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USING PREDICTIVE ANALYTICS TECHNIQUES IN ORDER TO CREATE A SUSTAINABLE LAND USE DECISION MANAGEMENT SYSTEM. CASE STUDY: ROMANIA

Abstract. *Ever since the appearance of the first instruments in the Iron Age, which offered mankind a new perspective on land use, to the appearance of automated decision engines, which classify their use in the most complex ways, the world's population has tried to fully understand the notion of property, land and to robotise the processes within them. This work aims to create a decision-making management system regarding the counties in Romania. To achieve the desired result, predictive analysis methods, such as the Random Forest algorithm to classify the counties and the ARIMA model, will be used to be able to forecast the financial plan. The aim of the paper is to analyse the lands in Romania regarding long-term sustainability. It is desired to identify a solution regarding their productivity and establish a suitable strategy for the type of land found in each county (plain, hill, mountain).*

Keywords*: Decision Management System, Random Forest, Sustainability, ARIMA model, land use*

JEL Classification: C40, C53, D81

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1. Introduction

Although the number of methods of applying technology in working with land has increased and diversified in the last century, especially in the last twenty years (Gomes et al., 2021), humanity faces great problems, synthesised in two fundamental reasons that causes it to rethink the way land is used: a) How much space will there be left on the planet for the diversification of agricultural and industrial activities, given that the land offers limited space (Hansen et al., 2022) and b) How will it be used this space in a sustainable way, considering that both the intensive agricultural activities of industry 4.0, together with non-compliant practices, have led to the degradation of agricultural land, as well as the massive deforestation followed by not planting trees specific to the area, together with the dismantling of renewable energy, do not lead to a sustainable use of lands (Yaqoob et al., 2022).

This paperwork aims to build an analysis of sustainable land use by utilising decision engines and automated classification. To be able to achieve this goal, we created an application that takes data from several variables related to both land modeling (for example, their number) and the necessary infrastructure in certain counties (for example, large university centers), for being able to classify them through indicators and statistical decision trees. Later, their results are added to a decision management system that provides a sustainable action plan based on the decision made by the program and creates a clear objective of long-term land use or reuse.

At the same time, by accessing certain parts of the application, anyone can easily parameterise a new decision or modify the parameters of existing decisions. This application stands out both from a statistical and a decisional management point of view, as they help to take a decision much faster with the help of decision rules and statistical indicators that it composes, as well as by offering an innovative perspective on the use and land sustainability through real numbers and statistics. Therefore, the role of this program becomes notable, on one hand, thanks to the benefits that provide the user with a rational decision based on truthful data and statistics, and, on the other hand, by encouraging the use of a decision management system, which leads to an innovative and sustainable future.

2. Literature Review

For the bibliography search, initially, the same search model for scientific studies on decision systems (D.M.S) for land was used as the search model of Blondeel et al. (2021). This involved searching for terms such as, “grounds” and “automated decision systems”, to see if there are any decision systems similar to the decision system analysed in this paper.

Most studies have revealed that one of the main causes contributing to land shaping is the population's economic and political constraints. (Sannigrahi et al., 2020). Thus, in the first part of the decades, land decision systems that have already been implemented are encountered, in which decisions are focused on agriculture and social factors. With the emergence of these decision systems, the themes addressed considered the optimisation of several types of factors such as economic, biophysical, social, political, cultural, and institutional (Hasan et al., 2020). A decision system in an objective planning process with a desired outcome will help the planning project to streamline risk levels (Pop et al., 2022), reduce costs and prioritise areas where certain measures need to be adapted based on certain algorithms or attenuate certain risks (Leal, 2021). At the same time, a decision system also contributes to maximising the value of business operations (Riley et al., 2021).

Vincent Van Dijk (2021) wrote a study about a decision system implemented in the Netherlands, one of the countries of the European Union which, in the year 2021, adopted an environmental planning law called "Omgeingswet". Being called an operation by the Dutch government, it has the role of replacing most of the existing laws for environmental protection and bringing them together into only one, also implementing amendments to cover the issue of environmental sustainability. This law also brings with it a new rule-based decision system, which also contains the modeling of land through a rule-based model. The system called Digital Stelsel Omgevingswet (D.S.O.) helps, on one hand, the population, and, on the other hand, individuals to find the best solutions in various issues. Therefore, D.S.O. provides help in understanding what should be implemented in a particular location.

