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Proposals for an environmental and social just transition for the post-lignite era in Western Macedonia, Greece

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Abstract. This text formulates a set of coherent and realistic proposals for the after de-lignification period in Western Macedonia. The aim of these proposals is to avoid the economic decline and poverty of the Region. The first part, based on the literature and the best available practices, the proposals for the necessary environmental restoration of mine lands. Concerning the economic rehabilitation of the Region, a mix of actions referring to the whole production chain: from the primary to the tertiary sector of the economy, is proposed. The action that is expected to enhance the production potential of this region is the creation of branded products, under a single brand name, which will voluntarily bring together, in the context of synergies, the agri-food and manufacturing activities. Overall, it is estimated that the deadline set for de-lignification in 2023, is too early to start all those activities that will allow the economic transition of the Region, and to exclude the possibility of a massive wave of migration. For this reason, the extension of de-lignification, for a period of time within the European objectives to achieve the target of climate neutrality in 2050, are proposed.

1. Introduction

No other event was strongly in 2020 than the coronavirus pandemic which, was spread to all countries on the planet in just a few months. A year after the outbreak of the pandemic, in April 2021, the deaths from the pandemic had exceeded 3 million of people worldwide. The price paid by the economies of almost all countries was also very heavy. The world GDP decreased by 3.5% in 2020 (from 2.8% increase in 2019), the highest decrease in the last 60 years [1]. In the euro area, the decrease of GDP was 6.6%, from an increase of 1.3% in 2019.

In this landscape, the reduction of global CO₂ emissions by 6.7%, and even more, by 11.3%, in the EU27, was one of the few good news of 2020. However, the impact of lower CO₂ emissions on the average global temperature was almost indifferent in 2020. On the contrary, it should be noticed that the average global temperature in 2020 was the highest ever recorded. It is estimated that the footprint of the emissions reduction in 2020 in the reduction of temperature by 2050 will be only 0.01°C [2]. With regard to global efforts to curb global warming by 1.5-2°C by 2100 under the decisions of the Paris Agreement, the past year has shown that failure is the most likely scenario at the moment. According to most recent estimations the global surface temperature will increase by 2.1°C to 3.5°C in the intermediate scenario [3].

In this context, the EU, following the Green Deal of December 2019, has accelerated green energy transition policies. A target to reduce greenhouse gas (GHG) emissions by 30%, in comparison to 1990, is set for 2030. One of these actions is the energy transition, mainly by ceasing the use of coal.



In Greece this action is specified to the delignification of energy production and the transition to renewable energy sources (RES) and to natural gas [4].

However, this delignification will have a significant economic and social impact on the lignite regions; the largest of them in Greece is the region of Western Macedonia in Greece. In order to avoid the economic and social decline of this region, specific actions for its environmental and economic rehabilitation should be applied. In this work, specific actions are proposed; these are resulted from field research and interviews, the study of relevant statistics and an overview of the global best practices.

2. Legislation on mine closure and rehabilitation

Few countries have legislation on mine closures. In most cases, the closure process is described in other legislations, such as the general mining legislation [5]. The European Union does not have a specific law on mine closures [6].

The European Commission's Joint Research Centre has published a paper setting out the best available techniques for mining waste management [7]. However, there is no legislation that deals exclusively with this issue. Greek law follows the European legislation. However, there is no legislation that deals exclusively with this issue. Greek law follows the European legislation. However, the state has the obligation to verify that a quarry/mine that has ceased its activity has been properly closed and rehabilitated and there will not be any environmental problem in the future. For this reason, the best available technology must be used [6].

3. Process of mine closures and rehabilitation of the area

According to the Australian Government's manuals, there are two categories of rehabilitation of a mine after its closure. The first one is the rehabilitation, where the closure of the mines must lead the area to a stable, productive and self-sustaining state. The basic principles are: long-term stability and sustainability of the soil and, moreover, specific hydrology that can preserve ecosystems, provide services to people and exclude environmental pollution. The second one is restoration, where the ambition is to restore the area as it was before the start of the mining activities.

