Coastal Morphology Analysis

MorphAn

Deltares

Enabling Delta Life

Manual

MorphAn 1.5.0

Analytical tool for sandy coasts

User manual

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1 Getting started

1.1 Introduction

This chapter gives a brief introduction aimed at getting you started quickly with MorphAn. It describes the steps that must be taken to be able to work with MorphAn (Figure 1.1 gives a summary of the main steps).

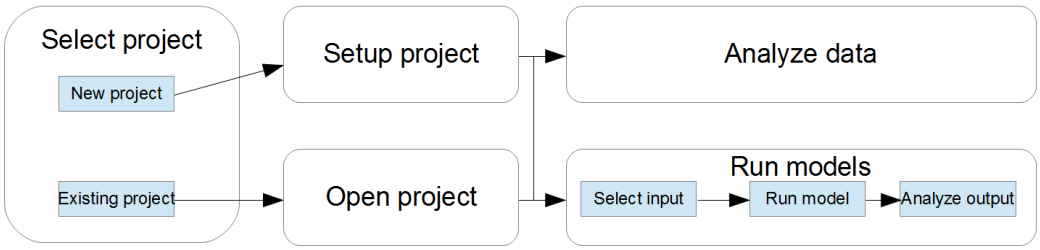


Figure 1.1: *Summary of main steps for working with MorphAn*

In general, the necessary steps are:

- Select project
- Setup project
- Open project
- Analyze data
- Run models

These steps and the options for performing them are explained in greater detail in the subsequent chapters of this manual.

1.2 Select project

Once MorphAn is started, an empty (new) project is displayed. At this point you can choose to build a new project. You can also reopen a previously saved project. Opening an existing project and setting up a new project are discussed in sections 1.3 and 1.4 respectively .

1.3 Open project

To open a previously saved project, click the **File** tab, then select **Open**. Projects are saved in files with the extension ".dsproj". From the Open file dialog box, search for the saved project you wish to open. When you have selected the saved project, click **Open** to load the selected project. Any projects saved using MorphAn version 1.1, 1.2, 1.3 or 1.4 can be loaded into MorphAn 1.5. Projects saved with versions of MorphAn older than 1.1 cannot be opened in this version. In such cases, we recommend that you export the relevant project data from the older software version, then process that data in a new project in MorphAn 1.5.

1.4 Setup project

A MorphAn project always contains a MorphAn workspace. A workspace contains data plus one or more models, and can be added to a project in two ways:

- In the **Home** ribbon, click **New Workspace** (see also Figure B.1)
- In the **Project Explorer** window, right-click on the project; then in the context menu, click "Add → New Item...". A dialog box then appears. Select "*MorphAn Workspace*" (see also

section 4.2, Figure 4.2).

A setup wizard will then start, enabling you to add models to the workspace, and select files containing data to be included in the workspace Data folder. For more information on the use of this setup wizard, see Appendix B. Chapter 4 describes the function and contents of a MorphAn workspace, and the different types of data that can be added to a workspace.

1.5 Analyze data

MorphAn provides several tabs for analysis of the imported data. The imported data can be found in the **Project Explorer** window. Below the newly-imported workspace is a folder with the name **Data**. This folder contains all imported data (including cross-shore profile measurements and boundary conditions). To view the imported cross-shore profile measurements, open the **cross-shore profile measurements** sub-folder. When you double-click on one of the items in the sub-folder, a selection screen opens (see Figure 1.3). This screen allows you select the locations and years for which analysis figures can be opened. When a selection is active, the buttons in the corresponding **Data** tab in the ribbon at the top of the screen become colored (Figure 1.2). Any of the colored buttons can then be clicked for a specific view of the selected data. For a detailed description of the available visualizations, see Chapter 5.

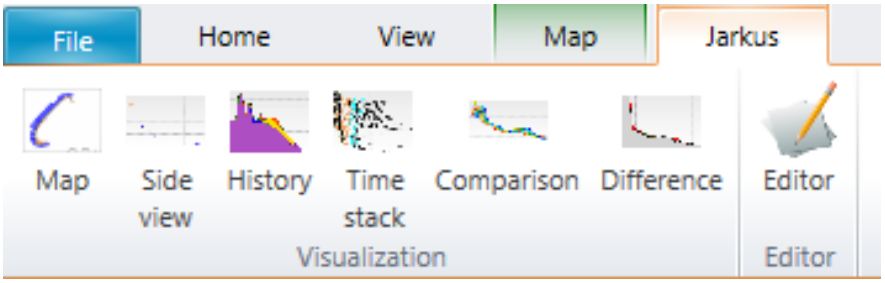


Figure 1.2: *The activated Data tab in the ribbon for analysis of measurement data*

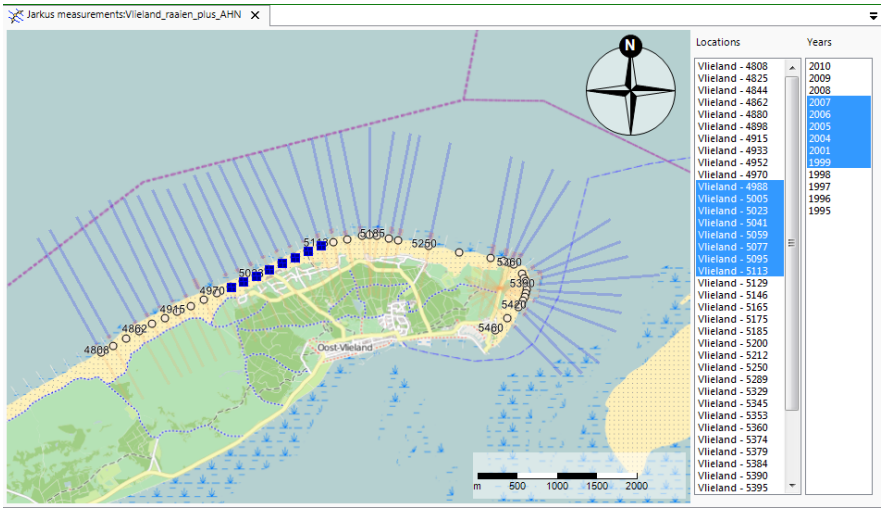


Figure 1.3: *Example of the selection screen for the analysis of measurement data. This screen enables locations and years to be selected for display in the analysis figures. This example shows the selection of a data set from the Vlieland coastal area.*

1.6 Run models

1.6.1 Select input

Before you can run a model, you must first make a selection of the locations and years to be modeled. You can see all input for a model by first expanding the model folder (click on the "+" beside the folder), and then also expanding the **Input** folder. The top-level models in the Project Explorer window all have three entries in the input list:

- ◇ Selection (the locations and transects to be modeled)
- ◇ New cross-shore profile measurement dataset (transect data to be used from the Data → cross-shore profile measurements folder). This item takes the name of the selected cross-shore profile measurement dataset.
- ◇ Boundary conditions (boundary conditions to be used from the Data → Boundary conditions folder). This item takes the name of the selected boundary conditions dataset.

The sub-models (for example, to calculate erosion points, normative results, momentary or expected coastline) work with the same input as the top-level models. This information therefore does not need to be re-specified. The **Input** folders of these sub-models also contain model-specific input.

To make a selection, double-click on the **Selection** item in the **Input** folder. A screen will then appear with a map and four lists (Figure 1.4). The two lists on the right show the measurements included (Selected) in a modeling run. The two lists on the left show the measurements (locations or years) that are still available for selection. You can use the buttons between the two location lists (**Unselected** and **Selected**) to add or remove items. The list of years (**Unselected**) then shows the available measurements for the selected locations. For a model to run successfully, the required years must also be added to the selection. The previously imported input files from the **Data** folder will then be displayed under the **Input** folder of each model, based on the selection made and the boundary conditions required for the specific model. The specification of model input is explained further in section 7.2.

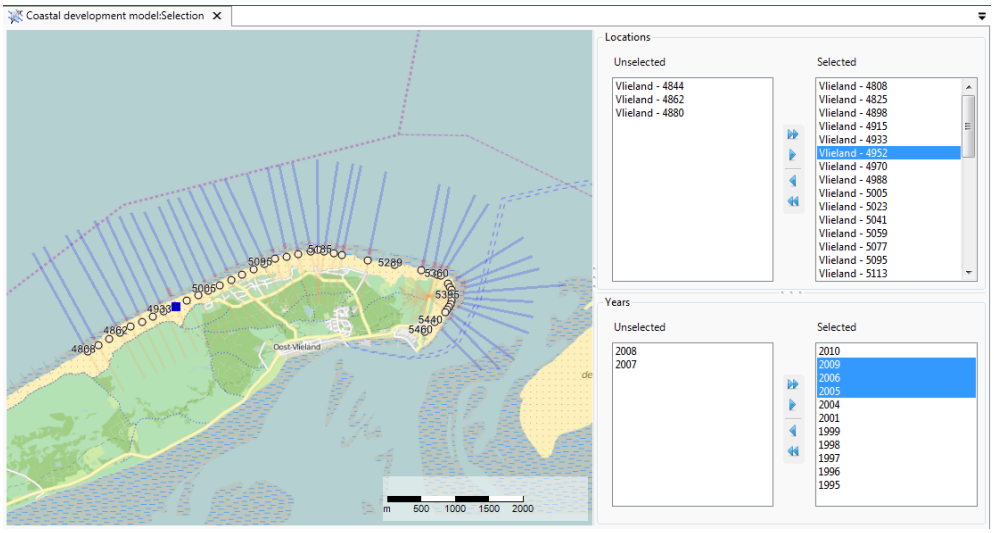


Figure 1.4: *Example of the screen in which locations and years are selected. This selection is used during model calculation (unselected measurements are disregarded during calculation).*

Some of the models and sub-models have a settings screen that will appear when you double-

click on the item in the **Project Explorer** window. This screen enables you to change the settings of the model for the next run. These settings generally apply to the entire model, rather than to an individual location or profile. Section 7.2 provides more information on how to specify input to models.

1.6.2 Run model

To start running a model, right-click on a model in the **Project Explorer**, then click **Run Model**. You can also start running a model from the **Home** ribbon. To run the highlighted (selected) model, click on the Run Current button (F9); to run all models in the project, click on the Run All button (Ctrl-F9). Information on the progress of the running model(s) is continuously refreshed in the **Messages** window. This information can also be reviewed in the **Output** folder of the relevant model (double-click **Calculation Report**).

1.6.3 Analyze output

To view the calculation results, double-click an item in the **Output** folder of the relevant model in the **Project Explorer** window (for more details, see section 7.3). To export the output data, in the Project Explorer, right-click on the output item in the **Export** folder of the relevant model, then click **Export...**. In certain cases a selection screen will appear, in which you can choose the type of data to be exported (e.g. as shown in figure 1.5, where you can select either calculation results in the form of images, or a text file in csv format with the results of a TCL calculation). You will then be prompted to give a name and location for the exported file. Data exported in csv (comma-separated values) format can be opened in Excel. Excel then automatically converts it to xls format, which you can further process and save as usual.

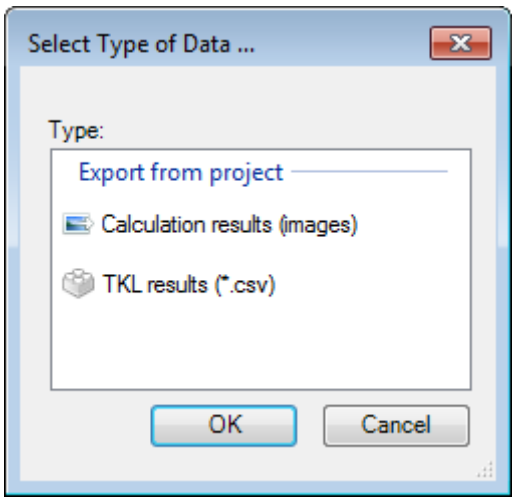


Figure 1.5: *Typical screen to select the data type for export. In this case, you have the option to export calculated TCL results.*

2 Introduction

2.1 What is MorphAn?

MorphAn is a software tool for the analysis and assessment of sandy coasts. The software installation includes standard a full set of annual cross-shore profile measurements for the North Sea coast of The Netherlands (JARKUS measurements) from 1965 through 2015, plus various boundary conditions for the assessment of coastal safety (dune erosion using DUROS model and normative results) and coastline development (MCL and TCL). Of course, MorphAn is also suitable for working with data sets other than the standard files included with the software. The graphical user interface supports various actions:

- ◇ **Analysis and visualization** of the transect data loaded into the software
- ◇ **Management and modification** of imported data
- ◇ Modeling of **dune safety** with the aid of the Duros+ (or D++) model linked to a normative model per location
- ◇ Determination of an **expected coastline (TCL)** based on the calculated momentary coastline (MCL) of selected profiles
- ◇ Calculation of **volume development** based on the imported measurement data

Functionality can optionally be added to MorphAn to support the following actions:

- ◇ **Analysis of bed development** aimed at preventing scour holes in front of water barriers
- ◇ Running dune safety calculations using **XBeach**
- ◇ Automation of actions or extension of MorphAn functionality by means of **Scripting**

This manual describes how to use MorphAn.

2.2 System Requirements

For MorphAn to run without problems, it is preferable (or in some cases essential) to install the program on a computer that meets the following minimum requirements:

- ◇ Microsoft Windows 7 or higher
- ◇ Microsoft .NET Framework version 4.0 or later
- ◇ Intel Pentium III / 800 MHz processor (or equivalent)
- ◇ 4 GB of RAM (8 GB of RAM recommended)
- ◇ Display resolution of 1024x768 pixels or better

2.3 The Delta Shell framework

Technically, MorphAn is a plug-in for the “Delta Shell framework” developed by Deltares. Delta Shell is an integrated modeling environment that provides a platform for the integration of various models, data and tools. It comprises a framework together with a user interface that supports those various models. The program is easy to configure and can be quickly learned. Delta Shell offers a user-friendly and open framework for morphological, hydraulic and hydrological applications. It contains tools for the setup or import of different types of data or models, performing simulations of individual models or combinations of models, and the analysis of data or model results. It has an open architecture that enables the user to integrate external software (referred to as plug-ins). The user can download information in a variety of standard data formats and from various GIS systems. A more detailed description of the Delta Shell framework has been written by Donchyts and Jagers (2010). Other plug-ins written for this framework (and therefore suitable for use with MorphAn) include: D-Flow FM, Sobek, KRW Explorer and Habitat.

