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Mental wellbeing, air pollution and the ecological state

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ABSTRACT

The ecological State puts environmental considerations at the centre of its actions. To explores its role in the association between air pollution and mental wellbeing, this work employs a hierarchical three-level analysis on the third wave (2011–2012) of the European Quality of Life Survey ($N_{citizens}$ = 25007, $N_{regions}$ = 216, $N_{countries}$ = 20). It uses a classification of Environmental Governance Regimes, subjective and objective indicators of air pollution, and the WHO-5 index of mental wellbeing. The findings show that the perception of major air pollution problems and worse mental wellbeing go hand in hand only in partial and established environmental States.

1. Introduction

The quality of physical environmental features such as air, soil, water (Macintyre et al., 2002) can be either health promoting or health damaging (Pearce et al., 2010). Clean and salubrious physical environmental conditions - such as good air quality and green areas - are vital for both the physical health (WHO Regional Office for Europe, 2013) and the mental and subjective wellbeing of individuals[1] (Dimitrova and Dzhambov, 2017; Ferreira et al., 2013; Huppert, 2014; Moughtin et al., 2009). One of the current environmental and public health emergencies is the risk posed by air pollution to physical human health (Sass et al., 2017), as for instance the negative association between air pollution and respiratory and cardiovascular diseases documents (Brunekreef and Holgate, 2002). Increasingly, the effect of air pollution on subjective wellbeing and mental health is also under scrutiny. The association between various air pollutants (from SO_2 (Ferreira et al., 2013) and $PM_{2.5\text{-}10}$ (Sass et al., 2017) to NO_2 (Knight and Howley, 2017)) and a range of wellbeing measures (from mental health (Tzivian et al., 2015), to psychological distress (Sass et al., 2017), subjective wellbeing (Ferreira et al., 2013) and life satisfaction (Luechinger, 2010; Orru et al., 2016)) has been extensively examined. However, unlike physical health, the evidence regarding the effects of air pollution on mental health and wellbeing is conflicting (for a review see Tzivian et al., 2015). The evidence seems to support a negative effect of air pollution on subjective and mental wellbeing (Brereton et al., 2008; Ferreira et al., 2013) while the effects of air pollution on psychological and cognitive functions are less clear (Tzivian et al., 2015). Moreover, the subjective perception of air pollution - that is the assessment of levels of air pollution made by individuals in their near environment - is also found to be associated with wellbeing. While the subjective perception of air pollution is shaped by individuals' socio-demographic characteristics, their environmental values (Liao et al., 2015), together with a variety of factors affecting the perception of quality of life such as trust in government (Campbell et al., 1976), this subjective assessment is regarded as a reliable measure of objective environmental conditions (Liao, 2009; Liao et al., 2015; Rehdanz and Maddison, 2008).

Notwithstanding the existing literature on possible moderators and mediators in the association between physical environments and mental wellbeing (Dimitrova and Dzhambov, 2017; Triguero-Mas et al., 2015), to the best of our knowledge there are no studies on the State as a potential moderator in this association. However, welfare States (Esping-Andersen, 1990) are acknowledged to affect people' health (Beckfield et al., 2015) and mental wellbeing (Levecque et al., 2011). In particular, comparative welfare State research (Bergqvist et al., 2013) found that in social democratic regimes people's health (Bambra and Eikemo, 2009) and mental wellbeing (Levecque et al., 2011) are better, due to the emphasis on income redistribution, and wide-ranging social security policies compared to other regime types such as liberal regimes (Esping-Andersen, 1990). More specifically, this body of research found

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[1] Individual determinants of wellbeing - notably gender (Senik, 2015; Van de Velde et al., 2013), age, personality, personal values (Huppert, 2014), employment status (Buffel et al., 2017), ethnicity (Levecque and Van Rossem, 2015) and education (Von dem Knesebeck et al., 2011) – have been widely studied. For reasons of space these studies are not reviewed in this article. Interested readers can consult the ample literature available on this topic (for a review see (Huppert, 2014)).

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that welfare States can modify (either by strengthening or weakening) the relation between social questions such as unemployment and job insecurity and mental health (Bambra and Eikemo, 2009). For instance, it has been found that the effect of income support measures on the health of the unemployed varies across different welfare State regimes (Bambra and Eikemo, 2009). Nevertheless, despite the relevance of physical environmental conditions for people's wellbeing, welfare State comparative health research has overlooked the effects on mental wellbeing (or health) of both (polluted) physical environments and States' environmental actions. However, since the emergence of an environmental crisis in the 1960s, there has been a rise of State intervention aimed at mitigating the environmental costs of the market economy (Gough, 2016), similarly to the welfare State intervention aimed at moderating the social and human costs of the market economy (Gough, 2016). Moreover, welfare State typologies (Brennenstuhl et al., 2011; Esping-Andersen, 1990) employed in these comparative studies are constructed on the basis of social and economic dimensions (Brennenstuhl et al., 2011) and exclude environmental considerations. Welfare typologies mirror the fact that welfare States and associated social policies were developed long before and without any integration with environmental policies (Gough, 2016; Meadowcroft, 2005).

However, there is a rich political science literature that explores the concept of 'ecological State'. This concept refers to "a State that places ecological considerations at the core of its activities" (Meadowcroft, 2005: 3). In recent literature (for a review see Bäckstrand and Kronsell, 2015), the terms 'ecological', 'environmental' or 'green' State, are used interchangeably to define and classify the various ways in which States deal with environmental issues. In Eckersley's (2004) pioneering work the ecological State refers to an ideal form of postliberal State that "involves an extension of state authority to new areas of social life, provides a response to perceived failures of markets and voluntary action, alters patterns of "normal" economic interaction, represents a continuing adjustment of state activity to new ecological problems, and has complex and contested normative associations" (Eckersley, 2004: 103). Though this paper uses the terms interchangeably, the term ecological state is preferred to indicate a move toward this ideal form of State to address environmental degradation effectively, as originally envisaged by Eckersley.