The rehabilitation of the mine must begin several years before its closure and can last many years after this closure. The gradual rehabilitation, i.e. the one that has been integrated into the normal operation of a mine, is more effective than the one that occurs after the activity has completely ceased. There are two basic conditions for the effective closure of a mine: geological stability and soil preparation. The design of the finished soil, which must be completed as early as possible, is the next stage. Geological stability requires the addressing of hydraulic failure by managing groundwater and surface water, and the management of sinkholes and soil retreat, to address slope stability and to protect the area from erosion.

The preparation of the soil for the restoration of its fertility is the second condition. It should be emphasized that the restoration of fertility can take many decades. This low soil fertility leads to a low economic yield of crops in these areas. For this reason, these areas are initially addressed to poor ecosystems, or they remain bare, or are converted into meadows, or converted into forests with non-demanding species (pioneer forests), or attributed to recreational uses [8].

4. Best international practices for mine closures

The best practices to use when an area is assigned for agricultural use or for the creation of a forest are briefly presented here.

For cultivation, the soil should ideally have a good yield in 20 years from its restoration [8]. Some basic principles are: a) Monoculture can be more efficient at first, as the soil is only prepared for one species. The first species must be resistant to difficult conditions. Some such species are: clover, vegetables, winter wheat, rapeseed or maize, b) The soil should be prepared in layers, the use of heavy vehicles should be avoided and the works should be done during the dry season to avoid the compacting of the soil, c) pH control is required for more than one meter depth and the appropriate

amount of CaO should be added to adjust it, d) The soil should be enriched with organic carbon (compost, manure, etc.), nutrients (N, P, K) and trace elements, e) The stones to a depth of 30-40cm should be removed, f) The soil should allow the cultivation of crops of relatively big size; g) The slope of the soil should not exceed 4-7%, h) The restoration of the soil must be in accordance with the requirements of the legislation for subsequent use.

The creation of a forest requires the formation of a suitable ecosystem, so that the different species can grow in a long time. The creation of a forest has the advantage of greater absorption of CO₂ from the atmosphere and its capture in the ecosystem at a higher rate than cultivations. Specific care is needed for the selection of trees, to avoid the several problems occurred in the past in several mine rehabilitations. Some basic principles are: a) The slope of the soil should be suitable for cutting timber with motorized means, b) PH should be adjusted to a depth of up to 1 meter, c) It is preferred to select local varieties, adapted to the characteristics of the soil, and to avoid monoculture, d) The tree varieties must be resistant to difficult soils, difficult climates and have small water requirements, e) A mixture of various species (trees, shrubs,...) should be used; local species that need protection can also be used, f) The forest should constitute a refuge for wildlife.

5. Rehabilitation study of Public Power Company (PPC), brief description of the Environmental Impact Study of the Ptolemais Mines in Western Macedonia

The basic principle of closure design of Ptolemais Mines in Western Macedonia is to maintain, on a long-term basis, the stability of the slopes of the excavations, of the filled cavities and the heaps of deposition of gallons. This should be achieved through the use of mild slopes, from 1:2 to 1:5, depending on the depth, on the nature of the materials and on the inclination of the layers of the geological formations in relation to the slope, as well as on the direction of the prevailing winds in the area. The surface runoff ends up in the corresponding artificial lakes that will be created after the interruption of pumping. In the area of the external deposits of the gallons, the final recipient of the surface runoff is the Soulou stream.

The final land uses of the closed mines are: a) In the case of the final excavation and deposition areas, where the soil has a slope: the creation of forest vegetation for the purpose of wood production, the creation of livestock zones and restored forest land, b) Agricultural use in the flat surfaces of the final areas of deposition, c) Recreational uses on the land with slope, where the lakes will be created. Some areas will be assigned for special uses: a landfill for domestic solid waste, the industrial waste disposal area of the mine Cardia and the motor cross sports center. At the same time, in the areas that will be created in the closed parts of the mines, the installation of various types of RES, as well as an Innovation Zone, is planned in an area of approximately 4,000 acres.

The degree of success of the closure will be assessed at the end of the rehabilitation works.

6. Just Transition Plan for Lignite Areas

The Just Transition Plan for Lignite Areas (JTPLA) follows the decision of the Greek Government to decrease lignite production more than 80% by 2023 and to complete stop it at 2028. It should be noticed that lignite activity is already steadily decreasing since 2010.

