005); and for the sectors that fall outside the scope of the EU ETS, the distribution among countries of the binding annual GHG reductions is considered (European Parliament 2018). Then, the overall mitigation target for every country is determined using both contributions (EU ETS and non-EU ETS).[1]

Table 2 displays the data collection contained in the mitigation section of the NDCs from the Mediterranean countries. In addition to the unconditional mitigation target, some countries present a conditional mitigation target that depends on receiving international aid. In this study, only unconditional targets will be considered. It is also important to underline that the majority of countries submitted mitigation commitments for all the GHG. For this reason, this study is carried out using cumulative GHG emissions (Meinshausen et al. 2009; Alcaraz et al. 2019).

To determine the cumulative emissions between 2018 and 2030 for each country in accordance with its NDC, first, the level of emissions that each country will have in 2030, according to its current NDC, is estimated. Due to the fact that some NDCs do not have clearly

[1] When the revision of this article was made, at the end of January 2021, the U27 had presented its NDC update. Despite this, until the UE has agreed on how this update will affect the emissions distribution efforts from their member countries, the goals shown below for the EU member countries remain in force.

Table 2 Information about the Mediterranean countries NDCs and the projection of the emissions in 2030 according to Climate Energy College, Climate Action Tracker, UNEP, and the authors (CAT; Climate & Energy College; UNEP)

	Reference indicator	Reference year[1]	Gases	Reduction in 2030 (% from the country reference)		Emission target in 2030 ($MtCO_{2eq}$)			
				Unconditional[2]	Conditional	Authors	CEC[3]	CAT[4]	UNEP[5]
Albania	BAU	2016	CO_2 Energy	11.5		7.1	11		5.4
Algeria	BAU		GHG TOTAL	7.0	22.0	263	272		
Bosnia and Herzegovina	Base year	1990	GHG TOTAL	−18.0	3.0	35	39		31
Croatia	Base year	1990	GHG TOTAL	24.4		25	27		
Cyprus	Base year	1990	GHG TOTAL	−13.1		6.6	7		
Egypt	Policies		CO_2 (-AFOLU)			433	478		
France	Base year	1990	GHG TOTAL	37.8		346	372		
Greece	Base year	1990	GHG TOTAL	8.4		95	94		
Israel	per capita emissions[8]	2005	GHG (-AFOLU)	22.6		82	77		82
Italy	Base year	1990	GHG TOTAL	29.8		368	377		
Lebanon	BAU	2011	GHG TOTAL	15.0	30.0	36	38		37
Libya[6]						115	146		
Malta	Base year	1990	GHG TOTAL	9.0		2.0	2.0		
Montenegro	Base year	1990	GHG TOTAL	30.0		3.8	3.0		4.1
Morocco	BAU	2010	GHG TOTAL	13.0	32.0	145	152	145	141
Slovenia	Base year	1990	GHG TOTAL	24.2		15	17		
Spain	Base year	1990	GHG TOTAL	−0.6		296	302		
Syrian Arab Republic	Policies					89	129		
Tunisia	Carbon Intensity[8]	2010	GHG TOTAL	8.8	37.8	70	79		63
Turkey[7]	BAU	2012	GHG TOTAL	21.0		919	877	999	928

[1] Reference year as indicated in each country's NDC (2020). Those countries with a BAU reference indicator use this year to determine their reference scenario

[2] EU-27 countries reduction calculated according to EU-27 effort distribution among its members (European Parliament 2018)

[3] NDC & INDC Factsheets. Climate Energy College (2020). University of Melbourne. http://climatecollege.unimelb.edu.au/ndc-indc-factsheets

[4] Climate Action Tracker (2020). https://climateactiontracker.org/

[5] Pledge Pipeline. UNEP (2020). https://www.unenvironment.org/explore-topics/climate-change/what-we-do/mitigation/pledge-pipeline

[6] Libya has not submitted its first NDC nor its INDC. Its emission target has been estimated based on a tendency scenario

[7] Turkey's analysis has been performed based on its INDC

[8] Israel and Tunisia offer an alternative BAU target

identifiable mitigation objectives, estimates from three external sources are taken into account (CAT; Climate & Energy College; UNEP) in addition to the authors' estimate. The expected emissions level, according to each source, can be observed in Table 2.

The method used by the authors to estimate the level of emissions that each country will reach by 2030, according to its NDC, depends on the kind of commitment the country acquires. As detailed below, all are calculated based on historical data from PRIMAP-hist dataset (Gütschow et al. 2019):

- For those countries that present a target in relation to a base year, the level of emissions that they will reach by 2030 is determined by applying the NDC target directly to the historical emissions data.
- For countries presenting a target in relation to a business as usual (BAU) scenario, the BAU scenario presented in the NDC is transferred to the historical dataset from PIK. The NDC reduction target is applied to 2030 in this scenario. In the case of Algeria, the NDC does not present a BAU scenario, so it is calculated based on the historical emissions data, doing a linear regression between the years 2000 and 2017.
- For those countries that have a policy-based NDC and therefore do not present a quantifiable emissions reduction target, as well as for Libya, that has not submitted an (I)NDC, a BAU scenario like the one described in the previous paragraph is calculated to determine its emission by the year 2030.