Consequently, while it is acknowledged that environmental degradation is socially produced (Bambra et al., 2014) - as in the case of air pollution - and that the State plays a key role in determining the health of a population (Bambra and Eikemo, 2009), there is no research evidence on the role of the State[2] in the association between physical environmental conditions and mental wellbeing or health. In order to fill this gap, this study explores the role of the State in this association in a comparative setting. Countries of the European Union provide an appropriate context for this study owing to the diversity of environmental States' approaches adopted. Thus, this paper presents an exploratory study on the role of the State in the association between air pollution and mental wellbeing as a result also of data restrictions and the empirical analyses are a preliminary investigation of the questions raised in this paper. Based on these preliminary results, new research avenues that might overcome the limitations of this study are suggested in the concluding sections of the paper.

2. Literature

The theoretical framework for this paper builds on political science literature (Barry and Eckersley, 2005; Gough, 2016) that brings together different theoretical perspectives to understand the greening of the State (Bäckstrand and Kronsell, 2015). Two main strands of this literature are of relevance for the exploration of the role of the State in the association of air pollution with mental wellbeing. Firstly, comparative environmental politics studies have developed a range of ecological (Duit, 2008), environmental (Duit, 2016; Jahn, 2014) or eco-social (Koch and Fritz, 2014) classifications, in a similar vein to the typologies developed to classify existing welfare States (for a review see (Bergqvist et al., 2013; Brennenstuhl et al., 2011). These environmental state classifications differ in terms of dimensions, countries classified and methodological approach. Duit (2016) employs the concept of environmental governance regime (EGR) (Duit, 2016) and develops a four-type classification (2016) - Established, Partial, Weak and Emerging Environmental States - on the basis of four dimensions viz. regulation (environmental policies developed in a country), redistribution (environmental taxes as percentage of GDP), organisation (administration-years for ministry of the environment, environmental agency, and council of environmental experts), and knowledge generation (environmental R&D expenditure as percentage of total R&D expenditure). This typology takes into account the basic structures of States' activity in the environmental arena instead of using environmental performance indicators such as the Environmental Sustainability Index (Duit, 2016; Esty and Porter, 2005). As an alternative, Jahn's classification (2014) delineates the three worlds of environmentalism (which bears parallels with Esping-Anderson's work on the three worlds of welfare State) for 21 highly industrialised countries, namely 'high environmental performance' countries, 'less successful environmental performance' countries, and countries with a 'high environmental performance but a 'productionist' policy regime', where 'productionist' refers to a country's adherence to the economic growth paradigm (Büchs and Koch, 2017) through the exploitation of nature to produce goods. Other classifications focus on a particular aspect of States' environmental actions, for instance the environmental response in the area of climate change (Christoff and Eckersley, 2012). Koch and Fritz (2014) looked at the correspondence between types of welfare States and environmental States, as some scholars theorised whether social democratic welfare States are in a better position to develop into ecological States (Dryzek et al., 2012; Eckersley, 2018; Gough et al., 2008; Meadowcroft, 2006). Koch and Fritz (2014) built their classification of thirty industrialised countries by contrasting macro-structural welfare and ecological indicators. However, Koch and Fritz (2014) found no exact match between environmental and welfare States, that is their findings showed that social democratic welfare States are not more likely to develop into Green States compared to other regimes. Duit's (2016) argument on the analytical value of environmental governance regimes is particularly relevant for the choice of an ecological State classification for this study. "The utility of the regime concept primarily lies in that it pays equal attention to policies, organisations, and institutions, thereby enabling more comprehensive descriptions as well as macro-scale comparisons of a policy area" (Duit, 2016: 76). Therefore, an environmental governance regimes approach, similarly to a welfare State regime, offers a comprehensive assessment of a country's engagement in the environmental arena in contrast to a classification based on environmental policies, politics, and institutions in separation from each other.

In relation to the second strand of political science research, studies have examined the relationship between countries' welfare regimes and citizens' attitudes towards environmental and economic issues (Jakobsson et al., 2017; Koch and Fritz, 2014; Lim and Duit, 2017). The argument is that people's attitudes towards economic and environmental actions might be determined not only by people's own political and personal interests - as individuals who are younger, hold a higher educational level, and on the left of the political spectrum object to the domination of economic over ecological issues (Jürgen and Holger, 2008) - but also by their own country's engagement with environmental issues in terms of environmental policy and organisational and

[2] While the State is not the only actor engaged in environmental protection, for instance international, national and local environmental organisations operate a key role in environmental governance, the State can contribute to the improvement or worsening of environmental quality through environmental law and regulations.

performance dimensions (Jakobsson et al., 2017; Koch and Fritz, 2014). For instance, Jakobsson et al. (2017) examined the relationship between citizen attitudes towards income redistribution and citizen willingness to pay for environmental protection. The authors found that attitudes in the two policy areas are weakly associated but vary by country, with for instance a statistically significant negative association for Germany and a non-significant relationship for Spain and the UK. Level of economic wealth of a country has also been found to explain attitudes towards the environment, with higher levels of economic wealth inversely related to individuals' priority for economic growth over the environment (Jürgen and Holger, 2008). Koch and Fritz (2014) instead investigated the extent to which variations in the institutional and organisational capabilities of combining welfare with environmental policies (the hybrid 'socio-environmental' State) are mirrored in people's attitudes and found that citizens from social-democratic countries are more willing than average to accept measures which would cut their living standards to protect the environment.

As proposed in previous literature (Jakobsson et al., 2017; Koch and Fritz, 2014), if there is an influence on people' attitudes towards economic and environmental considerations due to the State engagement (or lack of) in the environmental arena, then the association between environmental conditions such as air pollution or noise and mental wellbeing might change by type of ecological State. It can be assumed that individuals who live in more advanced ecological States are better environmentally educated, more aware of environmental issues and more willing to accept a cut in their standard of living for a better environment. At the same time, they might feel more protected from environmental hazards because of the environmental actions undertaken by their governments. Individuals in these countries may have a higher level of trust in their government (Edlund, 1999; Hudson, 2006; Kumlin, 2002) as a result of the country's engagement in the environmental arena (Jakobsson et al., 2017; Koch and Fritz, 2014; Lim and Duit, 2017). Based on these arguments, the ecological State might influence the nature and strength of the association between physical environmental conditions and mental wellbeing.