3. Data and Methodology

The current paperwork aims to build a management decision system, created by using Python programming language, where the database is processed using SQL. Thus, its purpose is to reallocate certain areas of land for other activities, which bring a better financial utility than the previous one.

The managerial system is based on a business model made up of strategies and decisions, and its result consists of an action plan carried out for a certain period, in which the reterritorialisation of land is proposed in the economic activity that reaches maximum utility.

The observation unit that frames the decision system is represented by the counties in Romania, which are filtered through 8 indicators: Production coefficient (percentages) - some of the lands require the introduction of a production coefficient as a filtering parameter, which can lead to a part, either to a reterritorialisation of the lands, if the production coefficient is lower than 0, or to a preservation of the territory, as in the agricultural area, and, on the other hand, to the allocation of a financial investment plan; Degradation coefficient (percentages) – this indicator was introduced because there are agricultural lands that can no longer be used for agricultural purposes, as their soil is degraded; Agricultural labor resources (number of people) – for profitable areas, if productivity exists and land degradation is not present, along with the lack of verification of the existence of a labor force to work the land, consequently, the reterritorialisation of the land cannot be abandoned; Degradation of deciduous/resinous forests (thousands of hectares) – the type of degraded woody material existing in the county must be known, because the final result cannot be an action plan in which resinous trees are planted on degraded land, where, previously, there were deciduous forests, because in this case the investment is not feasible; Educational units - this indicator is closely related to the Solar radiation indicator, because in some counties where it is desired to convert land into areas with solar panels for green energy, it is necessary to know if there is a strong level of solar radiation, as well as in the case in which, in the future, there would be an educated workforce to ensure maintenance.

The D.M.S. application (Decision Management System) is a script made in Python programming language, whose interface is provided by Jupyter Notebook. One of the advantages of choosing the Python programming language is the Jupyter Notebook working environment, which offers the possibility of implementing text cells. Thus, the program process can be described, providing fluidity and advanced reusability of the program, which can be used on any Windows and macOS operating system. In terms of the database, it is composed of the 42 counties of Romania, which also represent the observation units to which the decisions will be assigned. For the parameterisation variables, different proportions of relief were selected, expressed in percentages owned by the respective counties, as well as the degraded agricultural land in Romania between the years 2000-2014, the degraded forest fund between the years 2000-2014, respectively, the deciduous and resinous forests, agricultural labor resources from 2014, solar radiation from the 42 counties, vegetable production from each county between 2000 and 2014, as well as university education units and technical high schools from each county for 2014.

The script consists of four well-defined modules. The first module is represented by the strategy within which each county falls. Inside it, the input data is constituted by the relief area in which a county falls. Therefore, an example to show the logic on which this is based is that in a county with mountain topography it will not be possible to install wind systems due to strong currents. The next two modules are represented by decisions and their prioritisation. The decision algorithm can adapt the same county in several decisions. Therefore, a filtering of them is also needed. The last module is similar to the output of the application, which also provides the final result, whereby each decision has its own action plan.

Packages such as seaborn and matplotlib will be used to graph the obtained data, especially with the aim of turning certain parts of the application into statistical techniques. An example of this is the replacement of the county prioritisation stage in the "Strategies" module, where instead of using a simple prioritisation by choosing the maximum rank, a Random Forest algorithm will be used. The application uses the Pandas package for the data integration part. Data connection, as well as decision structure, is ensured by the "mysql.connector" package, which creates the relationship between the script and the database.

The role of the application is to classify the counties correctly, in order not to lose financial investments in non-productive areas, for example, not to install high-capacity photovoltaic systems on land where solar radiation is not strong or not to apply green energy on lands that are still productive and effective from the point of view of the soil, by taking into account the evolution of soil degradation in the first part of the 21st century in Romania.

4. Results

The architecture of an application is one of the key points of the project.