This plan has several general positive elements, the main ones being: the establishment of a vision for the next day of delignification, the determination to achieve its goals and the positive belief that that these goals will be achieved, and the integration of the particularities of each lignite region.

However, this plan has some points that may create some issues in the future. Some of them are: a) Taking into account the failures mentioned in the literature or even in the texts of the JTPLA, there is a need for risk analysis with alternative proposals in case of failure of the initial planning, b) There is a need for a monetary fund to be used in case of emergencies or failures. This fund will be a reserve that will be returned to the government when, with the agreement of all stakeholders, the transition will be judged complete and successful c) Consultation with the local community is mentioned in many places, but there is no mention of the consensus of the local community and the social partners in the proposals and the confidence they have in them, d) The plan refers little to the environmental

rehabilitation of mines. For example, the cost of soil rehabilitation is mentioned, or there are reports relating to the jobs of the people who will be employed in the rehabilitation, without mentioning the rehabilitation process, e). The plan does not take into account the long necessary duration for the soil to become fully productive for forest or agricultural use. Also, it is not mentioned that, as a consequence, the jobs that will be created in agriculture will emerge only several years later.

7. Proposals for the economic rehabilitation of the Region of Western Macedonia

7.1. Examples of productive restructuring and technological change

At European Union level in 2019, coal combustion provided a quarter of the total electricity generation. The coal sector employs 238,000 people working in the mining sector and power plants. It is estimated that by 2030, 160,000 jobs will be lost. The highest number of mines, according to 2015 data, are located in Poland (35), Spain (26), Germany and Bulgaria (12 in each country). The largest coal producer is Germany (184 million tons/year), followed by Poland (135 million tons/year), Greece and the Czech Republic (46 million tons/year for each country) [9].

7.1.1. Examples to be avoided. In mainland Europe, one of the many cases of cities that have paid a high social price due to the cessation of mining activity is the German city of Weisswasser, which is located near the border with Poland (180 km from Berlin). The cessation of coal mining resulted in its rapid population decline: its population, from 35,430 inhabitants in 1990, decreased to 26,107 in 2000, 19,055 in 2010 and to only 15,886 in 2019. The population of the city is reduced by more than half in thirty years, as a result of the migration of the most productive ages, who could no longer find a work after the cessation of coal mining in the area [10].

In Greece, Mantoudi in Northern Evia, Lavrio in Eastern Attica, Oinofyta in Boeotia, are some of the characteristic, among many others, examples of such cases. These cases demonstrate the miserable situation in which demographically, socially and economically prosperous cities or regions can be found after a major economic downturn, or after a change in technological paradigm, or after a change or cessation of a dominant productive activity.

7.1.2. Examples to follow. So far, the most ambitious transition plan is developed in Spain [11, 12]. The Spanish government has devised a very timely plan which is holistic and, above all, consensual. A starting point for the Spanish government is to acknowledge that the cost of the transition to the post-lignite era is more likely to be beard from the most vulnerable social groups. For that reason, the front page of the transition plan, which was agreed and drafted in 2019, states that "no one will be left behind".

At the heart of the transition was an agreement signed by the Spanish government with the social partners: CC.OO., UGT and USO, on behalf of the labor side, and the National Coal Mining Federation (Carbunion), on behalf of the employers side. A fund of 250 million euros will cover early retirement programs for workers over 48 years old and, at the same time, it will cover the creation of new specializations for the green economy and the environmental rehabilitation. This agreement is received very positively, and is characterized as an "exemplary exportable item" [13].

Of particular interest is the holistic way in which Spain has dealt with the energy transition, as the Integrated National Plan for Energy and Climate envisages not only the elimination of coal, but also the reduction of its energy dependence, the creation of quality jobs in the green economy, the boosting of small and medium-sized enterprises and the mitigation of energy poverty in Spain, which is higher than the EU average. The 6.6% of household in EU28 could not pay the energy bills in 2018, while a percentage of 7.3% stated that they could not keep the house warm enough; these values are 7.2% and 9.1% respectively [14]. These two above parameters are considered as the most reliable indicators for measuring and comparing European poverty. Greece's performance is very low for both these two indicators in the same year, as the 22.7% and 35.6% respectively of the population belong to these categories [14]. Energy poverty is equally widespread in Small and Medium-sized Enterprises in

Greece, with 15% having outstanding liabilities [15]. These values show the situation of energy poverty in Greece. However, the measures to mitigate energy poverty in the Just Transition Plan are insufficient and have to specific targets.

