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ECOPAY Flanders 2.0

A new version of the ecological-economic model for meadow birds management

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ECOPAY Flanders 2.0: a new version of the ecological-economic model for meadow birds management

Peter Van Gossum, Astrid Sturm, Melanie Mewes, Toon Van Daele

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Key findings

- Agro-environmental measures with a delay of first use to July or August are more cost-effective for meadow bird management than the June measures or the current policy, i.e. a delay until 14 June.
- The most preferred grazing system for meadow birds management is seasonal grazing with 2 cows during the resting period. The less preferred one is rotational grazing.
- The results are not influenced by given specific meadow birds a higher weight than the other meadow birds. Thus policy-makers does not need to select a priori the target meadow birds of a specific area.
- Including the distance to the farm house as an additional cost has a rather high influence when the cost increase to €1 for each meter distance.
- The effect of the manure processing cost when to less organic manure can be put on the field, is by current manure processing cost (€4/ kg N) rather small. The effect stays small even when to manure processing cost increase to €15 kg N.

Content

1. Introduction

The ECOPAY-local project have as target to develop a decision-supporting system to improve the cost-effectiveness of local meadow bird projects (100-5000 ha). The model gives the most suitable locations and the most suitable measures for the most suitable locations. The project starts from the ECOPAY-Flanders model and adapts the current model so that the adapted model can give a solution for the following three concerns.

(1) Refinement of economic models

The new model will take into account the following economic considerations:

- More grazing periods by seasonal grazing: farmers will take into account the temporal changes in grass growth and thus the cattle density will be higher when the temporal grass growth is higher and the cattle density will be less when the grass growth is less. This means that to calculate the financial impact of a delayed grazing more correctly it will be needed to split the current grazing period in sub-periods.
- Additional cost parameters, besides the potential grass yield of a pixel, which have an influence on the requested compensation of agro-environmental measures by the farmer:
  (1) the capacity to use structure-rich grass: not all farmers can use this product. Farmers, which cannot use the product, will demand a higher compensation: lost energy of the agro-environmental relative to the reference added by the residual energy of the delayed cut.
  (2) the distance of the pixel to the farm office: farmers will accept faster agro-environmental measures when the pixel is not the home plot and when it is located at a lager distance from the farm office.
  (3) The influence of different manure types on the variable cost: a reduction of organic manure in Flanders means an additional cost, while reducing inorganic fertilizer can be considered as a cost saving.
  (4) Compensations in function of owner category: nature organization will accept agro-environmental measures when the targets of those measures are in accordance with the management objectives of the nature area. The nature organisations need to be compensated for their work, but not for their income loss.

(2) Refinement of ecological data

The ECOPAY-local model need to work with (1) a greater variety of grassland types and (2) need to include linear landscape elements and solitaire trees.

(3) Visualization and transferability

It is important that the most likely meadow bird area scan be clearly visualized and that the visual results can be transferred to ArcGIS. In addition, it is important that the output can be saved in txt or cvs-format.

2. Model and database changes

The first ECOPAY Flanders model is described in Van Gossum *et al*. (2012). In this part only the main changes compared with the first ECOPAY Flanders model will be described. The changes are:

- a greater variety of grassland types,
- an inclusion of all green elements higher than 3 meter (these elements can increase predation because they can be used for nests or vantage point),
- an inclusion of varying cattle densities by seasonal grazing,
- an inclusion of additional cost parameters.

2.1. Grassland types

In ECOPAY version 1.0 only two grassland type were distinguished, i.e. the very species-poor production grassland and the species-poor production grassland. Both have as main grass species rye grass and their economic characteristics were the same. In addition, the types are also the most common agricultural grasslands. Nevertheless, to a smaller extent also other grassland types occur in Flanders. The other grassland types can be grouped in an additional 11 grassland types (Vriens *et al*. 2011). The spatial occurrence of these grassland types is given in the biological value map of Flanders. Many grassland could not be classified in a single grassland type, it was also needed to distinguished spatial mixtures of different grassland types. The first mentioned grassland type is always the most dominant one. In ECOPAY Flanders version 2.0 13 grassland types are included and each pixel can have a main grassland type and one secondary grassland type. These changes will have an influence on the following parameters:

- Bird values WES, WOLA and WKLA, resp. value for waders and ducks, open landscape meadow and cropland birds and small-scale landscape cropland birds,
- Dry matter production, given as a relative value to rye grass production,
- Grass quality, given as a relative value to rye grass production, and
- Grass height, given as a relative value to rye grass

The difference with the reference grassland (rye grass) is given in Table 2.1.

Table 2.1 The ecological and economic characteristics of the grassland types

Grassland type	WES	WOLA	WKLA	Dry matter (rel. rye grass)	Energy content (rel. rye grass)	Grass height (rel. rye grass)
Very species-poor production grassland	-0.5	-0.5	-0.5	100	100	100
Species-poor production grassland	0.3	0.3	0.3	100	100	100
Pasture complex with many locks and/or micro-relief	0.7	0.7	0.7	80	100	90
Species-rich pasture complex with many locks and / or micro-relief	0.9	0.9	0.9	45	70	70
Species-rich production grassland	0.7	0.7	0.7	45	70	70
Overgrown grassland	0.7	0.7	0.7	50	85	75
Marsh marigold grassland	0.9	0.9	0.9	30	60	65
Mesophilic meadows	1	1	1	30	60	65
Bent grass vegetation	1	1	1	30	60	65
Humid grasslands dominated by rushes	1	1	1	45	70	70
Salt marshes	1	1	1	30	60	65
Calcareous grassland	0	1	1	30	60	65
Violion caninae grassland	0	0	0	20	50	60

The choice of the possibility that two grassland types can occur in the same pixel has an effect on the formulas of the ecological and economic model. The new formulas are:

- For the dry matter calculation (DM: dry matter)

If NGT (number of grassland types) = 1then $DM_{RRG, i} = DM_{RRG, GT1, i}$

If NGT (number of grassland types) = 2 then $DM_{RRG, i}$ (dry matter)= $0.7 * DM_{RRG, GT1, i} + 0.3\ DM_{RRG, GT2, i}$

With RRG: relative to rye grass and GT: grass type

- For the energy calculation (EC: energy content)
  If NGT (number of grassland types) = 1 then $EC_{RRG\ i} = EC_{RRG,\ GT1\ I}$
  If NGT (number of grassland types) = 2 then $EC_{RRG,\ i} = 0.7 * EC_{RGR,\ GT1,\ i} + 0.3\ EC_{RRG,\ GT2,\ i}$

- For the bird value calculations

  If NGT (number of grassland types) = 1 then

  - $WESi = WES_{GT1,\ i}$ -1* OHG
  - $WOLAi = WOLA_{GT1,\ i}$ -0.5 * OHG
  - $WKLAi = WKLA_{GT1,\ i}$

  If NGT (number of grassland types) = 2 then

  - $WESi = 0.7 * WES_{GT1,\ i} + 0.3 * WES_{GT2,\ i}$ -1* OHG
  - $WOLAi = 0.7 * WOLA_{GT1,\ i} + 0.3 * WOLA_{GT2,\ i}$ -0.5 * OHG
  - $WKLAi = 0.7 * WKLA_{GT1,\ i} + 0.3 * WKLA_{GT2,\ i}$

  With OHG: occurance of high green (all green elements > 3m)

- For the grass height calculation (GH: grass height)
  If NGT (number of grassland types) = 1then $GH_{RRG,\ i} = GH_{RRG,\ GT1,\ i}$

  If NGT (number of grassland types) = 2 then $GH_{RRG,\ i} = 0.7 * GH_{RRG,\ GT1,\ i} + 0.3\ GH_{RRG,\ GT2,\ i}$
- For the grass height distribution of seasonal grazing
  - <10:
    - When NGT= 1: $RGHD_{RRG,\ i} = RGHD_i$ (cattle type) x $100/GH_{RRG,\ GT1,\ i}$
    - When NGT= 2: $RGHD_{RRG,\ i}$ = 0,70 x (RGHD (cattle type) x $100/GH_{RRG,\ GT1}$) + 0,30 x (RGHD (cattle type) x $100/GH_{RRG,\ GT1}$)
  - 10-30:
    - When NGT= 1: $RGHD_{RRG,\ i} = RGHD_i$ (cattle type) x $100/GH_{RRG,\ GT1,\ i}$
    - When NGT= 2: $RGHD_{RRG,\ i}$ = 0,70 x (RGHD (cattle type) x $100/GH_{RRG,\ GT1}$) + 0,30 x (RGHD (cattle type) x $100/GH_{RRG,\ GT1}$)
  - >30:
    - the remaining, thus 1 - $RGHD_{RRG,\ I}$ (<10) - $RGHD_{RRG,\ I}$ (10-30)

The choice to distinguish grassland types has also an effect on the ECOPAY database:

- In the *pixel* table the following columns will be added:
  - Number of grassland types which occur in a pixel: value can be 1 or 2
  - Grassland type 1 and type 2: 13 types will be distinguished
  - Occurrence of high green (trees, hedgerows, etc.): 0 no high green and 1: high green
- In the database the following table will be added: *Grassland type.* For each grassland type the following information will be given the value for birds or ducks, the value for open space farmland birds, the value for small-scale landscape farmland birds, the type, the dry matter production relative too rye grass and the quality relative to rye grass.

2.2. Occurance of high green

In Flanders a new geographical map was developed which give information on the occurrence of green elements. The map is a grid segmentation classification of the summer flight orthophotos in the classes high green (>3m), low green (<3), agriculture (low and no green classified as agriculture on the agriculture map) and no green (meaning urban, infrastructure, parking area, fallow). The green map was used to correct the bird values. The bird values (WES and WOLA) will be lower when high green occur. The reason is that high green elements attracts predators and thus probably increase the predation on the farmland birds.

2.3. Seasonal grazing

In ECOPAY Flanders version 1 the number of cattle units was fixed during the grazing season by seasonal grazing measures. However, in reality the cattle units vary during the grazing season because a farmer is trying to make maximal use of the variable grass growing speed, which is high in May and June. Therefore, the economic and ecological model was adapted to take into account the temporarily variable number of cattle units.

2.3.1. Economic model

A farmer applies by seasonal grazing different cattle densities during different quarter months. Four different periods are distinguished:

- Period 1: default values 3 cattle units and period 1-30 April
- Period 2: default values 7 cattle units and period 1 May to 30 June
- Period 3: default values 4 cattle units and period 1 July to 14 September
- Period 4: default values 3 cattle units and period 15 September to 30 October

Each period have a start and end period, a cattle density and a cattle type. It is presummed:

- that a farmer will use during the whole grazing season the same cattle type (adult or young and thus not for example adult cows during period 1 and 3 and young cows during period 2 and 4),
- that a farmer will apply the economic optimal number of cattle units outside the period that the agro-environmental measure reduce the cattle units as a meadow bird protection measure

In addition, by applying agro-environmental measures it can be that the number of periods can be less than four. In the below figure the new economic model is given.

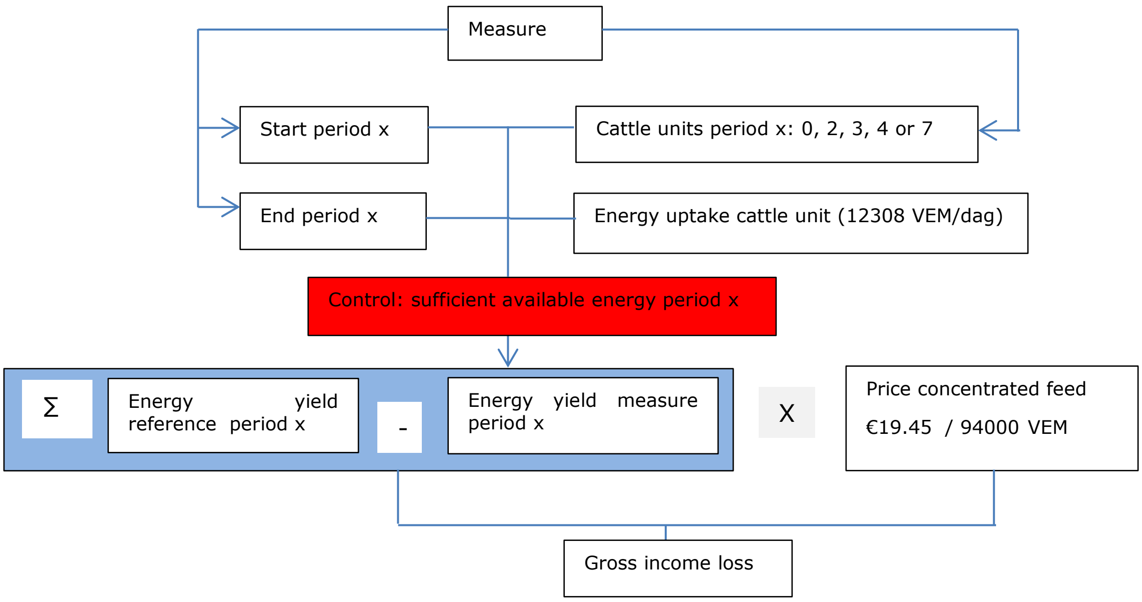


Figure 2.1Economic model gross income loss for seasonal grazing

The changed economic model has also an influence on the reference value (i.e. the return a farmer has without applying for an agri-environmental measure). The new reference value for seasonal grazing and mowing-seasonal grazing is given in Table 2.2.

Table 2.2 Reference value for seasonal grazing and mowing-seasonal grazing in ECOPAY Flanders 2.0

Measure	Energy matter_ref_380N	Energy matter_ref_245N
Grazing_seas	11.907.990	9.600.240
Mowing_pasture_seas	13.532.381	9.863.803

2.3.2. Ecological model

The grass height by seasonal grazing is depending on the livestock density. In addition, livestock do not graze uniformly. To take this variation into account a grass height class distribution is estimated by grassland experts. This estimation was done for two livestock densities (0.5 and 4) and linear interpolated for in-between values (see Table 2.3). Based on these estimates also higher cattle densities where estimated by experts.

Table 2.3 The influence of livestock density on the grass height distribution (GHD) by seasonal grazing

Livestock density	grass height distribution		
	<10	10-30	>30
0,5	0,20	0,35	0,45
2	0,50	0,22	0,28
3	0,70	0,14	0,16
4	0,90	0,05	0,05
5	0,94	0,03	0,03
6	0,98	0,01	0,01
7	1,00	0	0

2.4. Specific cost elements

In ECOPAY Flanders version 1.0 it was assumed that farmers could always use the structure-rich grass. Nevertheless this is not always the case. In addition, it was assumed that grassland of the same quality have the same economic value for a farmer. Nevertheless, farmers will apply less for agri-environmental measures when the grassland is closer tot their farmer's house. Both aspects are included in ECOPAY version 2.0. However it was not possible to get the data because of privacy concerns. Finally, it was taken into account that farmers can only save on inorganic manures and that a saving on organic manures is an additional cost in Flanders because the organic manure was cannot put on the land need to be processed.

Farmer's possibility to use structure-rich grass

In the pixel table a column will be added to indicate if a farmer can use the grass of a specific pixel as structure rich grass. If he can use it as structure rich grass the normal economic model is followed (value 1 in pixel table). If not a second economic model is used, whereby the usefulness of the remaining energy yield of the grass during the resting period is equaled to zero (value o in pixel table). Thus the energy yield of the resting period is multiplied by an usefulness structure rich grass factor.

Distance to farm house

In the pixel table a column will be added to include a higher cost when the pixel is closer to the farm house. This cost value is added to the calculated value of the economic model.