This study puts forward the following hypotheses. Firstly, a negative association between air pollution and mental wellbeing is expected. Secondly, it is hypothesised a moderating role for the State in this association. For this second hypothesis two alternative explanations are put forward. These explanations build on the reasoning that a country's proactive engagement with environmental issues and policies are reflected in people's attitudes (Koch and Fritz, 2014). On the one hand, this association might be weaker in established environmental States as individuals might feel more protected by the environmental actions undertaken by their governments compared to other environmental States. On the other hand, the association might be stronger if the fact of living in an established environmental State makes people more aware of the negative consequences of environmental problems such as air pollution.

Hence, the paper examines whether air pollution has significant negative impacts on mental wellbeing as reported in the literature (Ferreira et al., 2013) and whether this association varies by ecological State. To test the hypotheses, this paper employs a comparative cross-national approach - similar to the work conducted in comparative welfare State research (Bergqvist et al., 2013) by employing the environmental governance regime classification developed by Duit (2016). In addition, it takes into account air pollution conditions closer to the experience of individuals by using both subjective and objective measures (Liao et al., 2015) of air pollution in order to maximise the understanding of its effects on mental wellbeing. These measures and their significance will be explained in detail in the next section.

3. Data and methods

The data are provided by the European Quality of Life Survey (EQLS), wave 3 (2011–2012), which has a random sample of adult population resident in 34 countries including the current 28 EU member countries (as at March 2019). In the majority of the countries, a multi-stage stratified and clustered sampling design was applied, and the surveys were carried out face-to-face (EQLS, 2012). The survey provides valuable information on the living conditions and wellbeing of Europeans. A weight (w4: Final weight trimmed and standardized, EQLS, 2012) was applied and the sample size equaled 36,113 respondents in the 28 EU countries. For the analyses, a subsample of 20 countries was used, depending on the availability of information on air pollution at the regional level and on environmental governance regimes (EGR) at the country level.

A 'regional' level of analysis is employed in this paper. It refers to a subnational level rather than to a group of similar countries, as sometimes used in the literature. The 'region' level is an intermediate level of analysis between the individual and the country level. The concept of region, its definition and the delimitation of regions (known as 'regionalisation') are complex undertakings. Regions can be subjectively and objectively defined. Subjective regions are an end to a function, a model for a specific purpose, while objective regions are 'natural' areas, defined by natural features, for instance the so-called 'bioregions' (Moughtin et al., 2009). To take advantage of the availability of data collected by the European Commission, the Nomenclature of Territorial Units for Statistics (NUTS) that is the subjectively defined administrative subnational areas developed by EUROSTAT (the EU statistical service) are used. The terms 'region' and 'NUTS' are used interchangeably in this paper. Both countries and regions in the EU vary greatly in terms of population size (Eurostat, 2018). However, "comparing data at a regional or subnational level is often more meaningful and such an analysis may also highlight disparities within countries" (Eurostat, 2018: 8). Comparability issues were overcome by using a representative sample of EU citizens by country and region.

The database was built merging together five different data sources. Firstly, a reference administrative geodatabase boundary (from GISCO, the geoportal of the European Commission) was used as reference. Secondly, socioeconomic data (from Eurostat, the statistical office of the European Commission) and environmental data (from the European Environment Agency) were added to this reference database. Thirdly, aggregate regional information was added to the EQLS data. Initially, the level of regional analysis considered was NUTS3. However, the EQSL does not provide enough information for NUTS3 level analysis to be conducted. Consequently, the second level of the Nomenclature of Territorial Units for Statistics (NUTS 2) was used and for some countries, the first level (NUTS1), as no information was available at the second level. There was a certain degree of discrepancy between the regional information included in the EQLS dataset and the reference GISCO geodatabase as for some regions the information in the EQLS data did not match exactly one of the reference NUTS included in the GISCO geodatabase. Therefore, ad hoc matching between a subset of EQLS regions and GISCO regions was undertaken (available on request from authors). After recoding and omitting cases with missing information, a total of 216 regions (NUTS 2 as baseline or NUTS 1 if NUTS2 are not available) were retained. As a result, the final sample contains information for 25,007 respondents.

4. Measures

4.1. Individual and local level

The outcome variable mental wellbeing is measured by the 5-item scale (WHO-5) developed by the World Health Organisation. It is a robust and validated measure widely used in a variety of research studies (see for instance Layte, 2012; Mitchell et al., 2015; Topp et al., 2015). The WHO-5 reflects both hedonic and eudemonic dimensions of wellbeing (Deci and Ryan, 2008). The five items assess positive mood, vitality and general interest over the past 2 weeks and is an effective tool for revealing the frequency of depressive symptoms in the general

population (Layte, 2012). Each answer is scored from zero to five and summed to produce a score out of 25. The scores in the EQLS data set are available rebased between 0 and 10. The higher the score the better the MWB.

To assess air pollution at the local level, a question on perceived air pollution included in the 2011 EQLS data set is used. This question asks whether the respondents have major, moderate or no problems in their neighborhood with air quality. It is a categorical variable with three categories: no problems perceived, moderate problems and major problems. A physical environment index was used for sensitivity purposes, which in addition to air pollution, included perceived problems with traffic congestion - as proxy for air pollution problems. A summative index was created, with higher scores referring to more perceived problems with air quality.

In order to capture socioeconomic inequalities at the individual level, educational status is taken into account. Based on a Directed Acyclic Graph (DAG) (Pearl, 2009) of the hypotheses, the model conditions only on educational status (and not on employment status, income level and ownership of a house, which initially were also included in the model) as this is sufficient to close the 'backdoor path'. In this way, 'over control bias' (Elwert and Winship, 2014) - that results from conditioning a variable on a causal path between treatment and outcome - is overcome and the models are parsimonious. Educational status is a categorical variable, consisting of primary or less, secondary and tertiary education.

