

Litter Analyst 3.0

User Manual



February 2016

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User Manual

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1 Introduction

Litter Analyst 3.0 is a standalone Windows program for statistical analysis of beach litter data. It is developed in the Matlab environment. To enable the presentation of results of this program, Excel 2007 or a later Excel version must be installed.

Litter Analyst can read OSPAR csv-files of litter data, execute a data cleanup and export them to OSPAR csv-files or Excel spreadsheet files. Furthermore it can perform statistical trend analysis, using the Mann-Kendall test and the Wilcoxon ranksum test. It presents and exports evaluation tables of items, sources and materials, various plots of the litter data and trend results.

The program can be downloaded from:

<http://www.amo-nl.com/wordpress/software/download/litter-analyst/>

More backgrounds can be found in the following report:

Baggelaar, P.K. and Van der Meulen E.C.J. (2014): *Evaluation and fine-tuning of a procedure for statistical analysis of beach litter data*. Icastat-AMO, October 30 2014, 43 pages.

This report is available in the Help-menu of Litter Analyst.

2 Data validation

The validation of the quality of the national beach litter data is primarily the task of the national beach litter database manager. In addition, the OSPAR beach litter database gives clear guidance on the data format in which beach litter database can be entered into the database. For validating the beach litter data in the OSPAR csv-files we propose the following checks:

- Check for surveys with total item count =0. We propose the following solution: remove these survey(s).
Litter Analyst automatically removes surveys with no item counts. Litter Analyst gives the warning 'File contains surveys with no counts, they are removed' with the first line number in the file of a survey removed.
- Check for surveys dates that occur two or more times in data of the same beach. We propose the following solution:
 - the item counts of the surveys are identical: remove one or more of these surveys, such that only one remains;
 - the item counts of the surveys are different and each has a total item count > 0: contact the person responsible for the beach litter data of that country or check the beach survey forms , to find a solution.

Litter Analyst automatically corrects double survey dates by selecting the data of the first date. Litter Analyst gives the warning 'File contains double dates, they are corrected' with the first line number in the file of a survey removed.

- Check for standardized beach litter names. The worksheet 'Regions-Beaches' of the configuration file Litter Analyst_config3.xlsx (in the directory *\config) contains the standardizes beach litter

names. If the same beach has been introduced in the database under a slightly different name, adjust this beach name to the standardized one.

Litter Analyst handles new beach names like standardized beach litter names, but will not save their beach weights (see § 3.3) in the worksheet 'Regions-Beaches' of the configuration file Litter Analyst_config3.xlsx.

- **Outlier check.** If there is any doubt about the correctness of extreme values in a data series plot or in a year box plot, contact the person responsible for the beach litter data of that country or check the beach survey forms.

In Litter Analyst checks are built-in for the control of the format and values of the data, see § 3.1 and § 3.4.

3 Input of Litter Analyst

3.1 Read OSPAR csv-file

Once the program is started, the main screen appears. Choose 'File' and then 'Read data file', to read beach litter OSPAR csv-files. The file can contain beach litter data from a single country, from several countries, from a region or from all OSPAR countries. Beach litter files can be downloaded from the OSPAR beach litter database by the national beach litter data managers who are authorized to login to this database.

The beach litter OSPAR csv-file has the following format:

<i>Refno</i>	Reference, e.g. REG (not used by Litter Analyst)
<i>Beach name</i>	Beach name, e.g. Heacham Beach
<i>Country</i>	OSPAR country, e.g. 'The Netherlands
<i>Region</i>	Some OSPAR countries, e.g. Southern North Sea
<i>Survey date</i>	DD/MM/YYYY, e.g. 01/04/2001
<i>Period</i>	Quarter of a year {1,2,3,4}
<i>Plastic: Yokes [1]</i>	First item, counts, a number ≥ 0
<i>Survey: Old_cloth_rope [210]</i>	Last item, counts, a number ≥ 0

Litter Analyst checks the fields names of the first line and the format and the values of the data (text, dates or numbers) in all other lines. If a check fails Litter Analyst responses with a warning or an error, see also § 3.4.

All OSPAR beach names, countries, regions, beach litter item codes, descriptions, materials and probable sources are given in the Appendix in the table 'Items-Materials -Sources'.

3.2 Analysis settings

Before reading the selected csv-file a window appears with the possibility to set the analysis settings for:

1. Periods to analyze
2. Aggregation conditions
3. Length top-X-H list

4. Top-X-H selection of items
5. Redistribution condition
6. Clustering after 2010
7. Logging aggregation

Figure 3.0: The dialogue window to define one or two periods to analyze, to set the aggregation condition of the required availability of survey data, to set the length of the top-X-H list, to set the ranking system of items in the top-X-H list, to set the redistribution of multiple survey data in quarters of a year, to set the clustering if all periods to analyze starts after the administrative changes of 2010 and to set the logging of the aggregation of items of beaches.

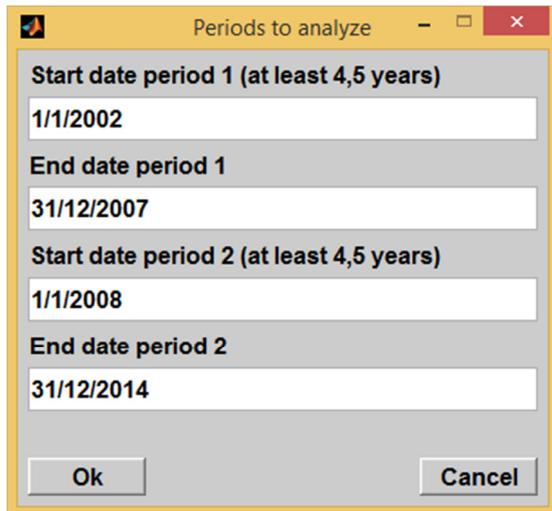
3.2.1 Periods to analyze

The user can define the start date and the end date of one or two periods to be analyzed. If two periods are defined the third period is automatically defined by the start date of the first period and the end date of the second period. Statistical and trend analysis are applied to one period or each of these three periods. In figure 3.1 one period is defined. If two periods are defined, the two periods must fulfill the following two conditions:

1. They are not empty.
2. They do not overlap.

Litter Analyst gives a warning if no trend analyses can be performed. Trend analysis can only be performed if the period length is at least 4,5 years.

Figure 3.1: The dialogue window to define one or two periods to analyze. If two periods are defined, the third period is defined by the start date of the first period and the end date of the second period.



The image shows a dialog box titled "Periods to analyze". It has a yellow border and standard window controls (minimize, maximize, close). The dialog contains four text input fields for dates. The first field is labeled "Start date period 1 (at least 4,5 years)" and contains "1/1/2002". The second field is labeled "End date period 1" and contains "31/12/2007". The third field is labeled "Start date period 2 (at least 4,5 years)" and contains "1/1/2008". The fourth field is labeled "End date period 2" and contains "31/12/2014". At the bottom of the dialog are two buttons: "Ok" and "Cancel".

3.2.2 Aggregation condition

The user can set the minimum percentage of beaches that is required for aggregation of beaches of a region. For each quarter (of a year, starting on 1 January, 1 April, 1 July and 1 October) the aggregated count of an item of a region is determined as the weighted average of counts of that item on the selected beaches of that region. If a beach contains litter data of two or more surveys in the same quarter, then for each item of that beach the median of the counts of these surveys is used as the count for that beach.

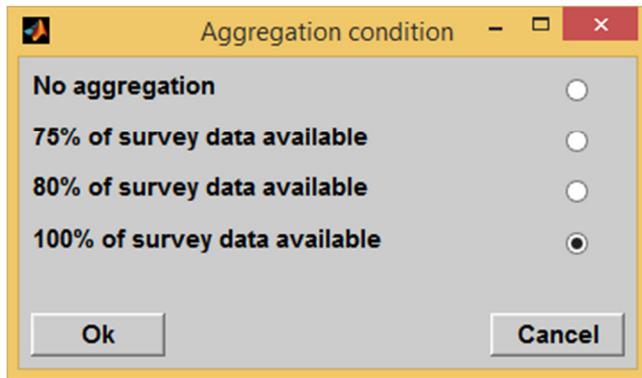
The user can choose between the following settings:

1. No aggregation of beaches; also no logging of the aggregation (see § 3.2.7).
2. Required availability of 100%. If for a specific quarter the data of an item is missing from at least one of the beaches, the aggregated count of that item is set to a missing value for that quarter.
3. Required availability of at least 80%. If for a specific quarter the data of an item is missing from more than 20% of the beaches, the aggregated count of that item is set to a missing value for that quarter.
4. Required availability of at least 75%. If for a specific quarter the data of an item is missing from more than 25% of the beaches, the aggregated count of that item is set to a missing value for that quarter.

If the required availability is 100%, this can lead to sparse time series with many missing values. This can inhibit trend analysis, due to an inhomogeneous distribution of the data. In such cases it can be considered to set the required availability to 80% or 75%. However, take care in lowering the required availability, as it may lead to biased results.

It is highly recommended to exclude beaches with a low data density in national and regional aggregation, because they will strongly reduce the information content of the aggregated data. Their weights should be set to zero in the worksheet Region-Beaches of the configuration file Litter Analyst_config3.xlsx.