Manure type

The current idea is that a farmer will use 170 kg organic fertilizer. Thus, the current model can be kept until the farmer will drop below 170 kg organic fertilizer. When the farmer will drop below, than the less manure will get an additional cost instead of a cost saving. Thus I suggest a formula like:

x ≥170: (380- x) * saved cost of man-made fertilizer

x < 170: (380-170) * saved cost of man-made fertilizer - (170-x) * additional cost of organic manure processing

x= applied manure

additional cost of organic manure processing is 4 €/kg N

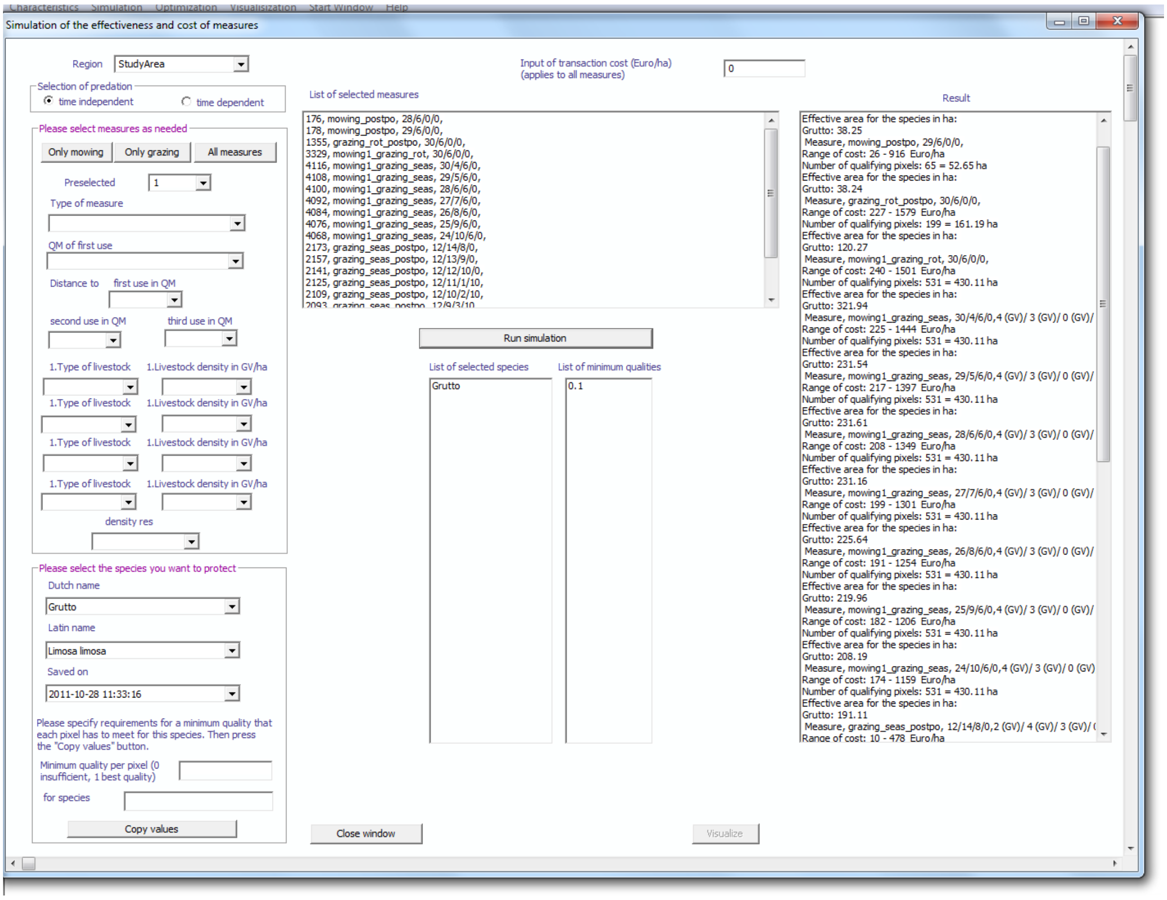
3. Visualizations

Ecopay offers three different ways to export results, results are written into the database and can be exported to Excel files, results can be visualized and the map can be saved to a bit file and last results can be written into a text file. The next paragraphs are a step by step introduction how to export results.

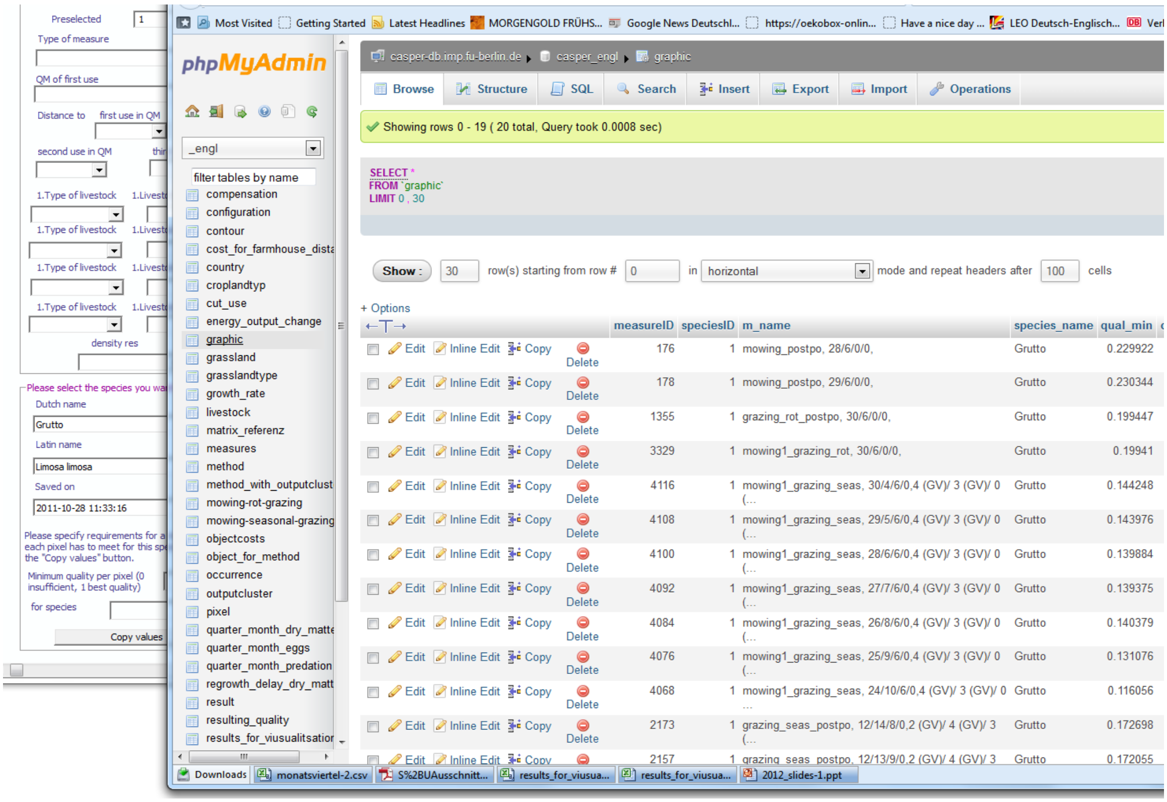
3.1. Exporting simulation results to Excel files

After running a simulation of effectiveniss and cost of measures, there is the possibility to export the resulting data to an excel file . Each time a simulation is run, the results are written by the software into the table “graphic” in the database. If these data is to be saved, it has to be exported. The table itselve will be cleaned before each simulation, to ensure a not overflowing database.

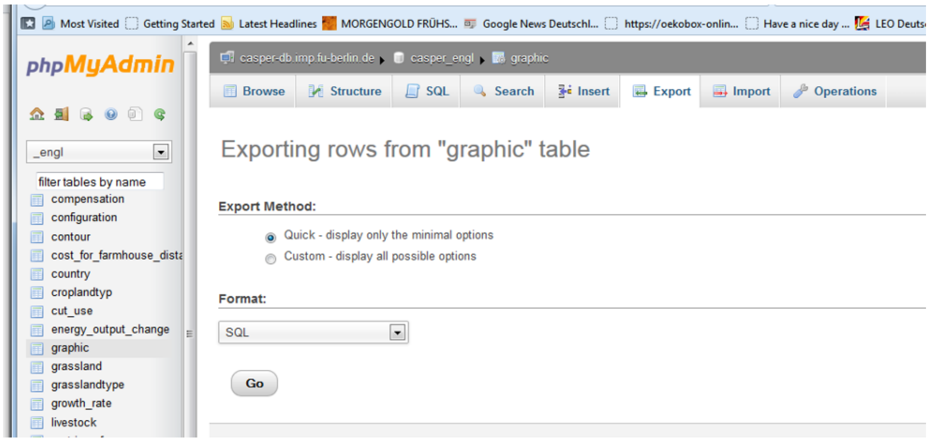
Step 1: Run a simulation.



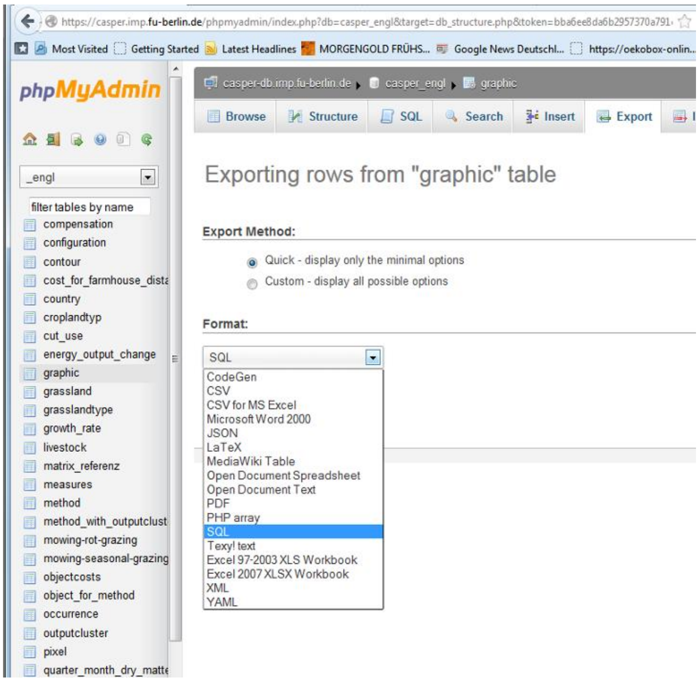
Step 2: The results are written automatically into the database. Open the database and double click on "graphic"



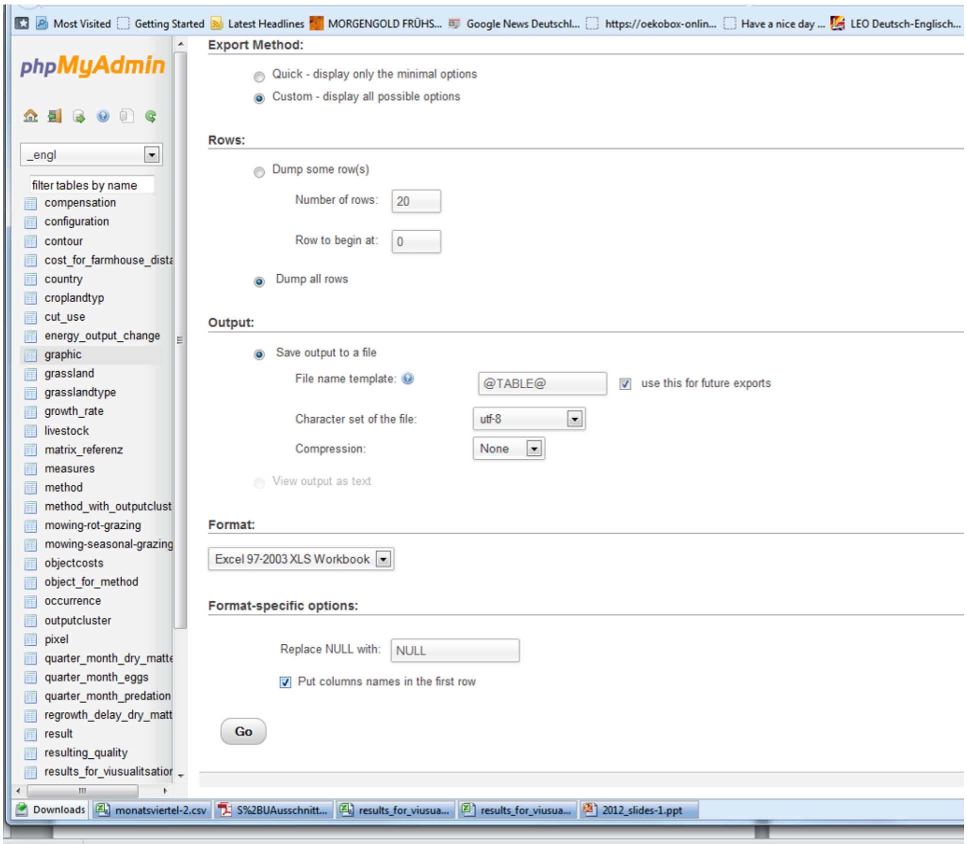
Step 3: Click on „Export".



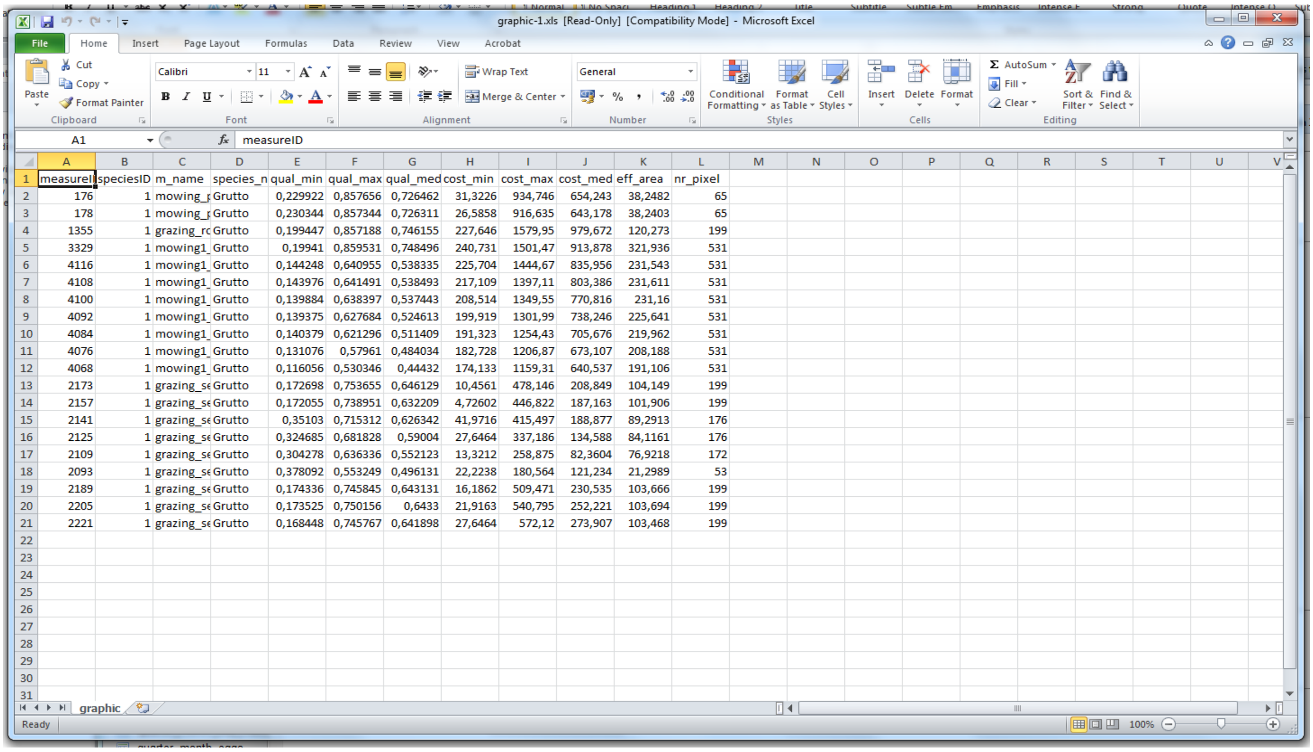
Step 4: Change the "Format" to the desired format, Excel, and change by clicking the "Export Method" to "Custom-display all possible options".



Step 5: Make sure you click "Put columns names in the first row" under "Format-specific options". If desired the name of the file to be saved can be changed in "Output" – "File name template".



