Climate change adaptation through spatial planning: the case study of the region of Western Macedonia

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Abstract. In this paper the compatibility and complementarity between the Regional Adaptation Action Plans (RAAPs) and other regional-scaled plans, such as the Regional Spatial Planning Frameworks (RSPFs), are examined, using as a case study the Region of Western Macedonia. The compatibility and complementarity of objectives, measures and tools between the RAAP and the RSPF of Western Macedonia are assessed. The analysis of the RAAP and the RSPF of Western Macedonia revealed the interconnection between spatial planning policies and adaptation to climate change policies. However, severe doubts are raised about the usability of the revised RSPF of Western Macedonia since it does not assess the crucial new conditions and priorities related to the region's future development, including the de-lignification and the Just Transition initiatives.

1. Introduction
The European Commission adopted a European Union (EU) strategy on adaptation to climate change in April 2013 [1], which was revised in February 2021 [2]. The new strategy sets out how the EU can adapt to the expected impacts of climate change and become climate resilient by 2050 [3]. This new revised strategy aims to make EU climate change adaptation smarter, swifter, and systemic [3].

The EU committed to climate neutrality by 2050 and set a more ambitious emissions reduction target of at least 55% by 2030, compared to 1990 [3]. The European Parliament has also made a declaration of climate emergency while the European Council characterised climate change as "an existential threat" [4].

The impacts of climate change affect various sectors. The effects of climate change worsen the society risks to food security, social inequalities, biodiversity, cultural heritage and the health and well-being of the Europeans as well. The EU will also be increasingly affected by climate impacts outside Europe through spillover effects on trade or migration [2].

The green transition in the Recovery and Resilience Facility and the next generation Cohesion Policy programmes provide an opportunity to frontload investments and reforms that can help increase resilience to climate shocks and accelerate the decarbonisation of the EU society and economy.

The Greek National Adaptation Strategy (NAS) was adopted in 2016 [5]. The objectives of the NAS are further analysed through the development of Regional Adaptation Action Plans (RAAPs), which are expected to be endorsed within this year (L. 4414/2016).
The most severely affected Greek Region by the EU decarbonisation initiatives is undoubtedly the Region of Western Macedonia. Therefore, this paper examines the compatibility and complementarity of objectives, measures and tools between the RAAP and the Regional Spatial Planning Framework (RSPF) of Western Macedonia.

2. The Greek National Adaptation Strategy

The Greek National Adaptation Strategy (NAS) aims to strengthen the country's resilience against climate change [5]. It attempts to be the starting point for formulating a strategic approach to promote adaptation to climate change in Greece, setting in motion a continuous consultation, review, updating and realignment of Greece’s climate change adaptation strategy [5].

The NAS provides an initial five-year horizon for developing Greece's ability to adapt to climate change and prioritise and implement a set of adaptation measures concerning the sectors that are characterised as the most vulnerable to the expected impacts of climate change in Greece [5].

Its main objectives are to [5]: (i) systematise and improve the decision-making process about adaptation decisions, both in the short-term and in the long-term, (ii) promote a sustainable model of development using regional and local adaptation action plans, (iii) link adaptation policies with all sectors of the Greek economy, (iv) create a mechanism for monitoring, evaluating and updating the actions and policies related to the adaptation to the effects of climate change, (v) strengthen the adaptive capacity of the Greek society through raising public awareness initiatives.

The main pillars of the NAS are the [5]: (i) analysis of climatic danger and vulnerability of the Greek territory, (ii) critical review of alternative adaptation measures in all sectors of the Greek economy, (iii) presentation of the main tools for evaluating adaptive investments and policies, (iv) development of tools for integrating adaptive policy into broader policies, (v) incorporation of the international dimension of adaptation in all the local and regional adaptation policies, (vi) strengthening of the country's adaptive capacity at national, regional and local levels, (vii) promotion of the public consultation among social partners about climate change adaptation, (viii) continuous monitoring and evaluation of the implemented adaptation policies.

Specifically, the NAS proposes a set of adaptation measures concerning the following sectors that are characterised as the most vulnerable to the expected impacts of climate change in Greece, which namely are: The NAS provides an initial five-year horizon for developing Greece's ability to adapt to climate change and prioritise and implement a set of actions [5].