Once the emissions for each country are estimated, a linear mitigation path between the latest historical data, 2017, and the target year, 2030, is assumed. Finally, the cumulative emissions are determined by adding the emissions between 2018 and 2030. In cases where data from the different sources cited before are available, the cumulative emissions are calculated using the target of each source, and then the results are averaged.

3 Results and discussion

3.1 Allocating emissions using the MCJ

Using the MCJ to the Mediterranean country group in the 2018–2100 period, the total emissions allocated are 53 $GtCO_{2eq}$. This figure represents 6.5% of the cumulative emission that the RCP1.9 scenario projects for the world in the same period. This percentage is slightly higher than 6.3%, the percentage of the projected Mediterranean population with respect to the world in this same period, according to the UNDESA medium variant scenario (Table 3) (UNDESA 2019).

When the cumulative emissions allocated for the future period (2018–2100) are compared with the emissions from the historical period (1994–2017), it is confirmed that the former represents a slightly lower percentage compared to the world, specifically 6.5% compared to 7.1%. The percentage of the population is also lower in the future period (6.3%) when compared with the percentage in the historical period (6.8%).

Table 1 shows that in the historical period considered, the emissions per capita from the Mediterranean group were 6.3 tCO_{2eq}, slightly above the world's emissions, which were 6.0 tCO_{2eq}. As a whole, Mediterranean basin countries have a historical responsibility, evaluated

Table 3 Comparison between the historical period (1994–2017) and the future (2018–2100) of the percentages that represent the cumulative emission and the population of the Mediterranean group with respect to the world and the different groups of interest (Annex I/non-Annex I and EU27/non-EU27) with respect to the Mediterranean total

	Percentage of cumulative emissions		Percentage of population	
	1994–2017	2018–2100	1994–2017	2018–2100
Mediterranean with respect to the world	7.1%	6.5%	6.8%	6.3%
Mediterranean Annex I	70.1%	45.0%	56.3%	42.8%
Mediterranean non-Annex I	29.9%	55.0%	43.7%	57.2%
Mediterranean from EU27	57.1%	28.6%	40.9%	27.8%
Mediterranean non-EU27	42.9%	71.4%	59.1%	72.2%

as cumulative emissions per capita, similar to the world average. This is the reason why the MCJ allocates in the future for this region, a global emissions percentage similar to the population percentage represented by this region with respect to the world.

The correspondence observed between the Mediterranean cumulative emissions and population percentages with respect to the world is broken when the Mediterranean countries included in the UNFCCC Annex I and non-Annex I are analyzed separately (Fig. 1). Responsibilities from Annex I and non-Annex I countries are clearly differentiated. In the historical period considered, Mediterranean Annex I countries, in which 56% of the region's population is concentrated, have been responsible for 70% of the emissions. In contrast, the non-Annex I group, with 44% of the population, has been responsible for 30% of the emissions. This confirms that the historical distribution of the Mediterranean emissions has not been egalitarian. For this reason, when the MCJ is used to calculate the distribution of future emissions, this situation is reversed. It should also be taken into account that according to the UNDESA prospects, in 2100, the population of non-Annex I countries will increase by 81% while the population of Annex I countries will decrease by 13% with respect to 2017. This significantly changes the population distribution between these two groups, with non-Annex I countries hosting 57% of the Mediterranean population (Table 3), and this affects the distribution of emissions made by the MCJ when it applies the principle of equality.

The change in the population distribution as well as the historical responsibility compensation incorporated by the MCJ radically changes the emissions distribution in the 2018–2100 period, with respect to the historical period, allocating to Annex I countries a 45% and to non-Annex I countries a 55% of the region's cumulative emissions.

Despite the change cited before, the percentage of cumulative emissions allocated to Annex I Mediterranean countries by the MCJ (45%) might seem high, taking into account that in the future, it is expected that they will host only 40% of the region's population. This is due to the specific situation of Turkey among the Annex I countries, which will be discussed throughout this paper. When Turkey is excluded from the Annex I country group or, in other words, when Mediterranean countries that are part of the EU27 and those that are not are analyzed separately, a vision complementary to the previous one is obtained.