Step 6: After pressing "Go" the file is saved and can be opened with Excel.

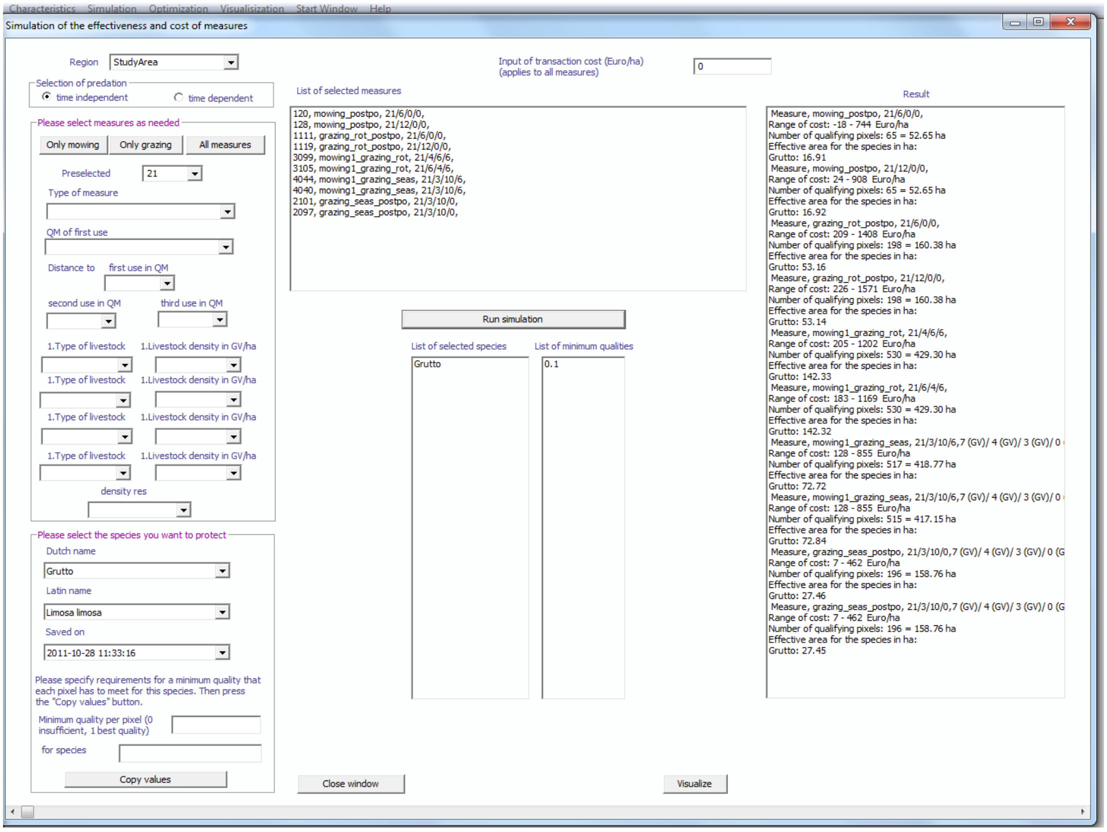


measureI	speciesID	m_name	species_n	qual_min	qual_max	qual_med	cost_min	cost_max	cost_med	eff_area	nr_pixel
176	1	mowing_p	Grutto	0,229922	0,857656	0,726462	31,3226	934,746	654,243	38,2482	65
178	1	mowing_p	Grutto	0,230344	0,857344	0,726311	26,5858	916,635	643,178	38,2403	65
1355	1	grazing_rc	Grutto	0,199447	0,857188	0,746155	227,646	1579,95	979,672	120,273	199
3329	1	mowing1_	Grutto	0,19941	0,859531	0,748496	240,731	1501,47	913,878	321,936	531
4116	1	mowing1_	Grutto	0,144248	0,640955	0,538335	225,704	1444,67	835,956	231,543	531
4108	1	mowing1_	Grutto	0,143976	0,641491	0,538493	217,109	1397,11	803,386	231,611	531
4100	1	mowing1_	Grutto	0,139884	0,638397	0,537443	208,514	1349,55	770,816	231,16	531
4092	1	mowing1_	Grutto	0,139375	0,627684	0,524613	199,919	1301,99	738,246	225,641	531
4084	1	mowing1_	Grutto	0,140379	0,621296	0,511409	191,323	1254,43	705,676	219,962	531
4076	1	mowing1_	Grutto	0,131076	0,57961	0,484034	182,728	1206,87	673,107	208,188	531
4068	1	mowing1_	Grutto	0,116056	0,530346	0,44432	174,133	1159,31	640,537	191,106	531
2173	1	grazing_se	Grutto	0,172698	0,753655	0,646129	10,4561	478,146	208,849	104,149	199
2157	1	grazing_se	Grutto	0,172055	0,738951	0,632209	4,72602	446,822	187,163	101,906	199
2141	1	grazing_se	Grutto	0,35103	0,715312	0,626342	41,9716	415,497	188,877	89,2913	176
2125	1	grazing_se	Grutto	0,324685	0,681828	0,59004	27,6464	337,186	134,588	84,1161	176
2109	1	grazing_se	Grutto	0,304278	0,636336	0,552123	13,3212	258,875	82,3604	76,9218	172
2093	1	grazing_se	Grutto	0,378092	0,553249	0,496131	22,2238	180,564	121,234	21,2989	53
2189	1	grazing_se	Grutto	0,174336	0,745845	0,643131	16,1862	509,471	230,535	103,666	199
2205	1	grazing_se	Grutto	0,173525	0,750156	0,6433	21,9163	540,795	252,221	103,694	199
2221	1	grazing_se	Grutto	0,168448	0,745767	0,641898	27,6464	572,12	273,907	103,468	199

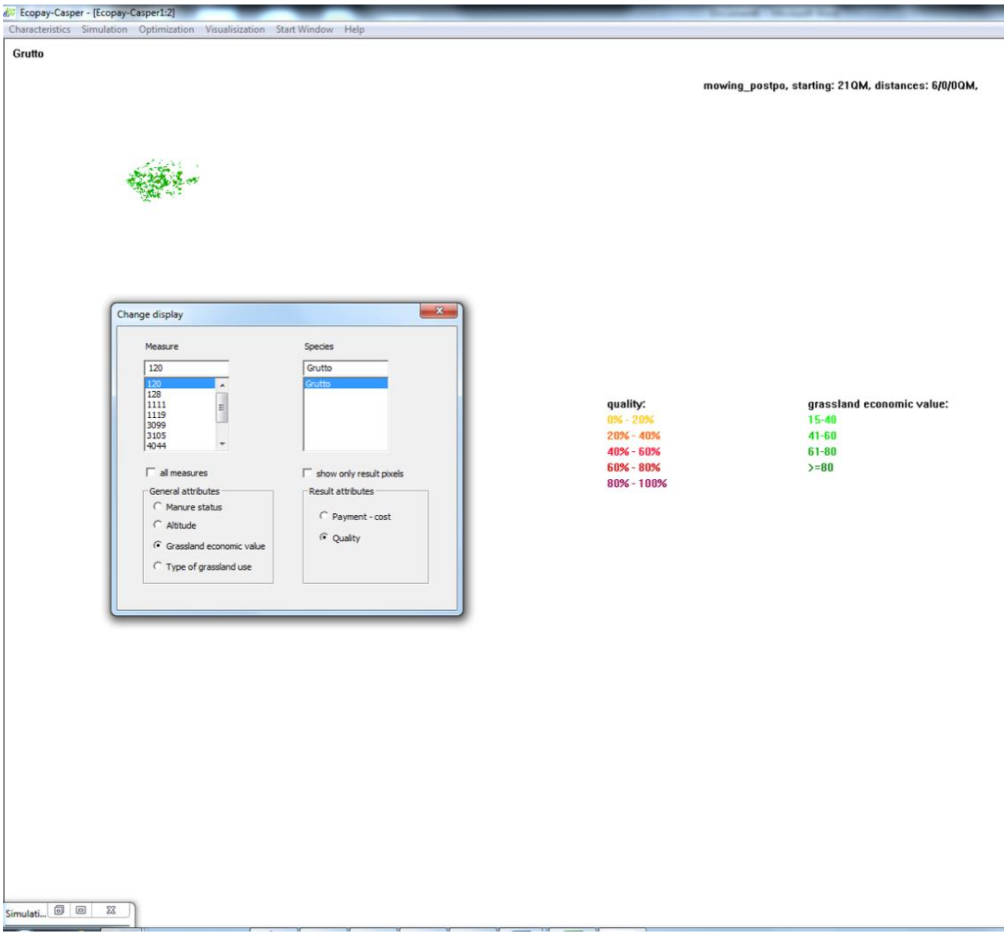
3.2. Visualization of results

After running a simulation or an optimization, there is the possibility to visualize the result (if the number of choosen measures does not exeed 20). Each time a visualization is run, the results are written by the software into the table "results_for_visualization" in the database. If these data is to be saved, it has to be exported. The table itselve will be cleaned before each simulation and optimization, to ensure a not overflowing database.

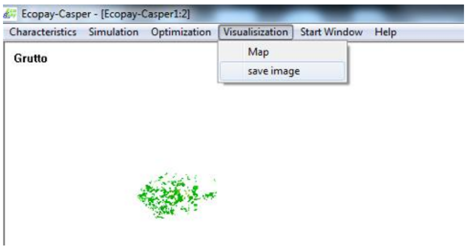
Step 1: Run a simulation or an optimization.



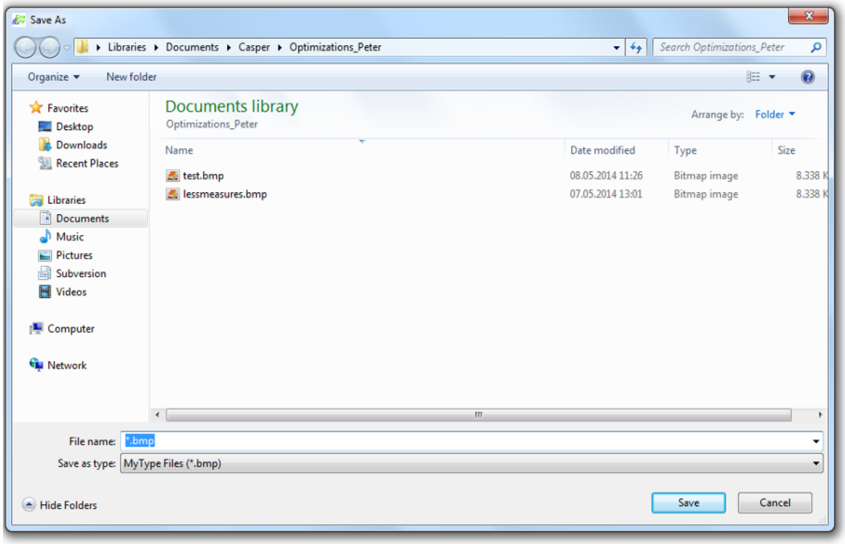
Step2: Click on the button "visualize". Now the software opens the visualization window and automatically writes the data needed for visualization into the database table "results_for_visualization".



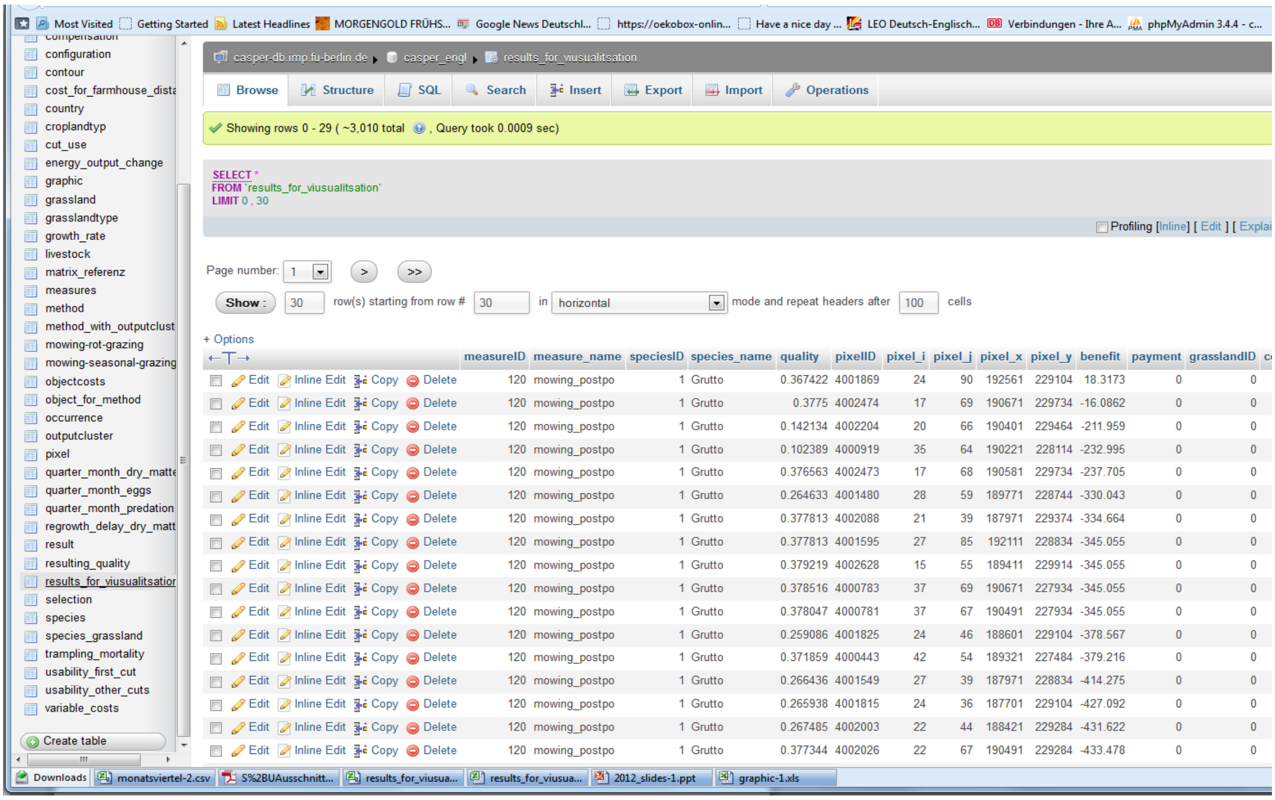
Step 3: By choosing different option in the "change display" window the visible output can be altered. Each Map can be saved into a bit map file by chlicking on "Visualization" in the main menu and then choosing "save image".



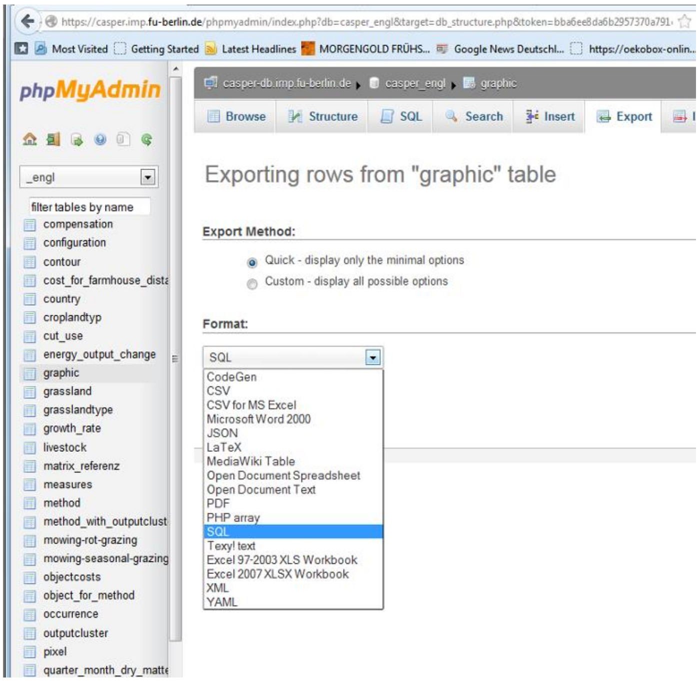
Step 4: Saving the image to the desired location.