3. The Regional Adaptation Action Plans in Greece

The NAS is the first step in establishing a continuous and flexible planning and implementation process of the necessary adaptation measures and actions at a national, regional and local level. It aims to draw up guidelines. Consequently, it does not (i) analyse the necessary sectoral policies in-depth, (ii) decide on the feasibility of individual adaptation measures and actions at the local/regional level and (iii) attempt to prioritise the indicatively proposed measures and actions. These issues are the subject of the individual RAAPs (L. 4414/2016).

The RAAP is a comprehensive plan that identifies and prioritises the necessary adaptation measures and actions a region should follow to enhance its resilience against the expected effects of climate change. Each RAAP comprises (L. 4414/2016): (i) a thorough analysis of its objectives, (ii) a brief reference to the environmental, social etc. data used, (iii) an assessment of the expected climate change impacts at the region and an analysis of the climate vulnerability of various sectors and geographical areas, (iv) an assessment of the immediate and long-term environmental, economic and social effects of climate change in various areas of the region, (v) a description of the proposed measures and actions for the priority sectors and areas, (vi) an estimation of the possible implementation costs and a scheme of government implementation, (vii) a set of proposed measures and actions to adapt other existing policies to the expected impacts of climate change (e.g. natural disaster management policies), (viii) an
examination of the compatibility and complementarity of the RAAP with other regional plans, (ix) an analysis of the compatibility between the RAAP and the RAAPs of the neighbouring regions, (x) a proposed public consultation approach, (xi) a set of indicators about the awareness measures, (xii) a system to monitor the implementation of the RAAP, (xiii) a non-technical summary.

Each RAAP is evaluated every seven years, but it could be revised even sooner, if required, according to the findings of a thorough assessment (L. 4414/2016).

4. The Region of Western Macedonia
The Region of Western Macedonia is one of the thirteen Regions of Greece. It is located in the Northwest part of Greece and is regarded to be the energy core of Greece but is the only Greek region not bordering the sea. The Region of Western Macedonia consists of the Regional Units of Kozani, Grevena, Kastoria and Florina. It covers 9,451 km² and comprises primarily mountainous and semimountainous land (82%). The population of the Region of Western Macedonia was estimated at 283,689 inhabitants (2011) [6]. The Region of Western Macedonia has a rich natural heritage, including eleven ecotypes of the NATURA 2000 network [6].

The region’s main economic activities are agriculture, mining sites, electric power production, tourism and fur [6]. The Region of Western Macedonia produced 2.43% of Greece's GDP in 2013. Its distribution per sector was [6]: 45% from mines, quarries, industry, electricity supply, etc., 17% from public administration, social insurance, education, human health, social care, etc., 11% from wholesale and retail trade, transportations, accommodation & catering services, 10% from real estate, 6% from agriculture, forestry and fishery, 4% from the construction sector, while all the rest (ICT, scientific, technical, administrative activities, entertainment & recreation, arts, finance & insurance, etc.) show percentages of 1-2%.

In 2010 the Public Power Corporation (PPC) extracted 43.3 million tonnes of lignite from the West Macedonia Lignite Centre. Until June 2010, twenty-two lignite units of 5.288 MW operated in eight Steam Power Plants of PPC, six of which in the Region of Western Macedonia (eighteen units), and two in Megalopolis, in the Peloponnese (four units) [6].

5. Decarbonization and Western Macedonia Region
Under pressure from European environmental legislation, the Greek Government decided to shut down eight lignite units with a total capacity of 913 MW (six in the Western Macedonia Region and two in the Peloponnesse Region) since June 2010 [6]. In addition, due to the need to comply with the new, stricter EU Directive on industrial emissions (2010/75/EC), PPC had to put six lignite units of a total capacity of 1.850 MW (all located at WMR) under restricted operation [6]. These units will be withdrawn at some point until 2023 at the latest. From the remaining eight units with a total capacity of 2.525 MW that operate at full power, the six are located in the Western Macedonia Region [6].

The goal of complete decarbonisation of the country by 2028 is an ambitious goal the Greek Government set in 2019 and is reflected in the National Energy and Climate Plan [7]. It is in line with the European Climate Neutrality Strategy, which, among other things, urges towards the elimination of greenhouse gas emissions by 2050 [8].

To address the economic and social repercussions, the Greek Government announced the Just Development Transition Plan in 2020 [9]. The masterplan presents twelve measures that shall contribute to a successful transition towards the post-lignite era. Through the envisaged investments, the master plan estimates that 8.000 new jobs will be created by 2028, using a total budget of about €5 bn.