The group of 8 Mediterranean EU27 member countries has been responsible for 57% of the region's cumulative emissions in the historical period, and if it follows a distribution of the future cumulative emissions based on equity criteria, it will only be allocated 29% of the future emissions. This group should address its immediate future with very drastic emissions reductions. Fortunately, these countries have been implementing GHG emissions reduction

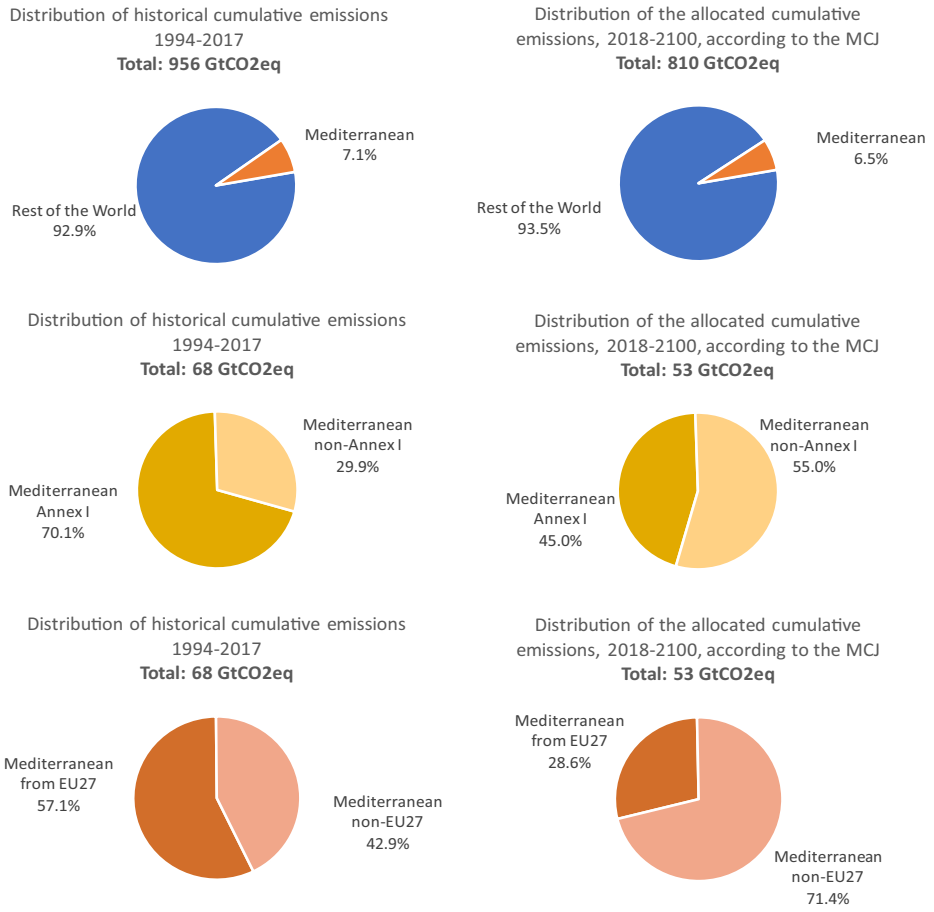

Fig. 1 Comparative between the cumulative emissions distribution in the historical period 1994–2017 (graphs to the left) and the cumulative emissions allocated by the MCJ in the period 2018–2100 (graphs to the right). Upper section, of the Mediterranean with respect to the World cumulative emissions percentages; central section, distribution between Mediterranean Annex I and non-Annex I countries; lower section, distribution between EU27 member and non-member countries

policies. These policies have led to a gradual reduction of the historical responsibility per capita. The GHG emissions per capita, which in 1994 were 8.85 tCO_{2eq}, had already been reduced down to 7.36 tCO_{2eq} by the end of 2017. In Section 3.2, these details will be discussed.

Figure 2 shows both the details of the released cumulative emissions in the historical period and the ones allocated by the MCJ in the future, allowing a comparison to be made. In the figure, three groups of countries are distinguished: those that should address the future with a significant reduction of their emissions with respect to the historical cumulative; those who can produce an emissions budget similar to the one emitted in the historical period; and those who can have higher cumulative emissions than the ones from the historical period.

The RCP1.9 scenario is a very ambitious mitigation scenario that entails a drastic reduction of global emissions. At a global level, the cumulative emissions projected by the RCP1.9 for