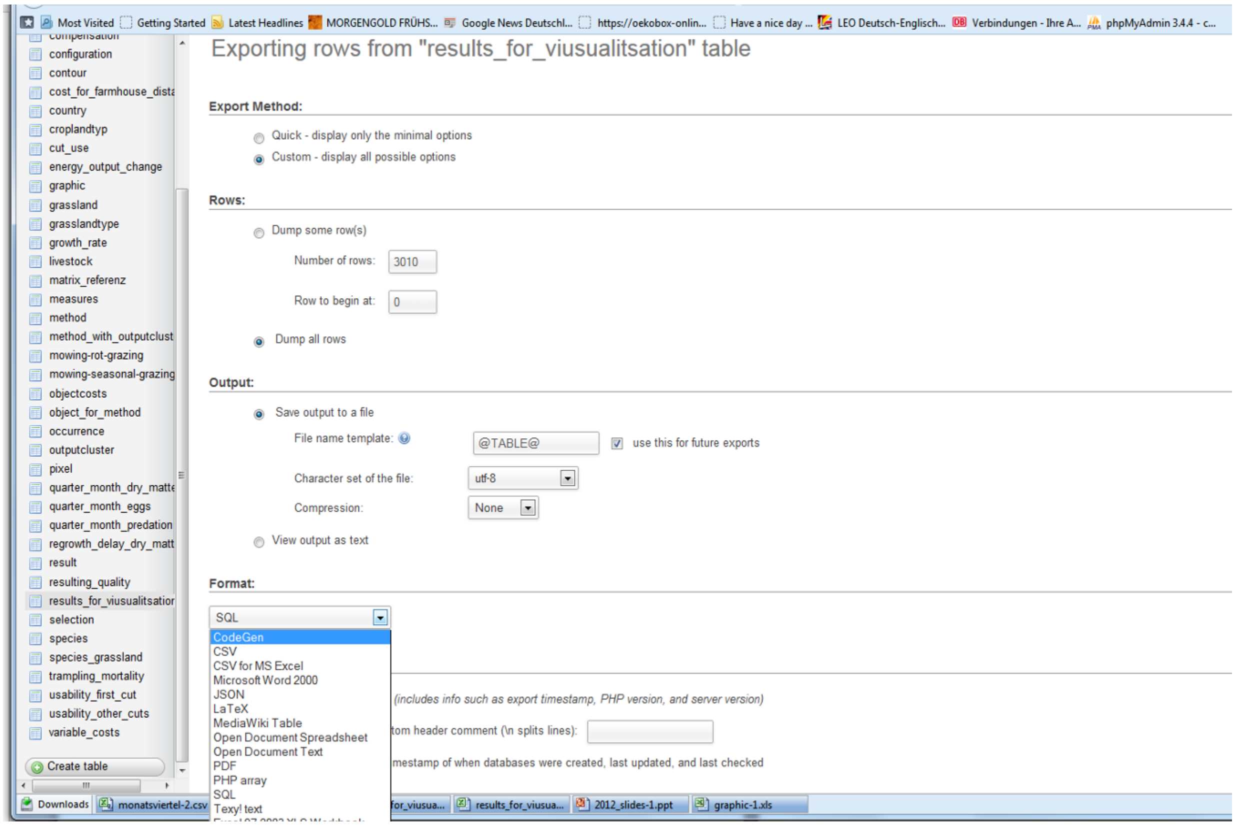


Step 5: To export the results to visualize with e.g. ArcGis, open the databse and double cklick in the left menu on "results_for_visualization" to open the data set.

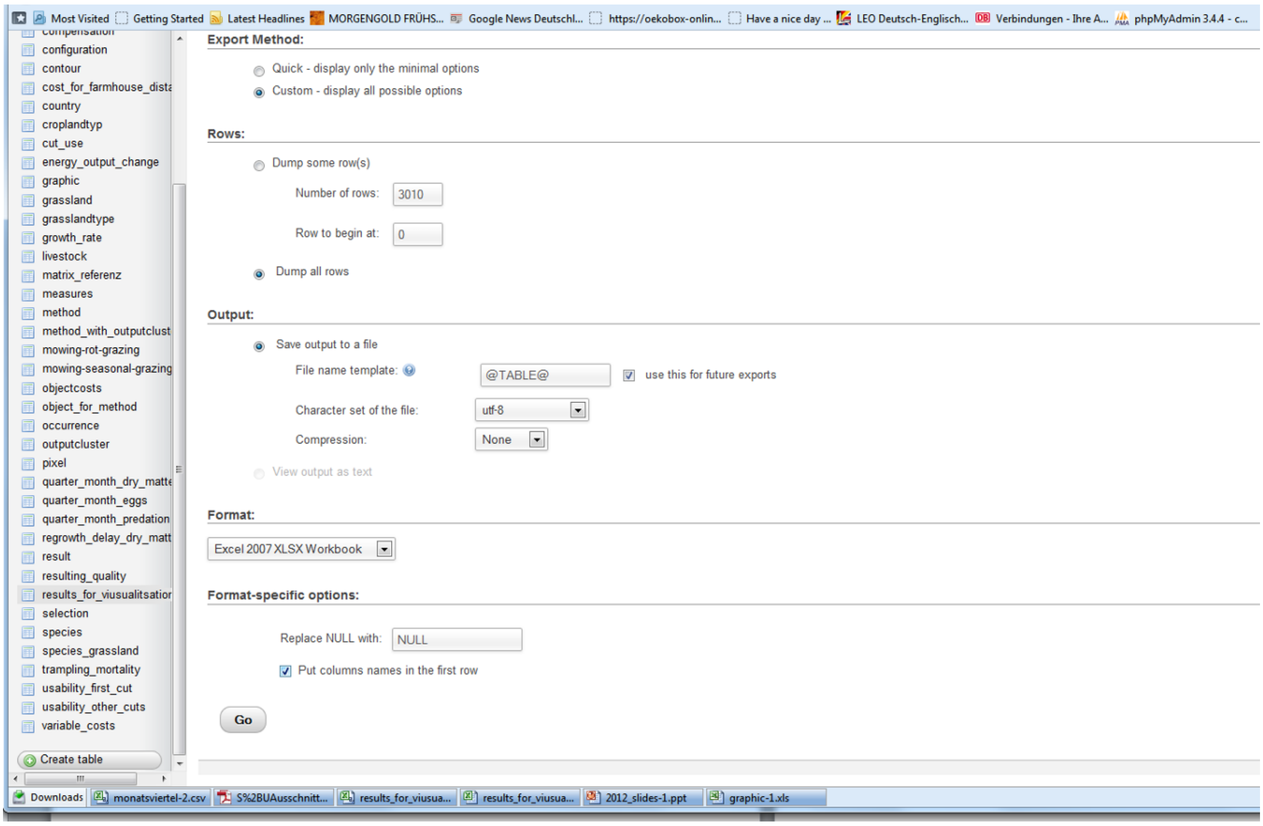


Step 6: Click on "Export" in the upper menu and change the "Format" to the desired format, Excel, and change by clicking the "Export Method" to "Custom-display all possible options".





Step 7: Make sure you click "Put columns names in the first row" under "Format-specific options". If desired the name of the file to be saved can be changed in "Output" – "File name template".

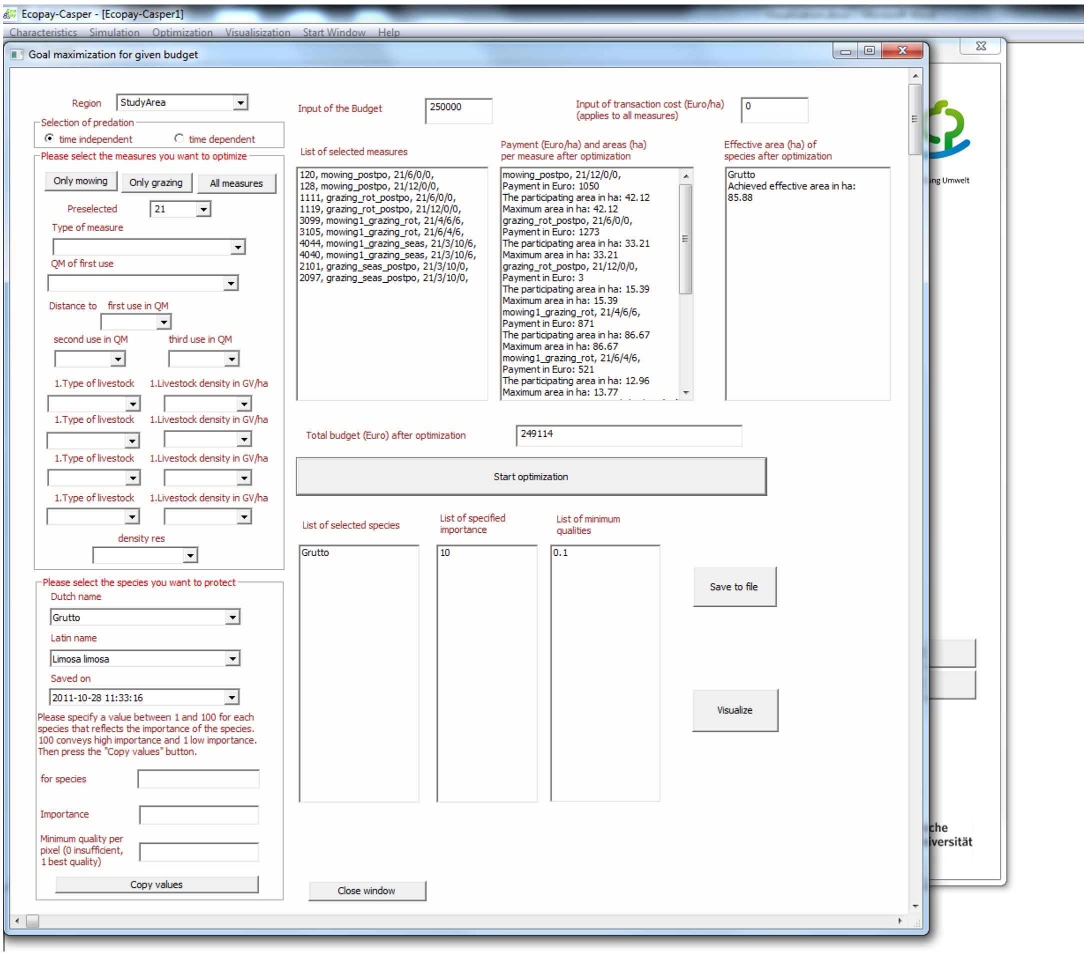


Step 8: After pressing "Go" the file is saved and can be opened with Excel and imported to ArcGis.

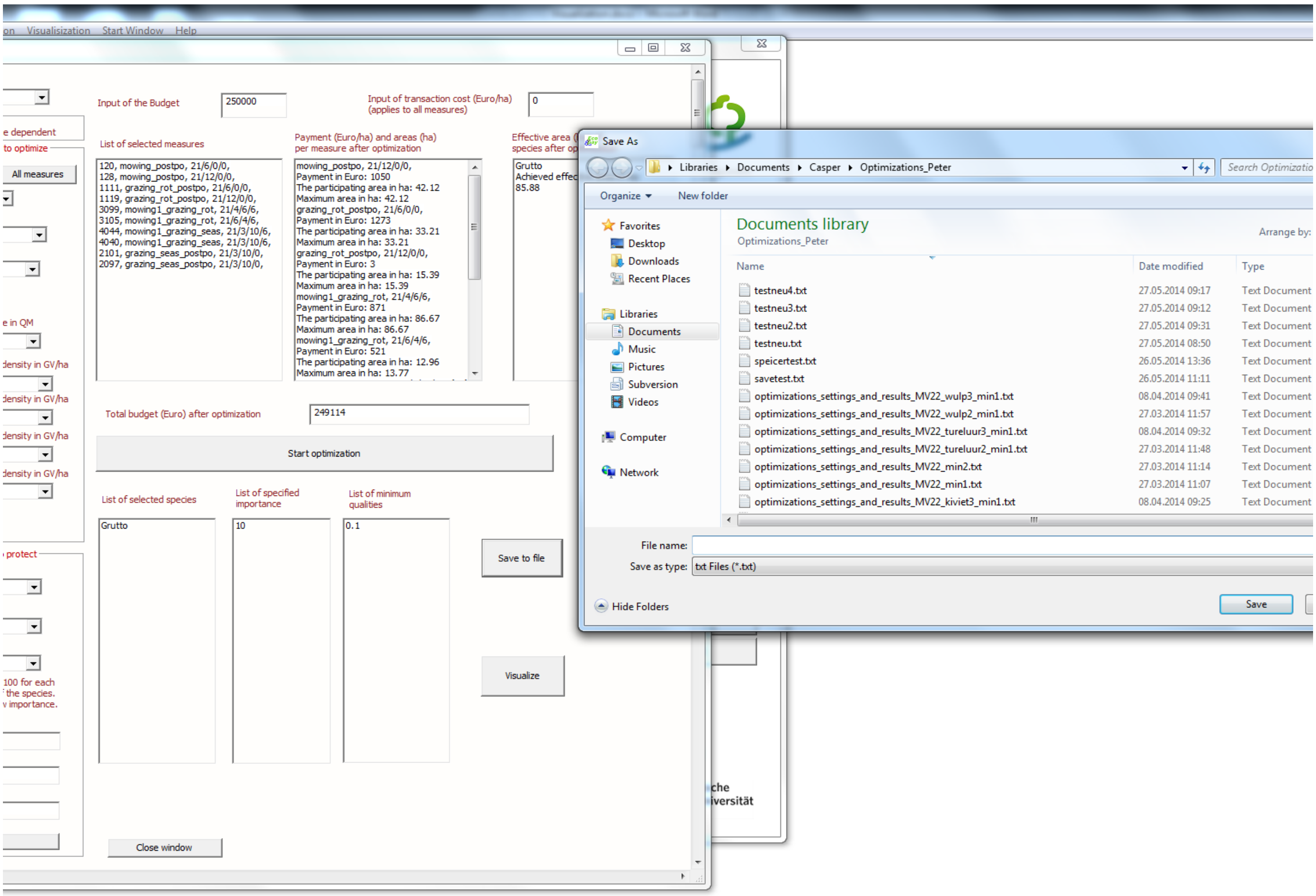
3.3. Exporting results to text files

After running a Simulation of agri-environmental programmes or an optimization, there is the possibility to save the results to a text file.

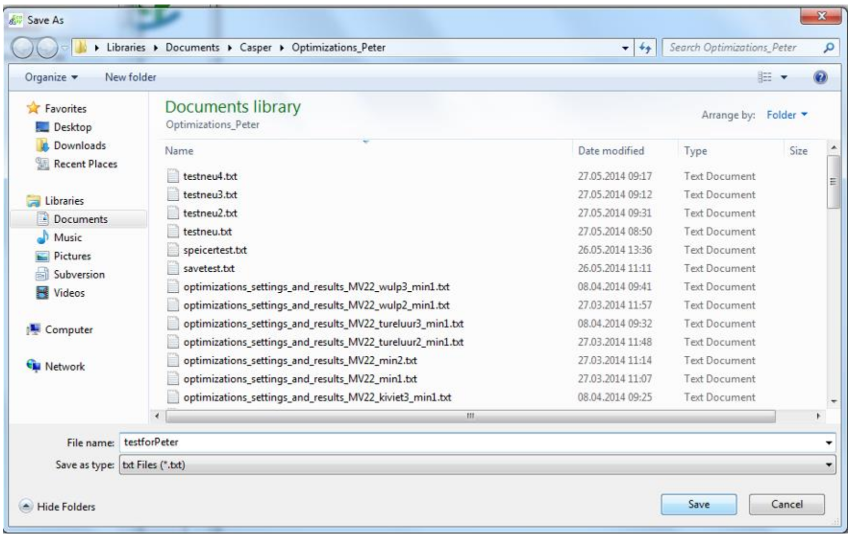
Step1: Run the simulation or optimization.