Individual control variables known to be associated with depression and perceived air pollution are included: gender as a dummy variable and age as a metric variable. Household type is assessed through a five-category variable (single, couple without children, single parent, couple with children and other). Spatial control variables include the degree of urbanization which is measured using four categories (rural, village/small town, medium/large town and city/suburb). Migration status is a categorical variable consisting of non-migrant, migrant from an EU country and migrant from a non-EU country.

In addition, trust in local and national political institutions is controlled in the models, because the impact of EGR on the relation between air pollution and mental wellbeing is expected to be stronger as people have a higher level of trust in politics and institutions (Edlund, 1999; Hudson, 2006; Kumlin, 2002). Trust in political institutions was measured by a scale of three items. Each item begins with 'how much do you personally trust' followed by one of the following institutions: the national parliament, the government, and the local (municipal) authorities. The higher the score, the higher the level of institutional trust. The Cronbach's alpha of the scale is 0.84.

4.2. Regional level

For air pollution levels, SO_2 emission data from the European Environment Agency (EEA) were used. SO_2 emissions ($\mu g/m^3$) are the result of fossil fuel combustion at power plants and other industrial facilities, while CO, NO_2 and PM_{10} derive from non-stationary emitters such as road transport. Ferreira et al. (2013) suggest that SO_2 is a better indicator of regional air pollution in contrast to other pollutants which produce more localized effects. The SO_2 data were aggregated based on the procedures described by Ferreira et al. (2013). The SO_2 emissions could not be matched to individual respondents (as there is not enough information in the EQLS to geocode individuals' location) consequently the regional level (NUTS1/2) was used to capture general objective environmental conditions in which individuals live.

To take the regional macroeconomic conditions into account, Gross domestic product (GDP) - expressed in purchasing power standards (PPS) - and the unemployment rate are controlled. Information was retrieved from Eurostat.

4.3. Country level

To classify countries according to their engagement in the environmental arena, the Environmental Governance Regime (EGR) typology developed by Duit (2016) was used as follows: *Established* (Austria, Netherlands, Denmark, UK, Sweden, France, Germany, Finland), *Partial* (Greece, Poland, Slovakia, Spain) and *Emerging* (Italy, Belgium, Ireland, Portugal, Hungary) Environmental States. A fourth *weak* environmental State category is omitted as it includes non-EU countries. Instead, a category named *other* environmental States - consisting of Czech Republic, Estonia, and Slovenia which were not included in Duit's (2016) categorization - is added. In addition, the analysis controls for national GDP per capita.

5. Analytical strategy

The method consists of a multilevel analysis performed on the total sample, using a hierarchical three level framework: individuals are nested in regions, which are nested in countries. Multilevel analysis enables us to take the clustering of the data in regions and countries into account, and it allows us to estimate the impact of the air pollution on mental health.

A stepwise construction of the models is performed based on the DAG of the hypotheses. The first model only includes the paths between air pollution - at the individual and regional levels as the independent variables - and mental wellbeing, as the dependent variable (Model 1). Thereafter, the control variables (at the individual, regional and country level) are stepwise added to the model to close the backdoor paths, and to see whether the relation between local and regional air pollution and mental wellbeing can be partly ascribed to respectively individuals' SES, and regions' and countries' macroeconomic conditions (Model 2). In the third model, the moderator variable Environmental Governance Regime (EGR) is included. In the following two models, the cross-level interaction effects with air pollution at the local and the regional level are added (Model 4 and Model 5). By testing these interaction effects, it is investigated whether the relation between air pollution (perceived local and regional) and mental wellbeing is different according to EGR. Finally, the interaction between EGR and institutional trust is added (Model 6), exploring whether the relation between EGR and MWB is modified by individuals' level of institutional trust. The models were estimated in MLwiN (Charlton et al., 2017). Markov Chain Monte Carlo (MCMC) estimation procedures were used as this approach has proved to be far more robust when including higher-level variables and cross-level interactions (Stegmueller, 2013). However the results were not different from the Iterative Generalized Least Squares (IGLS) estimation consequently the latter are reported. In addition, for each model the intra class correlation (ICC) and the corresponding deviance information criterion (DIC) of the MCMC results are presented.

6. Results

6.1. Descriptive results

Table 1 presents mental wellbeing (mean scores for the categorical variables) and perceived air pollution (percentages for the categorical variables) cross-classified against individual, regional and national control variables. Firstly, men, non-EU migrant, couples without children, people living in the open countryside, those with tertiary education, individuals living in established EGR, and those who do not perceived air pollution problems in their neighborhood have a higher level of mental wellbeing. The percentages of individuals who report no problems with air pollution in their near neighborhood are highest among men, singles, open countryside residents, individuals with primary education, and citizens of established EGR. In contrast, women, single parents, EU migrants, people from the city, individuals with

Table 1
Mental wellbeing and perceived air pollution by individual level variables and EGR.

	Mental wellbeing		Perceived air pollution		
	Mean	(SD)	% No problems	% Moderate problems	% Major problems
Gender					
women	6.13	(2.06)	75.5	19.5	5.0
men	6.45	(1.98)	77.9	17.5	4.6
Migration status					
Native	6.27	(2.03)	76.7	18.6	4.8
migrant from EU	6.28	(2.14)	75.2	18.0	6.8
non eu migrant	6.37	(2.03)	74.4	20.5	5.1
Household type					
single	6.09	(2.14)	78.5	17.1	4.4
couple without children	6.47	(1.98)	77.9	17.9	4.2
single parent	5.62	(2.16)	74.4	19.1	6.5
couple with children	6.39	(1.84)	74.5	20.5	5.0
other	6.16	(2.08)	75.1	19.3	5.6
Type of community					
The open countryside	6.48	(1.99)	91.3	7.1	1.6
A village/small town	6.19	(2.03)	82.9	14.2	2.8
A medium to large town	6.31	(2.04)	73.7	21.4	5.0
A city or city suburb	6.26	(2.03)	62.7	27.9	9.4
education					
Primary or less	5.83	(2.28)	82.8	13.6	3.6
secondary	6.25	(2.04)	75.9	18.8	5.3
tertiary	6.53	(1.82)	75.5	20.4	4.1
Perceived air pollution					
No problems	6.35	(2.02)			
Moderate problems	6.09	(1.97)			
Major problems	5.72	(2.23)			
Environmental Governance Regime					
Established EGR	6.41	(1.99)	82.3	14.8	2.9
Emerging EGR	6.38	(1.96)	73.1	20.3	6.6
Partial EGR	6.00	(2.21)	71.8	22.3	5.9
Other EGR	5.93	(1.92)	68.6	24.5	7.0

secondary education, and individuals living in Eastern European countries (other EGR) report major problems with perceived air pollution.