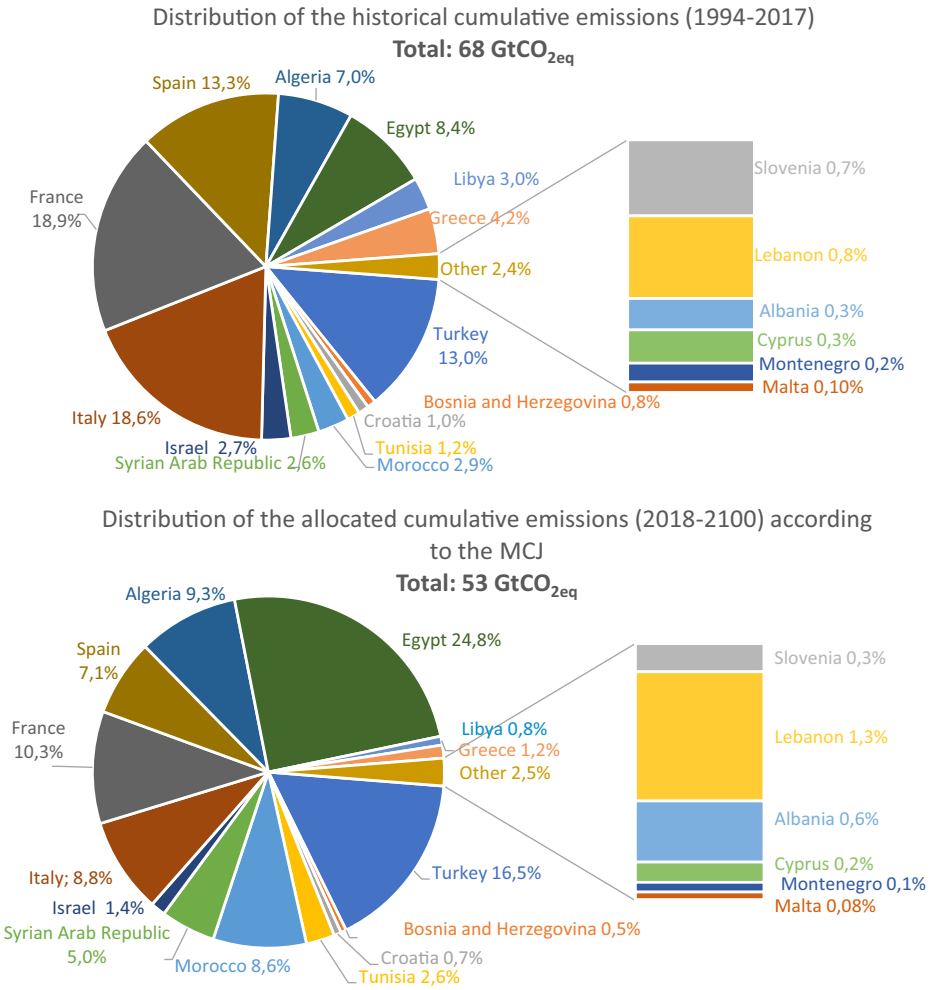

Fig. 2 Comparative of the cumulative emissions in the historical period 1994–2017 (upper pie-chart) and the cumulative emissions allocated by the MCJ in the 2018–2100 period (lower pie-chart) for the Mediterranean countries

83 years, 2018–2100, reach 53 $GtCO_{2eq}$ and are 15.3% lower than the ones emitted in the 24 year period from 1994 to 2017. This implies that, on average, between 2018 and 2100, 15.3% less than the cumulative emissions released into the atmosphere in the period 1994–2017 will be available to the world. However, based on equity, some countries should make reduction efforts above the world average while others could remain below. Taking this 15.3% as a reference value and looking at the results from Table 4, two significant groups can be defined (Table 4):

- Those that would have to address the future with a reduction of cumulative emissions greater than the world average, which means greater than 15.3%: Bosnia and Herzegovina, Croatia, Cyprus, France, Greece, Israel, Italy, Libya, Malta, Montenegro, Slovenia, and

Spain. Of these Mediterranean countries, eight belong to the EU27, and all of them along with Israel are classified by the WB as high-income countries. The remaining three, Bosnia and Herzegovina, Montenegro, and Libya, are classified as upper-middle-income countries. Bosnia and Herzegovina and Montenegro are coal producers, and their electricity sector is based on this fuel, and Libya is a great oil and natural gas producer (IEA 2019b). All of these countries have emissions per capita above the Mediterranean region average, even doubling them, as in the case of Libya or almost doubling them as in the case of Israel (Table 1). In all of them, a trend in GHG emissions reduction is observed, with the only exception of Bosnia and Herzegovina, a trend also reflected in Table 1, as their emissions per capita in 2017 are lower than the average in the historical period (1994–2017) (PIK 2019). This group should implement more ambitious mitigation policies and lead the fight against climate change.