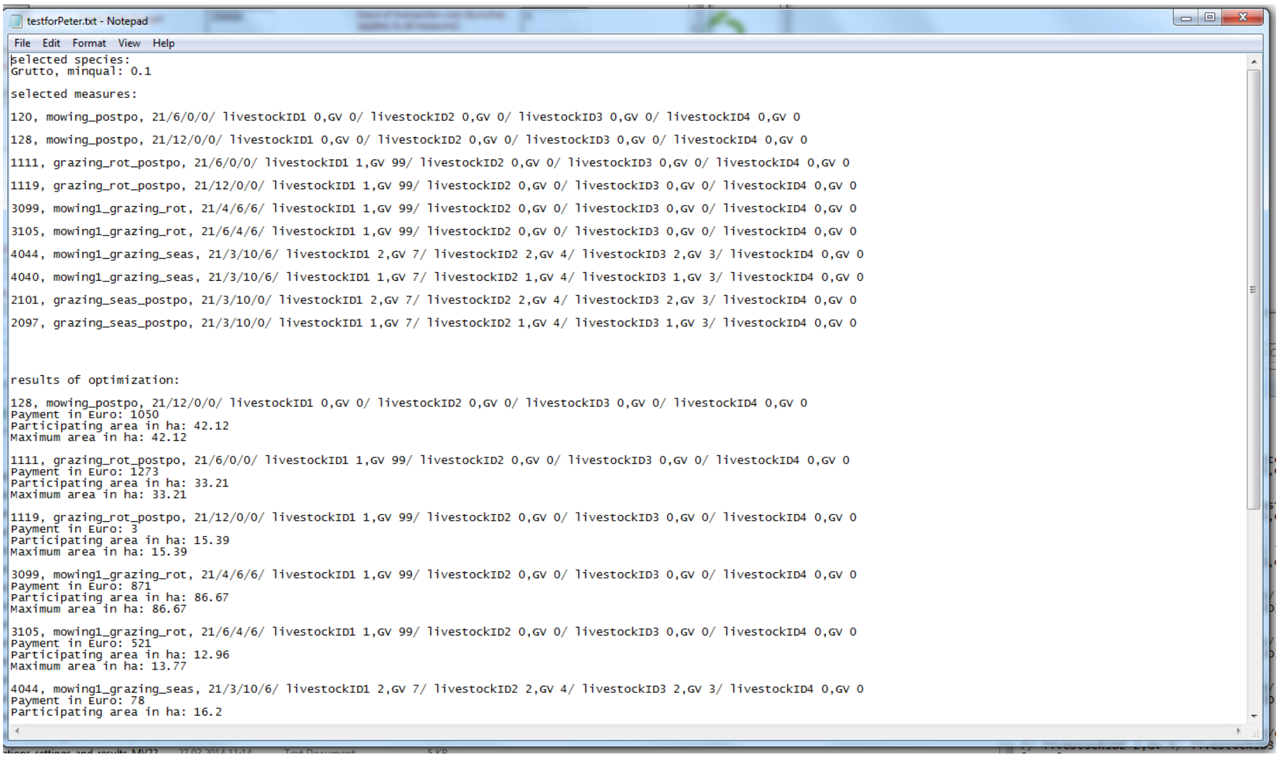
Step2: Press the button "save to file". If you press the button before the simulation or optimization process was finished, only the chosen settings, measures and species, are saved to the file.



Step 3: Choose the location and the file name and press "save".



Step 4: The saved file can be opend in any text file editor, e.g. Notepad.



```
selected species:
Grutto, minqual: 0.1

selected measures:

120, mowing_postpo, 21/6/0/0/ livestockID1 0,GV 0/ livestockID2 0,GV 0/ livestockID3 0,GV 0/ livestockID4 0,GV 0

128, mowing_postpo, 21/12/0/0/ livestockID1 0,GV 0/ livestockID2 0,GV 0/ livestockID3 0,GV 0/ livestockID4 0,GV 0

1111, grazing_rot_postpo, 21/6/0/0/ livestockID1 1,GV 99/ livestockID2 0,GV 0/ livestockID3 0,GV 0/ livestockID4 0,GV 0

1119, grazing_rot_postpo, 21/12/0/0/ livestockID1 1,GV 99/ livestockID2 0,GV 0/ livestockID3 0,GV 0/ livestockID4 0,GV 0

3099, mowing1_grazing_rot, 21/4/6/6/ livestockID1 1,GV 99/ livestockID2 0,GV 0/ livestockID3 0,GV 0/ livestockID4 0,GV 0

3105, mowing1_grazing_rot, 21/6/4/6/ livestockID1 1,GV 99/ livestockID2 0,GV 0/ livestockID3 0,GV 0/ livestockID4 0,GV 0

4044, mowing1_grazing_seas, 21/3/10/6/ livestockID1 2,GV 7/ livestockID2 2,GV 4/ livestockID3 2,GV 3/ livestockID4 0,GV 0

4040, mowing1_grazing_seas, 21/3/10/6/ livestockID1 1,GV 7/ livestockID2 1,GV 4/ livestockID3 1,GV 3/ livestockID4 0,GV 0

2101, grazing_seas_postpo, 21/3/10/0/ livestockID1 2,GV 7/ livestockID2 2,GV 4/ livestockID3 2,GV 3/ livestockID4 0,GV 0

2097, grazing_seas_postpo, 21/3/10/0/ livestockID1 1,GV 7/ livestockID2 1,GV 4/ livestockID3 1,GV 3/ livestockID4 0,GV 0



results of optimization:

128, mowing_postpo, 21/12/0/0/ livestockID1 0,GV 0/ livestockID2 0,GV 0/ livestockID3 0,GV 0/ livestockID4 0,GV 0
Payment in Euro: 1050
Participating area in ha: 42.12
Maximum area in ha: 42.12

1111, grazing_rot_postpo, 21/6/0/0/ livestockID1 1,GV 99/ livestockID2 0,GV 0/ livestockID3 0,GV 0/ livestockID4 0,GV 0
Payment in Euro: 1273
Participating area in ha: 33.21
Maximum area in ha: 33.21

1119, grazing_rot_postpo, 21/12/0/0/ livestockID1 1,GV 99/ livestockID2 0,GV 0/ livestockID3 0,GV 0/ livestockID4 0,GV 0
Payment in Euro: 3
Participating area in ha: 15.39
Maximum area in ha: 15.39

3099, mowing1_grazing_rot, 21/4/6/6/ livestockID1 1,GV 99/ livestockID2 0,GV 0/ livestockID3 0,GV 0/ livestockID4 0,GV 0
Payment in Euro: 871
Participating area in ha: 86.67
Maximum area in ha: 86.67

3105, mowing1_grazing_rot, 21/6/4/6/ livestockID1 1,GV 99/ livestockID2 0,GV 0/ livestockID3 0,GV 0/ livestockID4 0,GV 0
Payment in Euro: 521
Participating area in ha: 12.96
Maximum area in ha: 13.77

4044, mowing1_grazing_seas, 21/3/10/6/ livestockID1 2,GV 7/ livestockID2 2,GV 4/ livestockID3 2,GV 3/ livestockID4 0,GV 0
Payment in Euro: 78
Participating area in ha: 16.2
```

4. Material & methods

4.1. Case study

In Figure 4.1 the location of the case study is given. The case study is located in the province of Antwerp. In Figure 4.2 the land use of each pixel is given. The main land uses are grassland and cropland.

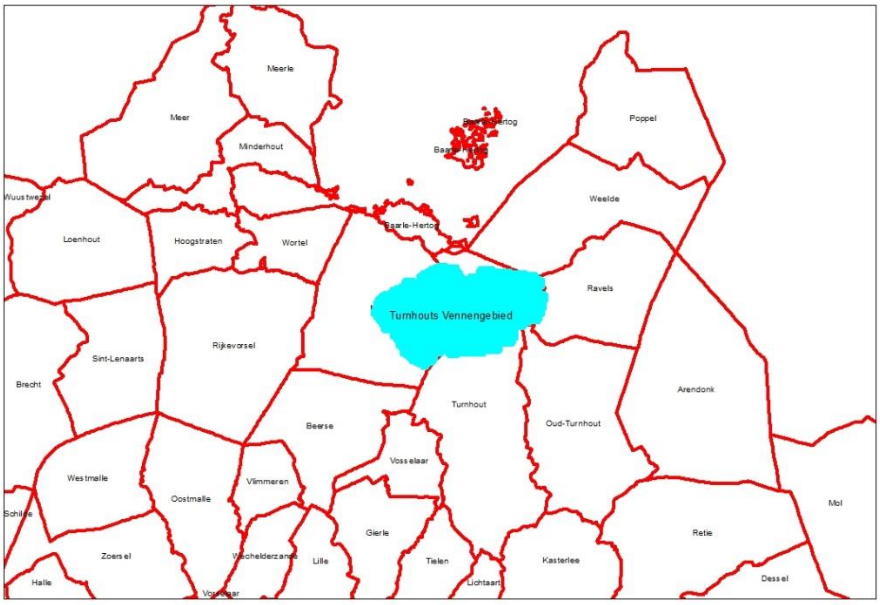


Figure 4.1 Location of the case study "Turnhouts vennengebied"

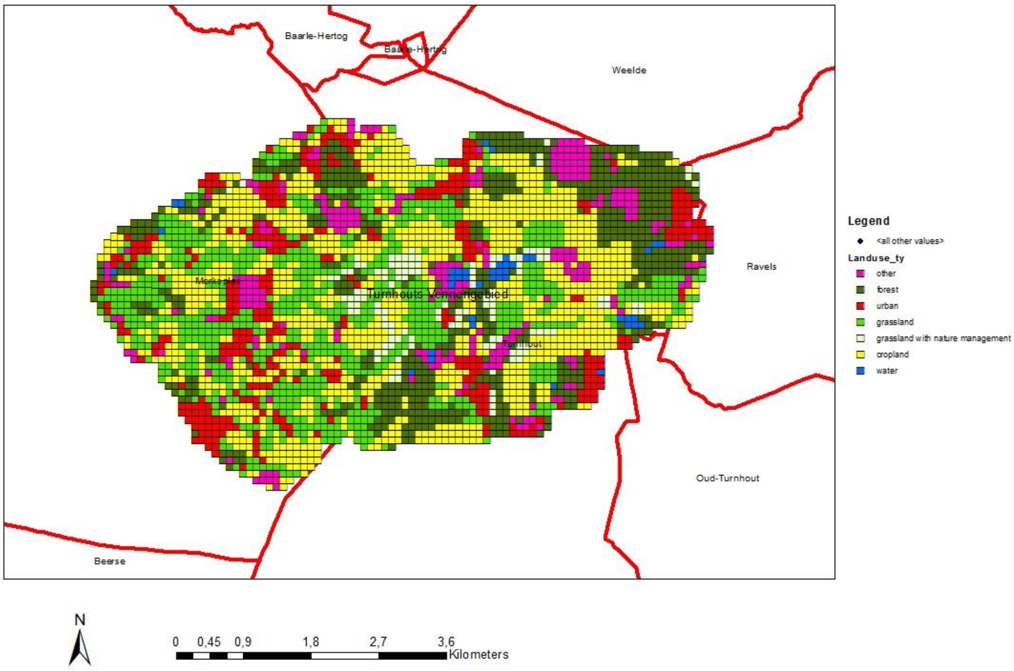


Figure 4.2 Land use in Turnhouts vennengebied

4.2. Simulations: cost-effectiveness of a longer delay of first use

To get a better insight in the data simulations were done. The aim was to get insight if a longer delay of first use could improve the cost effectiveness. In Table 4.1 the measure table for the cost-effectiveness simulations is given.

Table 4.1 Measure table for the cost-effectiveness simulation

QM	Seas grazing	Mowing (even numbers)	Mowing – rot grazing (odd numbers)	Mowing – seas. grazing	Rot. grazing (odd numbers)
21	2101, 2093, 2097	110, …, 128	3093, …, 3111	4040, 4044	1101, .., 1119
22	2117, 2109, 2113	130, …, 140	3113, …, 3123	4048, 4052	1121, …, 1131
23	2133, 2125, 2129	142, 144, 146, 148, 150	3125, …, 3133	4056, 4060	1133, …, 1143
24	2149, 2141, 2145	152, 154, 156, 158	3135, 3137, 3139, 3141	4064, 4068	1145, 1147, 1149, 1151
25	2165, 2157, 2161	160, 162, 164	3143, 3145, 3147	4072, 4076	1153, 1155, 1157
26	2181, 2173, 2177	166, 168, 170	3149, 3151, 3153	4080, 4084	1159, 1161, 1163
27	2197, 2189, 2193	172, 174	3155, 3157	4088, 4092	1165, 1167
28	2213, 2205, 2209	176	3159	4096, 4100	1169
29	2229, 2221, 2225	178	3161	4104, 4108	1171

4.3. Optimization

4.3.1. General scenario’s

In a next step scenarios were analyzed. The aim was to get a better understanding of different important variable for meadow bird managements, like bird weights, ecological quality, delay of first use and type of grassland management (seasonal grazing, mowing, rotational grazing and mixed forms). In total 38 scenarios were analyzed with the following parameters:

Fixed parameters in our scenario’s

- Budget: 250.000 euro
- Selected meadow birds: godwit, redshank, curlew and lapwing

Variable parameters

- Minimal ecological quality: 0,1 (36 scenarios) and 0,2 (2 scenarios)
- Measures (see table 4.2): current policy (QM22), June measures (QM21-24), July – beginning August measures (QM25-29) and all (QM21-29)
- Bird weights: equal weight, godwit twice and three times as important as others, redshank twice and three times as important as others, curlew twice and three times as important as others and lapwing twice and three times as important as others

Table 4.2 Measure table for the general scenarios

QM	Seas grazing	Mowing	Mowing – rot grazing	Mowing – seas. grazing	Rot. grazing
21	2101, 2093, 2097	120, 128	3099, 3105	4040, 4044	1111, 1119
22	2117, 2109, 2113	136, 138, 140	3117, 3121, 3123	4048, 4052	1121, 1127, 1131
23	2133, 2125, 2129	142, 150	3125, 3129, 3133	4056, 4060	1133, 1143
24	2149, 2141, 2145	152, 156	3135, 3139	4064, 4068	1151
25	2165, 2157, 2161	160, 162,	3143, 3147	4072, 4076	1157
26	2181, 2173, 2177	170	3149, 3153	4080, 4084	1163
27	2197, 2189, 2193	172, 174	3155, 3157	4088, 4092	1165, 1167
28	2213, 2205, 2209	176	3159	4096, 4100	1169
29	2229, 2221, 2225	178	3161	4104, 4108	1171

4.3.2. Specific questions

In the final step specific questions were analyzed with a reduced set of measures. The reduced set of measures are given in Table 4.3.

Table 4.3 Measure table for specific questions (in red: additional measures for yellowhammer)

QM	Seas grazing	Mowing	Mowing – rot grazing (	Mowing – seas. grazing	Rot. grazing
21	2093				
22	2109				
23	2125				
24	2141			4068	
25	2157			4076	
26	2173			4084	
27	2189			4092	
28	2205	176		4100	
29	2221	178		4108	
30			3163	4116	1175

The specific research questions are:

- Will the reduced set give a comparable ecological result than the more extended set? (included bird species: godwit, redshank, curlew and lapwing)
- Is there an effect of bird preferences when the weight increase to five times more important than the other three birds? (included bird species: godwit, redshank, curlew and lapwing)
- Is there an effect of bird preferences when an additional bird with contrasting ecological characteristics (i.e. yellowhammer) is included? (the bird preference weight increase to 100 and the budget reduces to 50.000 and 125.000)
- What is the decrease of the ecological result when distance to the farm house is included? (x €0,1, €0,25, €0,5 or €1 for each meter distance)
- What is the decrease when the manure processing cost is included with and without farm house distance (x €0,5/m)

5. Results

5.1. Simulations: cost-effectiveness of a longer delay of first use

In Figure 5.1, Figure 5.2, Figure 5.3, Figure 5.4, Figure 5.5 and Figure 5.6 the simulation results are given for respectively mowing, rotational grazing, mowing-rotational grazing, mowing seasonal grazing and seasonal grazing are given. Based on these figures it is possible to conclude:

- that a delay of first use from QM22 to QM26 is cost-effective, especially for mowing, rotational grazing and mowing-rotational grazing,
- that mowing, rotational grazing and mowing-rotational grazing is not suitable for lapwing (not possible to get by delaying of first use in grassland an ecological effective result),
- that is most cost-effective for lapwing to have a first use in QM21 for mowing-seasonal grazing and seasonal grazing without cattle during resting period and in QM23 for seasonal grazing with cattle (because earlier first use dos not result in an ecological effective result)
- that cattle during resting period by seasonal grazing gives a high cost-effectiveness.