6. Expected Climate change effects at the Region of Western Macedonia
The average annual temperature of the Region of Western Macedonia is expected to increase by 1.5°C until 2050 and by 3.5°C until 2100 [10].
These temperature increases are expected to have a significant impact on the structured environment of the Region, the main effects of which will be [10]: (i) increased energy demand for (cooling) during the summer months in homes, public and private facilities (eg. industrial facilities, offices, cultural venues), (ii) reduction of the thermal comfort of the citizens, (iii) amplification of the Urban Heat Island (UHI) effect.

According to the NAS [5], the structured environment of the Region of Western Macedonia is highly vulnerable to the increase of temperature inside buildings. A significant rise in the average annual temperature at a typical house is expected to rise for the Emission Scenario A1B 2.9°C by 2050 and 5.3°C by 2100. The rise of the internal temperature for Emission Scenarios A2 and B2 is also relatively high (approximately 6.5°C and 5°C respectively until 2100) [5].

7. The RAAP of Western Macedonia
The main objective of RAAP of Western Macedonia is to contribute to strengthening the resilience of the region against the effects of climate change through [10]: (i) analysing in-depth the necessary sectoral policies, (ii) considering the feasibility of individual adaptation measures and actions at local/ regional levels, (iii) prioritising the indicatively proposed measures and actions, (iv) setting immediate adaptation priorities at the local level.

The main priorities of the RAAP of Western Macedonia are the same as the NAS previews at the national scale. The preparation of RAAP of Western Macedonia included the [10]: (i) analysis of the objectives of the NAS, (ii) description of the characteristics of the natural and man-made environment of the region, (iii) assessment of the expected climate change impacts across the region, (iv) analysis of the climate vulnerability of its sectors and geographical areas, (v) assessment of the immediate and long-term effects of climate change in various sectors and setting sectoral and spatial priorities, (vi) proposal of measures and actions for the priority sectors and areas, (vii) integration of the proposed measures and actions for adaptation to climate change to other existing policies, (viii) examination of the compatibility and complementarity of the RAAP with other existing or regional plans and priorities, (ix) exchange of knowledge between the RAAP with other RAAPs and especially with those of the neighbouring Regions, (x) proposal for a well-structured and practical consultation approach, (xi) use of specific awareness tools focused on public and the social partners, (xii) continuous monitoring of the implementation of the RAAP. According to L. 4414/2016 (art. 43) each RAAP is assessed every seven years, but it can be reviewed sooner, if required, following a thorough evaluation.

8. Adaptation of Region of Western Macedonia: Urban and regional planning measures
Concerning the climate change adaptation of the Region of Western Macedonia, in terms of urban and regional planning, the RAAP proposes the following set of measures and actions [10].

8.1. Construction of urban flood drainage infrastructure
According to the RAAP of Western Macedonia, the planning of projects related to rainfall management usually do not include flood discharge projects that could mitigate extreme weather phenomena related to climate change. Thus, the RAAP of Western Macedonia proposes a set of measures to minimise these effects that include [10]: (i) the development of master plan studies about urban flood discharge projects, (ii) the construction of flood discharge zones in the context of city plans, (iii) the creation of "green roofs" in public buildings, (iv) providing incentives for the creation of "green roofs" in private buildings.

According to the RAAP of Western Macedonia, priority should be given to the region's largest cities, namely Kastoria, Florina, Ptolemaida, Kozani and Grevena.

8.2. Rational rainwater management in buildings
In cases of heavy rainfall, a saturation of the existing rainwater drainage networks of the cities will be observed, resulting in the occurrence of flood events, when mainly some of the water collection wells
are blocked by ferns [10]. The load the rainwater drainage network of cities has to process could be reduced if the runoff of buildings (e.g. from roofs, terraces) and yards have other recipients besides the urban rainwater network. These recipients can be gardens, orchards and rain tanks for watering. This measure aims to reduce the flood benefits of the urban rainwater network of the region’s cities but also to save drinking water for irrigation [10].

In this direction, indicative measures proposed by the RAAP of Western Macedonia are [10]: (i) providing incentives to individuals to create separate rainwater networks in buildings and properties, (ii) carrying out an information campaign of the citizens on the possibility of different rainwater networks in the buildings and properties.