2.4 Reading guide

This document describes the components and features of MorphAn. The general layout of the interface and its tools are described in Chapter 3. Chapter 4 describes the purpose of a MorphAn workspace and how to add this to a project. The analysis of source data is discussed in Chapter 5. Ways to manage and modify the data in a project are described in Chapter 6). The models and calculations added to the framework by MorphAn are discussed in Chapter 7; the use of these models for predictive purposes is explained in more detail in Chapter 8 (Dune Safety assessment model), Chapter 9 (Coastline Development model) and Chapter 10 (Volume Development model). The final chapters of this manual describe additional installation options (Chapter 12), help with troubleshooting (Chapter 13) and the differences with previous releases of MorphAn (Chapter 14).

3 Project structure and user interface

This chapter provides a general overview of the main features of MorphAn. The first section explains the project structure used by MorphAn. The main features of the graphical user interface (GUI) are then explained, including all of the various tool, image and document windows. The last section of this chapter covers the possibilities for import and export of data and results.

3.1 Project structure

The structure of a MorphAn project is displayed in the **Project Explorer** window (see subsection 3.2.4). There are two ways to add folders, data and models to a project:

1 In the **Home** tab of the ribbon, click **New Folder**, **New Item** or **New Model** (see Figure 3.1).
2 In the **Project Explorer** window, right-click on the desired project, then click Add, followed by **New Item...**, **New Model...**, or **(**see Figure 3.2).

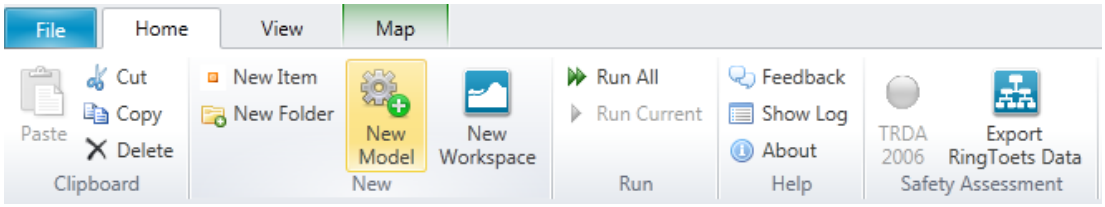


Figure 3.1: *MorphAn home tab "New" group with shortcuts to add a new object to the project.*

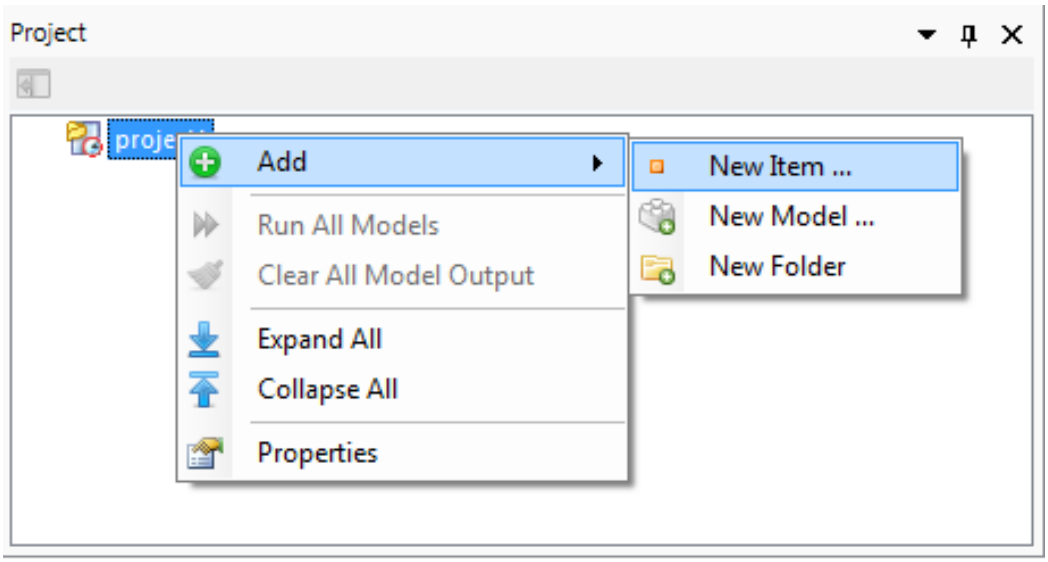


Figure 3.2: *Typical context menu that appears when you right-click on a project. The Add option enables you to add new objects to the project.*

The objects that make up a MorphAn project are usually one of the following three types (explained further below):

◇ **Item** - Shows data of any type
◇ **Model** - Shows a model

- **Folder** - Shows a folder (analogous to a folder in the windows file system)

3.1.1 Item

An item can contain information of any type. Three types of data are always present in MorphAn:

- Map (World) - Adds an empty map to the project
- Text Document - Adds an empty text document to the project
- Web Link - Adds a web link to the project
- MorphAn workspace - Adds a MorphAn workspace (see also chapter 4)

Every item generally has a related (document) window for viewing, and if applicable, to edit the item contents. To open the window (if applicable), go to the **Project Explorer** window, and either double-click on the item, or right-click on the item, followed by *Open*.

3.1.2 Model

A model is a calculation engine with associated input and output. Every DeltaShell model therefore always has the standard folders *Input* and *Output*. The input and output folders are containers for items that describe the input and output. A model can be run in several ways:

- Right-click on the model in the **Project Explorer** window, then click **Run Model**
- Click (Run Current) or (Run All) in the **Home** tab of the ribbon (see also section 3.2.3)
- Select a model and press F9, or press Ctrl+F9 to run all models in the project

Within MorphAn, a model can only be added to a workspace. MorphAn does not permit models to be added outside a workspace (with the exception of the optional XBeach 1D plug-in; see also Chapter 12).

3.1.3 Folder

A Folder in a MorphAn project is comparable to a folder or directory in the windows file system. A folder can be used to organize and group data (items and models). Folders are also used in Models to group input and output items.

3.2 Components of the interface

Figure 3.3 gives an overview of the interface, showing as many windows and panels as possible. This section discusses those components. The user interface is arranged by default as three vertical panels, in which a set of tool and document windows are shown. These can be reordered and repositioned in the interface as desired. In addition, the interface has a quick access toolbar (no. 1 in the figure) and ribbon (no. 2 in the figure) to manage and modify the project, data and display. This section will first focus on the features you can use to make the interface as suitable as possible for your specific needs. Each of the tool and document windows will be briefly explained later in this section. The numbers within brackets refer to the numbered items in Figure 3.3.

Tool windows

Tool windows display the properties of the currently selected item. MorphAn provides the following tool windows:

- Project Explorer (3)
- Map (4)
- Chart (5)
- Properties (6)
- Messages (7)
- Time Navigator (8)

Document windows

Document windows are used to visualize and edit certain types of data. They are opened in the central panel (9) of the MorphAn application window when the program is started. Examples of document windows are:

- Map (one or more)
- Editors
- Visualization windows

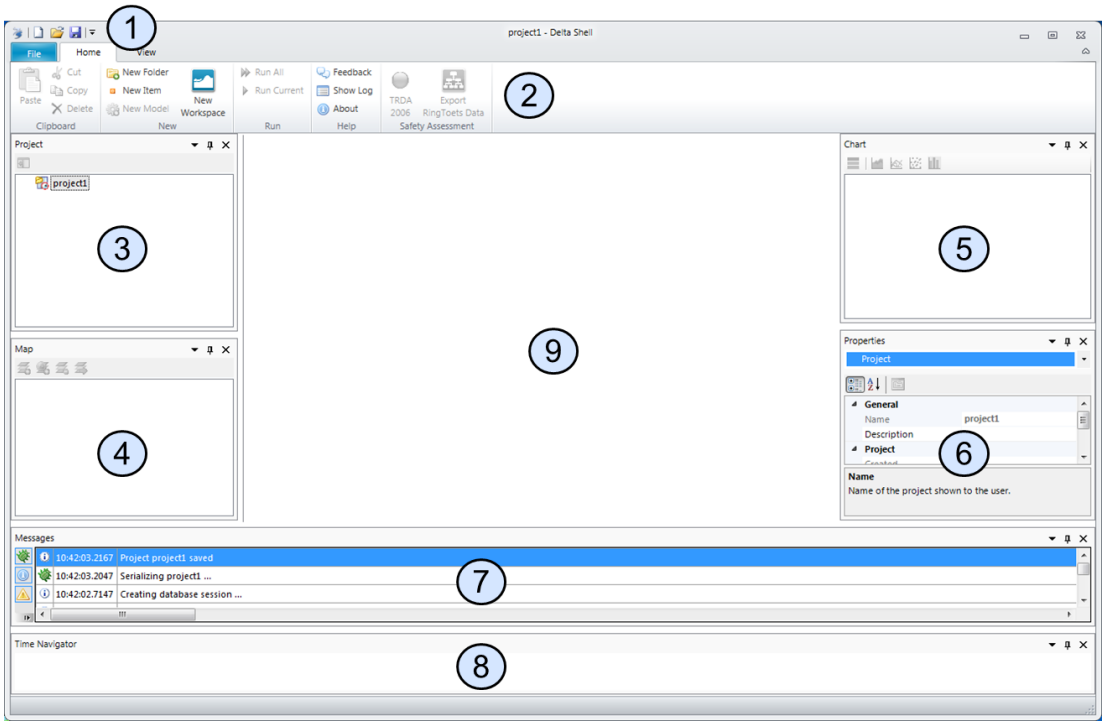


Figure 3.3: *The MorphAn interface*

3.2.1 Central panel

The central panel is where all open document windows (e.g. maps and editors) can be viewed and worked with. The central panel uses a tab structure similar to that in an Excel workbook. You can navigate through the open tabs using the selection icon in the upper right corner. Windows can be moved and docked (see subsection 3.2.2), enabling you to use various document windows side by side, if that is more convenient to you.

3.2.2 Docking and modifying windows

The graphical user interface can easily be adapted to personal preference by docking the windows. When you drag the title bar of a window with the left mouse button pressed, a docking guide will appear (see Figure 3.4). Now, when you "drop" the window under one of the indicators in the docking guide, the window will be docked in the corresponding panel. This can be done with all open tabs, but also with tool windows. You can also undock any window from its current position and display it anywhere you want on the desktop (Floating). Two icons are present in the title bar of every open window (see figure 3.5). Their purpose is:

- ◇ pin - fix the window's position or auto-hide the window by moving it to a tab;
- ◇ cross - hide the window from the interface until you show it again using the Show/Hide button in the View tab of the ribbon.

You can also adjust the size of the display panels to your own needs: simply drag and drop the border between two panels using the left mouse button.

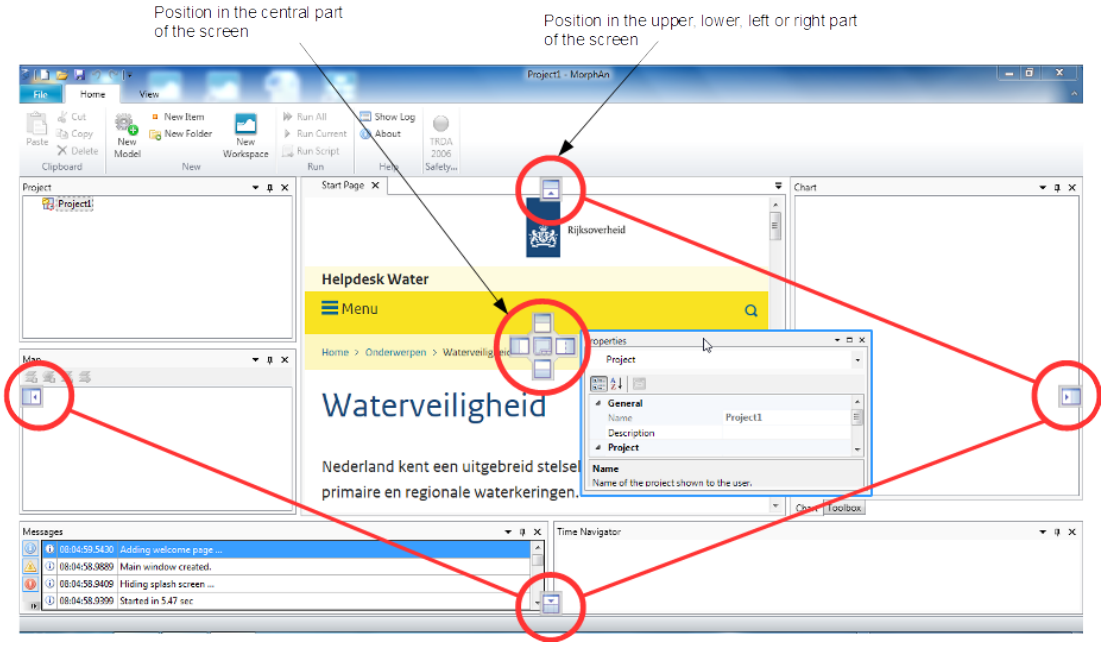


Figure 3.4: *Docking guide that appears when dragging a tool window across the screen*