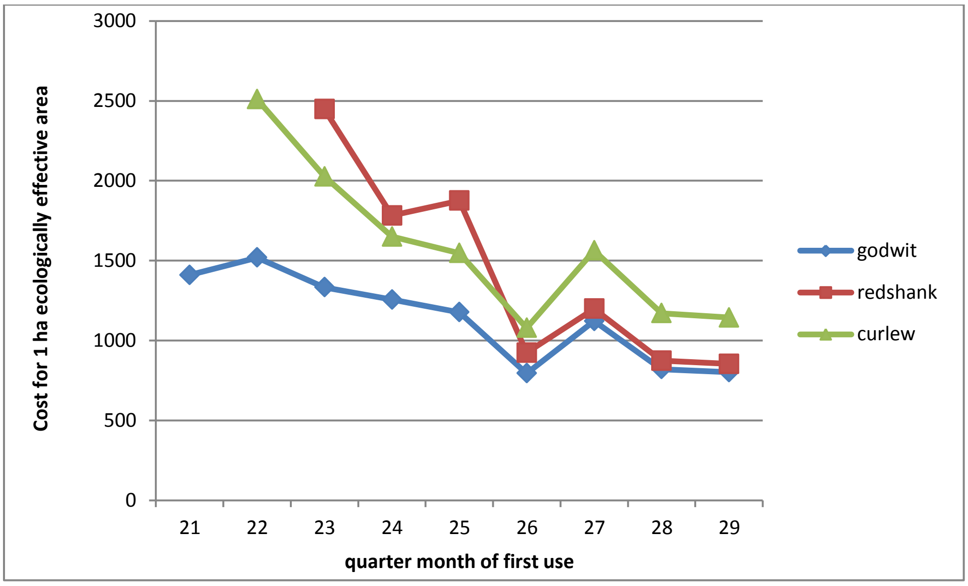


Figure 5.1 Mowing: cost-effectiveness of a longer of first use

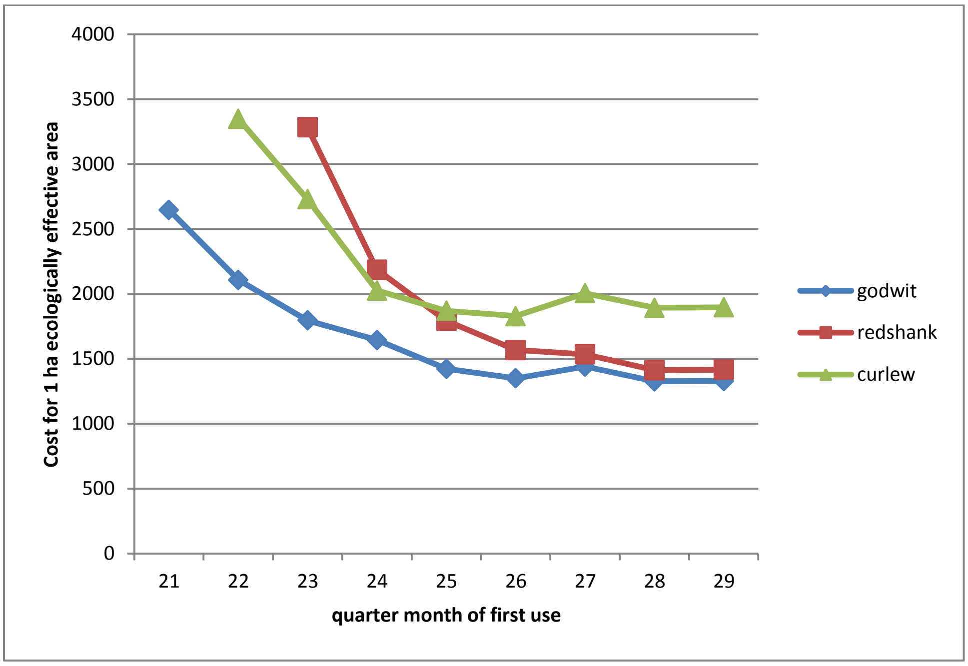


Figure 5.2 Rotational grazing: cost-effectiveness of a longer of first use

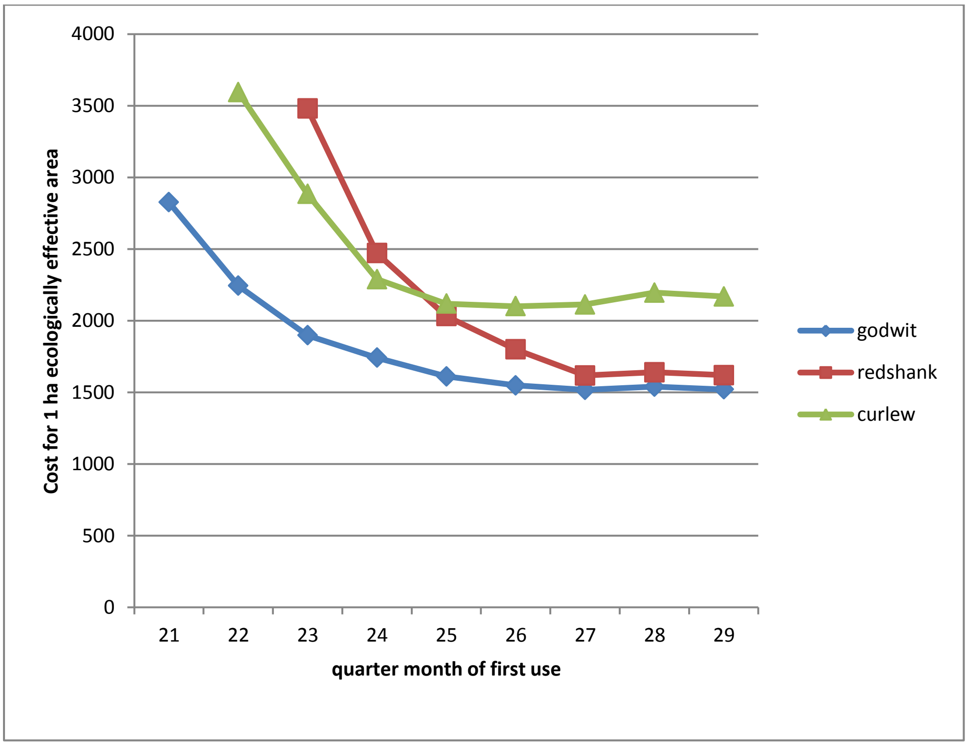


Figure 5.3 Mowing-rotational grazing: cost-effectiveness of a longer of first use

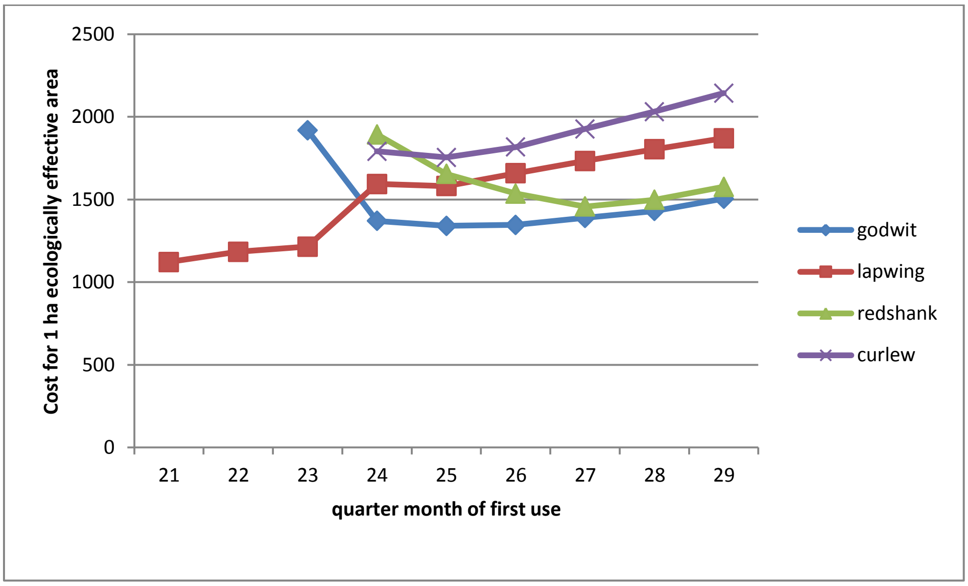


Figure 5.4 Mowing – seasonal grazing: cost-effectiveness of a longer of first use

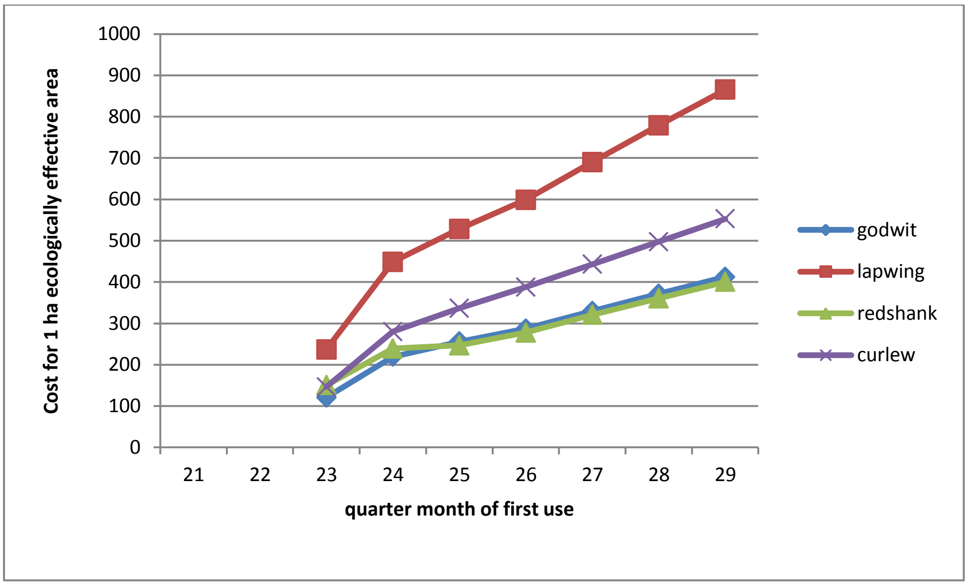


Figure 5.5 Seasonal grazing with 2 cattle units during resting period: cost-effectiveness of a longer of first use

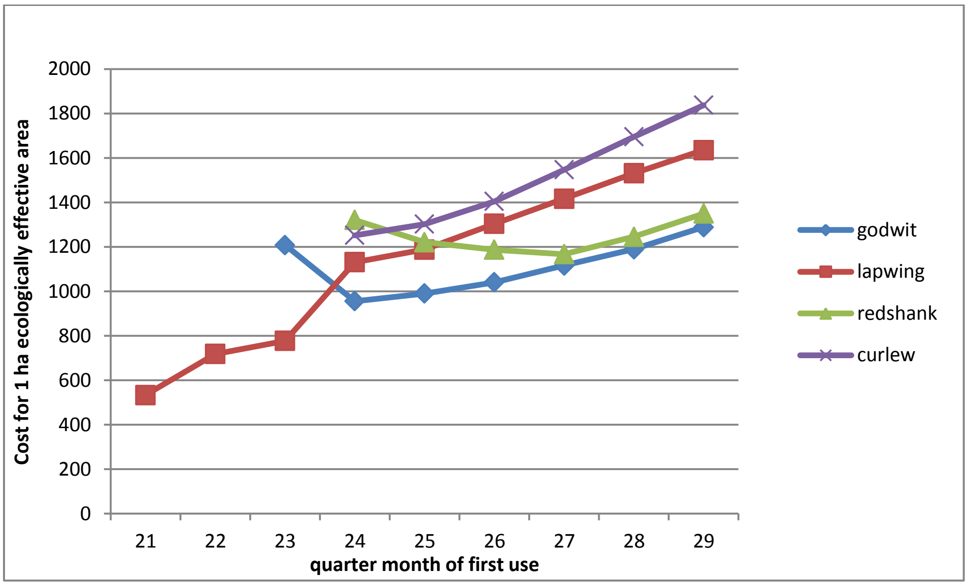


Figure 5.6 Seasonal grazing without cattle units during resting period: cost-effectiveness of a longer of first use

5.2. Optimization

5.2.1. General scenarios

In Figure 5.7, Figure 5.8, Figure 5.9, Figure 5.10 and Table 5.1 the optimization results are given. Based on these figures it is possible to conclude that:

- the July-August and all measure scenarios give the highest mean ecological effective result. The effect is the strongest for Redshank and occur to a lesser extent also by Curlew and Godwit,
- bird weights does not have much influence on the ecological effective area of the preferred bird specie
- the cost for a hectare ecological effective area is the lowest for the July-beginning August measures,
- seasonal grazing with 2 cows during resting period is the most preferred grazing system when a cost effective solutions is the target: it seems that the negative effects of trampling mortality is outweighed by the more optimal grass height for meadow bird chicks.
- rotational grazing is the less preferred grazing system for meadow bird management when a cost effective solutions is the target,
- in scenarios where it is possible to select all measures (QM21-QM29) cost-effective solutions are especially based on measures with first use in QM26-QM29: thus July-August measures.