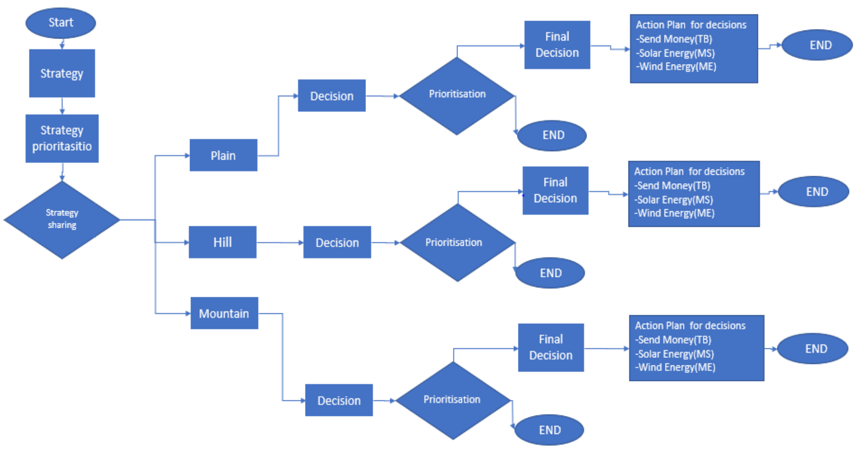

Figure 1. U.M.L. diagram – D.M.S process representation of reterritorialisation

When the "county" observation unit begins going through the decision-making process on its lands, it first enters the Strategy section, where the counties are divided into three types of strategy: plain, hill, and mountain. After completing the choice of a strategy, each of them will have a number of decisions, which is distributed for each one. Sometimes, however, it happens that certain strategies have more decisions, meeting their parameters. In this case, a prioritisation of decisions is needed, so that the journey through the reterritorialisation process is completed, and for the winning decision to add the action plan corresponding to this decision. The action plan is divided into five main categories. Thus, money can be sent for investments in agriculture or for the purchase of trees for replanting, or photovoltaic solar panels can be installed on land that is degraded and no longer useful, or wind energy can be installed in areas favourable to it, all depending on the decision that was taken by the application in the related section.

Romania's relief is varied; each county being able to have several types of relief units on its surface. As a consequence, the process of parameterisation of strategies in the decision-making system is hampered. In order to be able to offer the counties only one type of strategy, the percentages with Romania's relief were taken over from the relief map, and for the first 20 counties, the strategy was decided by manually introducing the predominant relief unit that it calls. The decision logic lies in the form in which the strategy was chosen, representing the most predominant share of a relief unit that a county can have. For example, Alba County has 10% plain, 30% hill and 60% mountain, therefore the decision-making strategy is represented by the mountain.

For the other 22 administrative units, it was decided to use a Random Forest supervised algorithm, based on manually set data. This is one of the simplest and most flexible shafts, being considered one of the algorithms with the highest accuracy that can support missing values. The Random Forest algorithm replaces the strategy prioritisation stage. At the end of it, the decision rule "RandomForestStrategy=Plain/Hill/Mountain" is added to the algorithm, depending on the preponderance relief area of the county.

Table 1. Strategies D.M.S.

Strategy Name	Decision Rule
Plain	RandomForestDecisionStrategy=Plain
Hill	RandomForestDecisionStrategy= Hill
Mountain	RandomForestDecisionStrategy= Mountain

As this is a machine learning tree, the 22 observations were split into 70% training data and 30% test data. After running the model, the 22 counties are classified according to the prevailing landform. The accuracy of the model is high, with a value of 83.33%. To observe the distribution of the strategies resulting from running the Random Forest algorithm, the matplotlib.pyplot package was used.

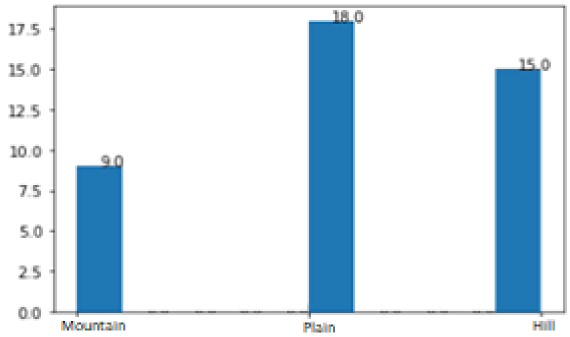

Figure 2. D.M.S. strategies – geographical segmentation

Due to the variety of relief in Romania, during the strategy stage, most of the counties (18) fell into the plain strategy, followed by the hill strategy (15), and the remaining 9 are found in the mountain strategy. Next, it was desired to construct 9 decisions regarding the three relief units:

Four decisions that are for the Plains strategy, named intuitively to establish the objective for which they are created, such as: Degraded land in the plain area, productive plain areas, decreasing forest floor area, and degraded land, respectively, forest floor area in subsidence and degraded land. In the construction of the decisions, geographical factors were also taken into account, for example, for the decision Declining Forest floor area and degraded lands, the forest floor of the deciduous forests was taken into account, being specific to the altitude for the relief of the plain, and not the forest floor of the coniferous forests.