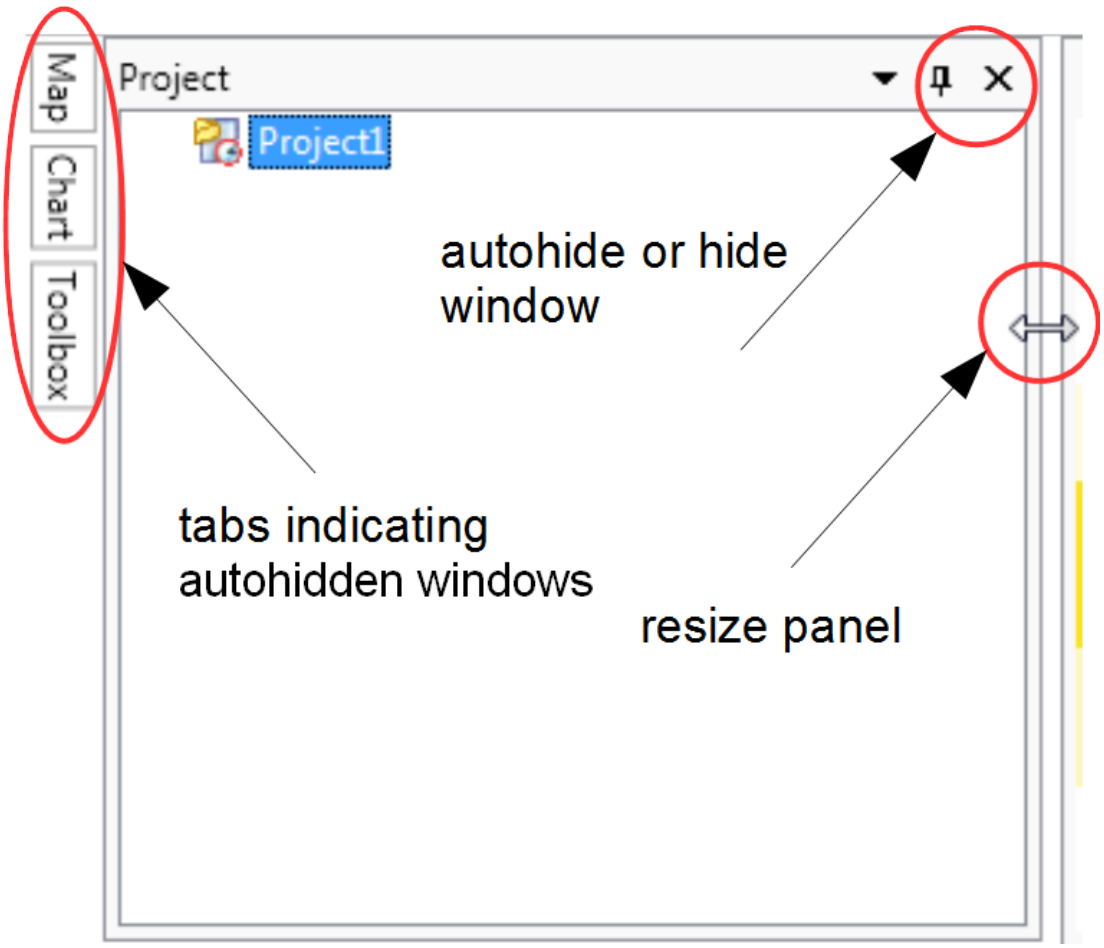


Figure 3.5: *Features used to dock, autohide or hide a window, or to resize a panel*

3.2.3 Ribbon

The ribbon is the upper area of the user interface (no. 2 in Figure 3.3). The ribbon contains action buttons, for example to show a map (when the document window is selected) , or to edit project items (shortcuts). The ribbon is organized as a set of tabs:

Home This is a general tab with many handy shortcuts for working with projects (see Figure 3.6).

View This tab enables you to show and hide windows. You need it to restore a window that you have hidden by clicking the cross in the title bar of the window (see Figure 3.7). In addition, the “Offset column” button enables you to include an additional column for “Offset” in any table with a “Location” column. This makes it easier to sort and filter the tables.

Chart When a chart is shown in one of the document windows, the Chart tab provides actions to adjust the display of the chart (e.g. font size, color palette), or export the chart (see Figure 3.8).

Map When a map is shown in one of the document windows, the Map tab provides actions to customize the map display according to your preferences, or to export the map (see Figure 3.9).

Data This tab has been added by the MorphAn plug-in to provide optional screens for the analysis and modification of data (for more information see Chapter 5).

Profile Generation This tab has been added to support profile generation based on grid measurements. The tab and its actions are described further in section 6.6.

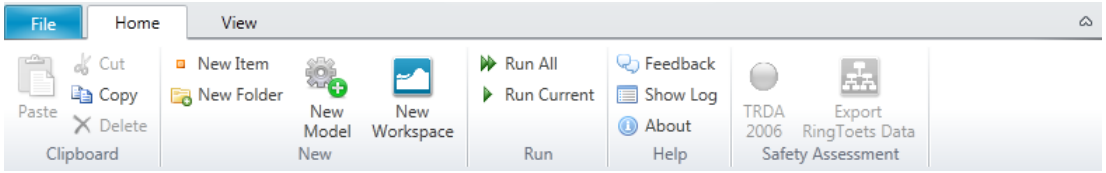


Figure 3.6: *Features available in the Home tab of the ribbon*

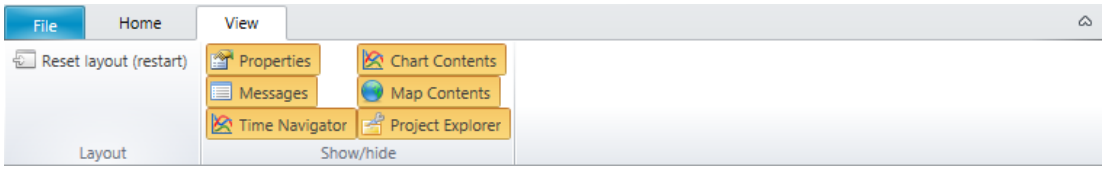


Figure 3.7: *Features available in the View tab of the ribbon*

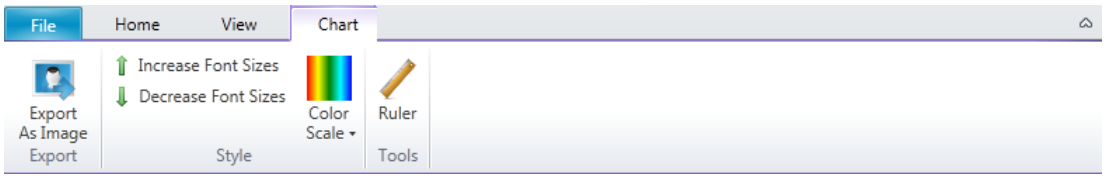


Figure 3.8: *Features available in the Chart tab of the ribbon*

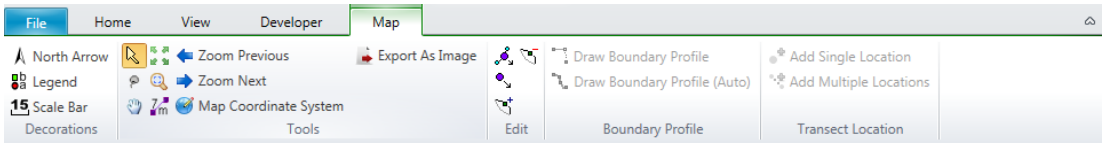


Figure 3.9: *Features available in the Map tab of the ribbon*

3.2.4 Project

The **Project Explorer** tool window is the main tool for navigation through projects and their data. This window presents all components of a project in a tree structure (see Figure 3.10). Within this window, you can organize the project into Folders (see section 3.1), drag and drop items between folders, or use cut (Ctrl+X) and Paste (Ctrl+V). The project explorer can be hidden or removed, using the pin or cross icons in the top right corner (see also subsection 3.2.2). The window can be restored by clicking the **Project Explorer** button in the **View** tab of the ribbon (see also Figure 3.7). To find out exactly where in the project tree the active item belongs that is shown in the central panel, simply click the “+/-” icon (expand or collapse) in the top left of the Project Explorer window.

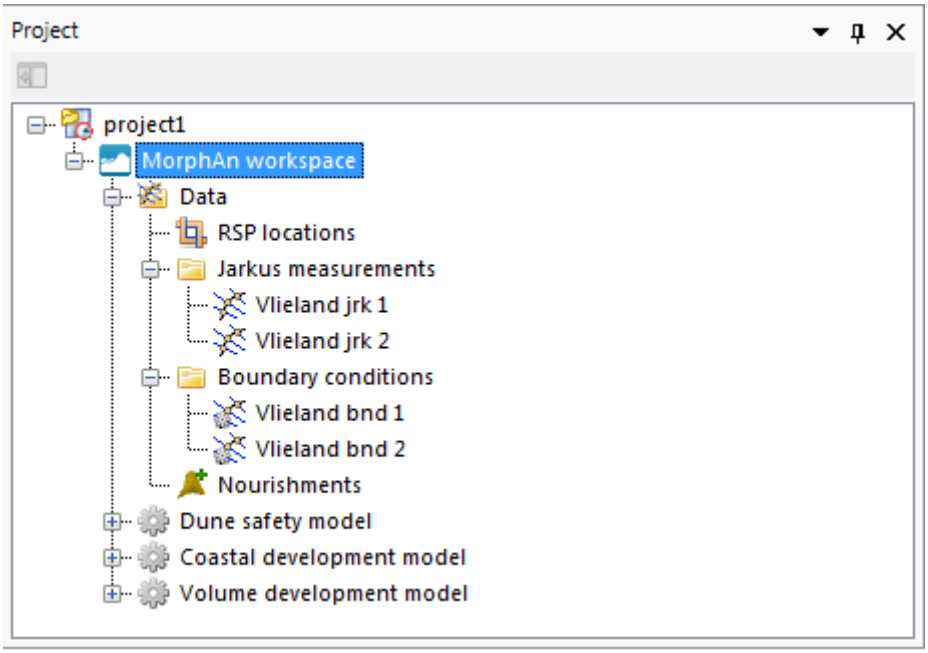


Figure 3.10: *Project Explorer window showing a typical MorphAn project structure*

There are various ways to view or edit the project structure:

- ◇ left-click to select
- ◇ right-click for a context menu of available actions
- ◇ double-click to show the document window, depending on the item or model that was clicked

3.2.5 Map

You can add and edit GIS maps in MorphAn (see Figure 3.11). A map consists of one or more layers on which information can be displayed, such as features (points, lines, or planes, often supplied as an .shp file) or a photo with a georeference (e.g. a .tiff file) like those from ArcGIS. The **Map** tab with its shortcut buttons will appear in the ribbon (subsection 3.2.3, Figure 3.9) whenever a map is opened. At the same time, the map layers will be displayed in the **Map** tool window, and if the map is time-dependent, it will be linked to the **Time Navigator** (see subsection 3.2.9). You can use the Map tab shortcuts to show or hide decorations such as the north arrow, scale bar and legend, or to adjust the zoom or position of the displayed map area. A map is one of the standard items in MorphAn. Section 3.1 explains how to add a map item. This map is used in multiple places, for example as an aid to selecting model input, or to present calculated data (see section 7.3).

It is possible to assign a standard background map for use wherever a map layer is shown (see subsection 3.2.6). To achieve this, add a new map to the project (or search for an existing map in the **Project Explorer**), then right-click on the map item for the context menu, and select “Use as default background layer”. The map name then becomes bold, and the map is added as a background layer in any screen that shows a map. Alternatively, you can also create a standard background map via the setup wizard for a new MorphAn workspace (see also section 4.2 and appendix B).

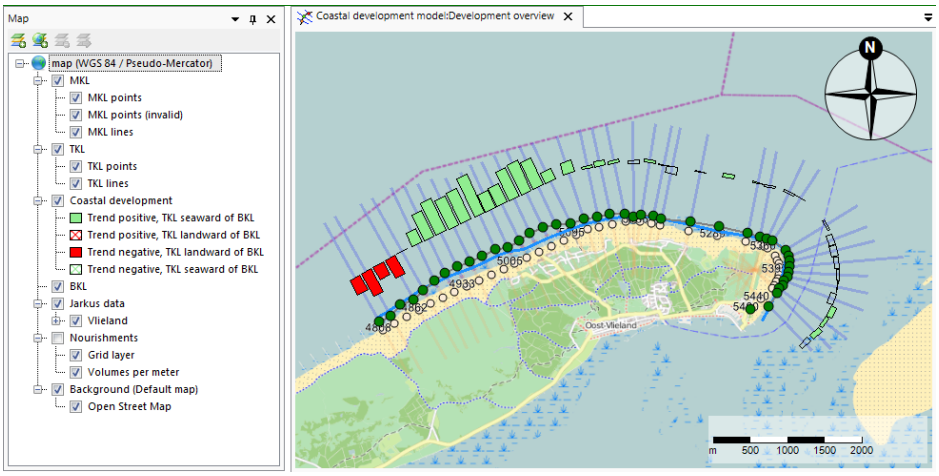


Figure 3.11: *Example of a map with results from the Coastal Development Model*

3.2.6 Map tool window

When the document window shows an active map (Figure 3.11), you can manage the map layers in the **Map** tool window (Figure 3.12).

The four icons in the upper left corner of the window enable you to add or remove layers based on e.g. shapefiles (.shp) or TIFF files (.tiff) with georeferences. It is also possible to export a map layer to a shapefile. The Map tool window can be hidden or removed using the icons at the right of the window title bar. To restore the window, click the **Map** button in the **View** tab of the ribbon (see also Figure 3.7).

Each layer can be shown or hidden by checking/unchecking the check box beside the item. You can do this for an entire layer, or just for specific sub-layers within a layer (if present). When you double-click on a layer, the layer properties editor will open showing line styles, line weights, colours, etc. You can modify these properties according to your preferences.

When you right-click on a layer, a menu appears with options for that layer (see Figure 3.13). Among these options are the following:

- **Properties** - edit the drawing style of the layer. This allows you to modify the color (scale) and display of the features on this layer. The properties editor is also where you can set labels on or off.
- **Zoom to extent** - set the zoom level of the map such that all information in this layer fits exactly into the display panel.
- **Show in legend** - show this layer in the map legend.
- **Hide all layers but this one** - show only this layer on the map and hide all the others.