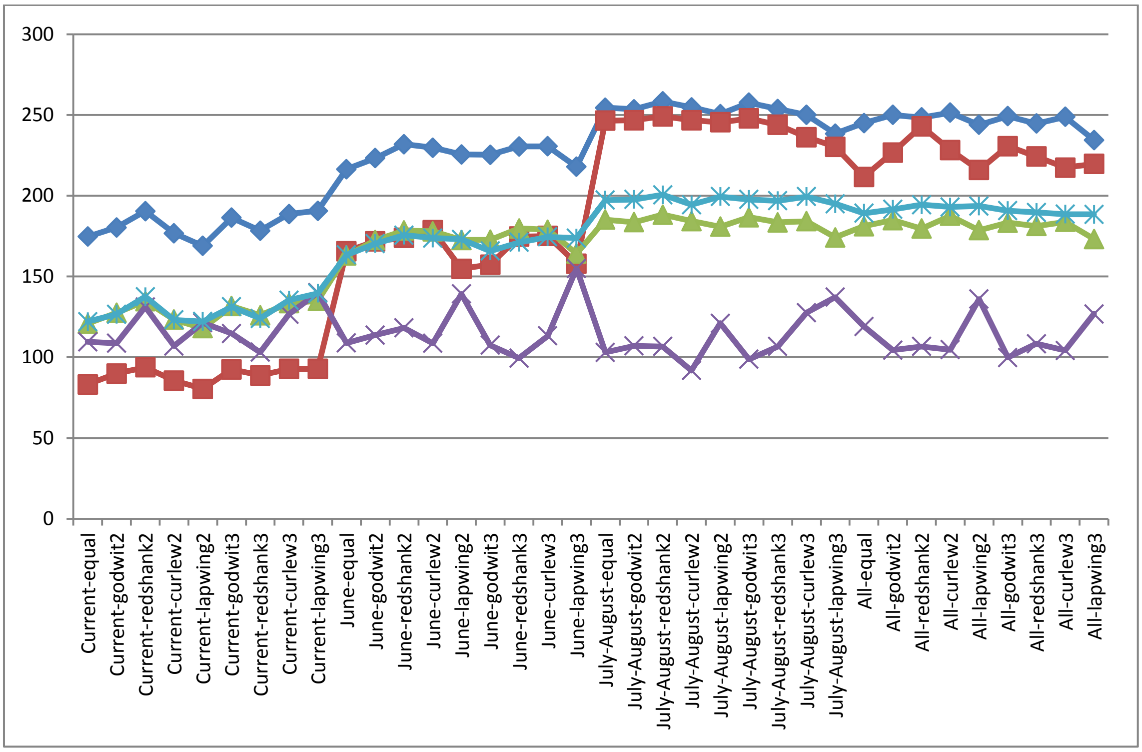


Figure 5.7 The resulting ecological effective area for godwit (dark blue), redshank (red), curlew (green) and lapwing (purple) and the mean ecological effective area of the four birds together (light blue) of the different investigated scenarios (godwit2 and godwit3 means that godwit gets resp. a double and triple weight than the three other birds)

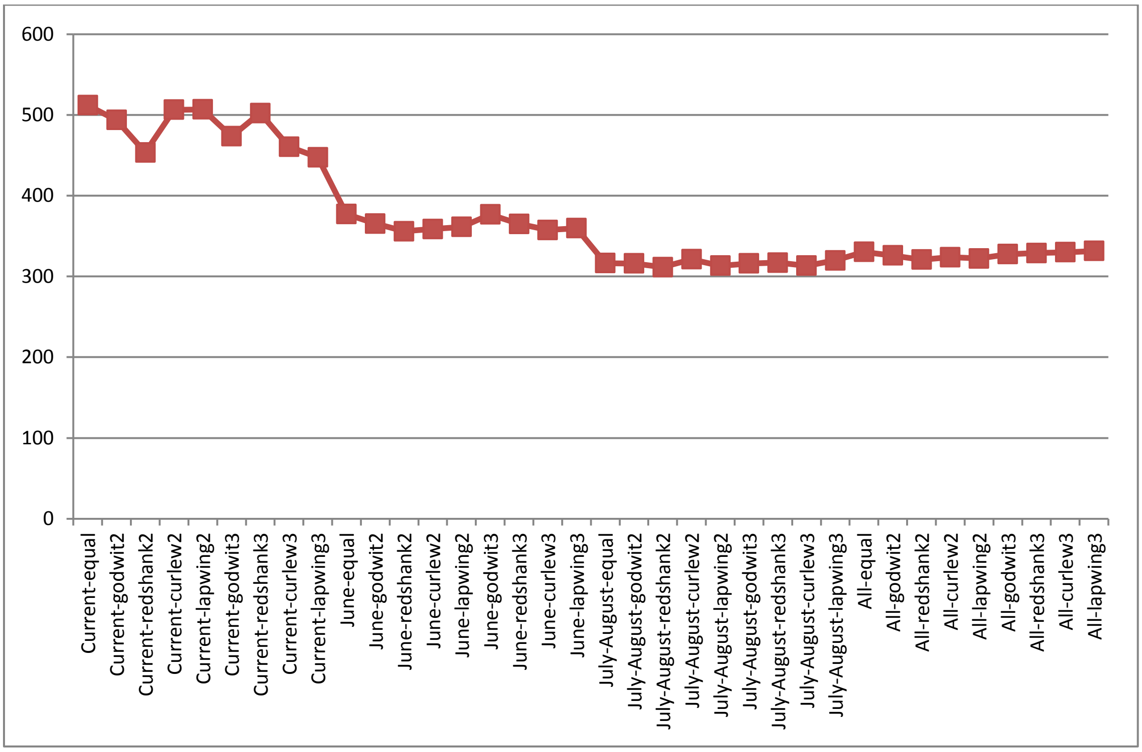


Figure 5.8 The cost of 1 ha of ecological effective area of the different investigated scenarios

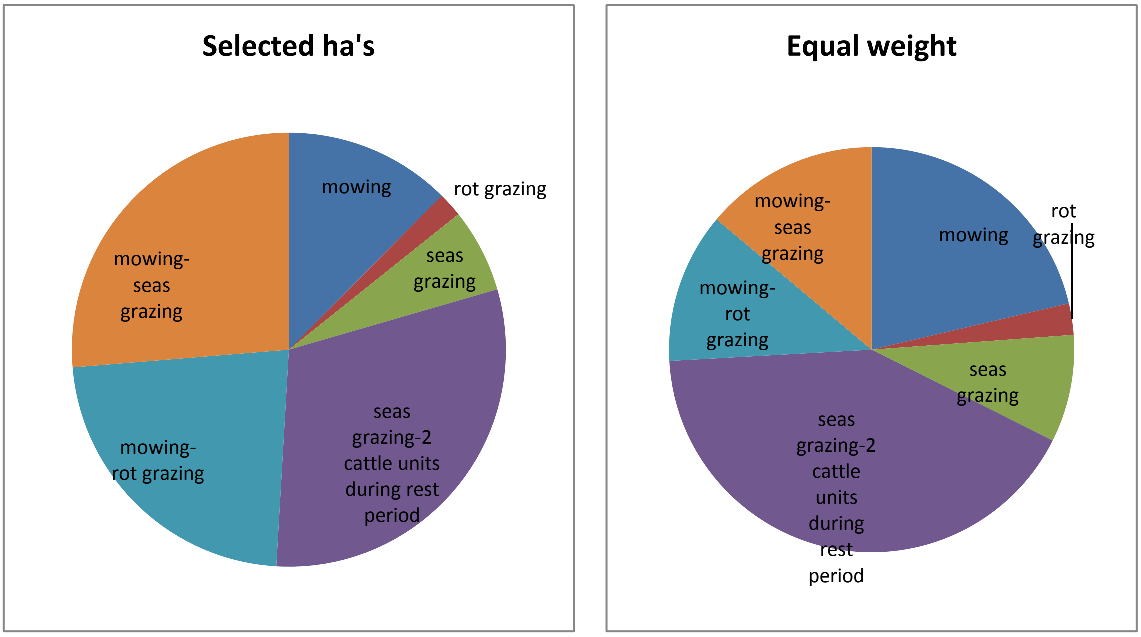


Figure 5.9 The preferred grassland management system based on all investigated scenarios (left: based on the grassland management system distribution in the case, right: corrected to give each grassland management system equal weight)

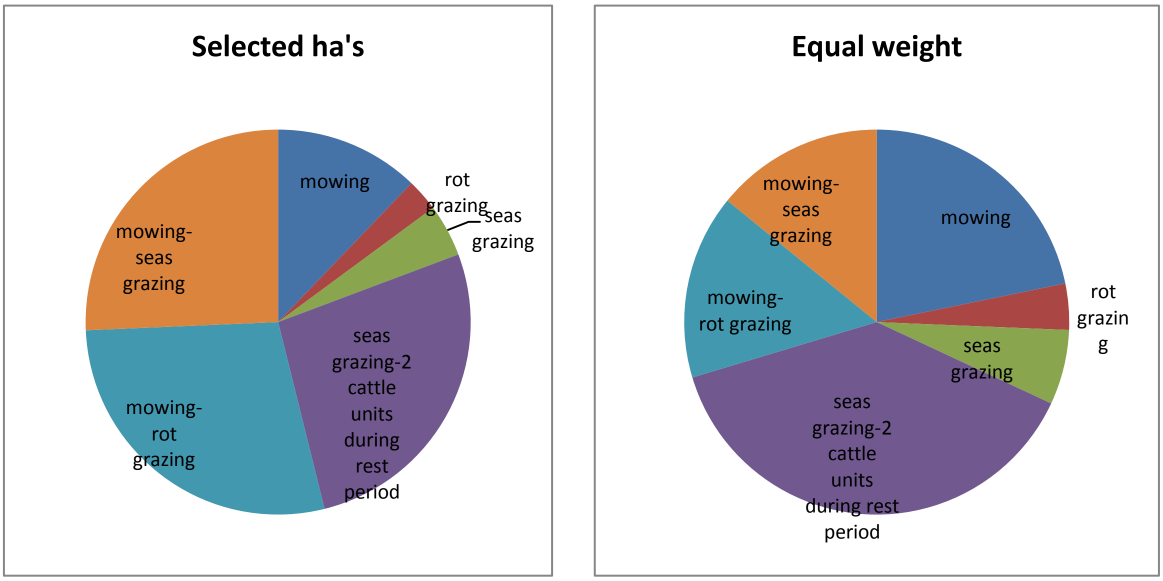


Figure 5.10 The preferred grassland management system based on the current policy scenarios (left: based on the grassland management system distribution in the case, right: corrected to give each grassland management system equal weight)

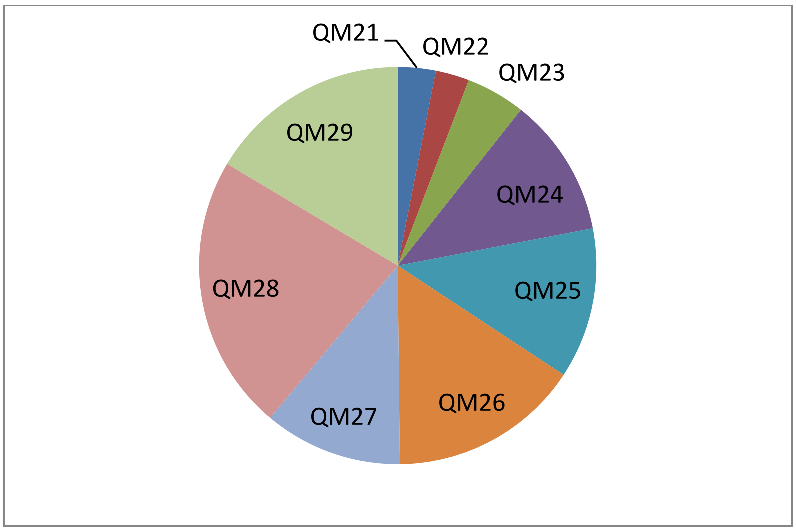


Figure 5.11 The selected quarter months in the scenarios with all measures (QM21-QM29)

Table 5.1 The measures with the highest probabilities (>3%) in all measures scenarios and July-August scenarios

Measure	Probability (%)	
	all	july-august
Mowing (first use QM26, second use at QM34 and no third use)		4,27
Mowing (first use QM28, second use at QM34 and no third use)	5,64	3,42
Mowing (first use QM29, second use at QM34 and no third use)	5,07	4,43
Seasonal grazing (first use QM21 with 2 cattle units during resting period)	3,08	-
Seasonal grazing (first use QM23 with 2 cattle units during resting period)	4,64	-
Seasonal grazing (first use QM24 with 2 cattle units during resting period)	7,59	-
Seasonal grazing (first use QM25 with 2 cattle units during resting period)	3,49	7,85
Seasonal grazing (first use QM26 with 2 cattle units during resting period)	3,49	10,66
Seasonal grazing (first use QM28 with 2 cattle units during resting period	4,6	4,45
Seasonal grazing (first use QM29 with 2 cattle units during resting period	5,1	
Seasonal grazing (first use QM26 and no cattle during resting period)	3,56	12,14
Mowing – rotational grazing (mowing in QM26 and rotational grazing in QM31 and QM37)	3,37	
Mowing – rotational grazing (mowing in QM27 and rotational grazing in QM33 and QM39)	3,76	6,57
Mowing – rotational grazing (mowing in QM28 and rotational grazing in QM34)	4,6	4,31
Mowing – rotational grazing (mowing in QM29 and rotational grazing in QM34)		6,94
Mowing – seasonal grazing (mowing in QM25 and then seasonal grazing)	5,79	4,86
Mowing – seasonal grazing (mowing in QM27 and then seasonal grazing)	5,07	6,55
Mowing – seasonal grazing (mowing in QM28 and then seasonal grazing)	6,95	9,38
Mowing – seasonal grazing (mowing in QM29 and then seasonal grazing)	3,55	4,41
Total probability of all measures (>3%)	79,35	90,24

5.2.2. Specific questions

The reduced set of measures give a comparable result than the more extended measure set (Table 5.2). This means that the measure set can be decreased without losing in cost-effectiveness.

Table 5.2 Comparing the effective ecological area of the reduced and extended set

Scenarios	Effective ecological area				
	Godwit	redshank	curlew	lapwing	tot
extended set	244,971	211,618	181,13	119,03	756,749
reduced set	241,91	231,485	177,125	139,156	789,676

The influence of bird weights is, even with a weight of 5 times more important, rather low (Table 5.3). Thus finding do not change when a contrasting bird, i.e. yellowhammer, is included with a weight of 100 times more important (Table 5.4, Table 5.5). The finding stays also the same for a budget of 250.000 (Table 5.3), 125.000 (Table 5.4) and 50.000 (Table 5.5). This means that the government doesn't need to decide which meadow birds are more important in a specific meadow bird area.

Table 5.3 The influence of bird weight on the effective ecological area for a specific bird species by a budget of 250.000

Scenarios	Effective ecological area				
	Godwit	redshank	curlew	lapwing	tot
equal	241,91	231,485	177,125	139,156	789,676
godwit5	241,687	232,624	176,544	138,102	788,957
redshank5	241,134	236,649	175,169	137,217	790,169
curlew5	243,659	233,933	178,22	141,258	797,07
lapwing5	257,632	219,201	190,287	167,007	834,127

Table 5.4 The influence of bird weight on the effective ecological area for a specific bird species by a budget of 125.000

Scenarios	Effective ecological area					
	Godwit	Redshank	Curlew	Lapwing	Yellowhammer	Tot
Equal	190,289	166,922	140,918	101,722	76,0566	675,9076
Yellowhamer100	188,788	162,448	138,694	89,7871	88,3593	668,0764
Godwit100	182,438	168,141	132,074	95,339	76,2617	654,2537
Lapwing100	185,512	149,808	139,854	111,253	70,6604	657,0874

Table 5.5 The influence of bird weight on the effective ecological area for a specific bird species by a budget of 50.000

Scenarios	Effective ecological area					
	Godwit	Redshank	Curlew	Lapwing	Yellowhammer	Tot
Equal	128,922	102,866	98,1075	67,208	46,1748	443,2783
Yellowhamer100	111,605	98,6067	84,7031	49,206	47,2709	391,3917
Godwit100	122,575	102,626	91,8487	65,5783	46,1949	428,8229
Lapwing100	122,224	96,605	93,4237	72,887	42,0341	427,1738

The influence of an additional cost, which reflects the distance to the farm house, is rather high (Table 5.6). This is less the case for the manure processing cost, which a farmer encounters when his organic fertilizer use falls below 170 kg N/ha (Table 5.7).

Table 5.6 The influence of the additional cost distance-to-farmhouse on the effective ecological area

Cost distance to farmhouse (€/m)	Effective ecological area					
	Godwit	Redshank	Curlew	Lapwing	Yellowhammer	Tot
0	260,523	245,437	188,553	94,7109	126,77	915,9939
0,1	238,217	223,893	174,975	119,181	101,894	858,16
0,25	230,598	208,436	171,373	107,864	100,304	818,575
0,5	203,296	193,432	149,935	85,3687	86,0599	718,0916
1	158,8557	154,979	115,936	72,0496	65,3914	567,2117

Table 5.7 the influence of the additional cost manure processing cost with and without the additional cost distance-to-farmhouse (€0,5/m) on the effective ecological area

Manure cost (€/kg N)	Effective ecological area					
	Godwit	Redshank	Curlew	Lapwing	Yellowhammer	Tot
4	247,356	242,31	178,79	104,988	115,68	889,124
6	253,405	246,75	183,238	110,281	113,498	907,172
8	237,303	231,573	171,98	110,524	111,178	862,558
10	246,86	241,257	178,314	104,44	114,164	885,035
15	243,643	238,161	176,467	112,737	108,369	879,377

5.3. Visualization

Through the possibility to export the ECOPAY results to ArcGIS the visualization of the results improves. Figure 5.7, Figure 5.8, Figure 5.9, Figure 5.10 and Figure 5.11 give an example of the visualization possibilities.