Four decisions that are for the Hill strategy, the first two decisions are similar to those in the plain area, only the strategy is changed, and for the decisions of Decreasing Forest area and degraded land and Decreasing Forest area and degraded land, they took into account the forest fund of coniferous forests, considering the fact that the attitude is increased in these areas and allows the development of coniferous trees. For the mountain strategy, only two decisions were considered to build, namely Declining Forest Floor Area and Declining Forest Floor Area and Strong Solar Radiation.

The ten decisions and their parameters will be entered into the Python script along with the SQL language. The database is created online, so you can run the script from any device with a browser installed, along with knowing your user credentials, password, and database name. The library mysql.connector from mysql.connector is used for this operation. After the running of the 10 decisions, the counties will be included in 38 decisions, even before their prioritisation, by leaving the double decisions, the 42 counties do not all qualify in the decision process.

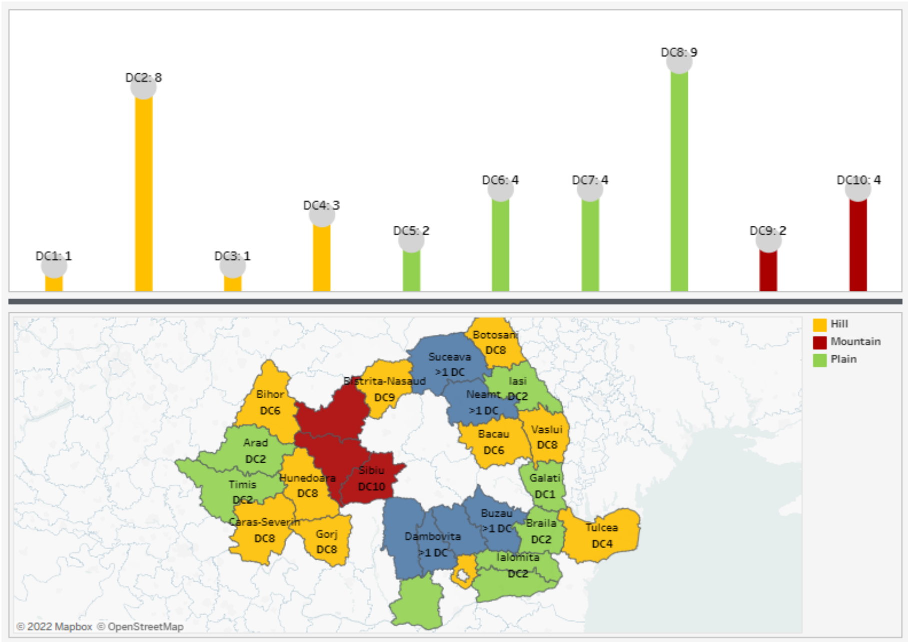

Figure 3. County repartition using Tableau Desktop software

Most of the counties (9 counties) fell under decision 8, which is a decision regarding the forests in the hill area, where their number decreased during the chosen period. Romania is known for illegal deforestation and the failure to plant new trees, and this decision requires an action plan to invest in tree replanting.

Second, eight counties were classified in decision 2 – Productive plain areas, representing areas of the south-east of the country and the west of the country, where there is a large number of workers in the agricultural system, as well as a very high productivity in major crops. Therefore, the respective counties are eligible for substantial investments in agriculture, including Călărași, Brăila, Ialomița, Buzău, Teleorman, Iași, Timiș, and Arad. The decision took into account the productivity coefficient obtained from the cluster analysis. Therefore, it tries to discover the counties where Productivity is very high and high, where the parameter of labor resources is also added (the value of the 3rd quartile was taken into account).

Four of the counties were classified in decision 7 – Forest floor area decreasing and the possibility of installing wind power, being the counties with hill relief, forests in a state of degradation, the forest floor area being decreasing, and replanting does not take place. However, they have a large number of technical high schools. As a consequence, this fact would allow the introduction of wind energy on the land surface, given the lack of trees, the altitude that brings the wind, but also the cheap maintenance, having a number of technical graduates who could take care of the maintenance of wind power plants.