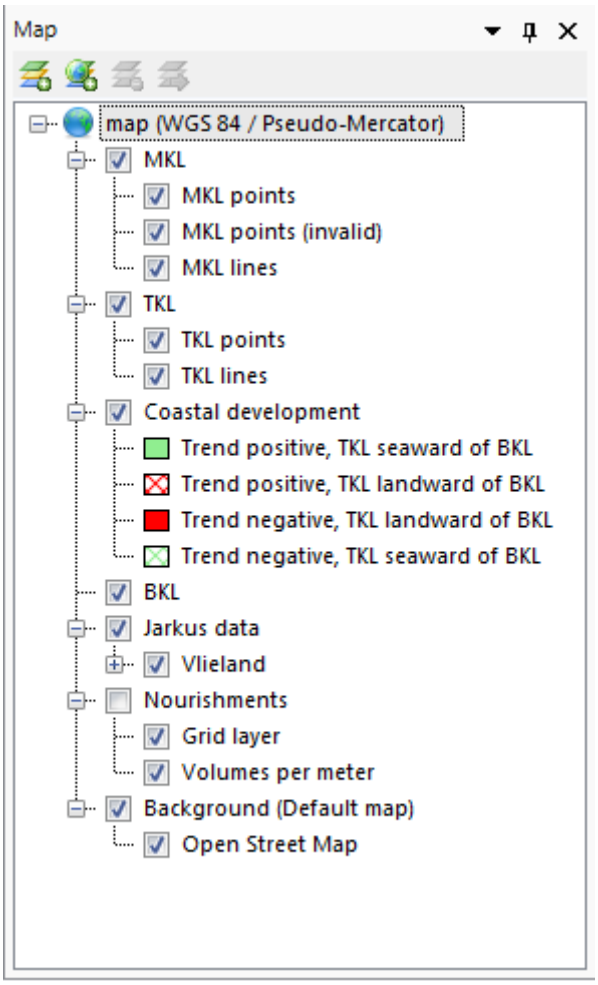


Figure 3.12: *A typical Map tool window showing various map layers. In this case, the map layers show the results of a Momentary Coastline (MCL) model.*

3.2.7 Chart tool window

When the document window shows a chart object (e.g. line or bar chart) the **Chart** tool window (see Figure 3.14) shows the individual lines and points along with their properties. If you click on an item in the Chart tool window, the **Properties** tool window will show the full properties. You can then edit the properties, for example to change the range of the chart axes, or to modify the chart colours and labels. This makes it possible to export the figures with uniform axes. You can also temporarily switch certain lines or points on or off. Please note that this function is not yet available for the transect editor in the current version of MorphAn.

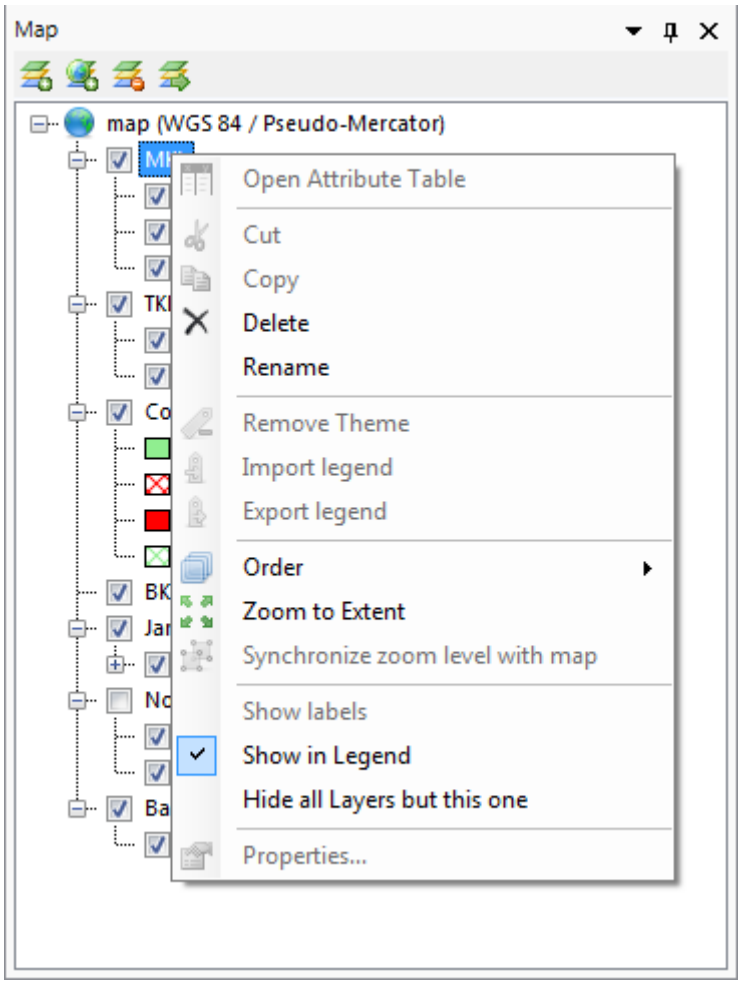


Figure 3.13: *Options menu that appears when you right-click on a map layer*

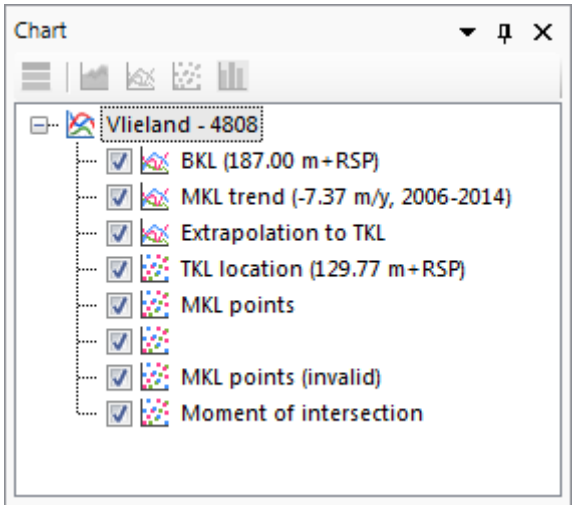


Figure 3.14: *Typical contents of the Chart tool window*

3.2.8 Properties

Whenever an element in the interface is selected (e.g. in the Project Explorer, on a map, in a results chart, or in the Chart tool window), the properties of that element will be displayed in the Properties tool window. The properties window can also be used to edit the displayed properties.

3.2.9 Time Navigator

The Time Navigator tool window is used to navigate through the time (steps) of a time-dependent variable. Any screen that displays time-dependent information has its own time navigator. This enables you to navigate through time. This time navigation can take two forms:

- ◇ Single time indication. In this case, the time navigator bar has a vertical line indicating position in time. Only a single moment in time is displayed, as stated on the left (see Figure 3.15).
- ◇ Time period (see Figure 3.16). In this case, the navigator bar has a rectangle indicating start and end time. All data points are displayed that lie between the start and end times.

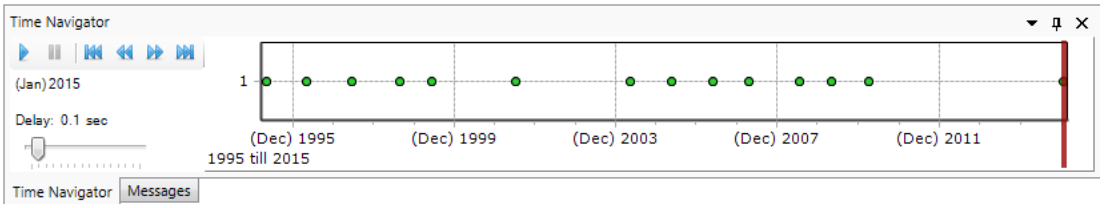


Figure 3.15: *Time Navigator with single time indication*

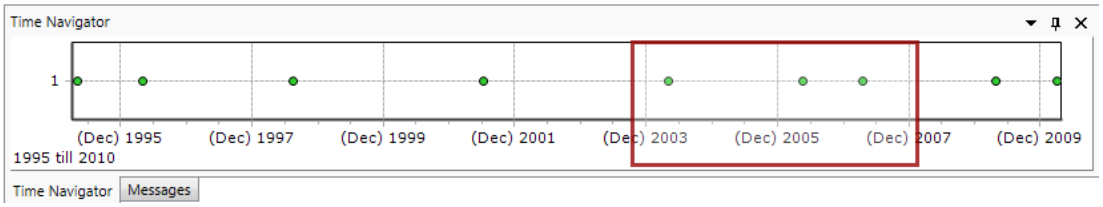


Figure 3.16: *Time Navigator with time period display*

3.2.10 Messages

The Messages window displays a continuously updated log. The models and various other parts of the system issue messages, which are displayed here in chronological order. Depending on the message contents, each message is preceded by an icon (see table 3.1 for an explanation). If the Messages window is closed then reopened (see subsection 3.2.2), only new messages will be displayed. Older messages are stored in two places:

1. In the Project Explorer, a calculation report is displayed in the output folder of each model when it is run. This report contains all messages issued by the model while running.
2. In addition, an application log is maintained for each session (from program start to exit) of MorphAn. This log file stores all messages generated during the session. You can view the application log at any time by clicking the **Show Log** button in the **Home** tab of the ribbon.

Table 3.1: *Message types*

Icon	Message Type
	Information
	Warning
	Error

3.3 Import Export

If there is an importer or exporter defined for an item in the **Project Explorer** window, then it is possible in to export or import data in MorphAn using the right-click context menu. Select either **Export...** or **Import...**. You can use a special plug-in, or a standard importer//exporter provided in the framework itself. Certain items can be exported in more ways than one (e.g. calculation results can be exported either as a figure, or in csv format for processing in Excel).

MorphAn has a predefined csv file exporter for all calculation results. This format is easy to load into Microsoft Excel. Note that a ";" (semicolon) is the defined separator between cells; furthermore, the "." (period) is always the standard decimal symbol (between whole numbers and decimals). See also section 7.4.

4 MorphAn workspace

4.1 What is a MorphAn workspace?

Every MorphAn project is assembled within a *MorphAn work space*. This workspace includes a **Data** folder that contains all required data. You can also add any number of models to the workspace. These models can access and use the data in the workspace Data folder. Figure 4.1 shows a typical project with a MorphAn workspace containing a set of data and three models.

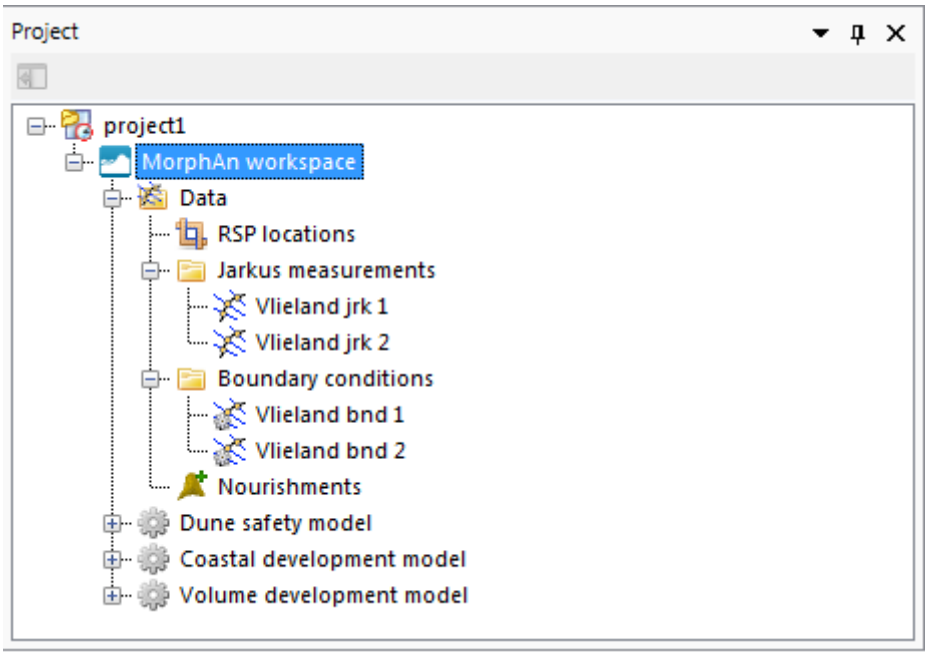


Figure 4.1: *Typical MorphAn workspace with Data folder and three models*

This chapter discusses the various parts of a MorphAn workspace **Data** folder. We will also describe how to create a workspace and populate it with data.

4.2 Add a workspace to the project

A MorphAn workspace can be added to a project in two ways:

- In the **Home** tab, click **New Workspace** (see also figure B.1)
- In the **Project Explorer** window, right-click on the project; then in the context menu, click "Add → New Item...". In the ensuing dialog box (figure 4.2), select "*MorphAn work space*".

A wizard will be started, enabling you to add models to the workspace, and to specify which files to include in the Workspace Data folder (more information on the use of this wizard can be found in Appendix B). You can specify this data in the wizard when you first set up a MorphAn workspace. You can also add much of the necessary data to the workspace at a later time. To do this in an existing MorphAn workspace, right-click on the workspace **Data** folder and select **Import...**. A selection dialog like that in figure 4.3 will appear. Here you can choose the type of data you wish to import. You will then be prompted to select a file containing the required data. The data in the selected file will then be added to the MorphAn workspace. We will now discuss the different types of data that can be added to the workspace, and their function within MorphAn. You can also refer to figure 4.3 for the import dialog. Appendix A specifies the required file format for import of all data types described in this chapter.