Also, as shown in Table 2, individuals reporting no problems with air pollution have a higher level of trust in political institutions, live in regions with a lower unemployment rate, a higher GDP at regional level, a higher GDP per capita at national level and a lower level of SO_2. Instead, individuals who report major problems with air pollution, have lower level of trust in institutions, reside in regions with a higher unemployment rate, lower GDP, a higher SO_2 level, and in countries with a lower GDP per capita.

Table 3 shows the mean scores of mental wellbeing, SO_2 emissions and macroeconomics indicators by EGR. Established EGRs have the lowest levels of SO_2 while partial EGRs present the highest level. The distribution of SO_2 emissions (Fig. 1) across EU regions shows clearly higher levels of emissions in Eastern European countries, Greece and southern Spain. Established EGRs also present highest regional GDP and national GDP per capita and lowest regional unemployment. Finally, the highest level of institutional trust is observed in established EGRs.

Correlation coefficients (Appendix 1) also show that as far as macroeconomic conditions are concerned, higher GDP per capita at the country level and the regional GDP level are associated with higher mental wellbeing. Higher unemployment levels at regional level are associated with lower mental wellbeing and worse regional air quality measured by SO_2. Better macroeconomic conditions (higher GDP levels and lower unemployment rates) are related to lower regional air pollution levels measured by SO_2 emissions.

6.2. Multilevel results

The variance decomposition (not presented) shows that 5% of the variance in mental wellbeing can be attributed to the higher levels. 2.6% can be explained by differences between countries and 2.5% by differences between regions ($ICC_{country} = 0.026$, $p < 0.01$; $ICC_{region} = 0.025$, $p < 0.001$).

In the starting model (Model 1, presented in Table 4), the two indicators of perceived air pollution and objective regional SO_2 emissions are included. Individuals who report moderate to major problems with air pollution in their near neighborhood, have poorer mental wellbeing. To the contrary, the multilevel analysis does not confirm that individuals living in a region with a higher SO_2 level, report poorer mental wellbeing. Thereafter the control variables are stepwise added to the model (Model 2). Men, younger people, couples without children, individuals with tertiary education, people with higher institutional trust in government and people living in the open countryside have better mental wellbeing. The regional level and country level control variables were not significant. After adding these variables, the negative association between perceived air pollution and mental wellbeing becomes slightly stronger. In Model 3, the moderator variable EGR is added. Lower mean levels of mental wellbeing are found in citizens of established EGRs. Over the three models, the ICC decreases from 4.7% to 3.2%, and also the DIC of each subsequent model is lower.

Table 5 shows the interaction effects between the air pollution variables and EGRs and between EGRs and institutional trust on mental wellbeing. The negative association between the perception of major air pollution problems in the near neighborhood and individuals' mental wellbeing is stronger in established and partial EGR compared to emerging EGR (Table 5, model 4). Instead, the interaction effect between EGR and SO_2 is not significant (Table 5, model 5). The interaction effects for institutional trust and EGR show that the positive association between trust and mental health is stronger in established EGR - or the negative relation between living in an established EGR (in comparison to emerging EGR) and mental health is weaker among individuals with a higher institutional trust - (Table 5, model 6). Important to mention is that the association between the perception of air pollution problems and worse mental wellbeing holds irrespective of

Table 2
Individual, regional and national level variables per categories of perceived air pollution (Means and SDs).

	Perceived air pollution		
	No problems Mean (SD)	Moderate problems Mean (SD)	Major problems Mean (SD)
Age	51.36 (18.13)	49.26 (16.96)	49.19 (16.67)
Trust in institution (0–10)	4.71 (2.13)	4.22 (2.08)	3.77 (2.16)
SO_2	4.01 (3.16)	4.54 (3.32)	5.12 (3.47)
Regional unemployment rate	9.63 (4.84)	9.81 (4.64)	10.00 (4.76)
Regional GDP (pps) (/10000)	2.57 (1.15)	2.43 (1.23)	2.40 (1.17)
National GDP per capita (pps) (/1000)	25.86 (5.45)	24.28 (5.48)	24.02 (5.25)

Table 3
Mean scores of mental wellbeing, regional air pollution and macroeconomic indicators by countries' EGR.

	Established		Emerging		Partial		Other	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Regional SO_2	2.71	(1.26)	3.62	(2.22)	8.16	(4.22)	3.82	(1.85)
Mental wellbeing	64.07	(19.88)	63.87	(19.66)	59.93	(22.16)	59.41	(19.21)
Regional unemployment	7.02	(2.06)	10.52	(4.06)	15.01	(6.03)	9.03	(2.57)
National GDP x capita (pps) (/1000)	29.70	(2.06)	24.79	(5.40)	19.86	(3.53)	19.39	(1.74)
Regional GDP (pps) (/10000)	3.30	(0.86)	2.43	(1.11)	1.51	(0.69)	1.48	(0.44)
Institutional trust	5.37	(2.00)	3.98	(2.00)	3.72	(1.99)	4.50	(2.04)