Table 2. Decisions

Decision Code	Decision Name	Decision Rule
DC2	Productive plains and fields	Strategy=Plain And Production Coefficient = ("High productivity" or „Very high productivity" WorkResources > 3344
DC5	Degraded and inefficient lands in hilly areas	Strategy=Hill and Degradeated Fields<0 and University >=1 and Technical HighSchool >=10
DC9	Decreasing forest zone	Strategy = Mountain and Coniferous Forests Degradated<0

Counties that are marked with ">1DC" on the map are counties that have had more than one decision in the decision selection process. For example, Buzău county qualifies for both decision 2 and decision 3.

Table 3. Priorities

Strategy Name	Decision code	Priority
Plain	DC1	1
Plain	DC2	2
Plain	DC3	3
Plain	DC4	4
Hill	DC5	1
Hill	DC6	2
Hill	DC7	3
Hill	DC8	4
Mountain	DC9	1
Mountain	DC10	2

As some of the counties were included in several decisions, a prioritisation of the decisions is needed to include a county in a single decision. That is why there is the system of prioritisation within the decision-making system, whereby the most important priority of a decision receives its lowest rank. As a result, if decision 2 and decision 1 rank for the same county, then after prioritisation only decision 1 will remain because it has a lower rank than decision 2. Prioritisation will be used after all decision tables have been transformed into a Pandas data frame, followed by combining them and making a final table using the SQL function “Select MIN(Decision) from FinalTable”.