- Those countries that could address the future carry out mitigation efforts below the world average, which is less than 15.3%: Albania, Algeria, Egypt, Lebanon, Morocco, Syria, Tunisia, and Turkey. Two subgroups can be distinguished in this group:

  – Algeria and Turkey have cumulative emissions in 2018–2100, similar to the ones accumulated in the historical period 1994–2017. To achieve the target of adjusting their future emissions to the allocated ones and thus adjust to the mitigation pathways compatible with the 1.5 °C goal, these countries should already be in their peak of emissions and start implementing policies to maintain themselves with a very limited budget. The trend of increasing emissions for Turkey, which moves the country away from the possible stabilization and reduction scenarios (PIK 2019), is of special concern.
  – Albania, Egypt, Lebanon, Morocco, Syria, and Tunisia could have clearly higher (30% or more) cumulative emissions compared to the historical period 1994–2017. All of these countries are non-Annex I and, therefore, under the UNFCCC, are considered developing countries. As observed in Table 1, the emissions per capita are around 40% below the region's average, and based on the results of the MCJ, they could delay reaching their peak of emissions for several years. A key aspect that will be discussed in Section 3.2 is that all these countries should dedicate their allocated emissions to their development agenda in order to ensure the well-being of their population as well as a low emissions future.

It should be noted that regardless of whether there are countries that, according to the MCJ, may be allocated cumulative emissions in the future above those emitted in the historical period, all countries should aim for their policies to mitigate their emissions progressively and, in this way, achieve emissions neutrality throughout the second half of this century.

3.2 Analysis of the NDCs submitted by the Mediterranean countries

When the cumulative emissions that Mediterranean countries will have emitted by 2030 according to their current NDCs are compared with the emissions budget allocated by the MCJ in the 2018–2100 period, see Table 4, it is confirmed that there are countries that, by

Table 4 Comparison of GHG cumulative emissions in the historical period (1994–2017) with those allocated by the MCJ for the period (2018–2100). The third column shows the percentage variation between the future and historical periods. In the last column, the cumulative emissions that imply the countries NDCs in the 2018–2030 period are shown

	Cumulative emissions ($GtCO_{2eq}$)		Percentage of variation	Cumulative emissions ($GtCO_{2eq}$)
	Historical period 1994–2017	MCJ allocation 2018–2100		according to NDC 2018–2030
Albania	0.20	0.32	60.9%	0.10
Algeria	4.73	4.91	3.9%	3.21
Bosnia and Herzegovina	0.54	0.27	−50.2%	0.46
Croatia	0.67	0.35	−46.8%	0.34
Cyprus	0.21	0.11	−49.7%	0.10
Egypt	5.68	13.16	131.6%	4.77
France	12.76	5.47	−57.2%	5.36
Greece	2.84	0.63	−77.8%	1.24
Israel	1.83	0.72	−60.5%	1.14
Italy	12.55	4.66	−62.8%	5.21
Lebanon	0.52	0.68	29.1%	0.45
Libya	2.05	0.43	−79.0%	1.12*
Malta	0.07	0.04	−39.8%	0.03
Montenegro	0.12	0.05	−57.3%	0.06
Morocco	1.96	4.54	131.8%	1.67
Slovenia	0.48	0.15	−69.4%	0.22
Spain	8.99	3.74	−58.3%	4.16
Syrian Arab Republic	1.78	2.67	50.1%	0.73
Tunisia	0.80	1.39	73.1%	0.83
Turkey	8.78	8.72	−0.6%	9.89
Mediterranean countries	67.55	53.02	−21.5%	41.08
Mediterranean Annex I	47.34	23.88	−49.6%	26.54
Mediterranean non-Annex I	20.21	29.14	44.2%	14.54
Mediterranean from EU27	38.55	15.15	−60.7%	16.65
Mediterranean non-EU27	29.00	37.87	30.6%	24.43
World	956	810	−15.3%	

*Libya has not submitted its NDC, so a projection trend scenario is made

2030, will totally exceed the budget assigned by the MCJ while others will, to a greater or lesser extent, remain below it.

Figure 3 helps to identify three main groups of countries:

1. Countries that by 2030 will have consumed less than 40% of their national emissions budget as allocated by the MCJ for the period 2018–2100. Among these are Syria, Morocco, and Egypt, all classified as low-income or lower-middle-income countries, and Albania which, despite belonging to the upper middle income country group, occupies the 16th place in the GDP per capita within the group of the 21 Mediterranean countries. These countries would receive, as of 2030, more than 60% of the budget assigned by the MCJ. This means that, within the framework of climate justice in which the MCJ operates, their NDCs can be

considered ambitious. The contributions from these countries are in line with the 1.5 °C global goal.

2. Countries that by 2030 will have consumed between 40 and 100% of their allocated national emissions budget for the period 2018–2100. Among these are:

- Four countries, Croatia, France, Cyprus, and Malta, are from the EU27 and therefore high-income countries. These countries should increase their ambition. Taking into account that, in December 2020, the EU27 updated its NDC and increased its ambition, it is expected that, when it reviews the internal emissions distribution among the EU27 countries, they will align firmly with the 1.5 °C global goal.
- In this group, there are also three non-Annex I countries: Algeria, Lebanon, and Tunisia. In their NDCs, these three countries present conditional targets that could be achieved if they receive foreign aid. Taking into account the existing cooperation frameworks between Mediterranean countries, it would be advisable to launch as soon as possible some mechanisms that will allow these countries to achieve their conditional commitments and in this way put them on the correct path to achieve the 1.5 °C global goal.