7.2. Suggestions for the next day

The following proposals concern: First, the strengthening of the primary sector; second, the enhancement of the processing of its products; third, the marketing of its products; fourth, the strengthening of the necessary infrastructure; fifth, the incentives for the agricultural production; sixth, the incentives for voluntary merge and collaborations of the producers; seventh, the increase of the educational level of the population; eighth, the provision of the income incentives; and finally, the continuous evaluation of these measures.

What is necessary to improve the economic situation of the entire region is to upgrade its entire production capacity and not to help the creation of only some “islands”, which will have no multiplier effect in the Region. Huge investments ("cathedrals in the desert") should not be proposed. These investments are usually abandoned after some years, and their added value to the existing productive capacity or to the specialization of the region and the workforce are usually very small. Also, huge investments in photovoltaic utilize the existing network for the transfer of electricity but, on the other hand, will reproduce the energy monoculture of the Region of Western Macedonia, without, at the same time, providing the number of jobs offered from the lignite exploitation for almost half a century.

7.2.1. Assessing the vulnerable people in the Region of Western Macedonia. The estimations on the number of employees affected by the cessation of mining activities vary considerably. In this research, we adopt the broader approach: 14,275 direct workers, 8,546 indirect workers and 53,330 workers whose income comes partly from lignite production, because this reflects the complexity of the structure of the economy and employment, and also the "dark" side of undeclared work. It should be noticed that these aspects of labor are not included in the Survey of Labor Force of Hellenic Statistical Authority.

7.2.2. Primary production. In total, the primary production of Western Macedonia, based on the Labor Force Survey, employed, in the third quarter of 2019, 18,249 people or 20.83% of the workforce of the Region [16]. Of these, 17,803 worked in crop and animal production, hunting and related activities and 446 in forestry and logging.

Regarding agriculture, based on the latest available data (2016) of the Survey of Structure of Agricultural and Livestock Holdings, the Region of Western Macedonia has 23,089 holdings, corresponding to 3.37% of the total holdings in Greece. Within the Region, the Regional Unit with the most farms is Kozani (11,079), followed by Florina (5,954) and Grevena (3,089). As for the type of crops in Western Macedonia, the vast majority of both holdings (20,356, or 88.16%) and cultivated areas (1,864,298 acres at a total of 2,146,859, or 86.84%) concern annual crops. In terms of livestock, almost two thirds of the production of the Region concerns sheep farming, with about half of the livestock production concentrated in one of the four prefectures: in the prefecture of Kozani [17].

The growth potential of primary production is underlined by the growing demand. In 2020, agriculture, forestry and fisheries recorded the largest increase of all sectors in Greece (3.1%). The increased demand for food is not only due to the inelasticity that characterizes this market, but also due to a shift towards a food of high quality. And this last phenomenon is expected to last also after the pandemic.

There are, however, three prerequisites for the agriculture to be able to secure an adequate income by replacing wages coming from jobs in lignite production.

The first condition concerns the proper rehabilitation of the soil of the closed mines, so that it will be suitable for agricultural use. The second condition is related to the financial cost required (over 50,000 euros) to start a cultivation that will yield a satisfactory income; the time required to achieve a satisfactory yield, which can exceed 3 years, should also be taken into consideration. Therefore, even

if the professional transition is made, the Just Transition Fund must ensure or contribute to both the initial cost of the investment and the survival of the farmers until the crops begin to pay off. The third condition for the conversion of the labor force to primary production concerns the processing and the marketing of the final products, better by establishing branded products.