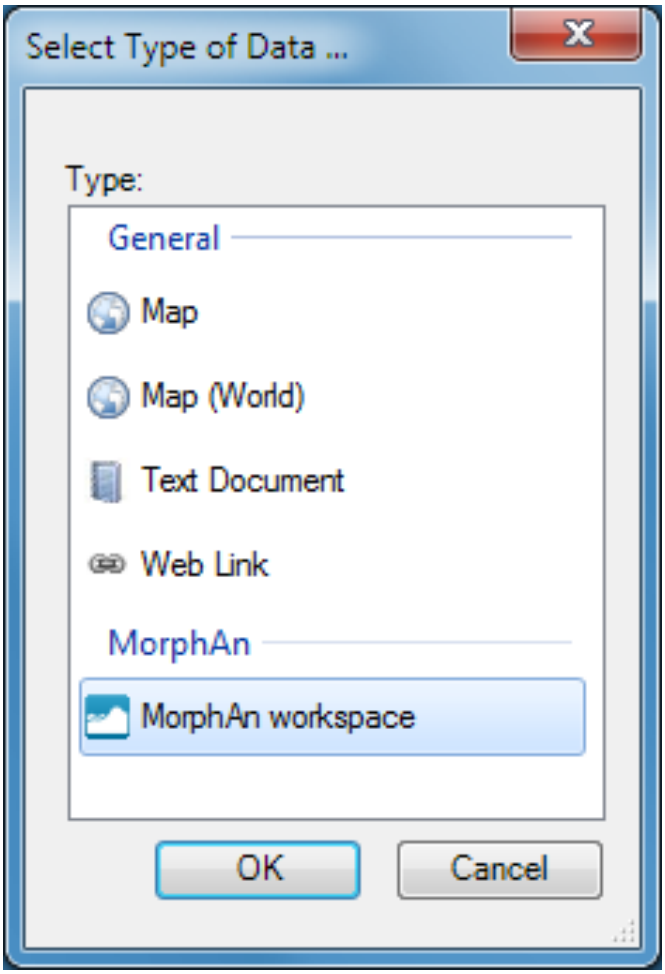


Figure 4.2: *Dialog box with options for adding a new item to a workspace. You can choose from general items, such as a map (Map or Map (World)), Text Document or internet address (Web Link). You can also choose to add a MorphAn workspace to the project.*

- ◇ Definition of coastal area names
- ◇ Locations (and filter) (Locations (*.grd), Location filter (*.csv))
- ◇ Cross-shore profile measurements (Cross-shore profile measurements (*.jrk))
- ◇ Boundary conditions (Boundary conditions (*.bnd))
- ◇ Grid Measurements (Time-dependent uniform grid)
- ◇ Nourishments database (Nourishments (*.nc), Nourishments (*.csv))

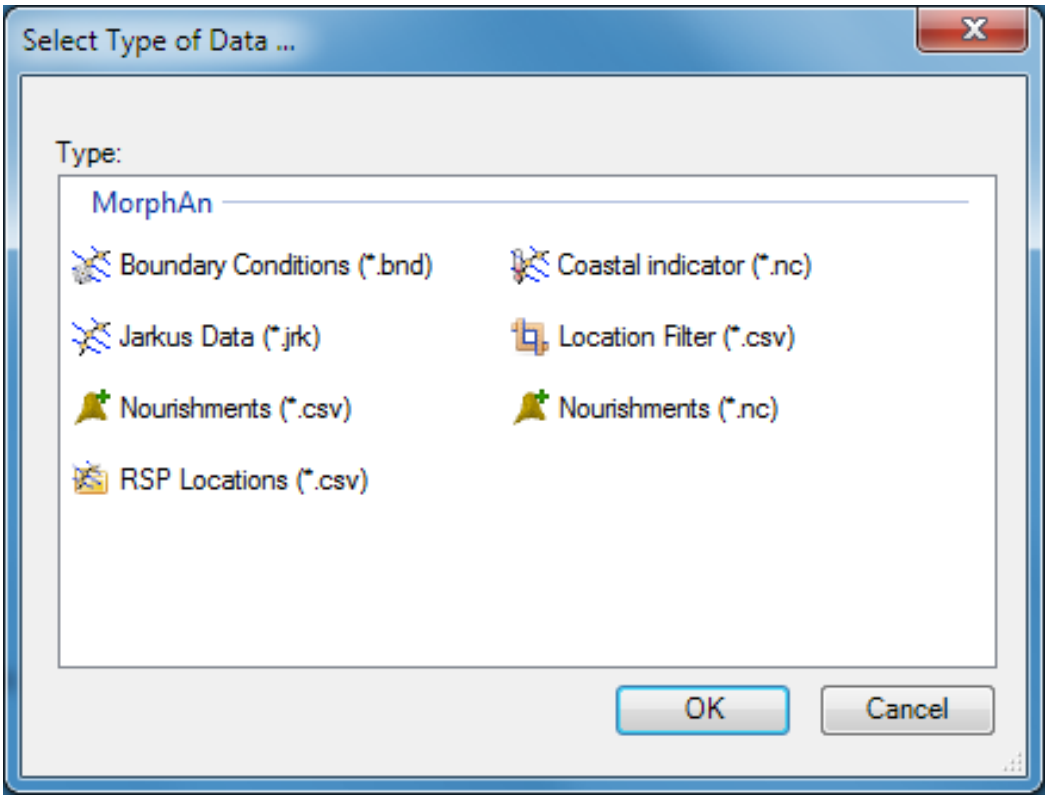


Figure 4.3: *Selection dialog for adding data to the "Data" folder within an existing MorphAn workspace*

4.3 Definition of coastal area names

Every coastal area referred to by number in the grid file (which defines the locations; see section 4.4) has a corresponding name. By default, every MorphAn workspace contains the names as defined in table 4.1. Any specified coastal area number that is not in this table will be designated as "Unknown". However, the MorphAn workspace setup wizard does allow you to manually define your own names for the coastal areas. The necessary file format for this is described in Appendix A (section A.1).

Note that you can only specify or change the names of the coastal areas at the time you create a MorphAn workspace. The import file with coastal area names can therefore only be used in the setup wizard.

Table 4.1: *Standard definition of coastal area names in a MorphAn workspace*

No.	Name
1	Rottum
2	Schiermonnikoog
3	Ameland
4	Terschelling
5	Vlieland
6	Texel
7	Noord - Holland
8	Rhineland
9	Delfland
10	Maasvlakte
11	Voorne
12	Goeree
13	Schouwen
14	Oosterschelde
15	Noord - Beveland
16	Walcheren
17	Zeeuws - Vlaanderen

4.4 Locations

All transect measurements and boundary conditions are linked to a location on the coastline (referred to as “RSP location” or simply “location”). A location is designated by a base point (usually specified in geographical coordinates) and an angle. Height and depth measurements are performed along the line described by the location. The results of the annual coastal survey are likewise reported with reference to this line. In addition, the boundary conditions are also linked to (coastal) locations. These locations fall within specific coastal areas, and contiguous coastal locations within a coastal area in turn describe a line along the coast. The distance in decameters (10 m) from the zero point of a coastal area to a specific location is referred to as the *offset* of that location.

By default, all predefined locations on the Dutch coastline are added to a new MorphAn workspace. The setup wizard allows you to add extra locations to this list, or even to specify a custom list. You can also add locations to an existing workspace, by right-clicking on the Data folder in the **Project Explorer**, and selecting “Import...”. Appendix A describes the file format for specifying RSP locations. If you use the default list, a total of 3616 locations will be available in the workspace. It is unlikely that you will be interested in working with the data from all of these locations at the same time. You can therefore choose to work with just a specified subset of these locations within your workspace, by means of a **Filter**. The filter can be configured in various ways:

- ◇ Manually, by clicking on the map
- ◇ By importing a filter stored previously
- ◇ By specifying a set of filtering rules

4.4.1 Configure a filter manually

To configure the filter, go to the **Data** folder of a MorphAn workspace in the Project Explorer, and either double-click on the **Locations** item, or right-click on the item and select Open. You will then be able to choose one of two document views: **Locations (filter)** or **Locations (manager)**. Using the manager view, you can permanently discard, add or modify coastal locations. The filter view enables you to customize the list of filtered coastal locations. The **Locations (filter)** view (figure 4.4) shows a map and two columns: **Locations not in filter** and **Locations in filter**. You can then make a selection on the map, and using the arrows between the two columns, you can modify the filter in the right column. If you check the box **Ignore filter**, no filter will be applied within the workspace, and all available locations will be visible everywhere.

This screen also enables you to export or import a filter (based on a previously stored filter or a filter prepared outside the MorphAn environment). There is also a button to remove, add or replace locations in the filter based on filter rules. These features are described in more detail below.

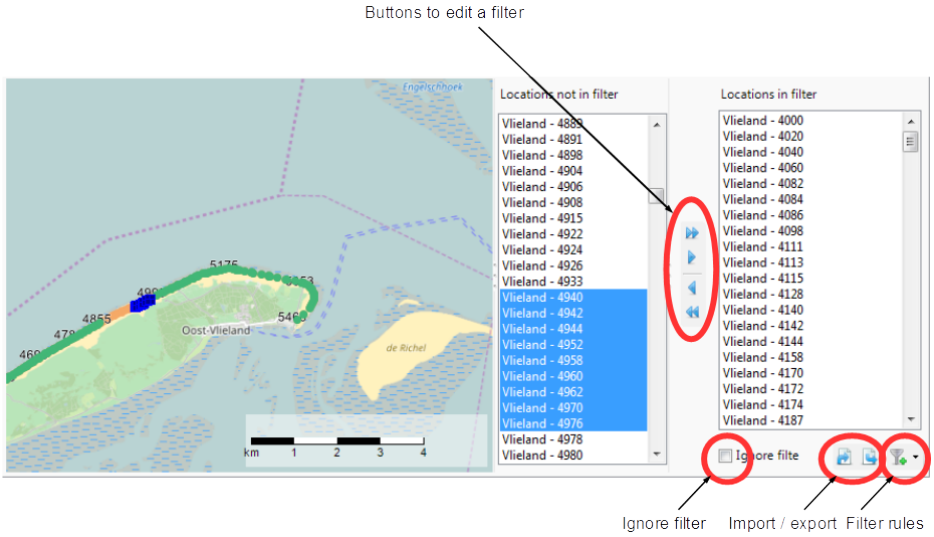


Figure 4.4: *Locations (filter) view for configuration of the applied filter*

4.4.2 Importing a previously saved filter

In addition to manual filter configuration, you can also load a previously saved filter. This can be done in three places:

- ◇ When using the wizard for to create a new MorphAn workspace, you have the option to specify the filter using a *.csv file.
- ◇ In the Project Explorer, when you right-click on the **Locations** item in the Data folder, you can also choose the option Import... to import a filter specified in a .csv file.
- ◇ Lastly, from within the Locations (filter) view of the **Locations** item, you can import a filter from a *.csv file (button in the lower right corner of the document window).

In every case, the file format for filter specification is identical. This format is described in more detail in Appendix A (section A.3).

4.4.3 Configuring a filter using rules

A third method for configuration of a filter is to specify filtering rules. A combination of rules can be applied to add, exclude, replace or remove coastal locations. Filtering rules are specified using the editor, as shown in figure 4.5. This can be used both in the wizard and by means of the button on the Locations (filter) view in the document window (figure 4.4). When configuring the rules, you can choose whether location selection requires fulfilment of all of the specified rules, or any (one or more) of the rules. You can specify a rule based on three types of "Object":

- ◇ **Location**. This object enables you to select locations either with defined boundary conditions or with imported cross-shore profile measurements.
- ◇ **Location offset**. This object type can be selected based on whether the location offset is greater than or less than a specific value.
- ◇ **Coastal area**. This allows locations to be selected (or ignored) based on whether they lie within one of the defined coastal areas.

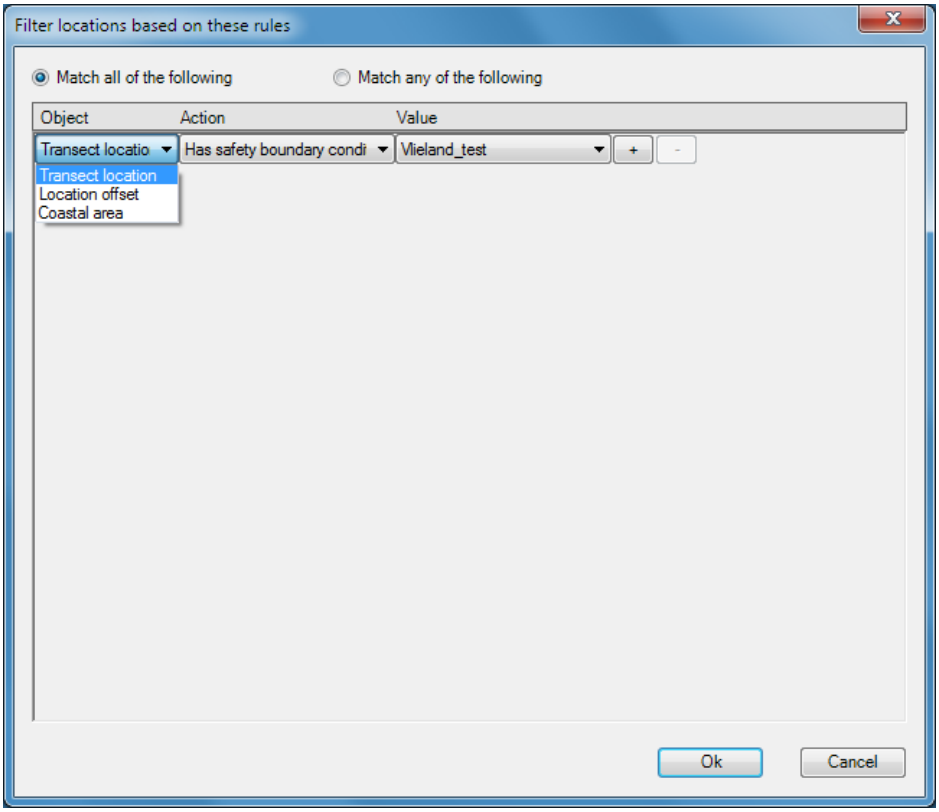


Figure 4.5: *Dialog for configuration of "filtering rules"*

4.5 Cross-shore profile measurements

A MorphAn workspace **Data** folder can be used to store cross-shore profile measurements. The **cross-shore profile measurements** subfolder is provided for this data, and can contain one or more sets of profile measurements. A set contains one or more cross-shore profile measurements and is therefore comparable to the contents of a .jrk file. You can select which set of cross-shore profile measurements is to be used as input to the models. This enables you to specify different variants of a dataset side by side in the same workspace, and to compare the analyses or calculations of those different sets with one another. MorphAn provides several places where you can use an import tool to fill or augment a dataset with measurements. The source data must always be supplied in a cross-shore profile measurement file

(*.jrk). Appendix A.4 provides a detailed description of this format.

There are two menus in MorphAn for management of cross-shore profile measurement sets, and both are activated with a right-click of the mouse. The first of these appears after a right-click on the **Cross-shore profile measurements** folder (see figure 4.6). The options in this context menu are as follows:

- ◇ **Open** - opens the document window for management of the various cross-shore profile measurement sets (see also section 6.3).
- ◇ **Create Empty** - creates a new set without adding measurements.
- ◇ **Import New...** - enables you to add a new set and immediately import the contents of a file (*.jrk. This option opens a file import dialog allowing you to choose the (*.jrk) file containing the data to be loaded.
- ◇ **Properties** - displays the properties of the selected set in the “Properties” tool window.