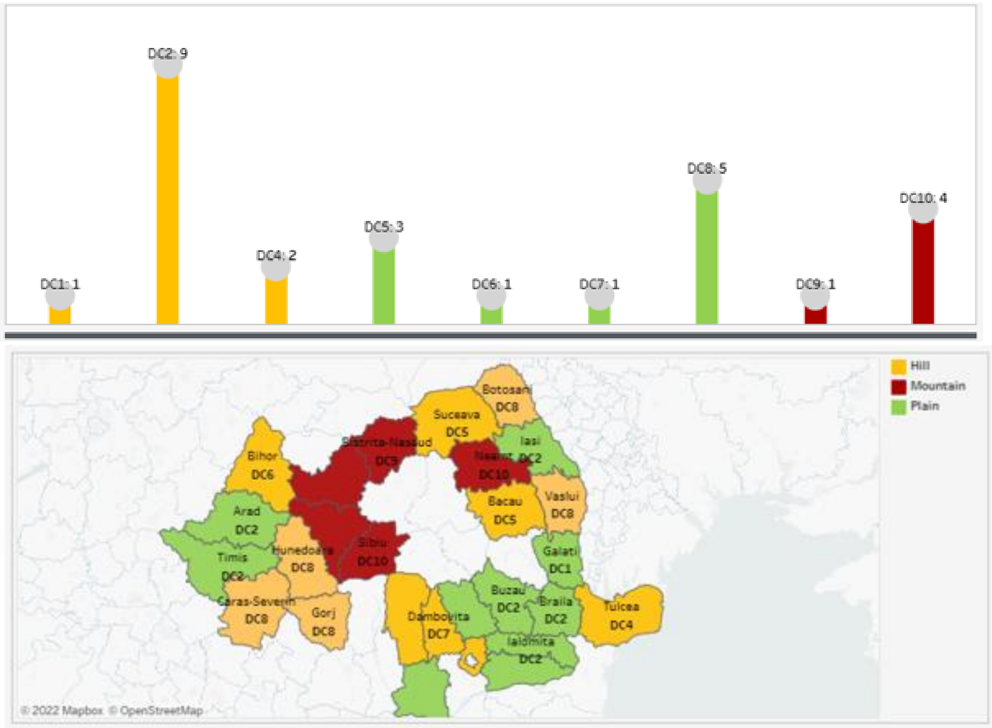

Figure 4. County repartition after prioritisation

yellow: **hill**

red: **mountain**

green: **plain**

After prioritisation, only 27 decisions remained. As only 27 counties were classified in the decision system, 15 failing to meet the conditions, it is advisable to analyse which factors have the greatest impact on decision-making. To analyse which variables influence the decisions the most (and as there are no binomial variables to run a logistic regression), Multiple Linear Regression will be used, using as the dependent variable the number of the decision, and as independent variables the 8 variables that were used as parameterisation in the decision system. The regression is to be run in R. Before running the regression, the independent variables were standardised to reduce multicollinearity and not to miss statistically significant results.

```
Residuals:
    Min      1Q  Median      3Q     Max
-4.5599 -1.7100 -0.0925  1.6765  4.6655

Coefficients:
                                          Estimate Std. Error t value Pr(>|t|)
(Intercept)                                5.48148    0.50638  10.825  2.6e-09
Std_DegradationCoefficient                 1.35754    0.60506   2.244   0.0377
STD_University                             0.18744    0.61356   0.306   0.7635
STD_TechnicalHighSchool                   -0.22954    0.56554  -0.406   0.6896
STD_AgricultureWorkResources              -1.47674    0.54279  -2.721   0.0140
STD_ProductivyCoeficient                   0.31716    0.58988   0.538   0.5974
STD_DegradationCoeficientOf HardwoodForests -0.50965  0.59537  -0.856   0.4032
STD_ConiferousForestsDegradation          -0.73276    0.63939  -1.146   0.2668
STD_SolarRadiation                         0.05726    0.56374   0.102   0.9202
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.631 on 18 degrees of freedom
Multiple R-squared:  0.503,     Adjusted R-squared:  0.2821
F-statistic: 2.277 on 8 and 18 DF,  p-value: 0.07016
```

Figure 5. Multiple linear regression

As only the degradation coefficient and the agricultural labour resource are significant at a significance level of 5%, we can conclude that only these two variables have influence on decisions, and only by increasing the parameterisation of the degradation coefficient from 0 to more, we could we have several counties in the decision system. As the agricultural labor resource has a coefficient of -1.47, only by subtracting from the chosen value, more counties can be included in the decisions. As the F-statistic (2.277) < F0.05.8, 18-critical (2.510) it is concluded that the multiple linear regression model is statistically valid.

Given that the linear regression model is valid and there are also two significant coefficients, one could use linear regression to re-parameterise the decision system and get a few more counties to qualify for decisions. And under these conditions, not all would qualify, and those that would succeed, would only qualify in the decisions that contain the parameters of labour resources and land degradation coefficient. The best approach would be to create new parametrisation coefficients, to either be added to new decisions or to create new decisions.

5. Discussion

The action plan represents the endpoint of the decision system, as well as the part of the decision system with which the end user interacts. Within it, each decision that resulted from prioritisation corresponds to a 7-year action plan.