Figure 3.2: The dialogue window to set the aggregation condition of the required availability of survey data.



Be cautious in presenting results of aggregated data

In presenting the results of aggregated data it must be made very clear that they can be only be regarded as representative for the group of beaches that are monitored and not for the population of national or regional beaches where these beaches come from, because no probability sampling (based on the theory of statistical sampling) was used in selecting them. An objective translation of the results of this group to a higher spatial level is only possible if on any survey date beaches are selected with probability sampling.

3.2.3 Length top-X-H list

The user can determine the length of the top-X-H list.

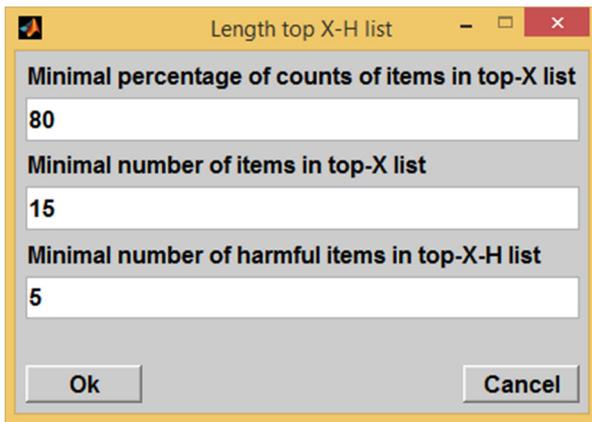
1. The minimal percentage of total counts of all items that the top-X list must represent.
2. The minimal number of items in the top-X list.
3. The minimal number of harmful items in the top-X-H list.

The top-X list is a list of the minimal number of top items that covers at least a certain minimal percentage of the total counts of all items. The top-X-H list is the top-X list including a certain minimal number of harmful items.

These three settings together determine the length and composition of the top-X-H list. By setting two of the three settings at a low value, the third setting will determine the list.

We advise not to include items with less than 1% of total counts of all items, because otherwise the percentage of zero-slopes (see *%Zero-slope* in the data density table) can be too high to get reliable trend results with the Mann-Kendall test.

Figure 3.3: The dialogue window to set the length of the top-X-H list.



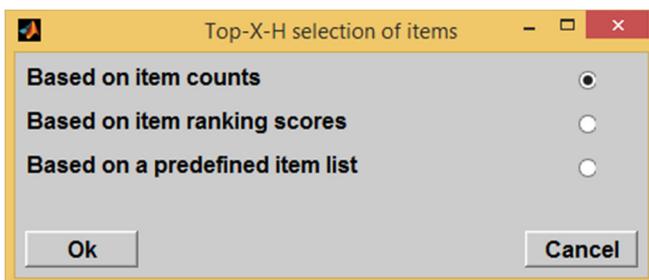
Harmful items are defined in the worksheet 'Ecological harm' of the configuration file Litter Analyst_config3.xlsx. The top-X-H list is displayed in the Evaluation tables of items (see § 6.1) and in the data density table (see § 6.7).

3.2.4 Top-X-H selection of items

The user can determine the Top-X-H list of (aggregated) items by choosing different systems for the ranking of items based on:

1. The counts of items. The ranking of items is based on the (weighted) average of the counts of an item in descending order (the item with most counts has rank 1).
2. The ranking of the scores of items. The ranking of items is based on the sum of the scores of an item in descending order. See the Appendix for the scoring system or see 'Conclusions of the Breakout Working Group on Assessment Criteria for OSPAR beach litter data', Vigo, 11th & 12th November 2014 and 'Additional concept specifications Litter Analyst'. If there are items with the same score their (weighted) counts will determine the ranking of the items.
3. The predefined item list. If there are items with the same rank in this list their (weighted) counts will determine the ranking of the items.

Figure 3.4: The dialogue window to set the ranking system of items in the top-X-H list.

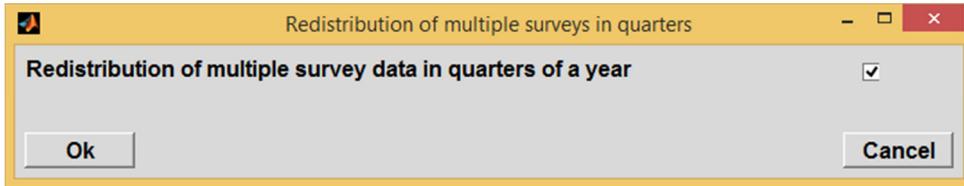


For an item on an individual beach there is no difference between the ranking of the top-X-H on basis of counts (1.) or scores (2.). The beach weighting is defined in the worksheet 'Region-beaches' of the configuration file Litter Analyst_config3.xlsx.

3.2.5 Redistribution condition

The user can choose for a redistribution or no redistribution of multiple surveys on beaches in quarters of a year to preceding or following quarters of a year with no surveys.

Figure 3.5: The dialogue window to set the redistribution of multiple survey data in quarters of a year.



The algorithm of redistribution of multiple survey data in quarters of a year consists of first a forwards redistribution (1, 2 and 3) and then a backwards (4, 5 and 6):

- 1) Determine the quarters with multiple surveys in the time series of the item 'Plastic: Yokes [1]'.
- 2) Determine the last dates of surveys of these quarters with preceding quarters with no surveys.
- 3) Give these surveys new dates: the end of the concerning quarters plus 1 week.
- 4) Determine the quarters with multiple surveys in the time series of the item 'Plastic: Yokes [1]'.
- 5) Determine the first dates of surveys of these quarters with preceding quarters with no surveys.
- 6) Give these surveys new dates: the start of the concerning quarters minus 1 week.

3.2.6 Clustering after 2010

The user can choose for clustering or no clustering of items if the periods to analyze starts after the administrative changes of 2010. For trend analyses the series length must be at least 4.5 years (period between first and last measurement). From half 2016 trend analyses without clustering can be performed to time series that starts begin 2011.

Figure 3.6: The dialogue window to set the clustering if all periods to analyze starts after the administrative changes of 2010.



3.2.7 Logging aggregation

The user can choose for logging or no logging of the aggregation of items of beaches. The log-file can be explored and be saved in an Excel-file (see § 6.10), only if the user didn't choose for 'no aggregation' (see § 3.2.2).

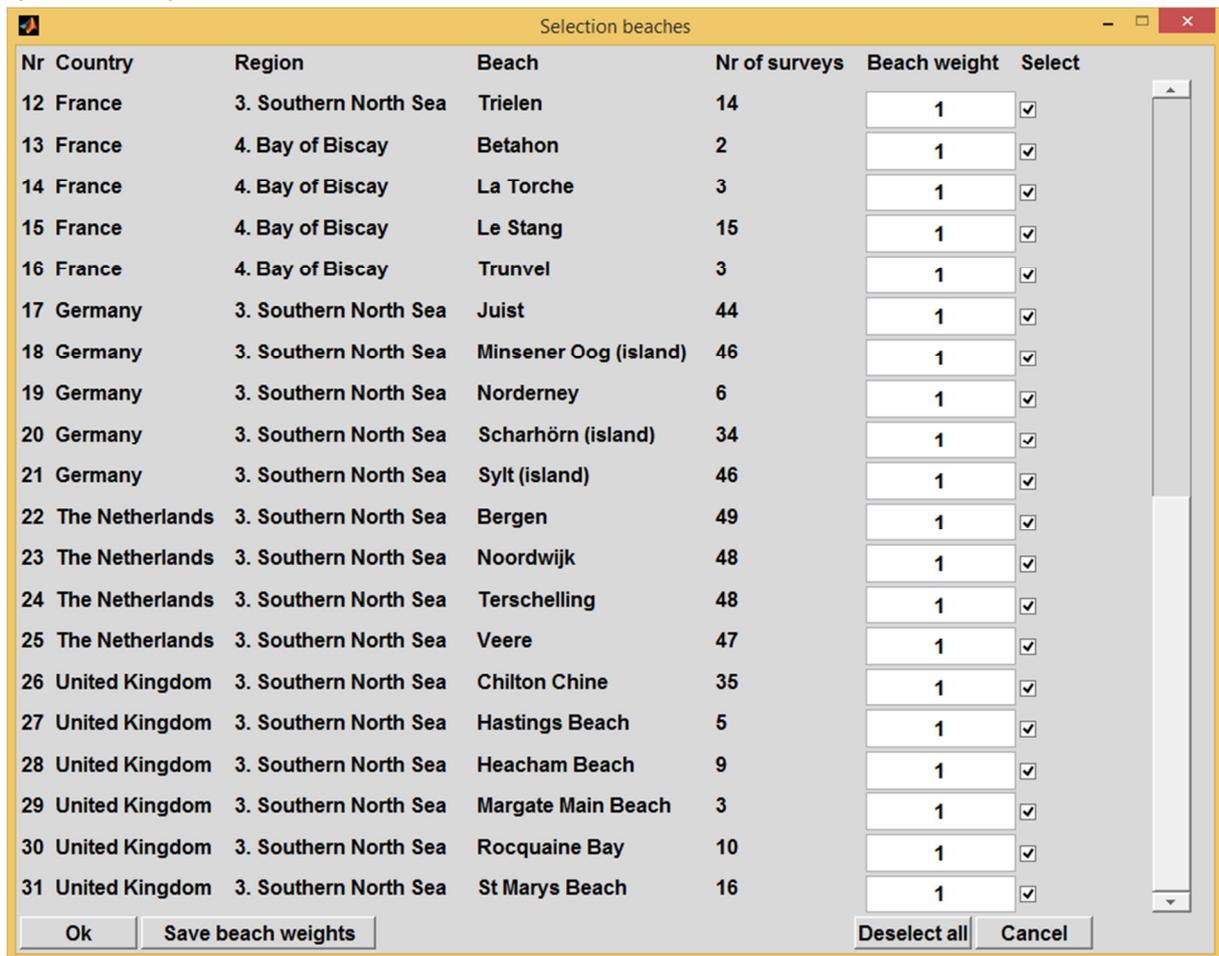
Figure 3.7: The dialogue window to set the logging of the aggregation of items of beaches.