3. Nine countries that, by 2030, will have released emissions above the budget allocated by the MCJ until the end of the century. Among these there are different groups:

- Four EU27 countries: Greece, Italy, Spain, and Slovenia. As mentioned before, it is expected that they will increase their ambition level within the framework of the updated EU27 NDC so as to bring them in line with the 1.5 °C goal.
- Two European countries, Bosnia and Herzegovina and Montenegro, which are coal producers with an electricity sector that is highly dependent on this fuel. Both countries have energy intensities, carbon intensities, and emission intensities above the Mediterranean regional average. The NDC of Bosnia and Herzegovina sets two mitigation targets, one unconditional and another conditional. The former indicates an 18% emission increase with respect to the base year, 1990, and the latter shows a 3% reduction. Montenegro only presents an unconditional target with a reduction of 30% with respect to 1990; however, it can allow for a much more ambitious target since, if it follows a trend scenario, it will already have reduced its emissions by nearly 50%.
- Israel, a high-income country with a commitment that, according to the MCJ framework, is unambitious. It is particularly concerning that the emissions of this country have not yet started to decrease and that the country has not yet expressed any intention to review the NDC submitted in 2016 (Israeli Ministry of Environmental Protection 2015).
- Turkey, an upper-middle-income country that belongs to Annex I of the UNFCCC, despite the fact that it has repeatedly shown its desire to abandon this categorization (Republic of Turkey 2018). Turkey is currently among the top 15 emitters, and its emissions are increasing. As mentioned before, the MCJ allocates a future emissions budget to Turkey that is similar to the one used for the 1994–2017 period. This budget, if managed properly, would allow it to make a smooth transition to a low emission development pathway. The fact that its INDC, by 2030, already uses more than its entire budget, and also that its emissions are increasing, means that this country is far offtrack from the 1.5 °C global goal.
- Libya deserves a separate comment. The armed conflict that has affected the country for many years explains why, to date, no national communication nor Biennale Update Report

has been submitted to the UNFCCC, so there is no evidence that this country intends to carry out mitigation policies. If this situation continues, this country, which is a large oil and natural gas exporter, will have consumed, by 2030, 2.6 times the emissions budget allocated by the MCJ.

As a whole, by 2030, the Mediterranean countries will have consumed 77% of the emissions budget allocated by the MCJ for the period 2018–2100 (Table 4). This takes the Mediterranean Basin countries away from the 1.5 °C goal, an extremely important target for both the survival of the ecosystems and the maintenance of the lifestyle of the human population within this region.

From the analysis conducted in this section, it can be observed that some countries are on target to achieve the 1.5 °C goal. Within this group, there are developing countries with emissions per capita below the world average, to which the MCJ allocates a budget for the future period higher than that emitted in the historical period considered. One argument here could be that perhaps these countries do not need their entire allocated emissions budget and that a "communicating vessels" effect should be incorporated into the distribution model or a possible implementation of it. However, before entering into this type of argument, it is necessary to consider both the historical evolution of and the socioeconomical differences between these countries.

Next, and without entering in detail for each country, two significant complementary groups are analyzed: the Mediterranean countries that are in the EU27 (all of them, high-income countries) whose climate action is developed within the European Union common framework, and the countries that are not in this group.

In the upper section of Fig. 4, the evolution of per capita emissions as a function of GDP per capita for the EU27 Mediterranean basin country group is compared with the non-EU27 group.