To establish the model's financial action plan and how the budget will be allocated, data on Agriculture and Forestry Expenditure from 1991 to 2021 will be used by running a Python Auto-ARIMA model. Python's auto_arima model will be run, showing that the best model is the ARIMA (0,1,1) model, given the model's attempt to minimise the smallest AIC coefficient.

```
predicted=479.326237, expected=497.460200
predicted=511.113467, expected=909.180900
predicted=1229.495707, expected=1068.005400
predicted=1070.097061, expected=1172.900000
predicted=1205.827813, expected=1772.500000
predicted=2116.947646, expected=2903.700000
predicted=3520.484548, expected=3065.600000
predicted=2853.553485, expected=4048.400000
predicted=4378.774673, expected=5241.300000
predicted=5542.146178, expected=6291.500000
predicted=6689.397204, expected=6175.200000
predicted=5942.332331, expected=7590.600000
predicted=8133.351605, expected=7021.200000
predicted=6860.272025, expected=6044.200000
predicted=5849.769070, expected=5811.800000
predicted=5801.401673, expected=5678.600000
predicted=5644.612229, expected=6000.300000
predicted=6097.216378, expected=7620.600000
predicted=8103.784877, expected=17207.200000
predicted=23101.896856, expected=20496.600000
predicted=20061.153504, expected=21373.000000
Test RMSE: 2212.562
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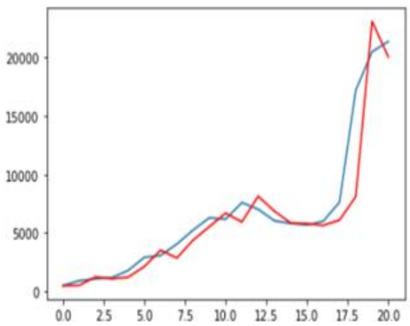

Figure 6. ARIMA model

The model was run on the test data and the training data. According to the line chart, the prediction model (red line) is close to the real data, only in recent years there is a fluctuation anomaly, which greatly affects the RMSE, which is quite far from the other values. The last recorded prediction value for 20061 is for the year 2019. To demonstrate the viability of introducing statistical decision trees in D.M.S. business systems, a financial action plan will be created, based on the data provided by the ARIMA model. and not on the real financial data taken to train the ARIMA model.

In the case of the budget for agriculture and forestry, considering that only 27 counties qualified in the decision system, it will not be used in full. Instead, the total expenses that the government has with each county will be taken and a weight will be established for the counties that entered the decision system. In the present case, the share of total expenses for the 27 counties with total expenses is 58.62% in 2014. The coefficient of 58.62% of the budget with total expenses will be multiplied by the budget allocated only for agriculture and forestry expenses of 5081.40 million of lei (2014), obtaining the budget of 3401.93 million (2014) lei, which can be used in the construction of the action plan of the D.M.S. for the year 2014. For the construction of the other years, the expenses with agriculture and forestry will be selected and the previous procedure will be repeated, and within the framework of the inclusion of several counties in a decision, the money will be divided equally between the counties. In the case of installing solar panels and installing wind energy, a budget of 10 million will be considered for all 7 years. For this, it was taken into account that 21076 lei will be spent for the installation of 3 kw of solar energy and 26900 lei will be spent for the installation of 3 kw of wind energy.

Because of the multitude of different weights and costs, the action plan table will be created manually, based on the 27 decisions, and separate from the rest of the

Python script. In the script of the decision system, there is only the table call structure and the code structure that will generate the final output, respectively, for each county of the 27 decisions, which action plan it has.

Table 4. Decision plan by counties

County	Decision Code	2014	2015	...	2017	2018	2019	2020
Alba	DC10	TB(1.48mil)	MP(68.18kw)	...	TB(7mil)	MP(322.49kw)	end	
Arad	DC2	TBA(125.97mil)	TBA(122.56mil)	...	TBA(175.96mil)	TBA(501.62mil)	TBA(435.60mil)	end
Arges	DC5	TB(1.85mil)	ME(109.46kw)	...	TB(3.46mil)	ME(204.73kw)	end	
Bacau	DC5	TB(1.85mil)	ME(109.46kw)	...	TB(3.46mil)	ME(204.73kw)	end	
Bihor	DC6	TBA(377.91mil)	TBA(367.69mil)	...	TBA(527.89mil)	TBA(504.88mil)	TBA(1306.80mil)	end
Bistrita-Nasaud	DC9	TBR(251.94mil)	TBR(245.13mil)	...	TBR(1003.25mil)	TBR(871.2mil)	end	
Botosani	DC8	TBR(1007.76mil)	TBR(980.52mil)	...	TBR(4013.02mil)	TBR(3484.82mil)	end	
Braila	DC2	TBA(125.97mil)	TBA(122.56mil)	...	TBA(501.62mil)	TBA(435.60mil)	end	
Buzau	DC2	TBA(125.97mil)	TBA(122.56mil)	...	TBA(501.62mil)	TBA(435.60mil)	end	
Calarasi	DC2	TBA(125.97mil)	TBA(122.56mil)	...	TBA(501.62mil)	TBA(435.60mil)	end	
Caras-Severin	DC8	TBR(1007.76mil)	TBR(980.52mil)	...	TBR(4013.02mil)	TBR(3484.82mil)	end	
Cluj	DC10	TB(1.48mil)	MP(68.18kw)	...	MP(322.49kw)	end		
Dambovita	DC7	TB(1.48mil)	ME(87.57kw)	...	ME(133.72kw)	end		
Galati	DC1	TB(0.37mil)	MP(17.04kw)	...	MP(54.08kw)	end		
Gorj	DC8	TBR(1007.76mil)	TBR(980.52mil)	...	TBR(4013.02mil)	TBR(3484.82mil)	end	
Hunedoara	DC8	TBR(1007.76mil)	TBR(980.52mil)	...	TBR(4013.02mil)	TBR(3484.82mil)	end	
Ialomita	DC2	TBA(125.97mil)	TBA(122.56mil)	...	TBA(501.62mil)	TBA(435.60mil)	end	
Iasi	DC2	TBA(125.97mil)	TBA(122.56mil)	...	TBA(501.62mil)	TBA(435.60mil)	end	
Ilfov	DC4	TBR(377.91mil)	TBR(367.69mil)	...	TBR(1504.88mil)	TBR(1306.80)	end	
Neamt	DC10	TB(1.48mil)	MP(68.18kw)	...	MP(322.49kw)	end		
Prahova	DC2	TBA(125.97mil)	TBA(122.56mil)	...	TBA(501.62mil)	TBA(435.60mil)	end	