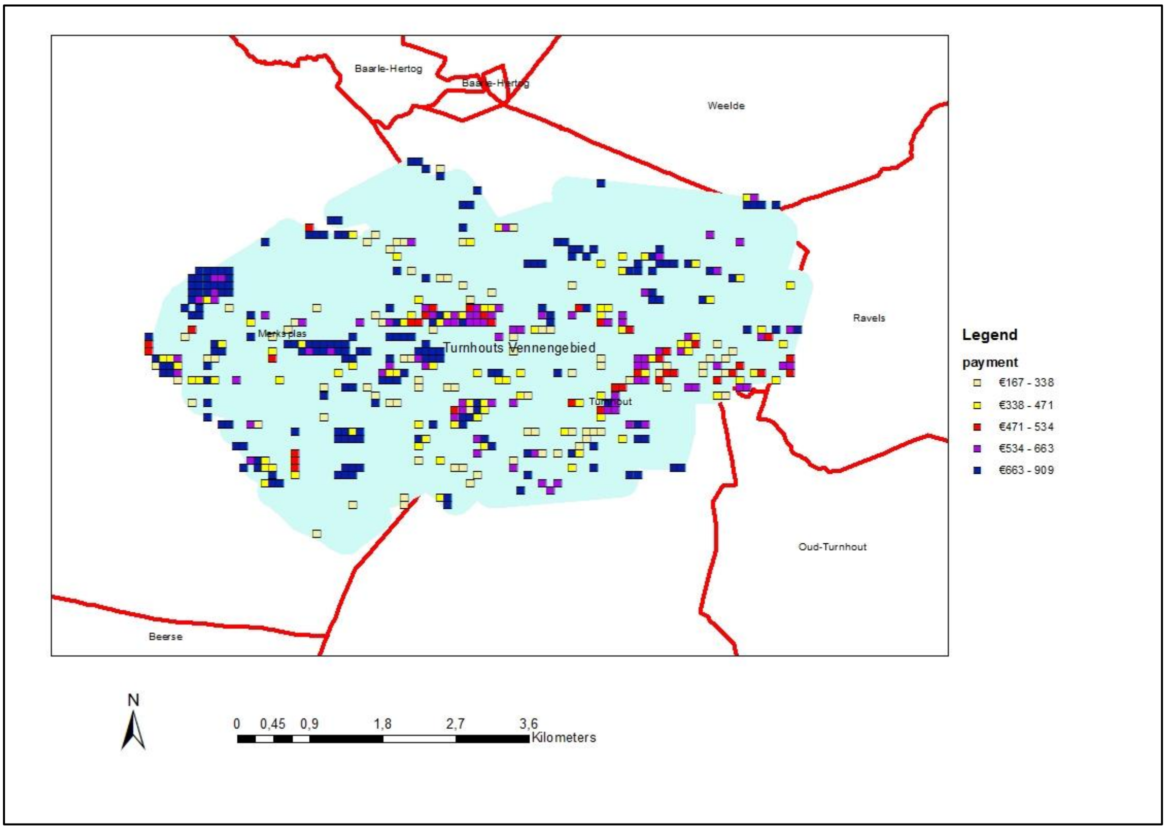


Figure 5.12 The farmers' payment for meadow bird friendly management

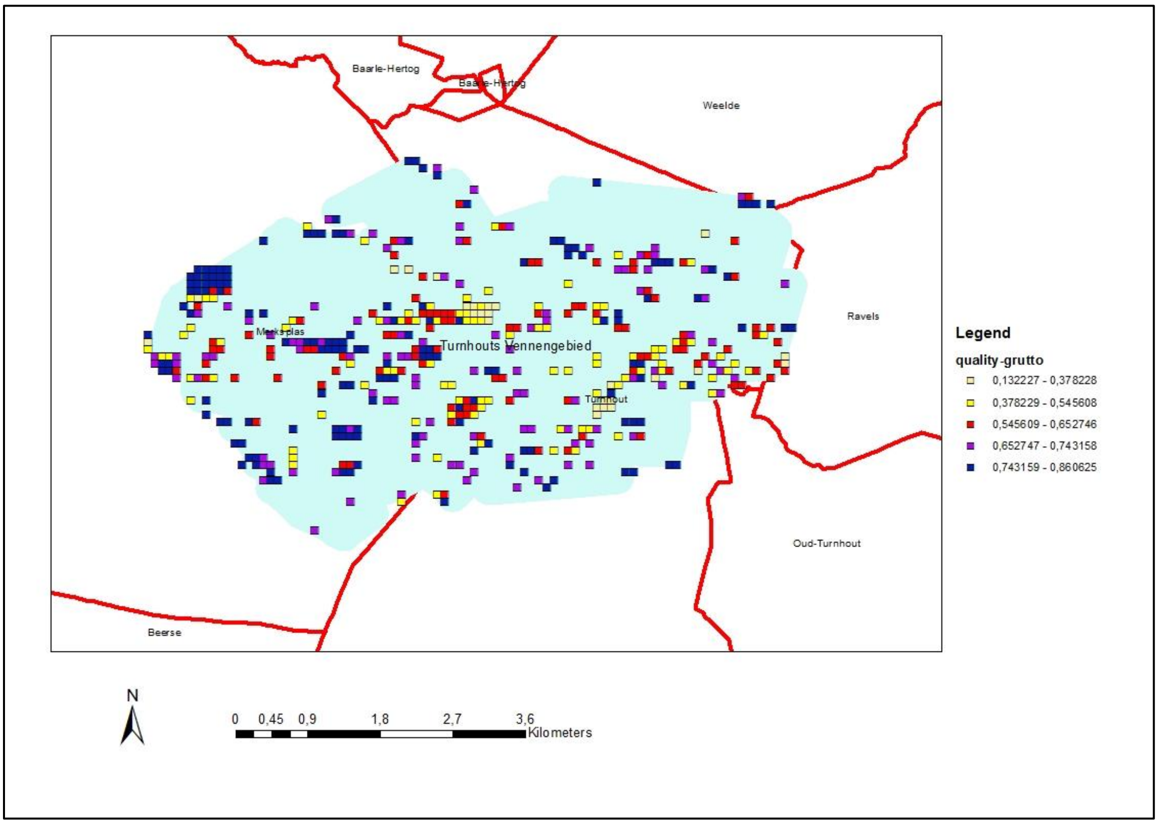


Figure 5.13 The ecological result for meadow bird friendly management for godwit

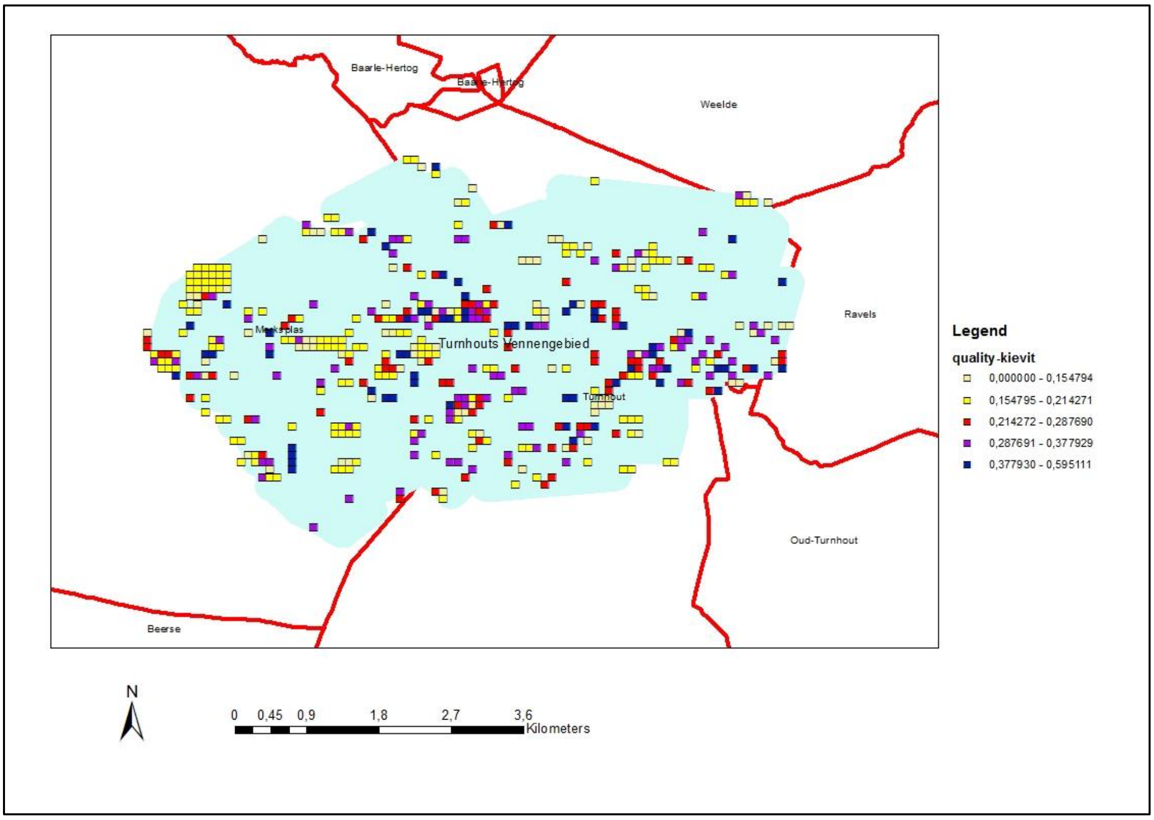


Figure 5.14 The ecological result for meadow bird friendly management for lapwing

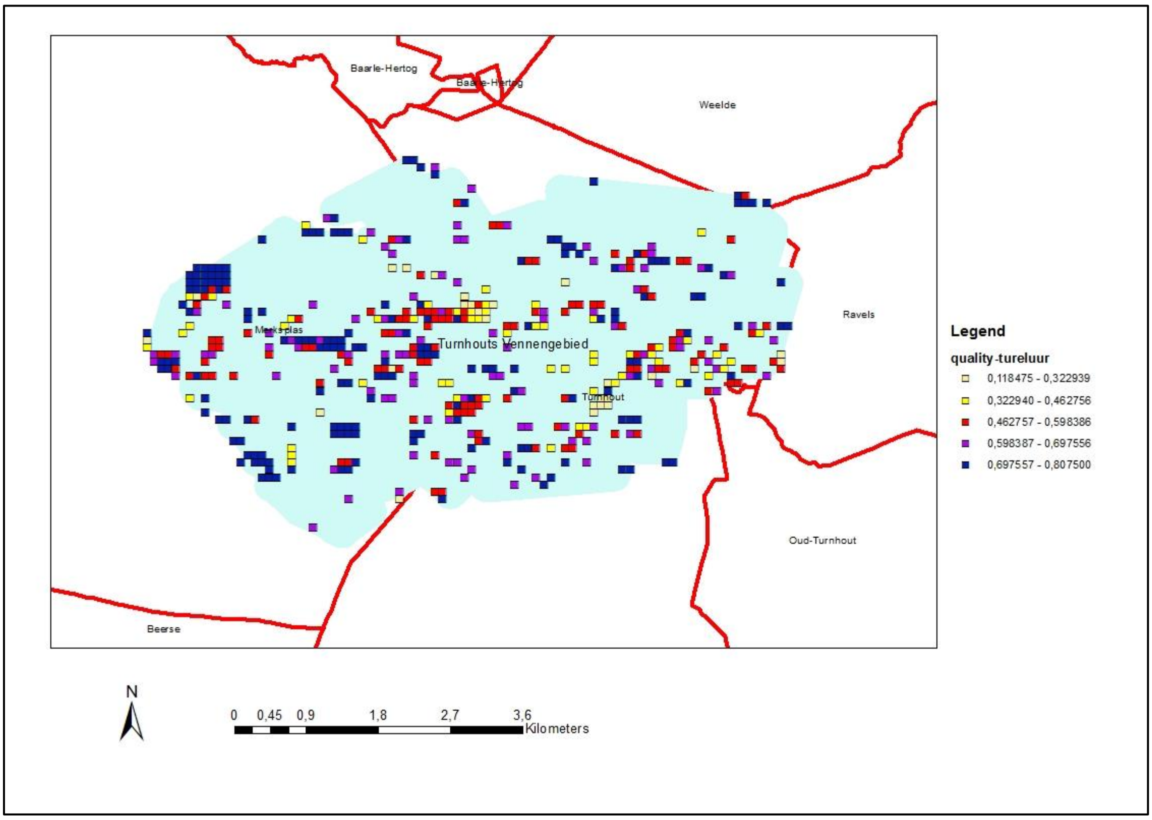


Figure 5.15 The ecological result for meadow bird friendly management for redshank

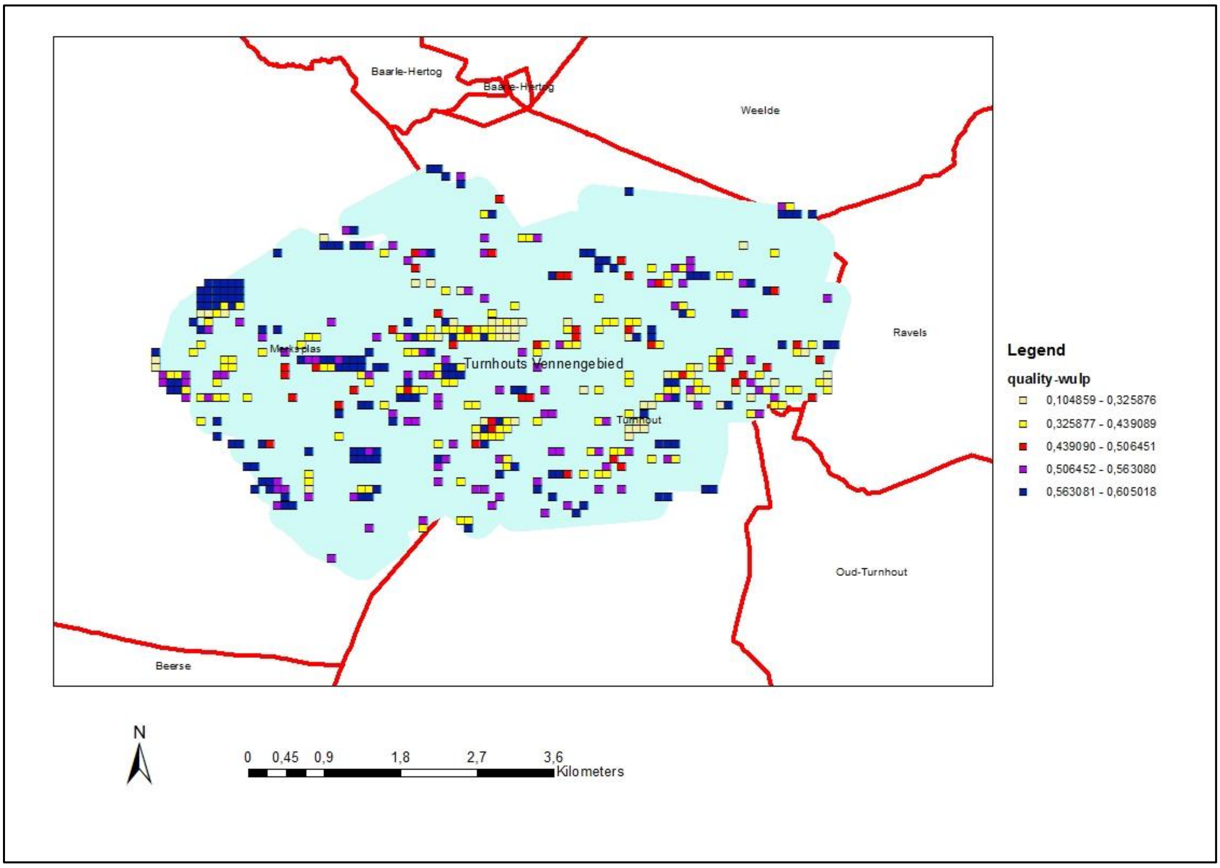


Figure 5.16 The ecological result for meadow bird friendly management for curlew

Referenties

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