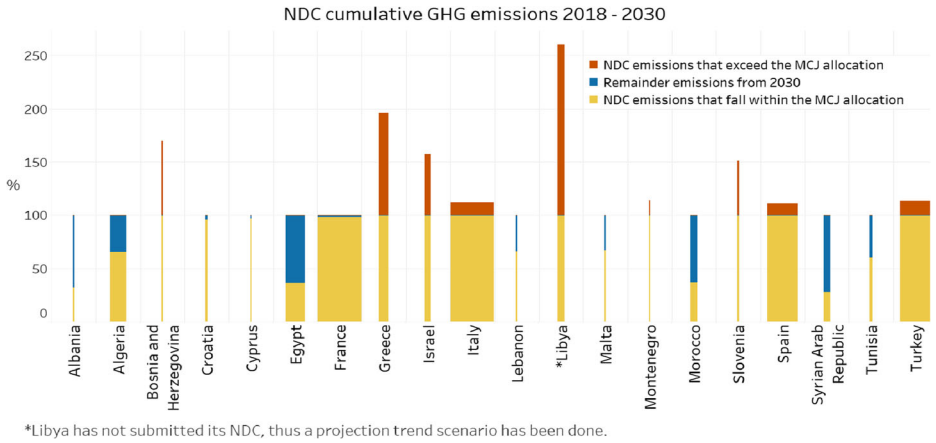

Fig. 3 Percentage of cumulative emissions that, according to the current NDCs, will have been released into the atmosphere in 2030 (bars beige + red) with respect to the emissions allocated by the MCJ for the 2018–2100 period. The beige bar indicates the percentage that falls within the allocated, and the red one, the emissions that exceed the allocation. The blue bar indicates the percentage that would be available for countries from 2030 onwards. The bars' width reflects the different cumulative emission levels between countries from 1994 to 2017, from the lowest value, which corresponds to Malta with 0.067 $GtCO_{2eq}$, to the highest value, which corresponds to France with 12.76 $GtCO_{2eq}$ (see Table 4)

In the figure, it can be observed that for some years now, countries from the EU27 have entered into a stage in which emissions per capita and GDP per capita are decoupled and that they are maintaining an economic growth that does not imply an increase of the emissions per capita. As seen in the lower-left section in Fig. 4, the cumulative emissions of these countries in the historical period have been higher than those from non-EU27 countries, and therefore, they have a smaller future emissions budget. Their capacity to undertake a very ambitious mitigation supported by a higher GDP per capita should enable them to increase their NDC ambition, which is currently not compatible with the 1.5 °C scenario.

On the other hand, it is observed that the group of Mediterranean countries that do not belong to the EU27 has not yet reached a decoupling between economic growth and emissions. Observing the trend for recent years, it may still take a few years to reach this point. It is also important to notice that the vertical scales of the two graphs are different. In terms of emissions per capita, the highest value reached by the non-EU27 countries is still below the lowest value reached by the EU27 countries, and the same situation occurs when their GDPs are compared. These two groups are situated in very different socioeconomic realities, and there is a gap between them that needs to be closed.

Taking into account that these groups are internally heterogeneous, and also according to Al-Zahrani et al. (2019), it can be said that the EU27 Mediterranean country group has reached a stage of decoupling between economic growth and emissions. On the other hand, as a whole, the non-EU27 country group is still in an industrialization stage in which, historically, development goes hand in hand with an increase in emissions. Consequently, it is foreseeable that the group of non-EU27 countries will need to use the atmospheric space that the MCJ grants them. This space should be dedicated to achieving a decent standard of living for their population, in other words, dedicated to the development agenda: housing, food, health care, water supply and sanitation, electricity, transport, communications, climate change adaptation, etc. (Rao and Baer 2012).

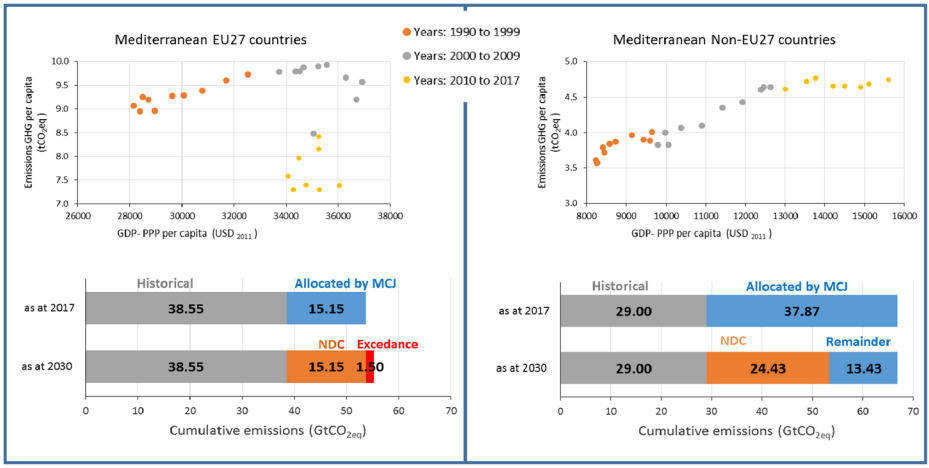

Fig. 4 The Mediterranean countries belonging to the EU27 (left section) are compared with countries not belonging to the EU27 (right section). In the upper section, the graph shows the evolution of the emissions per capita from these countries in function with the GDP per capita. The lower section shows the cumulative emissions per capita from the historical period, in addition to, firstly, those allocated by the MCJ and, secondly, those that would be consumed according to the NDC as at 2030

It is concerning to confirm (see the lower section of Fig. 4) that, by 2030, the group of EU countries will have consumed and exceeded the emissions budget allocated by the MCJ until the end of the century. To some extent, this excess use could be read as an appropriation of the atmospheric space that should be available for the developing countries. This reaffirms the view that the authors have previously mentioned: that the high-income Mediterranean countries (the EU27 group and Israel) should notably increase the ambition of their NDCs in order to make them not only compatible with the 1.5 °C global scenario but also to contribute to implementing the PA on the basis of equity.