3.3 Select beaches and their weights of aggregation

After reading the selected csv-file a new window appears with the possibilities to select beaches and their weights for the aggregation of the items. The beach weights are editable. Shown are the beach default weights. The beach default weights are defined in the worksheet 'Region-beaches' of the configuration file Litter Analyst_config3.xlsx.

Figure 3.2.8: The dialogue window to choose the beaches and to set their weights for the aggregation of the items of beaches.



For each quarter the aggregated count of an item is determined as the (weighted) average of counts of that item on the selected beaches, as follows:

$$ac_{i,y,q} = \frac{\sum_{b=1}^n c_{b,i,y,q} \cdot w_b}{\sum_{b=1}^n w_b}$$

with ac the aggregated count, c the count, w the weight, b the beach index, n the number of beaches, i the item index, y the year index and q the quarter index ($q = 1, 2, 3$ or 4).

The user can select the beaches to analyze and edit the beach weight. If the user chooses for 'Save beach weights' all beach weights will be saved in the sheet 'Region-beaches' in the file Litter Analyst_config3.xlsx.

3.4 Cleanup selected beaches OSPAR csv-file

The following 17 steps correct, prepare and aggregate the litter data of the selected beaches of a single csv-file:

1. Clean up.
 - The data of items with the code 31, 32, 46, 62, 84, 112 until 121, before 1 January 2010 are set to 'not a number' (blanks).
 - The data of items with the code 200 until 208 and 210 after 1 January 2010 are set to 'not a number'.
2. Remove pollutants and faeces.
 - The time series of the pollutants with the codes 108 until 111 are removed .
 - The time series of the faeces with the codes 121, 207 and 208 are removed.
3. Check for double survey dates. Surveys with only zeros counts (total item count = 0) are removed. If double survey dates occur only data from the first date is used.
4. Include sources and materials.
5. Make totals counts of all items (code 400) of sources (code 401 until 405) and materials (code 406 until 415).
6. Redistribution of multiple surveys in quarters of a year to preceding or following quarters with no surveys.
7. Make clusters. There are six clusters.
 - 'Nets and ropes [300]', contains the items with the codes 31, 32, 115, 116, 200 and 201.
 - 'Plastic polystyrene pieces < 50 cm [301]' contains the items with the codes 46, 117 and 202.
 - 'All cartons/tetrapacks [302]' contains the items with the codes 62, 118 and 204.
 - 'Other textiles [303]' contains the items with the codes 59 and 210.
 - 'All Gloves [304]' contains the items with the codes 25, 113 and 203.
 - 'All metal oildrums [305]' contains the items with the codes 84, 205 and 206.
8. Remove items included in the clusters in 7.
9. Make user defined clusters. These are defined in the worksheet 'User defined Clusters' in the file Litter Analyst_config3.xlsx.
 - Maximum number of clusters is 24 (until column Z).
 - Use a 0 or 1 for an item in a cluster.
 - An item can only be used in one cluster.
 - These clusters get the item numbers 500 and higher.
10. Aggregate the items of the selected beaches of a country or a region. Litter Analyst applies beach weighting in the aggregation of items of beaches (see § 3.2.2).
11. Determine the statistical characteristics of all items of the defined periods (see § 3.2.1) and perform the Wilcoxon ranksum test on a step trend of total counts.
12. Determine the data density table of the defined periods.
13. Perform trend analyses on the time series of all items of the defined periods.
14. Determine item trend indices (ITI's) of the defined periods.
15. Determine the evaluation table of items of the defined periods.
16. Determine the evaluation table of sources of the defined periods.
17. Determine the evaluation table of materials of the defined periods.

Also see § 2.4 of our report '*Evaluation and fine-tuning of a procedure for statistical analysis of beach litter data*'. It can be found in the Help-menu of Litter Analyst.

4 Output of Litter Analyst

Choose 'File' and then 'Save' or 'Save as ...' to export:

- The evaluation table of items to an Excel spreadsheet file
- The evaluation table of sources to an Excel spreadsheet file
- The evaluation table of materials to an Excel spreadsheet file
- The trend plots to a Word file
- The trend palet to an Excel spreadsheet file
- The trend boxplots to a Word file
- The trend judgement histograms to a Word file
- A cleaned up OSPAR csv-file (after performing the steps 1 - 5 of § 3.4)
- An Excel spreadsheet file (including new clusters and item counts) or a tai-file for the input of Trendanalyst, a program for performing trend analysis (after performing all steps 1-17 of § 3.4)
- The data density table to an Excel spreadsheet file
- The aggregation tables to an Excel spreadsheet file
- The trend analysis results to an Excel spreadsheet file

5 Settings of Litter Analyst

The menu 'Settings' offers the following possibilities:

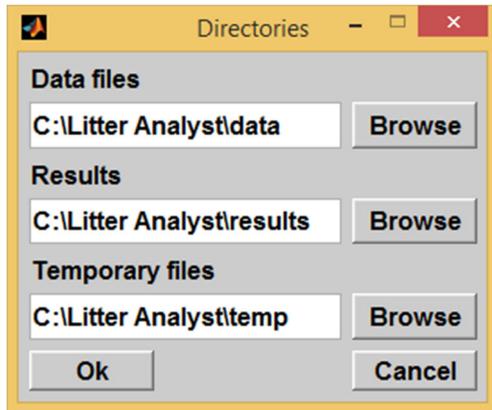
- Default directories
- Analysis settings
- Font graphics

5.1 Default directories

The user can set the default directories for:

1. Data files.
2. Result output files.
3. Temporary files; after closing the program temporary files will be deleted.

Figure 5.1: The dialogue window to set the directories of the litter data csv-files, the result files and the temporary files.



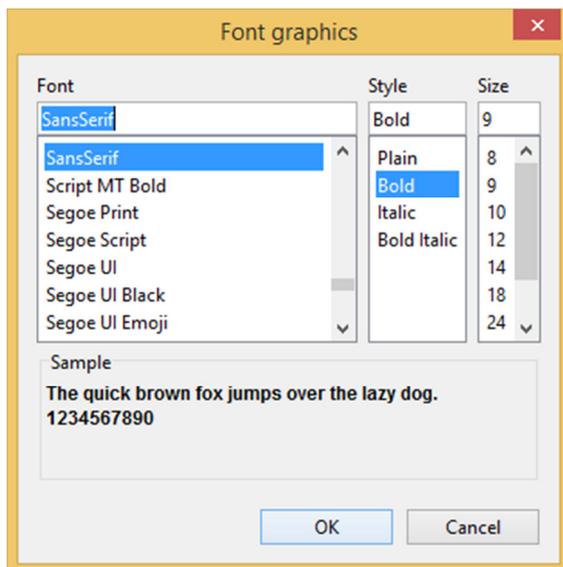
5.2 Analysis settings

The analysis settings can be set in the Settings of Litter Analyst or before reading the selected csv-file, see § 3.2.

5.3 Font graphics

In a dialogue box the user can set the font, the style and the size of graphical presentations in Litter Analyst. A font change can help to make better graphical presentations for the export to a Word file.

Figure 5.3: The dialogue window to set font, style and size of the graphical presentations.



6 Exploring results with Litter Analyst

The menu 'Explore' offers possibilities to view the following analysis results:

- evaluation table of items
- evaluation table of sources
- evaluation table of materials
- trend plot
- trend palet
- trend boxplot
- trend judgement histogram
- trend analysis results
- data density table
- year boxplot
- table of data series
- aggregation tables

6.1 Evaluation tables

The evaluation tables of items, sources and materials are presented in an Excel spreadsheet. The file is saved in the temporary directory.

To enable a concise presentation of the results of the various statistical analyses, we developed an evaluation table. It can present for each separate beach four groups of results. In § 6.1.1 we describe the metadata of the evaluation table. In § 6.1.2 - 6.1.6 we describe the details of the four groups of results and indicate what statistical conclusions can be drawn from them. And in § 6.1.7 we describe the differences between the items evaluation table and the evaluation tables of sources and materials.

6.1.1 Settings

The settings are presented in the first four rows of the evaluation table. These are the aggregation condition (see § 3.2.2), the ranking system (see § 3.2.4), the source / csv-file and parameters that determine the top-X-H list of items (see § 3.2.3). The latter is only applicable for top-X-H list items and not for the top-X list of sources and materials. In figure 6.1 we show an example of the settings in an evaluation table of items.

Figure 6.1: An example of the settings in an evaluation table of items.