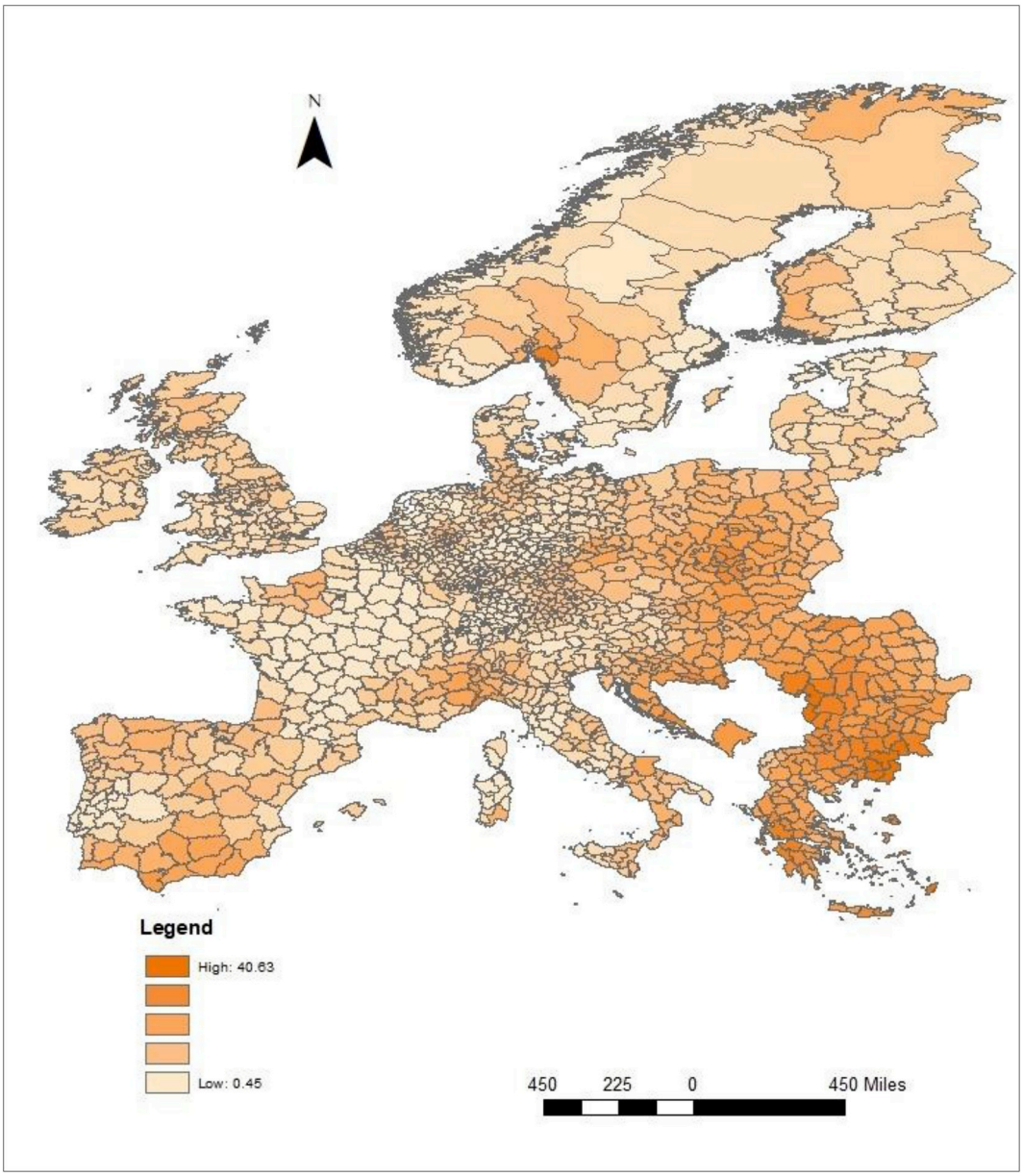

Fig. 1. 2011 SO_2 emissions ($\mu g/m^3$) in Europe by NUTS3 (Authors' own elaboration based on natural breaks. Data Source: EEA).

individuals' level of institutional trust. Model 6 is a better model both in terms of ICC and DIC.

The sensitivity analysis conducted using the physical environment index (consisting of perceived problems with air pollution and traffic congestion) confirmed the findings for perceived air pollution i.e., individuals who report major problems with both air pollution and traffic and live in established and partial EGR also report worse mental wellbeing.

7. Discussion

This study explores the role of the ecological State in the association between air pollution and mental wellbeing. The empirical analyses are a preliminary exploration of the questions raised in the theoretical

Table 4
Mental wellbeing regressed on perceived and objective air pollution.

	Model 1			Model 2			Model 3		
	b	se	sign	b	se	sign	b	se	sign
Individual level									
Cons	6.352	0.075	***	6.467	0.086	***	6.722	0.120	***
Perceived air pollution (ref. No problems)									
Moderate problems	−0.196	0.033	***	−0.205	0.033	***	−0.204	0.033	***
Major problems	−0.572	0.06	***	−0.530	0.060	***	−0.530	0.060	***
Age (centred)				−0.009	0.001	***	−0.009	0.001	***
Women (ref. men)				−0.242	0.025	***	−0.242	0.025	***
Household type (ref. couple without children)									
Single				−0.323	0.034	***	−0.323	0.034	***
Single parent				−0.825	0.073	***	−0.826	0.073	***
Couple with children				−0.239	0.038	***	−0.240	0.038	***
Other				−0.259	0.038	***	−0.261	0.038	***
Migration status (ref. no migrant)									
Migrant from EU				−0.160	0.100		−0.163	0.100	
Non EU-migrant				−0.009	0.089		−0.007	0.088	
Educational level (ref. primary)									
Secondary				0.355	0.045	***	0.357	0.045	***
Tertiary				0.544	0.050	***	0.545	0.050	***
Type of community (ref. country side)									
A village/small town				−0.170	0.047	***	−0.169	0.047	***
A medium to large town				−0.096	0.049	*	−0.093	0.049	
A city or city suburb				−0.112	0.052	*	−0.110	0.052	*
Institutional trust in government (centred)				0.131	0.007	***	0.132	0.007	***
Regional level									
SO_2	−0.016	0.009		−0.003	0.011		−0.004	0.011	
Unemployment rate (centred)				−0.006	0.009		−0.010	0.009	
Regional GDP (/10 000) (centred)				0.035	0.043		0.036	0.042	
National level									
National GDP per capita (/1000) (centred)				0.013	0.013		0.031	0.016	
Environmental Governance Regime (ref. emerging EGR)									
Established EGR							−0.468	0.160	**
Partial EGR							−0.083	0.170	
Other EGR (Eastern European Countries)							−0.302	0.182	
Variance: country level	0.094	0.035	*	0.060	0.024	*	0.035	0.016	*
regional level	0.100	0.015	***	0.089	0.013	***	0.089	0.013	***
individual level	3.928	0.035	***	3.742	0.034	***	3.742	0.034	***
ICC[a]	0.047			0.038			0.032		
DIC[b]	110004.3			104542.6			104540.9		