7.2.3. Processing of primary production. An important condition for further development of primary production is to fill, as soon as possible, the gap that already exists in the processing of agricultural products. Processing may involve the establishment of slaughterhouses and dairies for livestock production, a pasta factory for processing wheat, and also refrigerators, packaging establishments, canning, juice production, etc. for the rest of the agricultural production. Such units could decrease the seasonal nature of many crops (peaches, apples, cherries, etc.) by providing an annual income, decreasing the externalization of basic processing resources (as for example that of the simple packaging of the product), and create several hundreds of jobs in the Region, making a significant contribution to the national economy.

It is now clear that only the vertical integration of primary production will allow the creation of a high added value in the Region.

7.2.4. Marketing - sales promotion. Even the few processing units of agricultural products of the Region, some of them quite modern, have not achieved to manage the most serious obstacle that still exists in agricultural production: to reach the final consumers. The low production occurring some years, the variations in quality from year to year, the inability of producers to access distribution networks and the ignorance they often have about the promotion of their products, require the allocation of significant resources in this direction. To overcome this crucial problem, it is very important to create a modern brand, with the participation on a voluntary basis of the producers of the region, to ensure the homogenization of the production methods, the quality of the products, and to establish modern marketing techniques for their distribution to final consumers.

7.2.5. Infrastructure strengthening. The allocation of funds from the Just Transition Fund to infrastructure projects, subject to the conditions of sustainable development, would help increase the productivity of agricultural land.

7.2.6. Incentives for voluntary associations and collaborations. Creating incentives to form cooperatives, or producer groups, or clusters between, not only producers, but also between producers, processors, sales promoters and marketers can generate multiplier effects. The creation of similar synergies with the development of a strong and certified brand name identified with the Region is the only solution to overcome the problem of small production.

Three types of networks are commonly developed: horizontal collaborative formations, vertical and collaborative innovation formations. In Western Macedonia, the first ones (horizontal), which are characterized by relatively strong spatial concentration, organization of production at the local level, specialization in a specific sector and concern small businesses, are the most suitable.

7.2.7. Strengthening the educational level. In order for the shift to a sustainable primary production, modern or "intelligent agriculture" techniques should be applied. However, one of the most important obstacles encountered in the development of so-called "precision agriculture" (apart from costs, absence of funding or technological support) is related to the educational level of the producers who will implement it. The difficulties of adopting precision agriculture are higher in the Region of Western Macedonia, due to the low level of education compared to the rest of Greece.

To reverse this trend, which undermines any prospects for economic growth, specific measures are necessary to strengthen primary and secondary education. For example, the number of students per room could be reduced and thus the number of teachers should be increased, individualized student approach programs should be implemented, with the aim of zero dropout rates, the teaching hours

should be increased, the programs should be differentiated to be adapted in the conditions of the Region, etc. Promoting such a policy requires clear knowledge of the difficulties faced by the locals in bringing education level as high as the national average.

7.2.8. *Income aid.* The implementation of a set of measures that will start from the strengthening of new investments in the agri-food sector has a dual goal: the support of the economic robustness and the social cohesion of the Region.

Above all, there is a need for special provision for the unemployed people who will not be able to absorb funds of new investments, participate in retraining programs or programs of skills upgrading. In order to avoid a massive migration, a social marginalization and exclusion, Greek authorities are required to apply specific unemployment subsidy programs specifically for the people that will lose their works after the closure of lignite mines. These benefits to unemployment people should be granted for a few years. A prerequisite is to have a clear picture of the nature of unemployment in the Region of Western Macedonia, so to determine which part of it is structural, technological, circular, etc.

The financing of the unemployed people from the Transition Fund will act as a disincentive to perpetuate a situation of economic decline and social desertification and will push for the implementation of effective employment policies. In this way, the cost of de-lignification will be transferred to the policy makers and not to the society.

7.2.9. *Continuous evaluation of relief measures.* The goal of achieving a "just transition" to the post-lignite era requires that the accompanying measures will last on the future. The most crucial parameter is not to establish a rigid framework of measures that will be implemented "once and for all", without judging whether this framework will fulfill the purpose for which it was designed and funded. On the contrary, what needs to be done, is to check the effectiveness of these measures on a regular basis, using appropriate indicators and macro/micro-data analysis. These data will come either from the administrative authorities, or from surveys of the inhabitants of the Region. The purpose of this ongoing monitoring and feedback will be to re-intervene where is required.