Settings		Settings top-X-H selection of items	
Aggregation condition	80%	Minimal percentage of counts of items in top-X list	80%
Ranking system	Based on item ranking counts	Minimal number of items in top-X list	5
Source	C:\Litter Analyst\data\The Netherlands.csv	Minimal number of harmful items in top-X-H list	5

6.1.2 Metadata

The metadata of the evaluation matrix are the name of the OSPAR country, the name of the beach and the analyzed period. The period to analyze can be set by the user (see § 3.2.1).

6.1.3 Group 1: Summary of results from top-X-H items

First subgroup

Code and definition of each item of the top-X-H group for the three periods.

Second subgroup

Descriptive statistics of the top-X-H items for the three periods. This subgroup presents for each top-X-H item the median, the arithmetic average, the standard deviation (all in counts/survey) and the coefficient of variation (the ratio of standard deviation and average). Also presented is the relative contribution of each item to the beach total counts over that period. The top-X-H items are sorted, based on one of the three ranking systems (see § 3.2.4).

The median is a better measure of central location than the arithmetic average in the case of a non-symmetrical distribution. Because non-symmetrical distributions are predominant for counts of beach litter items, it is advisable to use the median instead of the arithmetic average for evaluations.

Third subgroup

If the number and temporal distribution of the survey data fulfill the criteria for trend analysis (see below), this subgroup shows the results of the trend analysis of the top-X-H items for the three periods, otherwise the corresponding cells are left empty. The following criteria for trend analysis are used:

- the series length is at least 4.5 years (period between first and last measurement);
- the series contains at least 5 values;
- there is a more or less homogeneous distribution of the data in time:
 - for a six years period: the series has at least one value in each of the three two years blocks of the six years period;
 - for a twelve years period: the series has at least one value in each of the three four years blocks.

If these criteria are fulfilled, the magnitudes (slopes) and statistical significances (p-values) of the estimated trends of the top-X-H items are shown, otherwise the corresponding cells are left empty. The trend magnitude (slope, expressed in counts/year) is estimated with the Theil-Sen estimator and the p-value is the result of testing on a monotonic trend, using the Mann-Kendall test.

The p-value is the two sided probability of observing this trend or a larger trend, if the null hypothesis of no trend is true. We consider it acceptable to use a confidence level of 95% for the testing. Thus, if the p-value is less than 0.05, than we can say with 95% confidence that there is a statistically significant trend.

If an estimated trend (slope) is negative, that cell is green and if it is positive, the cell is orange. If the p-value is less than 0.05, indicating a statistically significant trend, that matrix cell is grey.

In evaluating the trend results one should bear in mind that the overall risk of detecting one or more statistically significant trends when in reality no trends exist, increases with the number of time

series that is analyzed on trend. If only one time series is analyzed on trend this risk is 5%, because we test with 95% confidence. However, if two time series are analyzed on trend this risk increases to 9,8%, according to the following formula:

$$\text{Overall risc} = 1 - 95\%^n$$

where n is the number of time series that is analyzed on trend. For 10 time series the overall risk is 40,1%, for 15 time series it is 53,7% and for 20 time series it is 64,2%. If for example the top-X-H list contains 15 items, then the risk of detecting one or more statistically significant trends when in reality no trends exist is 53,7%. Therefore, one should be cautious with the interpretation of the statistically significant trends.

The trend analyses are performed on the counts of an item in quarters of a year except when the time series of that item consists of 30% or more missing values. In that latter case Litter Analyst chooses to perform trend analyses on yearly values. A year value is the median of the counts in the quarters of that year.

Fourth subgroup

The fourth subgroup shows the number of items in the top-X-H list and the number of surveys in the analyzed period.

6.1.4 Group 2: Summary of statistically significant trends

First subgroup

Number of statistically significant trends (slopes).

Second subgroup

This subgroup shows three versions of the ITI (Item Trend Index) for the three periods. The ITI's are presented in the sequence $ITI_{\text{sum of slopes}}$, $ITI_{\text{weighted average of slopes}}$ and $ITI_{\text{weighted average of trend signs}}$. Each of these ITI's integrates the information about statistically significant developments of individual items.

The $ITI_{\text{weighted average of trend signs}}$ highlights the general direction of change of the items that have statistical significant trends.

$$ITI_{\text{weighted average of trend signs}} = \sum_{i=1}^m \left(\frac{n_i}{N} \cdot \text{sign}(s_i) \right)$$

where m is the total number of items (the top-X-H items plus all the other items), i the index of the item ($i = 1, 2, \dots, m$), n_i the counts of item i in that assessment period, N the total counts over all items in that assessment period, s the estimated magnitude of the trend slope and $\text{sign}(s)$ the trend sign. If the trend is statistically significant, the trend sign is set to +1 for $s > 0$ and to -1 for $s < 0$. And if the trend is not statistically significant, or is not estimated (this is the case for all the items that are not in the top-X-H list), the trend sign is set to 0.

The $ITI_{\text{sum of slopes}}$ presents the net change of these items.

$$ITI_{\text{sum of slopes}} = \sum_{i=1}^m s_i^*$$

The $ITI_{\text{weighted average of slopes}}$ presents the average slope, weighted by the contribution of each item to the beach total counts and with all slopes set to 0 that are not statistically significant or are not estimated.

$$ITI_{\text{weighted average of slopes}} = \sum_{i=1}^m \left(\frac{n_i}{N} \cdot s_i^* \right)$$

where s^* is the filtered magnitude of the estimated trend slope, such that $s_i^* = s_i$ if s_i is statistically significant and $s_i^* = 0$ if s_i is not statistically significant or is not estimated (this latter is the case for all the items that are not in the top-X-H list).

It is important to realize that in deriving these ITI's all slopes that are not statistically significant or are not estimated (this latter is the case for all the items that are not in the top-X-H list) are set to 0. We refer to group 4 for an uncensored presentation of the characteristics of the slope estimates (regardless of their statistical significances), because that presentation can be more sensitive to a general tendency of change in one direction (improvement or deterioration).

6.1.5 Group 3: Summary of results from beach total counts

First subgroup

Descriptive statistics of beach total counts for the three periods. Presented are the median, the arithmetic average, the standard deviation (all in counts/survey) and the coefficient of variation (the ratio of standard deviation and average).

Second subgroup

If the number and temporal distribution of the survey data fulfill the criteria for trend analysis (see § 6.1.3), this subgroup shows the results of the trend analysis of the beach total counts for the three periods, otherwise the corresponding cells are left empty.

If the criteria are fulfilled, the magnitude (slope) and statistical significance (p-value) of the estimated trend of the beach total counts are presented for the periods. The trend magnitude (slope, expressed in counts/year) is estimated with the Theil-Sen estimator and the p-value is the result of testing on a monotonic trend, using the Mann-Kendall test.

If an estimated trend magnitude (slope) is negative, that cell is green and if it is positive, the cell is orange.

If the p-value is less than 0.05, indicating a statistically significant trend, that table cell is grey.

Third subgroup

The third subgroup is only presented for the third and longest period. It shows the magnitude (step) and the percentage change of the estimated step trend of the beach total counts, by comparing the second period with the first. The trend (step, expressed in counts/survey) and the percentage of change is estimated with the Hodges-Lehmann estimator. Only if for both, the first and second, periods the survey data fulfill the criteria for trend analysis (see § 6.1.3), the statistical significance (p-value) of the estimated step trend of the beach total counts is shown, otherwise the corresponding cell is left empty. This p-value is the result of testing on a step trend, using the Wilcoxon-ranksum test.

If an estimated trend or change is negative, that cell is green and if it is positive, the cell is orange. If the p-value is less than 0.05, indicating a statistically significant trend, that table cell is grey.

6.1.6 Group 4: Summary of trends (slopes) of top-X-H items

This group summarizes the results of all trends (slopes) of the top-X-H items, regardless of their statistical significances. This summary can be more sensitive to a general change in one direction (improvement or deterioration) than the ITI's, because these latter are only based on censored information (the statistically non-significant trends are set to zero).

First subgroup

Percentage of negative slopes (cell is green if the percentage is not zero) and the percentage of positive slopes (cell is orange if the percentage is not zero) for the three periods.

Second subgroup

Statistics of the estimated slopes for the three periods. Presented are the minimum, the 25-, 50- and 75-percentile and the maximum. If a slope statistic is negative its cell is green and if it is positive its cell is orange.