Priority areas are considered the large urban centres of Western Macedonia, namely Kastoria, Florina, Ptolemaida, Kozani, and Grevena, Florina and secondarily, the towns of Argos Orestiko, Siatista, Velventos, Serbia and Amynteo.

8.3. Special urban and building regulations in flood plains

This measure aims to identify the floodplains of the Region of Western Macedonia and propose special urban and building regulations in these areas to ensure their resilience against extreme flooding phenomena. The RAAP of Western Macedonia proposes the development of a study for the [10]: (i) identification of the flood plains, (ii) formation of special building provisions, (iii) cost-benefit analysis about the geotechnical and structural works needed for the safe construction of the buildings.

Indicative building conditions could be the deviation from the maximum permitted building height, the implementation of additional anti-seismic and geotechnical reinforcement of the buildings (according to the current anti-seismic regulation) based on embankments etc.

8.4. Reduction of the Urban Heat Island phenomenon.

The UHI effect takes place in the centres of cities where local temperatures are higher than those in the suburbs and other surrounding rural areas. This phenomenon is caused because of [10]: (i) the absorption of solar radiation and heat from buildings and roads and its release at night, (ii) the lack of green in city centres, (iii) the concentration of human activities in cities (e.g. excessive use of heat-releasing vehicles) and (d) the emission of air pollutants.

The UHI effect becomes more pronounced with climate change making the need to restore temperature in city centres imperative. The areas, which are vulnerable to this phenomenon, include all the major urban centres of Kastoria, Florina, Ptolemaida, Kozani and Grevena [10].

The RAAP of Western Macedonia, therefore, characterizes as necessary to reduce the UHI. As indicative actions in this direction are reported the [10]: (i) elaboration of a study to select best practices for the reduction of the phenomenon of the urban thermal island, (ii) application of the best practices selected by the study above to limit this phenomenon, (iii) creation of urban parks, urban gardens and similar "green islands" across the cities, (iv) development of "water corridors" across the cities, (v) application of shading practices in public spaces, (vi) development of Sustainable Urban Mobility studies for the cities that may suffer from the UHI effect.

8.5. Construction of flood protection projects

The new reality of climate change necessitates the construction of extensive drainage and transport projects. The adequacy of any related existing project or when planning the construction of new infrastructure should be assessed using these new data. However, according to the RAAP of Western Macedonia, such specifications are not yet evaluated. It is concluded that future flood protection projects are required to be studied and constructed after examining the new reality climate change introduces [10]. In this direction, the indicate measures proposed by the RAAP of Western Macedonia are [10]: (i) the adoption of parameters adapted to the expected effects of climate change when planning the construction of new infrastructure projects, (ii) the development of special capacity studies of the existing projects in the case of extreme weather phenomena, (iii) the design of new policy measures to speed up the creation of additional flood protection projects.
8.6. Dealing with increased temperatures and lack of water in buildings
The RAAP of Western Macedonia underlines that high temperatures result in a greater need for energy and water consumption in buildings. Therefore, it proposes a set of measures to minimise these effects that include [10]: (i) the provision of bioclimatic architecture when constructing or restore buildings, (ii) the promotion of the tiled roof in new buildings, (iii) providing incentives to convert the roofs of existing buildings into "green terraces" and the creation of vertical gardens, (iv) reducing the consumption of drinking water using specifically focused systems.

9. The Regional Spatial Planning Framework of Western Macedonia
The revision of the RSPF of Western Macedonia, which was established in 2003, began in 2012, following a decision of the General Secretary of Spatial Planning and was based on the specifications defined by Ministerial Decision (MD) 10106/2011 [11]. The study was co-financed by the European Union (NSRF 2007-2013). The consultation process of the relevant Strategic Environmental Impact Assessment took place in mid-2015 [11]. The final acceptance of the study was granted in August 2016, and the Strategic Environmental Impact Assessment was approved in November 2016. Finally, in December 2016, the YPEN suggested the endorsement of the updated RSPF of Western Macedonia [11]. Since October 2018, several revision studies of RSPFs were approved across Greece. In this context, the revision of the RSPF of Western Macedonia is expected to be approved soon. The main objective of the revised RSPF of Western Macedonia is to formulate a framework for regulating and balancing the decisions and policies affecting the area of Western Macedonia and redirect public investment towards resilience, adaptability and sustainable development of the region [11]. According to the proposal for the revised RSPF of Western Macedonia, the region relies mainly on electricity generation and lignite mining, contributing to the energy autonomy of Greece [11]. The objectives of the proposed model of spatial development assessed the conditions of economic, social and environmental crisis, the objectives set by the Ministry of Environment and Energy at that time, as well as the development proposals for the Programming Period 2014-2020.