Specific goals must be set to have effective actions. For example, unemployment rate of the Region should fall to the national average, the number of self-employed and small businesses should remain at the level it was on 31/12/2019 or based on the latest most reliable record, as well as income or consumer spending. The monitoring of fiscal targets in recent years has contributed to the development of tools, mechanisms and methods by the public administration that can be used to oversee the real economy.

The monitoring of the performance of the intervention measures will allow their effective evaluation. In the cases where they are inappropriate or did not perform as expected, new corrective measures can be implemented. Moreover, the establishment of such a monitoring mechanism, which will focus on the result, i.e. the social cohesion and prosperity of the Region of Western Macedonia, and not on mediated actions, such as the announcement of emblematic investments, will dispel the suspicion that no one in charge will be interested in the fate of the Region in the future.

8. Conclusions

The transition of Western Macedonia from the epicenter of lignite production to an economically flourish region in the frame of the Green Transition of Greece demands an extended set of investments which will cover the whole range of the economy, from primary to the tertiary sector. The duration of the implantation of these investments and to have a high output in favor of the local economy and its residents is quite long.

To avoid the economic and social marginalization and degradation of Western Macedonia, which is inevitable under the current delignification plan, we should revise and lengthen the plan. The recorded delay of the new investments in RES, which will replace the lignite production, and the recorded delay

on the implementation of the action to protect the more vulnerable people can justify the choice to postpone the delignification schedule.

References

- [1] The World Bank: <https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG>
- [2] United Nations Environment Programme 2020 *Emissions Gap Report 2020* Nairobi
- [3] IPCC 2021 Summary for Policymakers. In: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.
- [4] Zervas E 2020 *Critique of the just transition plan* (Greece: IME GSEVEE) pp. 1-36 In Greek https://imegsevee.gr/wp-content/uploads/2020/05/%CE%96%CE%AD%CF%81%CE%B2%CE%B1%CF%82_2020-%CE%95%CE%9A.pdf
- [5] Clark A and Clark J C 2005 An International Overview of Legal Frameworks for Mine Closure. VIII. An international overview of legal frameworks for mine closure https://www.elaw.org/system/files/11198931391clark_jcclark.pdf
- [6] Scannell Y 2012 The Regulation of Mining and Mining Waste in the European Union *Journal of Energy, Climate, and the Environment* **3** (2) 177-268
- [7] Garbarino H, Orveillon G, Saveyn H, Barthe P and Eder P 2018 Best available techniques (BAT) reference document for the management of waste from extractive industries *In accordance with Directive 2006/21/EC*, JRC ISBN978-92-79-77178-1
- [8] Knoche D, Rademacher A and Schleppehorst R 2019 Best practice report on environmental protection and post-mining land reclamation, TRACER - Transition in coal intensive regions <https://coaltransitions.org/publications/best-practice-report-on-environmental-protection-and-post-mining-land-reclamation/>
- [9] European Commission 2018 EU Coal Regions: Opportunities and Challenges Ahead *Joint Research Centre for Policy Report* <https://bit.ly/2NEP2iE>
- [10] Weisswasser https://www.weisswasser.de/zahlen_fakten
- [11] Ribera T 2020 A Just Transition with Climate and Social Ambition *Social Europe*, 21st January <https://bit.ly/2AgrJsx>
- [12] Bixel El 2020 Moving beyond Coal: Policy Lessons from across Europe, 29th January <https://bit.ly/2BUwAzP>
- [13] ETUC 2018 Spain guarantees a just transition for miners, October 16 <https://bit.ly/3gb5Xpf>
- [14] EU SILC (Income and Living Conditions) <https://ec.europa.eu/eurostat/web/income-and-living-conditions/data/database>
- [15] Vatikiotis L 2021 *Energy Poverty in Small and Medium Enterprises in Greece (IME GSEVEE working papers 22/2021)* (Athens: IME GSEVEE) pp 1-32 <https://bit.ly/2V87dos>
- [16] Hellenic Statistical Authority, Labor Force Survey: <https://www.statistics.gr/en/statistics/-/publication/SJO01/>
- [17] Hellenic Statistical Authority, Corops and Livestock Surveys: <https://www.statistics.gr/en/statistics/agr>