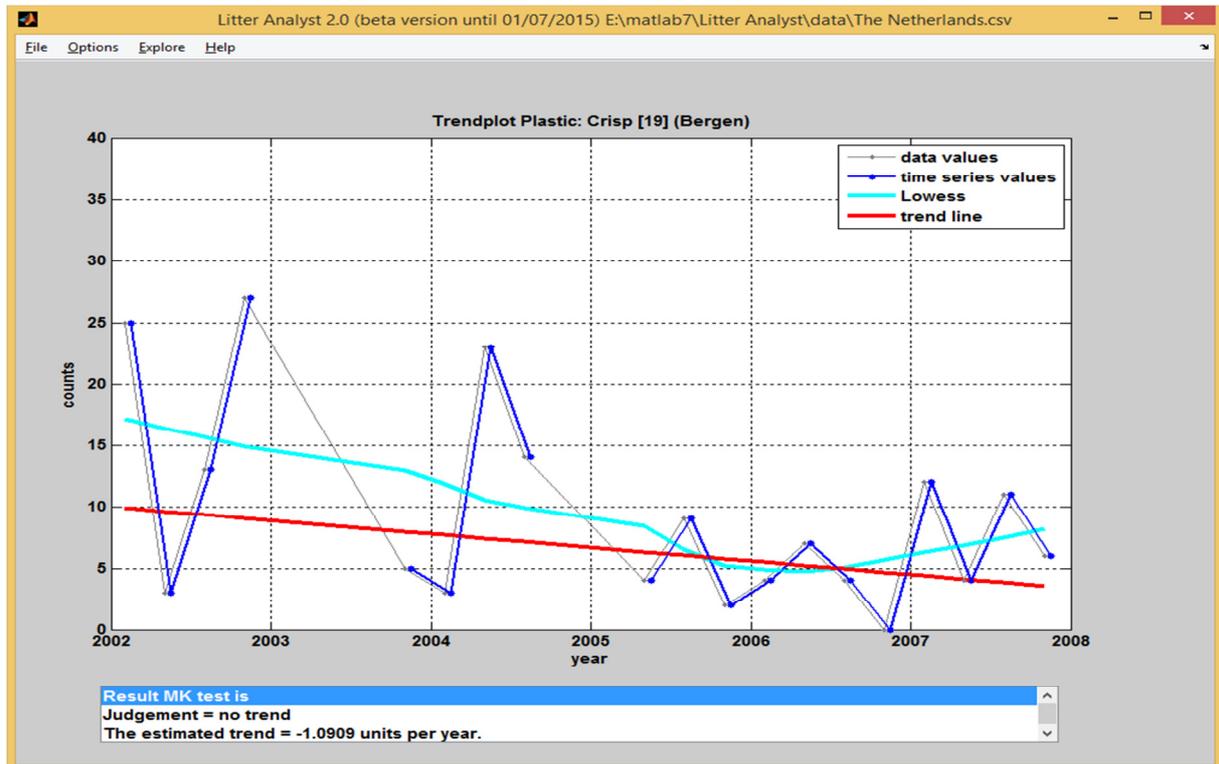
6.1.7 Evaluation table of items versus those of sources and materials

The evaluation tables of sources and materials are somewhat different from the items evaluation table. This is because no top-X-H list is used, but all five categories of sources or ten categories of materials are used instead. For completeness the evaluation tables of sources and materials also present the summary of results of the beach total counts (group 3). However, this summary is exactly the same for all three tables, because the beach total counts are the same at the levels of items, sources and materials.

6.2 Trend plot

The user can choose between all items of the selected beaches and presented is a trend plot. If more than one item is chosen all selected trend plots are presented in a Word document. A Word document contain at most 2000 trendplots. In figure 6.2 we show an example of the trend plot of Crisp (item-code 19) of beach in Bergen in The Netherlands.

Figure 6.2: Trend plot Crisp [19] of beach Bergen in The Netherlands.



6.3 Trend palet

A trend palet of the trend analysis is presented in different sheets of an Excel-spreadsheet. In figure 6.3 we show a part of the relative trend judgement of the aggregation of the Dutch beaches Bergen, Noordwijk, Terschelling and Veere.

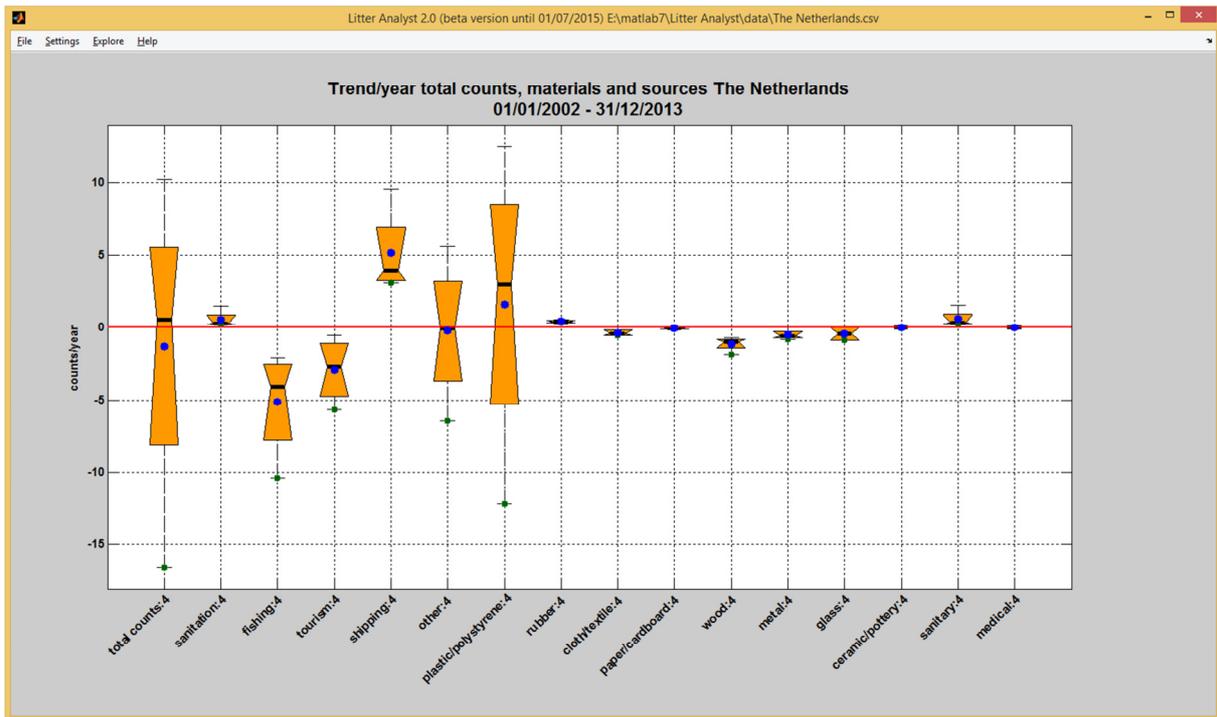
Figure 6.3: Trend palet of the first 5 items in three periods of the aggregation of the Dutch beaches. NaN (Not a Number) is given if the median of the series is zero (the relative trend is the ratio of trend and median and when the median is zero the relative trend cannot be calculated).

Item	Periods to compare	Ber Noo Ter Vee
Plastic: Yokes [1]	1/1/2002-31/12/2007	NaN
Plastic: Yokes [1]	1/1/2002-31/12/2013	NaN
Plastic: Yokes [1]	1/1/2008-31/12/2013	NaN
Plastic: Bags [2]	1/1/2002-31/12/2007	Very large trend
Plastic: Bags [2]	1/1/2002-31/12/2013	0,0%
Plastic: Bags [2]	1/1/2008-31/12/2013	Large trend
Plastic: Small_bags [3]	1/1/2002-31/12/2007	-28,7%
Plastic: Small_bags [3]	1/1/2002-31/12/2013	-3,7%
Plastic: Small_bags [3]	1/1/2008-31/12/2013	-5,7%
Plastic: Drinks [4]	1/1/2002-31/12/2007	-13,0%
Plastic: Drinks [4]	1/1/2002-31/12/2013	Moderate trend
Plastic: Drinks [4]	1/1/2008-31/12/2013	-6,9%
Plastic: Cleaner [5]	1/1/2002-31/12/2007	-8,1%
Plastic: Cleaner [5]	1/1/2002-31/12/2013	Moderate trend
Plastic: Cleaner [5]	1/1/2008-31/12/2013	Large trend

6.4 Trend boxplot

A trend boxplot of all trends is presented of the selected beaches of a period. In figure 6.4 we show the boxplot of the four Dutch beaches Bergen, Noordwijk, Terschelling and Veere of the total counts the materials and the sources of 01/01/2002 – 31/12/2013. On the X- and the Y-axes are given the items and the number of beaches and the trend per year.

Figure 6.4: Trend boxplot of the total counts, the materials and the sources of the four Dutch beaches of the period 01/01/2002-31/12/2013



It is possible to show the trend boxplot of:

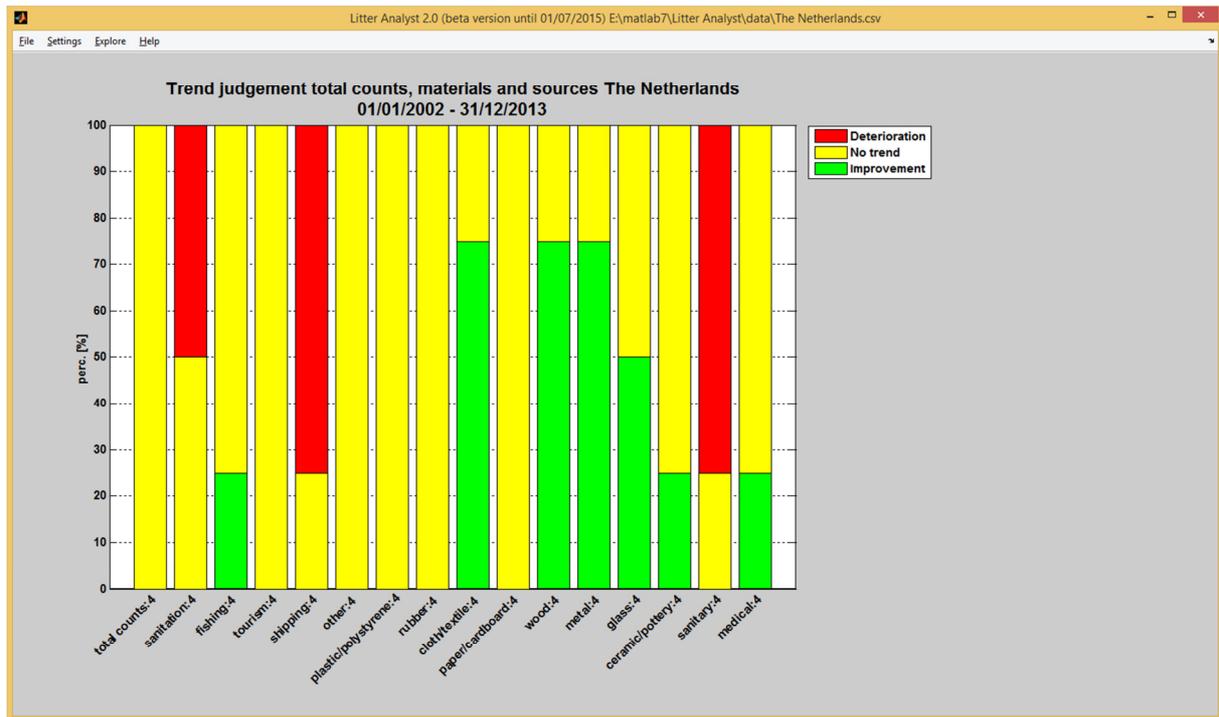
1. All clusters
2. Materials
3. Sources
4. Total counts, materials and sources

On the X-axis the items are shown with the number of beaches.

6.5 Trend judgement histogram

A trend judgement histogram of all trends is presented of a single period. In figure 6.5 we show the trend judgement histogram of the four Dutch beaches Bergen, Noordwijk, Terschelling and Veere of the total counts the materials and the sources of 01/01/2002 – 31/12/2013. A judgement can be a deterioration, no trend or an improvement.

Figure 6.5: Trend judgement histogram of total counts, materials and sources of the four Dutch beaches of 01/01/2002 – 31/12/2013.



It is possible to show the trend judgement histogram of:

1. All clusters
2. Materials
3. Sources
4. Total counts, materials and sources

On the X-axis the items are shown with the number of beaches.

6.6 Trend analysis results

The trend analysis results of all selected beaches are shown in an Excel-spreadsheet.

Explanation of parameters in the trend results:

<i>Maximum</i>	Maximum of the values of the data series
<i>Standard deviation</i>	Standard deviation of the values of the data series
<i>%Coefficient of variation</i>	Ratio of the standard deviation to the average in %
<i>Test</i>	Statistical test Mann Kendall (MK)
<i>Intercept</i>	Estimated intercept of the trend line
<i>Trend/year</i>	Magnitude of the estimated trend, expressed in counts per year
<i>Trend/median</i>	Ratio of the estimated trend and the estimated median of the values of the time series
<i>Significant trend?</i>	Statistical significance of the trend ('Yes', or 'No')
<i>Judgement</i>	Judgement of the trend. This judgement is 'No trend' if the estimated trend is statistically not significant, and if the estimated trend is statistically significant it is determined by the absolute value of the ratio of trend and median and this judgement is: 'Very small trend', 'Small trend', 'Moderate trend', 'Large trend' or 'Very large trend' (see figure 6.6).

Figure 6.6: The judgement of a trend, increase or decrease, depends on the statistical significance of the trend and on the absolute value of the ratio of trend and median.

Trend significant?	trend/median	Judgement
No	Irrelevant	No trend
Yes	≤ 1%	Very small trend
	> 1% - ≤ 5%	Small trend
	> 5% - ≤ 10%	Moderate trend
	> 10% - ≤ 25%	Large trend
	> 25%	Very large trend

6.7 Data density table

Shown is an Excel spreadsheet with the number of surveys per year of all items of the beaches. The file is saved in the temporary directory. Figure 6.7 shows a part of the data density table of Belgium.

Figure 6.7: A part of the data density table of Belgium.

Beach	Item	# surveys	# total counts	trendanalysis possible?	2002	2003	2004	2005	2006	2007
Koksijde: St. - André	Plastic: Yokes [1]	16	1	No	3	4	4	3	2	0
Koksijde: St. - André	Plastic: Bags [2]	16	16	No	3	4	4	3	2	0
Koksijde: St. - André	Plastic: Small bags [3]	16	31	No	3	4	4	3	2	0
Koksijde: St. - André	Plastic: Drinks [4]	16	50	No	3	4	4	3	2	0
Koksijde: St. - André	Plastic: Cleaner [5]	16	14	No	3	4	4	3	2	0
Koksijde: St. - André	Plastic: Food [6]	16	19	No	3	4	4	3	2	0
Koksijde: St. - André	Plastic: Toiletries [7]	16	4	No	3	4	4	3	2	0

Explanation of the parameters in the data density table

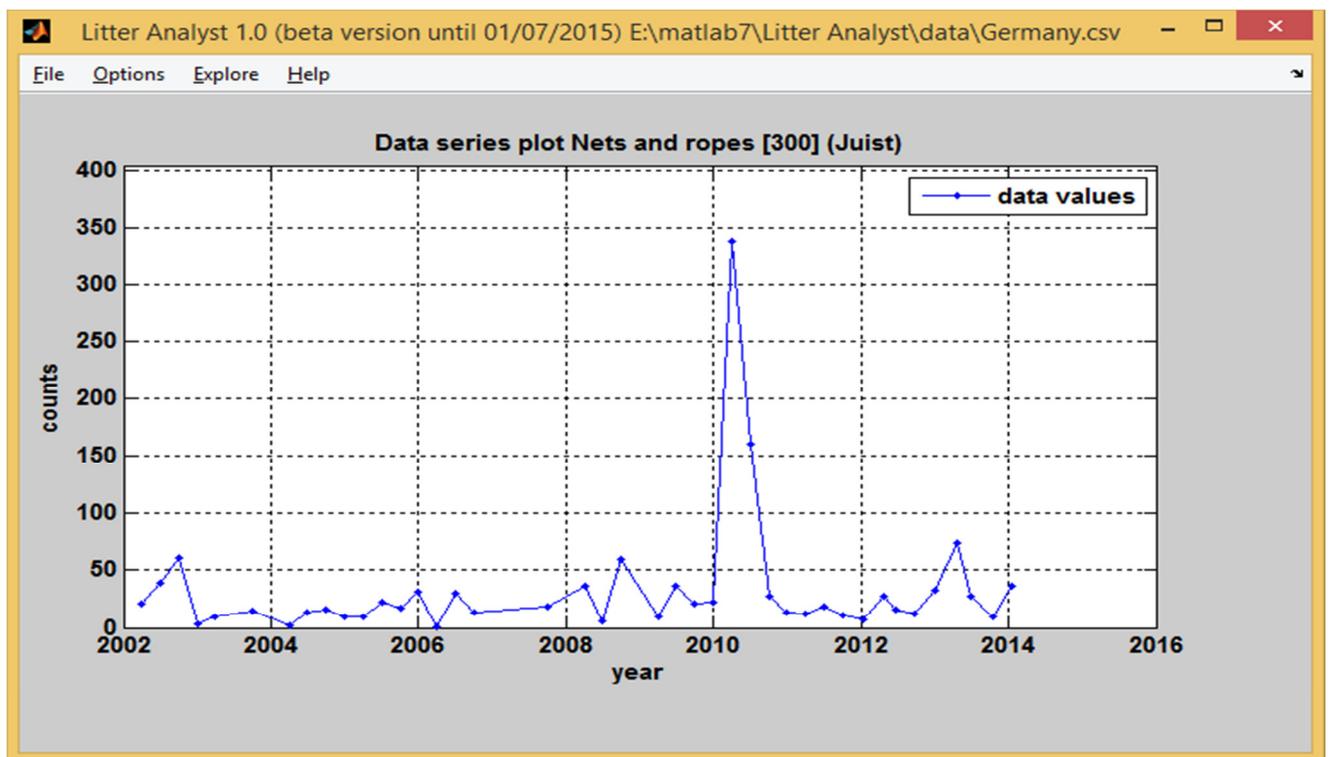
<i>Period</i>	Period of the trend analysis and data series of litter item
<i>Beach</i>	Name or code of monitoring beach or beaches
<i>Litter item</i>	Name or code of analyzed parameter/litter item(s)
<i>Start data series</i>	Start of data series of litter item
<i>End data series</i>	End of data series of litter item
<i>#Surveys</i>	Number of data series values
<i>Total counts</i>	Total of litter items found in that period
<i>Trend analysis?</i>	Are all criteria for trend analysis fulfilled?
<i>#Zero</i>	Number of zero counts in the time series
<i>%Zero</i>	Percentage of the zero counts in the time series
<i>#Year</i>	Number of years without missing values in the time series
<i>Min. #years?</i>	Is the length of the time series at least 4,5 years?
<i>Min. #measurements?</i>	Are there at least 5 data series values?
<i><50%zero?</i>	Is percentage data series values equal to zero less than 50%?
<i><80%zero?</i>	Is percentage data series values equal to zero less than 80%?
<i>Homogeneous?</i>	Are the data series values equally distributed over the period?
<i>#Unique counts</i>	Number of unique counts in the data series values
<i>#Zero-slope</i>	Number of zero slopes in the Mann-Kendall test
<i>%Zero-slope</i>	Percentage of zero slopes in the Mann-Kendall test
<i>Rank nr top-X</i>	Rank number in the top-X list of litter items on basis of their total counts
<i>%Cum counts</i>	Percentage of the total counts of all items in the top-X list with equal or higher Rank number in compare to all counts of all items in that period
<i>Top-X (**%) counts?</i>	Is the '%Cum counts' <= **, the minimal total of percentage of total counts of all items of the top-X list (see § 3.2.4).
<i>Total scores</i>	Scores given to the litter item on basis of the ranking system
<i>Rank nr top-X scores</i>	Rank number in the top-X list of litter item on basis of their total scores
<i>%Cum scores</i>	See '%Cum counts' accept that top-X list is now based on total scores
<i>Top-X scores (**%)?</i>	Is the '%Cum scores' <= **, the minimal total of percentage of total counts of all items of the top-X list (see § 3.2.4)?
<i>Rank nr top-X predefined</i>	Rank number in the predefined top-X list
<i>%Cum predefined</i>	See '%Cum counts' in which the top-X list is predefined
<i>Top-X predefined (**%)?</i>	Is the '%Cum predefined' <= **, the minimal total of percentage of total counts of all items of the top-X list (see § 3.2.4)?