Sibiu	DC10	TB(1.48mil)	MP(68.18kw)	...	MP(322.49kw)	end		
Suceava	DC5	TB(1.85mil)	ME(109.46kw)	...	ME(204.73kw)	end		
Teleorman	DC2	TBA(125.97mil)	TBA(122.56mil)	...	TBA(501.62mil)	TBA(435.60mil)	end	
Timis	DC2	TBA(125.97mil)	TBA(122.56mil)	...	TBA(501.62mil)	TBA(435.60mil)	end	
Tulcea	DC4	TBR(377.91mil)	TBR(367.69mil)	...	TBR(1504.88mil)	TBR(1306.80)	end	
Vaslui	DC8	TBR(1007.76mil)	TBR(980.52mil)	...	TBR(4013.02mil)	TBR(3484.82mil)	end	

Only a part of the 27 decisions can be found in the decision table. A decision whose action plan is the installation of solar panels is interpreted in the following way: for Alba county, decision number 10 was assigned, which consists of sending money (TB) in the amount of 0.493 million lei, for the installation of solar panels in the amount of 22.72 kw in 2015 from the money allocated in 2014, followed by a 2-year break in the period 2016 - 2017, followed by sending money again (TB) in 2018 and the installation of 107.33 kw of green energy in 2019. The action plan will end in 2020. Alba County is located in a mountain area, where the area of the forest fund has decreased drastically. High levels of solar radiation are recorded, allowing the land of forest areas to be converted into areas for solar energy.

Arad County is located in a plain area and falls under decision 2, in which investment in agriculture is preferred (TBA - sending money for agriculture), the land not needing reterritorialisation. This decision refers to productive areas and human resources for land-related activities. Also, investments are allocated according to each year's budget from agriculture and forestry.

For the counties qualified in decision 8, such as Caraș-Severin, the established budget can be used for tree planting considering that at the parameter level we have degraded resinous forests, along with the action code "TBR - sending money for replanting".

Decision 5 was established for Bacău county. In this decision, in 2014 money will be sent in the amount of 0.61 million lei, and in 2015 wind energy (ME) will be installed from the money allocated in 2014 in the amount of 36.46 kw, continuing with a break of 2 years. In 2018, money is allocated again, in the amount of 1.15 million lei, in 2019, wind power of 69.23 kW is installed, and in 2020 the action plan is concluded. Bacău County qualified in decision 5, which represents a decision that shows that the lands are degraded and, therefore, profitable agricultural investments can no longer be made. In addition to these, decision five also highlights the fact that there is a large number of higher education institutions and technical high schools, which would facilitate education, which would later bring trained people to offer cheap maintenance, also representing a support for the counties from the proximity of the hill area, where there is a small number of high schools and no higher institutions. Thus, investing in solar energy increases the economic utility of land.

Conclusions

In the coming years, the territorial future of Romania is uncertain, on the one hand, due to the rapid deterioration of agricultural surfaces, on the other hand, the need to fulfill the European strategic objectives, respectively, “Sustainability through zero hunger” and “Sustainability through climate action”. Therefore, the implementation of a quick and inexpensive solution is imperative for the appropriate territorialisation of land surfaces in Romania, with the aim of determining the maximisation of economic utility, as well as the occurrence of a zero impact on climate change.

The D.M.S. application proves its financial effectiveness considering the reduced costs it brings to the agricultural and forestry budget. At the moment, the economy is 1388.11 million lei, money that can be relocated to the counties that need green energy on the lands that no longer have an economic effectiveness, fulfilling the strategic objective "Sustainability through climate actions". Also, the budget can be invested within the decision system in decisions that constitute investments in agriculture in order to meet the European objective of "Sustainability through zero hunger". Even for green energy installation decisions, not all funds are used, as no county qualifies for decision 3: money from this decision can be reallocated to build new decisions or redistributed to installation decisions of green energy.

In addition to the novelty and business model brought by this application, it stands out especially for the fact that it uses machine learning algorithms and academically accredited statistical methods. It further encourages the veracity of the final decisions and how to share directions to determine the effectiveness of choosing the best way to choose a land use. In terms of weaknesses, there are some limitations caused by the decision-making system. One of them is the fact that the data part is the most important thing that the application creates, and in these conditions, their lack or inconsistency leads to a low accuracy of the decision system, directly affecting the statistical methods of parameterisation of decisions, also restricting the horizon of statistical methods that can be used. D.M.S. it can be improved in the future by creating new decisions for counties that have not currently qualified in the decision system.

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