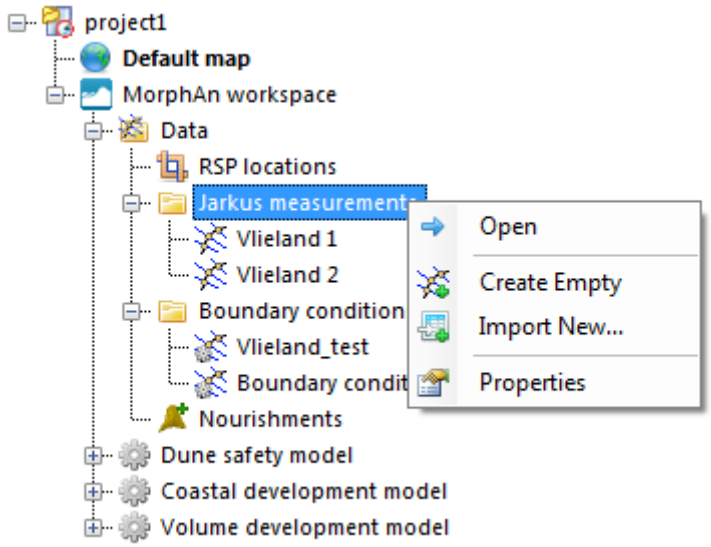


Figure 4.6: *Context menu for management of cross-shore profile measurement sets within a workspace*

The second type of context menu (see figure 4.7) appears when you right-click on one of the sets in the **Cross-shore profile measurements** folder. You can then choose from the following options:

- ◇ **Open** - opens the document window for the selected set of measurements. This is an output screen that enables you to perform an analysis or modify the data (see also Chapters 5 and 6).
- ◇ **Duplicate** - makes a copy of the current set. Use this option to modify an existing set and compare it with the original.
- ◇ **Extend** - launches a wizard with which you can add empty measurements for locations and years that do not yet have measurements included in the set. These empty measurements can be input using the “Editor” (see subsection 6.4).
- ◇ **Import...** - imports additional cross-shore profile measurements into the selected set. A dialog box will appear, allowing you to select the file containing data to be imported.
- ◇ **Export ...** - exports the measurements in the selected cross-shore profile measurements set to a file in .jrk format. A dialog box will appear, allowing you to specify the file name and folder for saving the data.
- ◇ **Delete** - deletes the selected set from the “Cross-shore profile measurements” folder (option shown only if there is more than 1 set in the folder).

- ◇ **Rename** - to change the name of the selected cross-shore profile measurements set (you can also press F2 when the set is selected)
- ◇ **Properties** - displays the properties of the selected set in the “Properties” tool window.

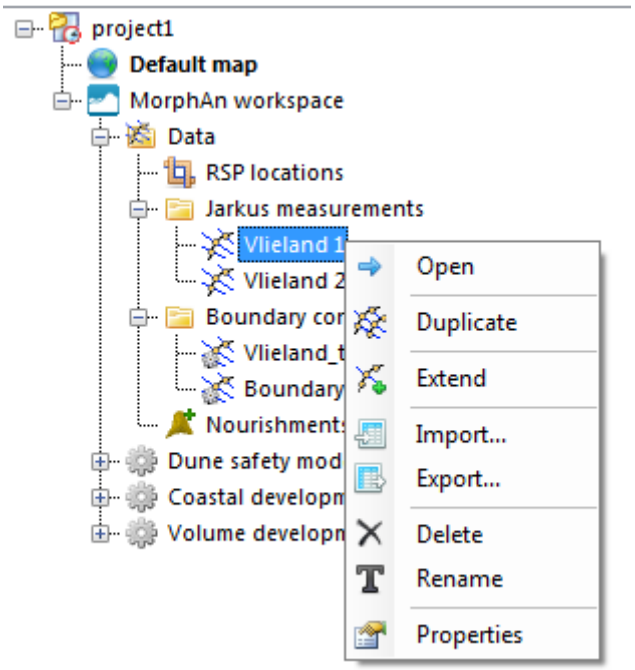


Figure 4.7: *Context menu for management of cross-shore profile measurement sets within a workspace*

4.6 Boundary conditions

A workspace also contains input data for use when running models. Just as with the cross-shore profile measurements (see section 4.5), you can also manage multiple sets of these **Boundary conditions**. When you right-click on the **Boundary conditions** item or one of the subitems in the **Project explorer**, the menus and their options are similar to those of the cross-shore profile measurements (figures 4.6 and 4.7). The format of a boundary conditions input file is described in appendix A.5.

When you double-click on one of the boundary condition sets (or select **Open** in the right-click context menu), the Boundary conditions view opens for the selected set of boundary conditions in the document window (figure 4.8). This view shows a table with all boundary conditions that are present in that set. You can use the filter selection drop-down list above the table to view only the boundary conditions needed for a certain model. The figure above the table shows (if possible) a visualization of the boundary conditions for the coastal location selected in the table.

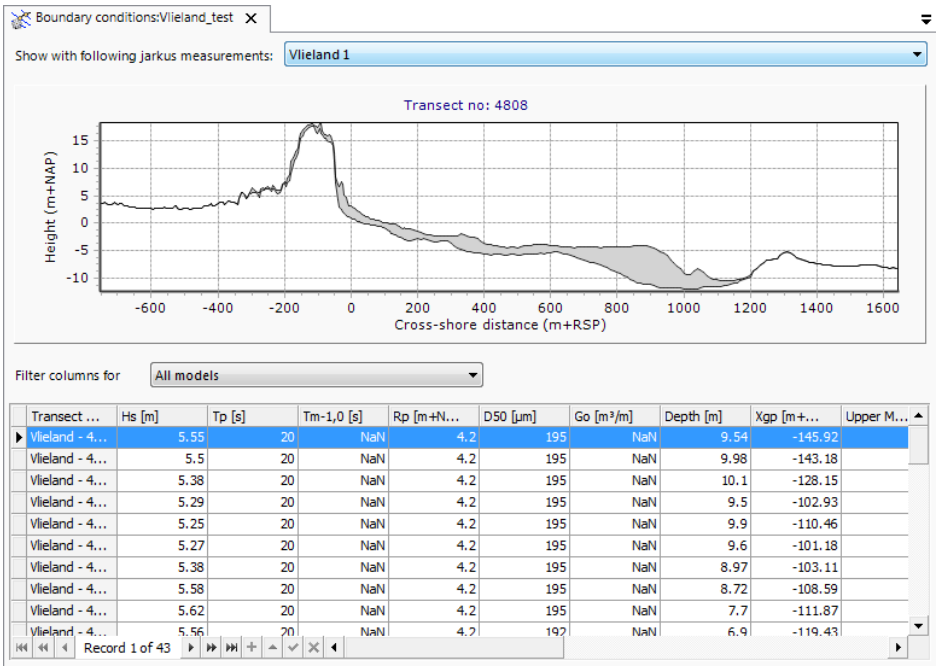


Figure 4.8: *Typical document window view for visualization or modification of a boundary condition set*

4.7 Grid measurements

In MorphAn 1.4 and later, it is possible to import and add time-dependent grid measurements to the MorphAn workspace. MorphAn enables you convert the grid measurements to cross-shore profile measurements, for subsequent analysis in a bank analysis model.

The grid measurements can be imported using an import wizard. To start this wizard, in the **Project Explorer** right-click **Data** (see left in figure 4.9), then click **Import...** in the context menu. In the dialog box that appears, select data type **Time-dependent regular grid** or **WCS (Internet)**, and confirm by clicking **OK** (see right in figure 4.9). You can also start the wizard by right-clicking **Grid measurements** in the **Project Explorer**, then clicking **Import New...** in the context menu.

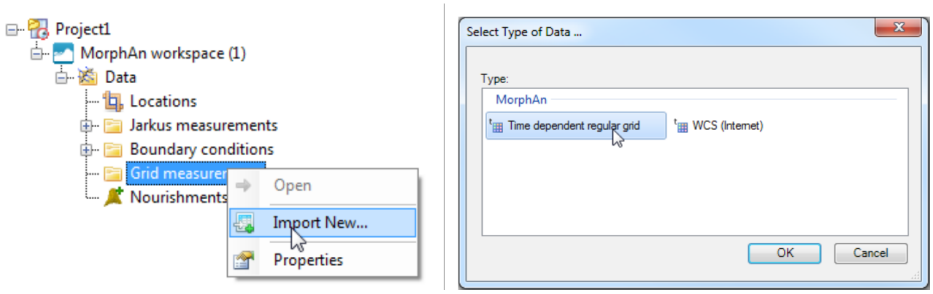


Figure 4.9: *Option* ***Import new...*** *for* ***Grid measurements*** *left, and* ***Select Type of Data...*** *right*

Click Next in the wizard welcome screen, and you will then see the “Import time dependent regular grid” screen (see figure 4.10). This is where you identify the files to be imported, and set a grid time per file.

◇ **1**) Click the **Add files** button to select the files. These appear in the table below the button.

- ◇ **2**) If you do not wish to select all files in the table (default is select all), then you should now select the files you wish.
- ◇ **3**) Set the start time with a time step and time units, then click the **Set grid time(s)** button.
- ◇ **4**) Click **Next** to continue.

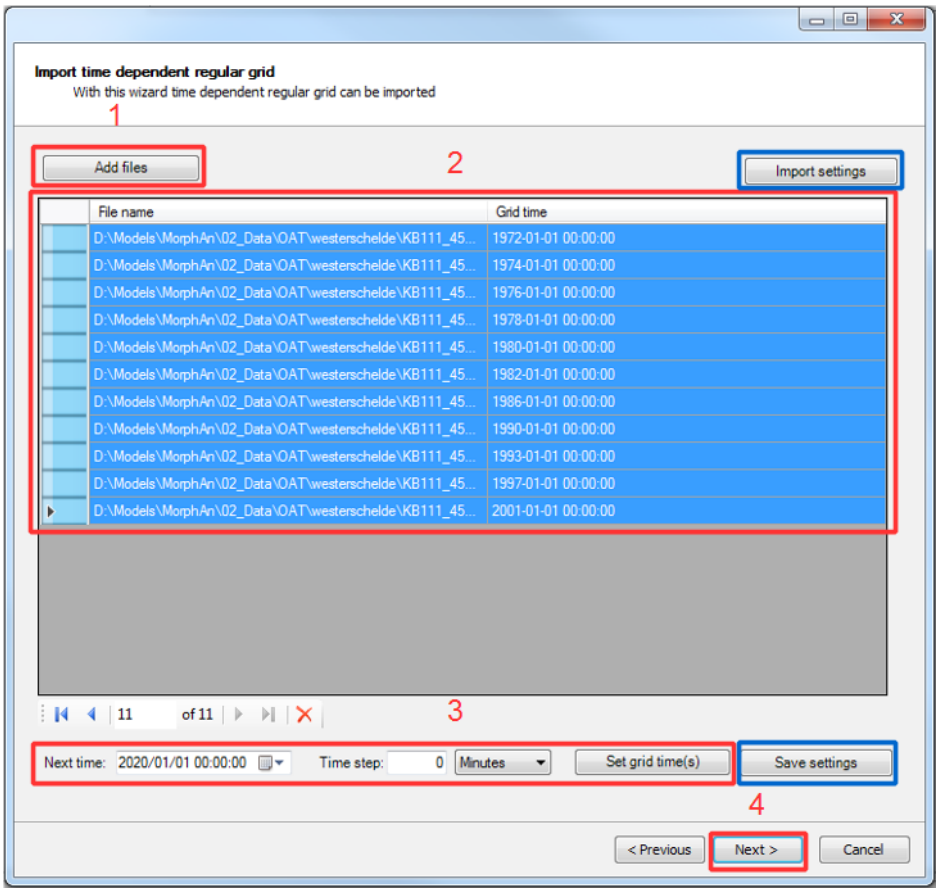
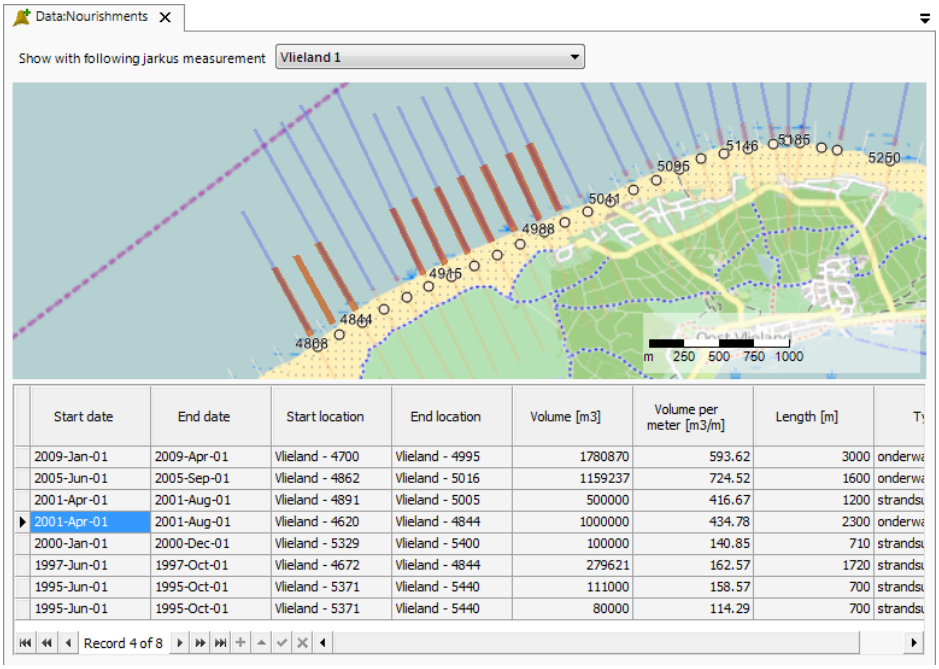


Figure 4.10: *Wizard screen for selection and time settings of the files to be imported as a grid measurements set*

The final screen of the wizard will now appear. Click **Finish** to close the wizard. The files are imported and added to a grid measurement set. This set is now included below the **Grid measurements** subfolder of the **Project explorer** window. See section 5.3 for the selection and visualization of the grid measurements.