<i>Harm list?</i>	The Rank numbers of the harmful items with the fraction of counts more than 1% of the total counts?
<i>Top-X (**%)?</i>	Is the '%Cum counts' <= **', the minimal total of percentage of total counts of all items of the top-X list (see § 3.2.4) of the chosen ranking system (counts, scores or predefined)?
<i>2001 ..</i>	Number of surveys in a year

6.8 Data series plot

The user can choose between all cleanup items and shown is a data series plot. In figure 6.8 we show an example of the data series plot of Nets and Ropes item-code 300 of beach Sylt in Germany.

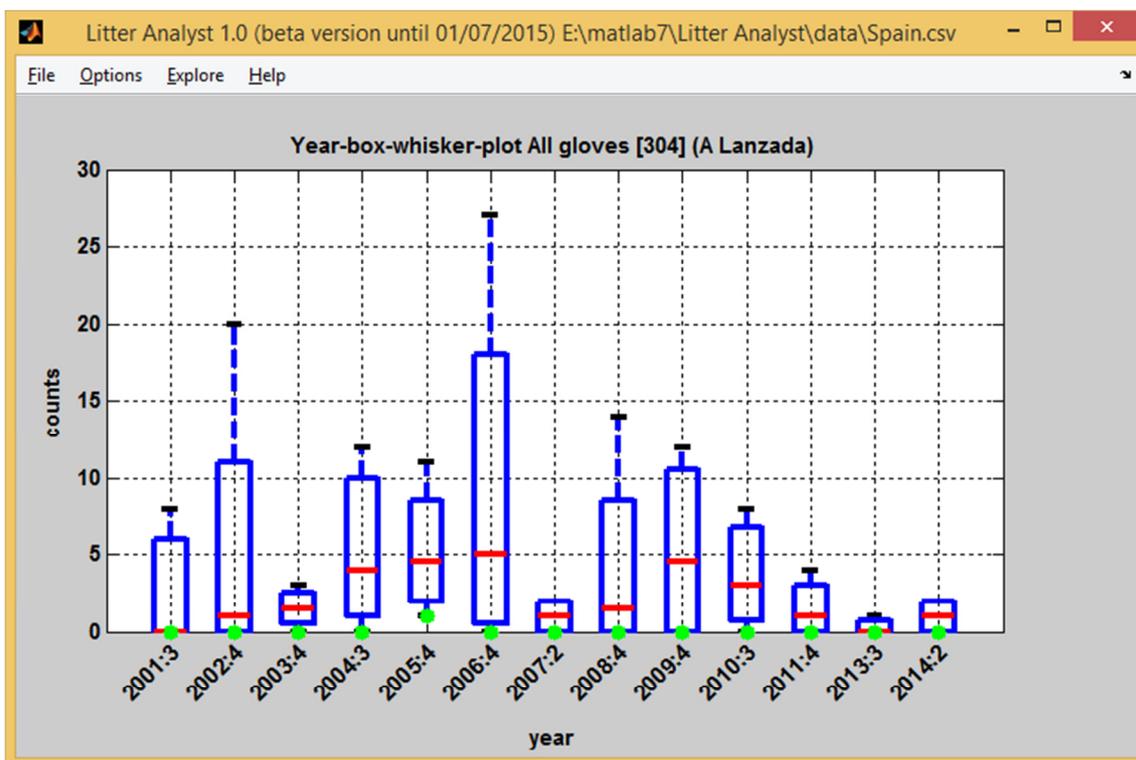
Figure 6.8: Data series plot of Nets and Ropes [300] of beach Sylt in Germany.



6.9 Year boxplot

The user can choose between all cleanup items and shown is a year boxplot. In figure 6.9 we show an example of the year boxplot of All Gloves item-code 304 of beach A Lanzada in Spain.

Figure 6.9: Year boxplot of All gloves [304] of beach A Lanzada in Spain.



6.10 Aggregation tables

Shown is an Excel spreadsheet with per sheet an item with the beaches, their weights of aggregation and the counts of that item in the surveys per year. Figure 6.10 shows a part of the sheet of the item Plastic: Bags [2] of the beaches of the Netherlands.

Figure 6.10: A part of the aggregation table of Plastic: Bags [2] of The Netherlands.

Plastic: Bags [2]	Bergen	Noordwijk	Terschelli	Veere	Aggr. (100%)
Weight	1	1	1	1	
2013-1	24	3	4	1	8
2013-2	0	4	4	3	2,75
2013-3	10	1	4	4	4,75
2013-4	7	6	6	0	4,75
2014-1	9	12	6	1	7
2014-2	10	3	3	1	4,25
2014-3	12	8	0	0	5
2014-4	2	3	2	1	2

7 Help

The menu 'Help' contains the possibilities to view:

- This user manual
- The report '*Evaluation and fine-tuning of a procedure for statistical analysis of beach litter data*'
- The version number of Litter Analyst, the development environment and the developers.

8 References

Baggelaar, P.K. and Van der Meulen E.C.J. (2014): *Evaluation and fine-tuning of a procedure for statistical analysis of beach litter data*. Icastat-AMO, October 30 2014, 43 pages.

M. Schultz, D. Fleet, W. van Loon and L. Oosterbaan (2014): *Joint proposal for a harmonized OSPAR beach litter assessment method*. Project plan, RWS and Germany, March 6 2014.

OSPAR ICG-ML, Conclusions of the Breakout Working Group on Assessment Criteria for OSPAR beach litter data, Vigo, November 11-12 2015.

Appendix

A simple ranking system

Example of a simple ranking system for determining the top-X-H items list. If an item is the most counted item on a beach it receives a score of 10, the second most counted item receives a score of 9, the third one a score of 8 etc.

In the example below “Nets and ropes” is the most counted item on 9 of the 14 beaches (score 90), the second most counted item in two of the beaches (score 18), the third most counted item on one beach (score 8), 6th on one beach (score 5) and 7th on one beach (score 4). In total the item receives a score of 125 and is ranked 1 for the aggregation of the 14 beaches.

Figure A1: An example of a simple ranking system, applied to a situation of 14 beaches. Each cell contains the score for 1st place on a beach, 2nd place on a beach, etc.

Item [OSPARID]	1	2	3	4	5	6	7	8	9	10	Total score
Nets and ropes [300]	90	18	8			5	4				125
Plastic polystyrene pieces < 50 cm [301]	20	54	16	28							118
Plastic: Caps [15]	10	18	40	7	6		4			1	86
San: Cotton bud sticks [98]	20	9	8	7	12						56
Rubber: Balloons [49]			8	7	6	5	8	3	2		39
Plastic: Crisp [19]			8		6	10	4	6	4		38
Plastic: Tangled nets [33]			8	14	6			6		1	35
Plastic: Other [48]				7	12	5	4	3	2		33
Plastic: Small_bags [3]				7	6		16		2		31
Wood: Other_<50cm [74]		9			12				2		23
Plastic: Industrial packaging [40]				7		10		3		2	22
Glass: Other [93]		9		7				3			19
Plastic: Foam_sponge [45]						5	4	3	6		18
Plastic: Drinks [4]						5	4		2	3	14
Plastic: Food [6]					12						12
Plastic: Large_bags [2]						5		3	2	1	11
Plastic: Strapping bands [39]							4	3	2	1	10
Paper: Cig_stubs [64]						10					10

Table 'Items-Materials -Sources'

In the table shows the worksheet 'Items-Materials -Sources' of the configuration file Litter Analyst_config3.xlsx

Table: 'Items-Materials -Sources'