The recommendations of the revised RSPF of Western Macedonia are to [11]: (i) promote sustainable spatial development initiatives through supporting the diversification of the economy of the region and the development of endogenous productive sectors, (ii) utilise the region's natural and cultural resources for the expansion of the production possibilities and its export orientation, (iii) establish a balanced network of urban centres and strengthen their role at the national scale, (iv) enhance the complementarity and collaboration of the region's urban centres through development initiatives, (v) strengthen the development capacity of the region's municipalities, (vi) support community-led rural development through region's municipalities, (vii) support any innovation initiatives that shape a model of development based on the region's specific cutting-edge advantages, (viii) complete the construction of the transport, communication and energy infrastructure needed to strengthen the role of the region as a cross-border gate, (ix) promote the sustainable management of the region's natural resources, (x) protect the biodiversity and the valuable rich natural ecosystems of the region, (xi) protect the high quality of the landscape and its interconnections with the local development in sustainable ways that preserve its unique features and characteristics, (xii) promote spatial development models to contribute to the adaptation and mitigation of climate change and protect the natural and man-made environment.

The study of the RSPF of Western Macedonia was characterised by a thorough analysis of the valid data when the study took place and clarity regarding the goals and directions for future organisation and development of the region. However, since the study had not been legislated during the last six years, it does not assess the crucial new conditions and priorities related to the region's future development, including the de-lignification and the Just Transition initiatives. Thus, the revised RSPF of Western Macedonia could be characterised as outdated although not yet legislated.
10. Conclusions

In 2013 the EU proposed a strategy concerning the adaptation to climate change, trying to urge its Member-States to develop climate change policies at a national scale. This strategy was revised in 2021 to make the EU more climate-resilient by 2050.

The Greek NAS was adopted in 2016, while the RAAPs is expected to be legislated within this year. The establishment of the NAS was the first important step to address the effects of climate change in Greece and promote adaptation measures. The next -and probably even more important-step is the establishment of the RAAPs. The provisions of the L. 4414/2016 states that the RAAPs should be aligned with other regional-scaled plans, such as the RSPFs, which, among other things, form the spatial organisation model each region should follow and propose measures concerning the structure of the residential network of each region.

The Region of Western Macedonia is undoubtedly the most severely affected Greek Region by the EU decarbonisation initiatives. Therefore, this paper examined the compatibility and complementarity between the RAAP and RSPF of the Region of Western Macedonia.

According to the RAAP of Western Macedonia: (i) the estimated increase in the intensity and frequency of floods and the rise of temperature are expected to cause significant problems on the built environment of the Region of Western Macedonia, (ii) the large urban centres of the Region of Western Macedonia are considered to be particularly vulnerable concerning the rainwater drainage infrastructure, (iii) the Region of Western Macedonia shows relative vulnerability concerning the rise of temperature inside the buildings, (iv) the UHI effect is expected to intensify in all the region's urban centres, especially in the largest cities with over 10.000 inhabitants.

It is concluded that the RSPF of Western Macedonia has a crucial role to play to promote the adaptation to the expected impacts of climate change. Moreover, it can drastically diversify the region's development model. These conclusions are even more critical after considering the opportunities provided by the Just Development Transition Plan, the Recovery Plan for Europe and the Recovery and Resilience Fund for Greece.

The revision of the RSPF of Western Macedonia began in 2012, and its Strategic Environmental Impact Assessment was approved in November 2016. However, it has not been legislated yet. Thus, this revised RSPF does not assess the crucial new conditions and priorities related to the region's future development, including the de-lignification and the Just Transition initiatives. As a result, severe doubts are raised about the usability of the revised RSPF of Western Macedonia.

The qualitative analysis performed revealed linkages between the studies of the RAAP and the RSPF of Western Macedonia in terms of objectives, measures and tools. However, there is an urgent need to create an effective mechanism to coordinate, monitor and evaluate the interconnections between spatial plans and climate change adaptation policies, which is currently missing.

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