4.8 Nourishments

Information can also be added to a workspace describing the time period and volume of any applicable nourishments that have been performed. To add nourishment data, right-click on the **Data** folder (or the **Nourishments** subfolder), then choose *Import...* in the context menu, and in the ensuing dialog select one of the *Nourishments* importers (.csv or .nc). The importer will then list the data under the **Nourishments** item. The “Nourishments” data will be shown in its own document window view, but also in the relevant charts and maps (this can be switched on and off in the **Map** or **Chart** tool window). The information is displayed where relevant, such as in the input and output screens of model calculations. The file format for nourishments import is described in section A.6 and section A.7.



Start date	End date	Start location	End location	Volume [m3]	Volume per meter [m3/m]	Length [m]	Ty
2009-Jan-01	2009-Apr-01	Vlieland - 4700	Vlieland - 4995	1780870	593.62	3000	onderwa
2005-Jun-01	2005-Sep-01	Vlieland - 4862	Vlieland - 5016	1159237	724.52	1600	onderwa
2001-Apr-01	2001-Aug-01	Vlieland - 4891	Vlieland - 5005	500000	416.67	1200	strandsu
2001-Apr-01	2001-Aug-01	Vlieland - 4620	Vlieland - 4844	1000000	434.78	2300	onderwa
2000-Jan-01	2000-Dec-01	Vlieland - 5329	Vlieland - 5400	100000	140.85	710	strandsu
1997-Jun-01	1997-Oct-01	Vlieland - 4672	Vlieland - 4844	279621	162.57	1720	strandsu
1995-Jun-01	1995-Oct-01	Vlieland - 5371	Vlieland - 5440	111000	158.57	700	strandsu
1995-Jun-01	1995-Oct-01	Vlieland - 5371	Vlieland - 5440	80000	114.29	700	strandsu

Record 4 of 8

Figure 4.11: *Nourishments visualization in the document window (example)*

5 Analyze data

5.1 Introduction

MorphAn analyzes the data based on profiles with measured values (profile measurements). Cross-shore profile measurements are stored in their own data folder. MorphAn's tools for analysis of this data are discussed in the following section (5.2). In addition, MorphAn provides features for importing time-dependent grid measurements and converting these to cross-shore profile measurements for the purpose of analysis. Grid measurements and their analysis are discussed in section 5.3.

5.2 Cross-shore profile measurements

5.2.1 Open an analysis window

Data can be analyzed in various windows. To access the various types of visualization, open the document window of a set of cross-shore profile measurements (double-click one of the sets or right-click → Open, see also section 4.5). The resulting window (Figure 5.1) shows a map and two lists. You can select the locations you wish to visualize from the Locations list. After you have made a location selection, the years for which there are measurements will be shown in the Years list. After you have made a selection of years, six buttons are enabled in the **Data** tab of the ribbon, which you can then use to open analysis views of the selected information (see also Figure 5.2). Each of these buttons can be used to open a new window for a different analysis of the selected data.

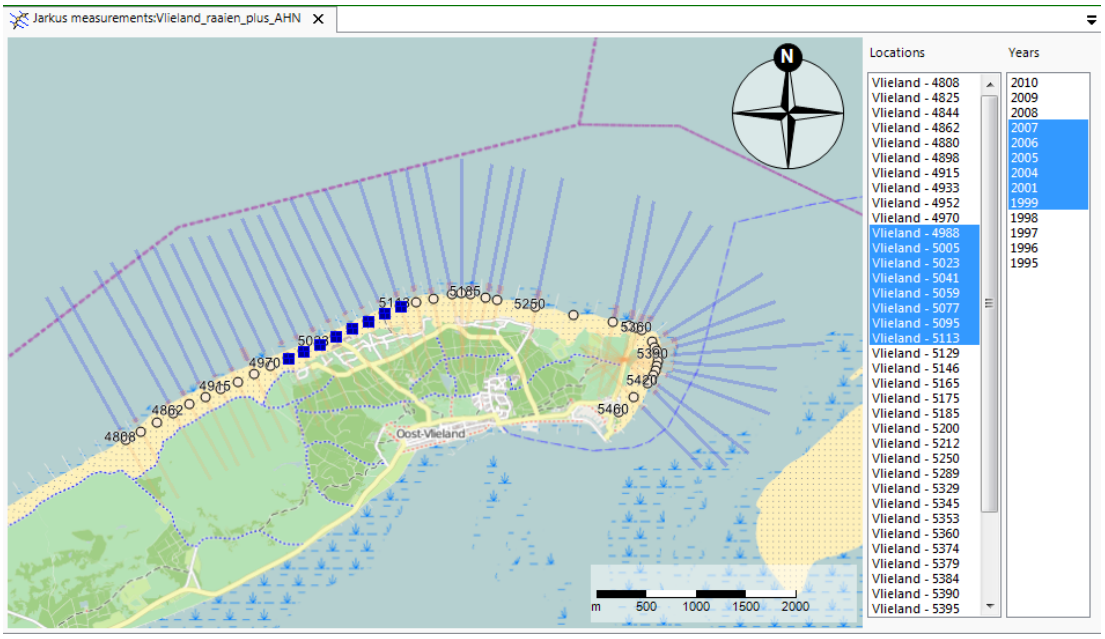


Figure 5.1: *Typical selection screen for analysis of profile measurement data. This screen enables locations and years to be selected for analysis using one of the options in the ribbon. This example shows the selection of a data set from the Vlieland coastal area.*

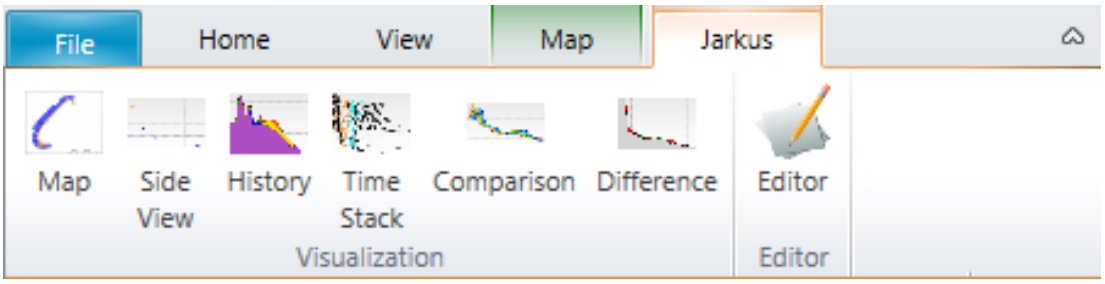


Figure 5.2: *Data tab in the ribbon from which various analysis windows can be opened*

The available windows are:

- Map
- History
- Time Stack
- Difference
- Comparison
- Side View

The windows are explained separately in the following subsections.

5.2.2 Map

The **Map** gives you a geographical view of the data of all available transects. The map only shows measurements with a specific date. You can use the Time Navigator to step through the data over time (see also subsection 3.2.9). The map can be modified or extended with other information (e.g. from shapefiles, or by using WMS layers). For more details, see subsections 3.2.5 and 3.2.6.

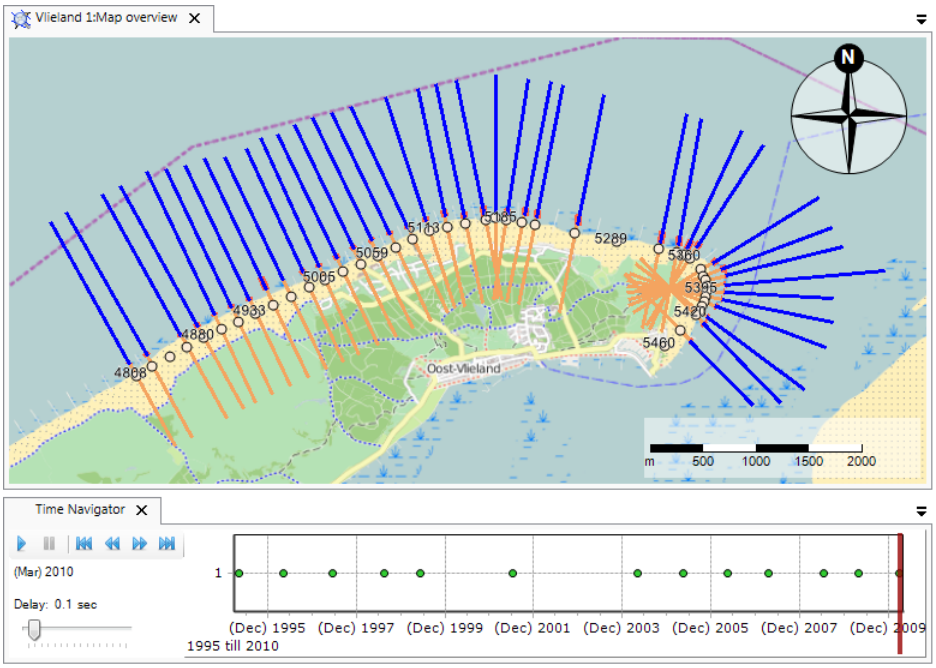


Figure 5.3: *Typical map analysis window with the Time Navigator tool window shown below, for navigating through time. This example shows selected measurements around Vlieland.*

5.2.3 History

The **History** window (Figure 5.4) shows a chart of measurements for a single location as overlaid areas, enabling you to analyze the development over time. You can omit certain years by checking the boxes beside each year in the Chart tool window (not shown in Figure). The charted location can be selected in the left side column of the history window. The chart then shows all measurements in the selected years for that location. The most recent measurement of the selection is displayed as a thick line to indicate the maximum. You can choose a palette of colors for the measurement series using the Color Scale button in the **Chart** tab of the ribbon. To adjust the color and style of the series or an individual year, first select the item in the **Chart** tool window, then its properties in the Properties tool window. This way you can optimize the chart for your analysis.

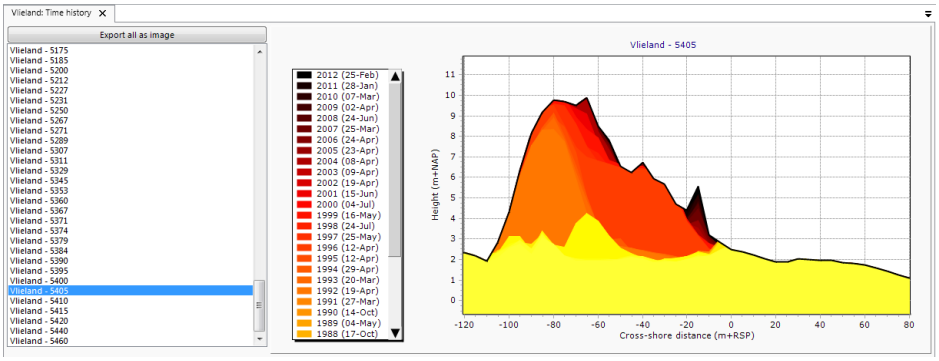


Figure 5.4: *Typical History analysis window*

5.2.4 Time Stack

The **Time Stack** window (Figure 5.5) shows the profiles of the selected locations for successive years. As with the History window, only a single location can displayed in the Time Stack window. This allows you to view the development of a particular part of the coast over time. To make the analysis easier, you can set two colors to highlight certain specific height zones in the profile.

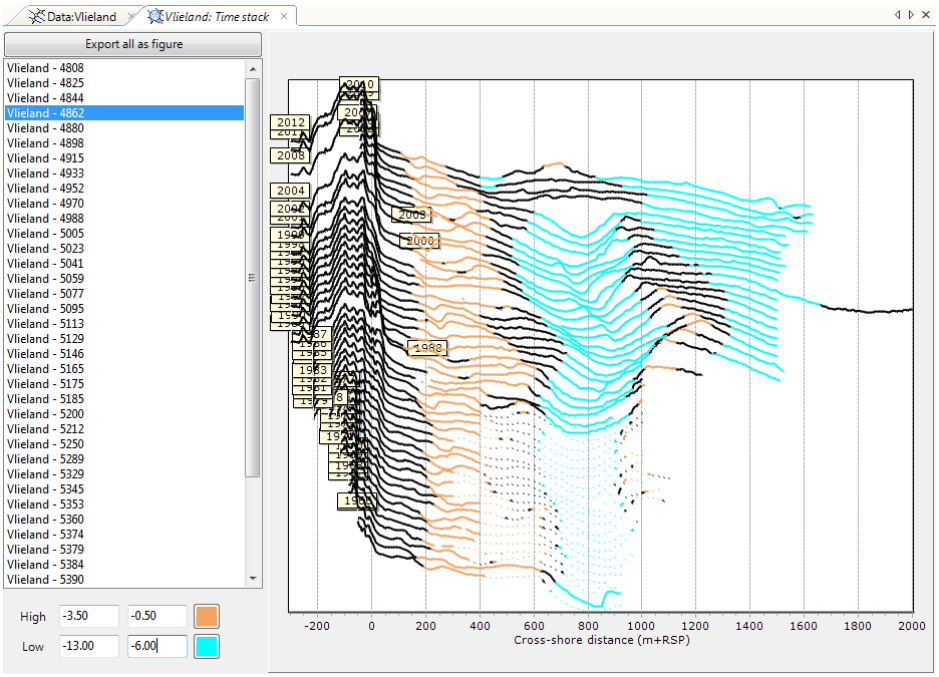


Figure 5.5: *Typical Time Stack analysis window*

5.2.5 Difference

The **Difference** window (Figure 5.6) charts the difference between the profiles of two different years at a selected location. You can change the length of this period using the Time Navigator (see also subsection 3.2.9). To change the dates of the first and last measurement in the period, simply drag the left and right edges of the slider in the Time Navigator. The colors are based on the difference between the two selected years in the navigator. Accretion (height of last measurement increased relative to first measurement) is shown as a green area; erosion (last measured height decreased relative to first) is shown in red.