OSPARID	ItemName	Material	Source (Netherlands)
I001	4/6-pack yokes	plastic/polystyrene	Tourism
I002	Bags (shopping)	plastic/polystyrene	Tourism
I003	Small plastic bags, e.g., freezer bags	plastic/polystyrene	Tourism
I004	Drinks	plastic/polystyrene	Tourism
I005	Cleaner	plastic/polystyrene	Shipping
I006	Food incl. fast food containers	plastic/polystyrene	Tourism
I007	Cosmetics	plastic/polystyrene	Tourism
I008	Engine oil <50 cm	plastic/polystyrene	Shipping
I009	Engine oil > 50 cm	plastic/polystyrene	Shipping
I010	Jerry cans (square plastic containers with handle)	plastic/polystyrene	Shipping
I011	Injection gun containers	plastic/polystyrene	Shipping
I012	Other	plastic/polystyrene	Other
I013	Crates	plastic/polystyrene	Shipping
I014	Car parts	plastic/polystyrene	Other
I015	Caps/lids	plastic/polystyrene	Other
I016	Cigarette lighters	plastic/polystyrene	Other
I017	Pens	plastic/polystyrene	Other
I018	Combs/hair brushes	plastic/polystyrene	Tourism
I019	Crisp/sweet packets and lolly sticks	plastic/polystyrene	Tourism
I020	Toys & party poppers	plastic/polystyrene	Tourism
I021	Cups	plastic/polystyrene	Tourism
I022	Cutlery/trays/straws	plastic/polystyrene	Tourism
I023	Fertiliser/animal feed bags	plastic/polystyrene	Shipping
I024	Mesh vegetable bags	plastic/polystyrene	Other
I025	Gloves	plastic/polystyrene	Fishing
I026	Crab/lobster pots	plastic/polystyrene	Fishing
I027	Octopus pots	plastic/polystyrene	Fishing
I028	Oyster nets	plastic/polystyrene	Fishing
I029	Oyster trays (round from oyster cultures)	plastic/polystyrene	Fishing
I030	Plastic sheeting from mussel culture (Tahitians)	plastic/polystyrene	Fishing
I031	Rope (diameter more than 1cm)	plastic/polystyrene	Fishing
I032	String and cord (diameter less than 1cm)	plastic/polystyrene	Shipping
I033	Tangled nets/cord	plastic/polystyrene	Fishing
I034	Fish boxes	plastic/polystyrene	Fishing
I035	Fishing line (angling)	plastic/polystyrene	Fishing
I036	Light sticks (tubes with fluid)	plastic/polystyrene	Fishing
I037	Floats/Buoys	plastic/polystyrene	Other
I038	Buckets	plastic/polystyrene	Other

OSPARID	ItemName	Material	Source (Netherlands)
I039	Strapping bands	plastic/polystyrene	Shipping
I040	Industrial packaging, plastic sheeting	plastic/polystyrene	Shipping
I041	Fibre glass	plastic/polystyrene	Other
I042	Hard hats	plastic/polystyrene	Shipping
I043	Shotgun cartridges	plastic/polystyrene	Shipping
I044	Shoes/sandals	plastic/polystyrene	Tourism
I045	Foam sponge	plastic/polystyrene	Other
I046	Plastic/polystyrene pieces 2.5 cm > < 50cm	plastic/polystyrene	Other
I047	Plastic/polystyrene pieces > 50 cm	plastic/polystyrene	Other
I048	Other plastic/polystyrene items	plastic/polystyrene	Other
I049	Balloons	rubber	Tourism
I050	Boots	rubber	Tourism
I052	Tyres and belts	rubber	Shipping
I053	Other rubber pieces	rubber	Other
I054	Clothing	cloth/textile	Tourism
I055	Furnishing	cloth/textile	Other
I056	Sacking	cloth/textile	Other
I057	Shoes	cloth/textile	Tourism
I059	Other textiles	cloth/textile	Other
I060	Bags	paper/cardboard	Other
I061	Cardboard	paper/cardboard	Other
I062	Cartons/Tetrapack (others)	paper/cardboard	Tourism
I063	Cigarette packets	paper/cardboard	Tourism
I064	Cigarette butts	paper/cardboard	Tourism
I065	Cups	paper/cardboard	Tourism
I066	Newspapers & magazines	paper/cardboard	Tourism
I067	Other paper items	paper/cardboard	Other
I068	Corks	wood	Tourism
I069	Pallets	wood	Shipping
I070	Crates	wood	Shipping
I071	Crab/lobster pots	wood	Fishing
I072	Ice lolly sticks/chip forks	wood	Tourism
I073	Paint brushes	wood	Shipping
I074	Other wood < 50 cm	wood	Other
I075	Other wood > 50 cm	wood	Other
I076	Aerosol/Spray cans	metal	Shipping
I077	Bottle caps	metal	Tourism
I078	Drink cans	metal	Tourism
I079	Electric appliances	metal	Tourism
I080	Fishing weights	metal	Fishing
I081	Foil wrappers	metal	Tourism
I082	Food cans	metal	Tourism
I083	Industrial scrap	metal	Other
I084	Oil drums	metal	Shipping

OSPARID	ItemName	Material	Source (Netherlands)
I086	Paint tins	metal	Shipping
I087	Lobster/crab pots	metal	Fishing
I088	Wire, wire mesh, barbed wire	metal	Other
I089	Other metal pieces < 50 cm	metal	Other
I090	Other metal pieces > 50 cm	metal	Other
I091	Bottles	glass	Other
I092	Light bulbs/tubes	glass	Shipping
I093	Other glass items	glass	Other
I094	Construction material e.g. tiles	ceramic/pottery	Other
I095	Octopus pots	ceramic/pottery	Fishing
I096	Other ceramic/pottery items	ceramic/pottery	Other
I097	Condoms	sanitary	Sanitation
I098	Cotton bud sticks	sanitary	Sanitation
I099	Sanitary towels/panty liners/backing strips	sanitary	Sanitation
I100	Tampons and tampon applicators	sanitary	Sanitation
I101	Toilet fresheners	sanitary	Sanitation
I102	Other sanitary items	sanitary	Sanitation
I103	Containers/tubes	medical	Sanitation
I104	Syringes	medical	Sanitation
I105	Other medical items (swabs, bandaging etc.)	medical	Sanitation
I108	Paraffin or wax pieces Size range 0–1 cm number/m	other pollutants	Other
I109	Paraffin or wax pieces Size range 1–10 cm number/m	other pollutants	Other
I110	Paraffin or wax pieces Size range > 10 cm number/m	other pollutants	Other
I111	Other unspecified number/m	other pollutants	Other
I112	Plastic bag ends	plastic/polystyrene	Tourism
I113	Gloves (industrial/professional rubber gloves)	rubber	Fishing
I114	Lobster and cod tags	plastic/polystyrene	Fishing
I115	Nets and pieces of net < 50 cm	plastic/polystyrene	Fishing
I116	Nets and pieces of net > 50 cm	plastic/polystyrene	Fishing
I117	Plastic/polystyrene pieces 0 - 2.5 cm	plastic/polystyrene	Other
I118	Cartons/Tetrapack Milk	paper/cardboard	Tourism
I119	Fish boxes	wood	Fishing
I120	Disposable BBQ's	metal	Tourism
I121	Bagged dog poo	faeces	Sanitation
I200	Rope/cord/nets < 50 cm	plastic/polystyrene	Fishing
I201	Rope/cord/nets > 50 cm	plastic/polystyrene	Fishing
I202	Plastic/polystyrene pieces < 50 cm	plastic/polystyrene	Other
I203	Gloves	rubber	Fishing
I204	Cartons/Tetrapacks	paper/cardboard	Tourism
I205	Oil drums (new not rusty)	metal	Shipping
I206	Oil drums (old/rusty)	metal	Shipping
I207	Human	faeces	Sanitation
I208	Animal	faeces	Sanitation
I209	Presence of plastic pellets yes/no	plastic pellets	Other

OSPARID	ItemName	Material	Source (Netherlands)
I210	Rope/strings	cloth/textile	Other
I300	Nets and ropes [300]	?	?
I301	Plastic polystyrene pieces < 50 cm [301]	?	?
I302	All cartons/tetrapacks [302]	?	?
I303	Other textiles [303]	?	?
I304	All gloves [304]	?	?
I305	All metal oil drums [305]	?	?
I400	<i>total counts [400]</i>	?	?
I401	<i>Sanitation [401]</i>	?	<i>Sanitation</i>
I402	<i>Fishing [402]</i>	?	<i>Fishing</i>
I403	<i>Tourism [403]</i>	?	<i>Tourism</i>
I404	<i>Shipping [404]</i>	?	<i>Shipping</i>
I405	<i>Other [405]</i>	?	<i>Other</i>
I406	<i>plastic/polystyrene [406]</i>	<i>plastic/polystyrene</i>	?
I407	<i>rubber [407]</i>	<i>rubber</i>	?
I408	<i>cloth/textile [408]</i>	<i>cloth/textile</i>	?
I409	<i>paper/cardboard [409]</i>	<i>paper/cardboard</i>	?
I410	<i>wood [410]</i>	<i>wood</i>	?
I411	<i>metal [411]</i>	<i>metal</i>	?
I412	<i>glass [412]</i>	<i>glass</i>	?
I413	<i>ceramic/pottery [413]</i>	<i>ceramic/pottery</i>	?
I414	<i>sanitary [414]</i>	<i>sanitary</i>	?
I415	<i>medical [415]</i>	<i>medical</i>	?