($N_{individuals}$: 25007; $N_{regions}$ = 216, $N_{countries}$ = 20).
p < 0.050 **p < 0.010 ***p < 0.001.
[a] Intra class correlation.
[b] Deviance Information Criterion.

framework, which emerged from comparative welfare State and health research work, and the green state literature. The paper developed a theoretical framework in which the ecological state plays a role in the association between air pollution and mental wellbeing. More specifically, the paper tested a set of hypotheses that examined the negative association between (perceived and objective) air pollution and mental wellbeing and the role of the ecological State. These hypotheses build on the reasoning that a country's proactive engagement with environmental issues and policies are reflected in people's attitudes (Koch and Fritz, 2014). States' environmental commitment is based on Duit's (2016) classification of Established, Partial, and Emerging environmental States with the addition of Other environmental States to include EU countries not classified by Duit (2016). On the one hand, a weaker association between air pollution and mental wellbeing is expected in established ecological States, because individuals feel more protected by the environmental actions undertaken by their governments. On the other hand, the association might be stronger if living in an established ecological State make people more aware of the detrimental health impact of air pollution. The preliminary findings seem to support the latter logic.

Firstly, the perception of poor air quality in the neighborhood has a clear association with poorer mental wellbeing. This finding is in line with recent research that shows a strong link between exposure to fine particulate matter ($PM_{2.5}$) and levels of anxiety (Power et al., 2015). Second, no significant association between objective air pollution and mental wellbeing was found. This can be attributed to the SO_2 emissions being only a very general indicator of environmental conditions in the various regions. While people have knowledge and are affected by the conditions of their local neighborhood, they may not be aware or affected by regional conditions. This reasoning bares some similarities with the effect of temporal exposure to air pollution, “with more recent exposures potentially more relevant than more distant exposures” (Power et al., 2015: 1).

Secondly, lower mental wellbeing was observed overall in established EGRs. Consequently, after taking their higher level of institutional trust, and their perception of less air pollution problems into account, citizens of EGRs report lower mental wellbeing. This finding needs to be interpreted in the light of the next finding, namely, EGR modifies the association between perceived air pollution and mental wellbeing: this association is particularly strong in established and partial EGR. It is assumed that citizens of established EGR countries are more aware of the negative consequences of environmental problems and that their higher awareness brings them to be more vulnerable, in terms of mental health, to major air pollution problems, despite their country being a ‘good’ environmental State. These associations occur irrespective of the level of trust in local and regional politics. These

Table 5
Mental wellbeing regressed on the interaction between EGR and air pollution, and EGR and trust.

	Model 4			Model 5			Model 6		
	b	se	sign	b	se	sign	b	se	sign
Individual level									
cons	6.702	0.120	***	6.732	0.116	***	6.706	0.118	***
Perceived air pollution (ref. No problems)									
Moderate problems	−0.155	0.067	*	−0.205	0.033	***	−0.205	0.033	***
Major problems	−0.251	0.108	*	−0.534	0.060	***	−0.532	0.060	***
Institutional trust (centred)	0.132	0.007	***	0.132	0.007	***	0.099	0.013	***
Regional level									
SO_2	0.001	0.011		0.022	0.030		−0.001	0.010	
Unemployment rate (centred)	−0.010	0.009		−0.009	0.009		−0.010	0.009	
Regional GDP (/10 000) (centred)	0.038	0.042		0.044	0.042		0.035	0.042	
National level									
National GDP per capita (/1000) (centred)	0.030	0.016		0.031	0.016		0.031	0.016	
Environmental Governance Regime (ref. emerging EGR)									
Established EGR	−0.435	0.161	**	−0.459	0.163	**	−0.480	0.157	**
Partial EGR	−0.044	0.171		−0.031	0.166		−0.079	0.167	
Other EGR (Eastern European Countries)	−0.313	0.184		−0.282	0.173		−0.289	0.178	
Interaction: perceived air pollution x EGR									
Moderate air pollution problems x established EGR	−0.112	0.085							
Major air pollution problems x established EGR	−0.335	0.153	*						
Moderate air pollution problems x partial EGR	−0.072	0.095							
Major air pollution problems x partial EGR	−0.544	0.161	**						
Moderate air pollution problems x other EGR	0.087	0.113							
Major air pollution problems x other EGR	−0.257	0.188							
Interaction: SO_2 x EGR									
SO_2 x established EGR				−0.005	0.041				
SO_2 x partial EGR				−0.035	0.032				
SO_2 x other EGR				0.071	0.058				
Interaction: Institutional trust x EGR									
Trust x established EGR							0.059	0.016	***
Trust x partial EGR							0.015	0.020	
Trust x other EGR							0.023	0.023	
Variance: country level	0.035	0.016	*	0.030	0.014	*	0.033	0.015	*
regional level	0.089	0.013	***	0.086	0.013	***	0.087	0.013	***
individual level	3.739	0.034	***	3.742	0.034	***	3.740	0.034	***
ICC[a]	0.032			0.030			0.031		
DIC[b]	104537.81			104542.61			104230.647		

($N_{individuals}$ = 25007; $N_{regions}$ = 216, $N_{countries}$ = 20).
All models controlled for age. gender. household type. migration status. and education.
*p < 0.050 **p < 0.010 ***p < 0.001.
[a] Intra class correlation.
[b] Deviance Information Criterion.