4 Conclusions

Global warming is undoubtedly advancing, and the world is rapidly approaching the 1.5 °C threshold established in the PA (WMO 2020). The emissions mitigation pathways compatible with the 1.5 °C goal entail drastic reductions, reductions that should be at least 7.6% per year in the 2020–2030 period. Nevertheless, GHG emissions continue to increase, and at a global level, the commitments for 2030 that are stated by countries in their current NDCs lead humanity away from the goal (UNEP 2019; Höhne et al. 2020).

During 2020, as a consequence of the COVID-19 pandemic that has affected the world, global emissions were drastically reduced during the obligatory confinements around the world (by 17% during the beginning of April). Even so, it is expected that by the end of 2020, the annual reduction will only be around 7%, and if no deep structural changes in the economic, transport, and energy systems are made, it is expected that emissions will rise again during the economic recovery (Le Quéré et al. 2020).

At a regional level, the impacts of global warming are becoming more acute and occurring in different ways all over the planet. In the Mediterranean region, if additional mitigation measures are not implemented, the average increase in temperature is likely to reach 2.2 °C as early as 2040. This will jeopardize the viability of the ecosystems in this region as well as the possibility of maintaining its peoples' lifestyles and centuries-old cultural traditions (Medecc Network 2019).

The reviewed NDCs that countries must produce during 2020 and 2021 could be the last opportunity to get the world onto the 1.5 °C pathway. This article analyzes the commitments of the Mediterranean Basin countries with the intention of providing a methodology for this analysis, as is explained in Section 2. The main conclusions are summarized below.

From the distribution analysis obtained using the MCJ, it is concluded that there are countries (Mediterranean countries belonging to the EU27 plus Bosnia and Herzegovina, Israel, Libya, and Montenegro) that should address their future with an emissions budget reduction from 2018 to 2100, which is, with respect to the historical one (1994–2017), higher than the global average reduction. Then there are countries (Algeria and Turkey) that can have a future budget similar to the one emitted in the historical period considered. And finally, there are countries (Albania, Egypt, Lebanon, Morocco, Syria, and Tunisia) able to have a future emissions budget that can exceed the historical by more than 30%.

With regard to the commitments submitted by the countries in their current NDCs, it can be observed that by 2030, the Mediterranean country group will have already consumed 77% of the emissions that the MCJ allocates until the end of the century. This means that, globally, the NDCs of the Mediterranean countries are not on the path to the 1.5 °C goal.

The following conclusions are gathered from the NDC analysis:

- High-income countries (countries from the EU27 and Israel) should review their first NDC by considerably increasing their ambition in order to align it with the 1.5 °C goal. These countries have GDPs per capita that are higher than the region's average and can support their capacity for ambitious mitigation. The revision of the EU27 NDC presented in December 2020 is an important step in order to regain leadership on climate change mitigation and to set an example for the international community. However, to assess the impact that the updated NDC will have at the Mediterranean level, we will have to wait until the EU27 carries out a new distribution of emissions reduction among its member countries.
- At a Mediterranean level, cooperation strategies should be launched in order to achieve conditional commitments that figure in the NDCs of countries such as Algeria, Bosnia and Herzegovina, Lebanon, Morocco, and Tunisia. This would enable those that are not aligned with the 1.5 °C goal to achieve this target and will also help the whole regional group to move towards this direction.
- Turkey, which has a future emissions budget similar to the historical one, has a not very ambitious NDC that consumes almost the entirety of it. The country should rethink its development model in order to reach the peak of emissions as soon as possible and then start a transition to a low emission model.
- Albania, Egypt, Morocco, and Syria are countries that in 2030 will not have consumed the 40% of the emissions budget assigned to them by the MCJ, and therefore they are in line with the 1.5 °C goal. It is important that they manage this budget properly in order to make it available to their development agenda and, in this way, achieve a coordinated implementation of their climate change and adaptation policies together with their sustainable development agenda.

The authors hope that this analysis will serve policy-makers when reviewing their countries' NDCs and also it shows the need to establish a cooperation framework that allows the regional group to move towards the 1.5 °C goal. A goal that should be a priority for the world and especially for the Mediterranean region.

The review of the NDCs will reveal how the world envisions managing the post-pandemic future. The recovery path that is undertaken from now on may turn the global emissions reduction anticipated for 2020 into a merely circumstantial event or an event that can serve as a guide towards achieving the 1.5 °C goal (Forster et al. 2020). Given the severity of the situation we are facing, a low emission sustainable development plan within a framework of both regional and international cooperation should be the only option.

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