findings can be interpreted as an indication that initial steps of governments to clean up the environment will probably not immediately translate into better personal wellbeing. Instead, these policies could raise awareness and resentment and contribute to worse mental wellbeing. Processes of relative deprivation (Walker et al., 2015) could be at play here. We speculate that, despite the good record in the environmental arena of established EGR countries, citizens living in these countries are more affected by the perception of air pollution than individuals living in emerging EGR (but less than in partial), because they are more aware of the potential of cleaning up the environment for their quality of life. This post hoc interpretation also aligns with the observation that especially in established EGR countries institutional distrust (trust) contributes to (better) worse mental wellbeing, while in these regimes overall levels of trust are highest. In other regimes, institutional trust is not associated with worse mental wellbeing, but this trust is at a lower level anyway. In sum, citizens' expectations may rise when governments start cleaning up their act and the environment, with as a result increasing feeling of resentment about any barriers to a more bountiful ecological future.

7.1. Limitations

The main limitations of this work are related to the data and the databases used to conduct the analyses. Despite the ample availability of data covering EU country and regions, there are many challenges to the construction of a robust environmental and socioeconomic database for a multilevel (from the individual to the country level) analysis in a comparative cross-country and cross-region setting within the European Union. More specifically, currently objective environmental data that measure individual exposure to environmental conditions such as air pollution cannot be matched to survey participants such as the EQLS or ESS.

The use of a single cross-sectional sample of European citizens drawn from the EQLS wave 3 for 2011 means that the findings must be interpreted with caution and verified in future research work. However, the decision to use one single wave was due to difficulties in finding socio-economic and environmental data to match the 2003 and 2007 EQLS waves. Also, it was not possible to adequately match objective air pollution data to each EQLS participant spatially. Instead, this work relied on objective air pollution data for NUTS2 and NUTS3 level. These regions are quite large areas. Consequently, individuals may not be directly affected or aware of the regional environmental conditions. Instead, personal exposure relies on subjective measures of self-perceived environmental conditions.

This work also relies on one single measure of objective air pollution for the year 2011 namely SO_2 emissions (though sensitivity analyses not reported in this paper were carried out using other air pollution indicators namely CO_2 transport emissions) and one perceived measure.

Consequently, the results might be affected by fluctuations in the data.

The work also hypotheses that the association between air pollution and mental wellbeing is moderated by the State due to the influence on individuals of their own country's engagement with environmental issues in terms of environmental policy and organisational dimensions. The work includes questions on trust in authorities as individuals in established EGRs might have a higher level of trust in their government. However, these questions do not include environmental dimensions of trust in authorities, which would have been more relevant for this study.

Finally, the paper made use of one environmental State classification to classify States into different types of ecological States. Other classifications might have produced different findings. Moreover, the State level might be irrelevant because of its distance from the daily life of people. In this context, the regional level might be more relevant in for a study of EU citizens. Finally, broad environmental State categories ignore variance between countries in the same category.

8. Conclusion and future research

This paper presented the preliminary findings of a study that aimed to contribute to issues around the role of the ecological State in the association between air pollution and mental wellbeing. These issues are still underexplored in the literature. However, mental wellbeing has entered the policy sphere (Stiglitz et al., 2009) and is acknowledged as an important and relevant condition for EU citizens, Member States, stakeholders and the EU economy as stated in the 2005 Green Paper (EC, 2005) and more recently in the European Pact for mental health and wellbeing (EC, 2008), a joint EU strategic agreement which calls for action in the area of mental health. A recent estimate of the total costs of mental disorders - for health systems, social welfare systems and the EU economy - is more than € 450 billion (Borg, 2013). Consequently, more research on the role of the ecological State in the association between physical environmental conditions and mental wellbeing is warranted. In particular, future research should assess whether these exploratory and preliminary findings are confirmed. Also, important is the further development of a theoretical framework to understand the mechanisms that can help to explain in more detail the pathways through which the ecological State moderates the association of air pollution (or other environmental aspects) with mental wellbeing.

Given the difficulties in the construction of a database with a focus on EU countries and regions, future research could conduct an audit of data availability for a comparative study of this type. More in-depth research is needed on a smaller set of EU countries and regions for which a set of rich and robust datasets of relevant variables exist. Also, comparative research that extends to all EU countries and regions and uses a smaller dataset of relevant variables is welcome. The challenge is to match large social survey data at the individual level, such as the EQLS, the European Social Survey or the International Social Survey Programme with objective environmental data available from the EEA, for instance. Large datasets are needed that allow for the comparison of differences amongst NUTS 2 and 3 regions within and between countries.

In addition to other air pollution measures, other dimensions of physical environmental conditions such as availability of green areas or water quality, or an overall index (Pearce et al., 2010) should be used in future work. Scoring countries and regions using relevant dimensional indicators should supplement the comparison of categories of countries or regimes.

Future work could explore the association for other time periods either by pooling together different waves of EQLS or ESS or employing longitudinal datasets. While this work considered individual level factors which might influence one's own assessment of environmental conditions, including education level, place of residence and trust in authorities, future research could use more detailed information on people's environmental attitudes together with people's own assessment of local environmental conditions. Also, future research should explore people's attitudes towards air pollution and other environmental issues (flooding, rising temperatures), as well as individuals' trade-off between environment and economy.

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Appendix 1. Pearson correlation coefficients

	SO_2	Environmental index	Institutional trust	Regional unemployment	Regional GDP	National GDP per capita
SO_2						
Environmental index (0–4)	0.059**					
Institutional trust (0–10)	−0.226**	−0.125**				
Regional unemployment	0.426**	0.002	−0.204**			
Regional GDP	−0.474**	−0.007	0.291**	−0.379**		
National GDP per capita	−0.493**	−0.096**	0.303**	−0.339**	0.808**	
Mental wellbeing	−0.068**	0.110**	0.170**	−0.050**	0.112**	0.122**

Appendix B. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.healthplace.2019.03.003.

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