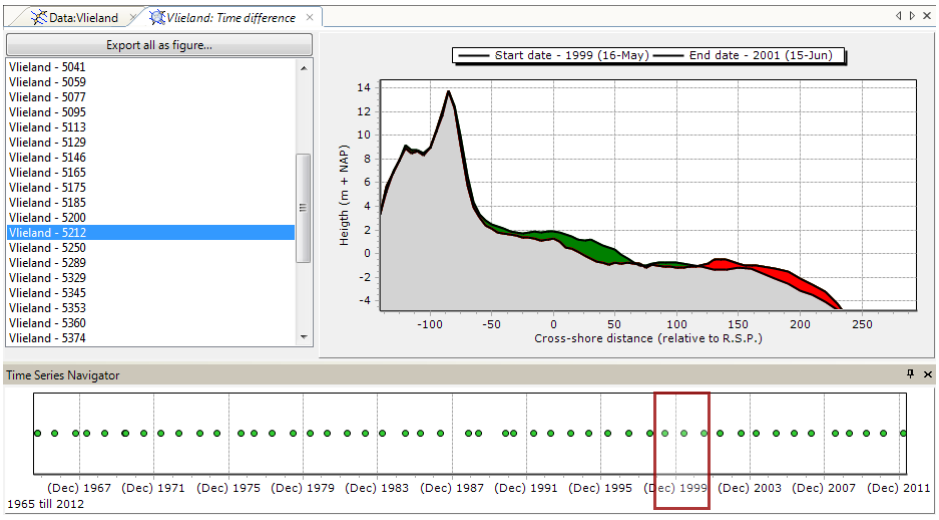


Figure 5.6: *Typical Difference analysis window showing also the Time Navigator tool window that can be used to set the analysis period.*

5.2.6 Comparison

The **Comparison** window (Figure 5.7) enables you to compare the profiles of different years for a single location, or the profiles of different locations for a single year. This window likewise provides a facility to optimize the legibility of the chart by selecting an alternative color scale in the **Chart** tab of the ribbon.

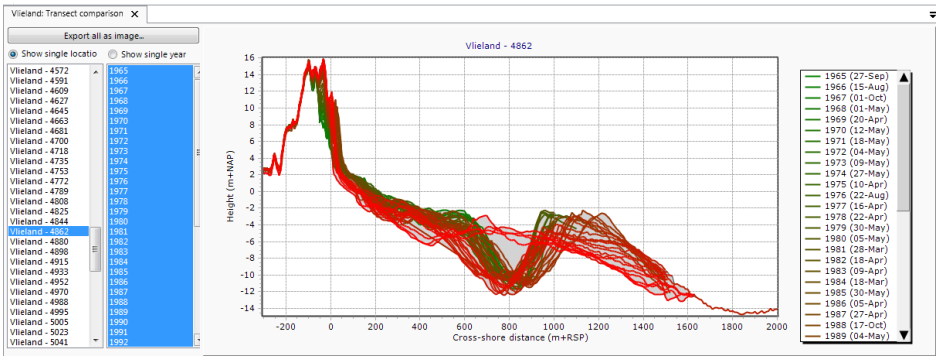


Figure 5.7: *Typical Comparison analysis window*

5.2.7 Side View

The **Side View** window shows the profile at the selected locations based on all individual measurements that together make up the profile measurement (see Figure 5.8). The colors indicate the type of measurement or the part that has been interpolated. Move the slider in the Time Navigator to go forwards or backwards in time through the data. The list to the left of the chart enables you to view transect data at a different location.

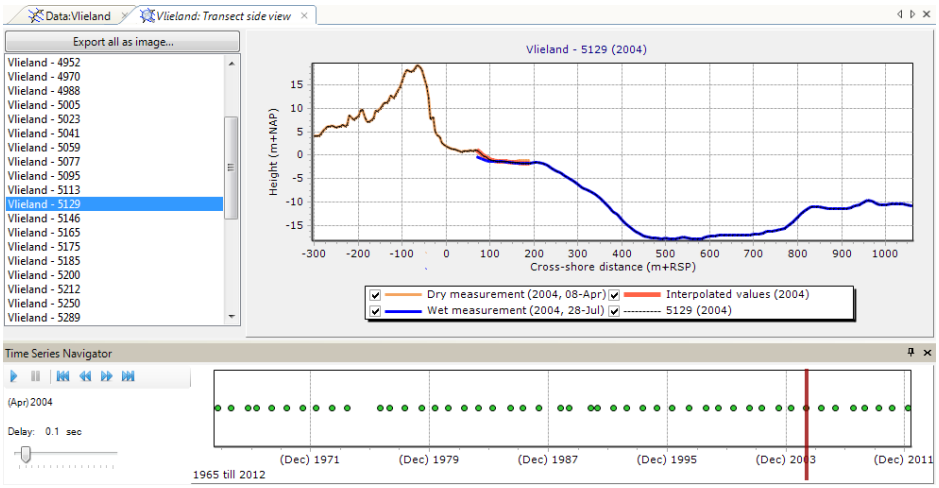


Figure 5.8: *Typical Side View analysis window with the Time Navigator tool window below.*

5.3 Grid measurements

To visualize grid measurements, double-click on a grid measurement set, or right-click a grid measurement set to open the context menu, then select **Open**(see Figure 5.9). The height visualization will initially be displayed. To hide the height visualization, uncheck the box beside **Height** in the Map toolbox window. To display the visualization of height, (sea)bed slope, or difference in height between two moments in time, simply check the box (see Figure 5.9) beside **Height**, **Slope** or **Difference**. These options are further explained below.

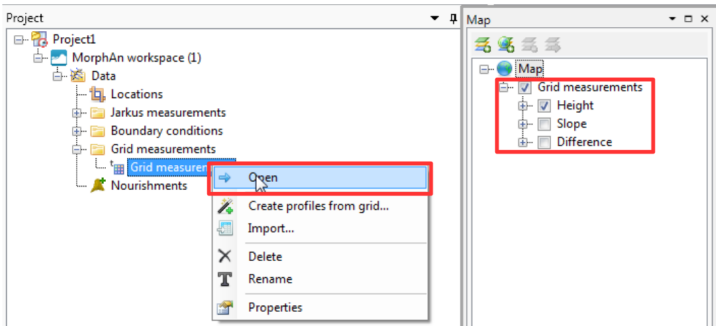


Figure 5.9: *Left, opening the visualization of grid measurements. Right, selecting different visualizations in the* ***Map*** *tool window*

5.3.1 Height

To visualize the heights of grid measurements, open the grid measurements, then check the **Height** box in the **Map** tool window. Use the Time Navigator (see subsection 3.2.9) to visualize the height for different periodic measurements.
Figure 5.10 shows a map window in which different heights are visualized.
The different heights displayed in the Figure are taken directly from the grid measurements.

No further calculations have been performed.

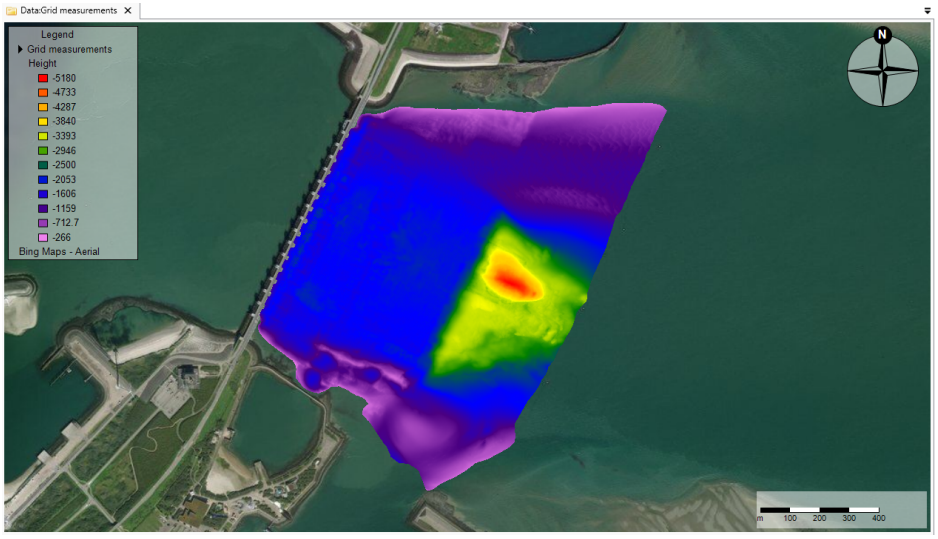


Figure 5.10: *Typical map display showing different heights.*

5.3.2 Slope

To visualize the slope of the beach or seabed, open the grid measurements (if not already open), then in the **Map** tool window, check the **Slope** box and uncheck the other visualizations (e.g. **Height**). Use the Time Navigator (see subsection 3.2.9) to visualize the bed slope for different periodic measurements. Figure 5.11 shows a map window in which the bed slope is visualized.

There are various methods for calculating the slope. To modify the calculation method, click on the map layer “Slope” in the Map tool window. MorphAn will display the properties of the selected map layer (see also Figure 5.12). The field “Distance for slope calculation” allows you to enter a value for MorphAn to apply when calculating a slope on the (sea)bed. Starting from a cell, MorphAn will look at the depth at the specified distance in surrounding cells, and divide the depth difference by the specified distance. You can choose an alternative “Method” to set the directions for inspecting surrounding cells. Methods such as “Right” or “Left” look exclusively in one direction and are therefore quick. The “Circle” method looks at all relevant cells, and is therefore more accurate, but it can be slow. To avoid a long wait, you can also opt for the method “Circle with maximum number of directions”. This tells MorphAn to calculate and display the maximum (sea)bed slope in no more than the specified number of directions. If the circle with specified radius circumscribes more cells than the maximum number of directions, MorphAn will divide the directions proportionally up to the maximum over the circle.

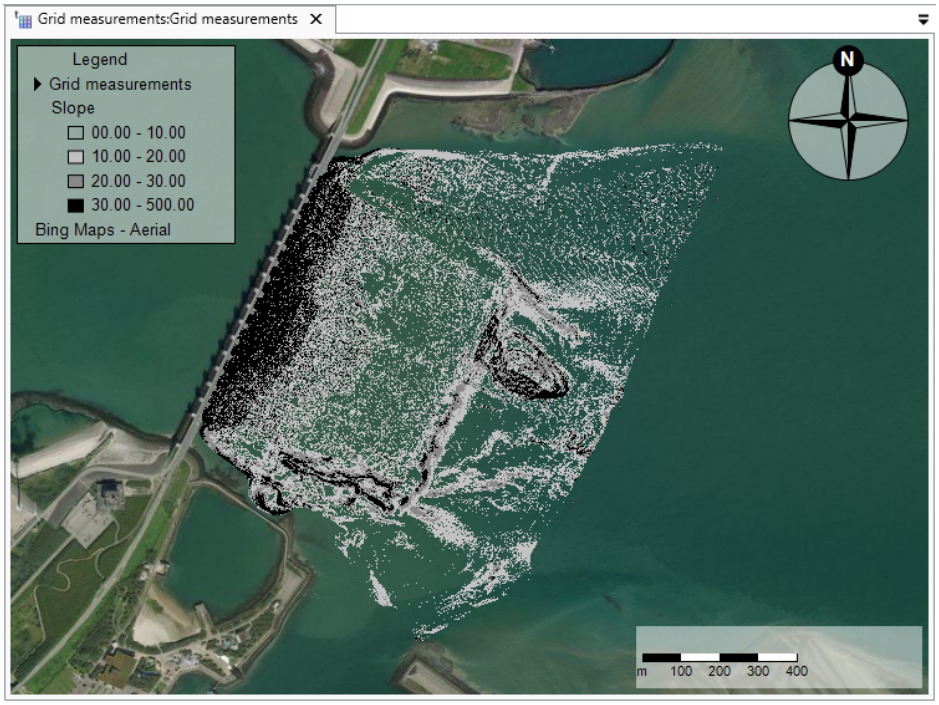


Figure 5.11: *Typical map display of the calculated slopes.*

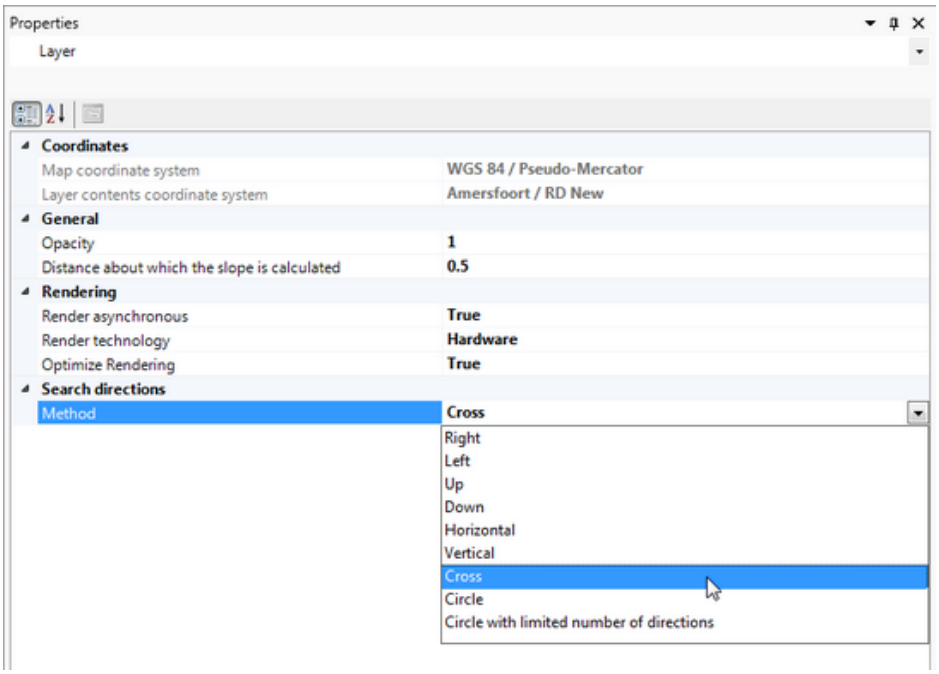


Figure 5.12: *Typical properties of a "Slope" map layer.*

5.3.3 Difference

You may wish to see what has happened to the bed height over time (Figure 5.13), or perhaps check whether, how and where nourishments or bed protection have been performed (figure 5.14). MorphAn can make a visualization of the difference in bed height over time to help you with this kind of analysis.
To visualize the height difference between two periodic measurements, open the grid measurements (if not already open), then in the **Map** tool window, check the **Difference** box and uncheck the other visualizations (e.g. **Height** and **Slope**).

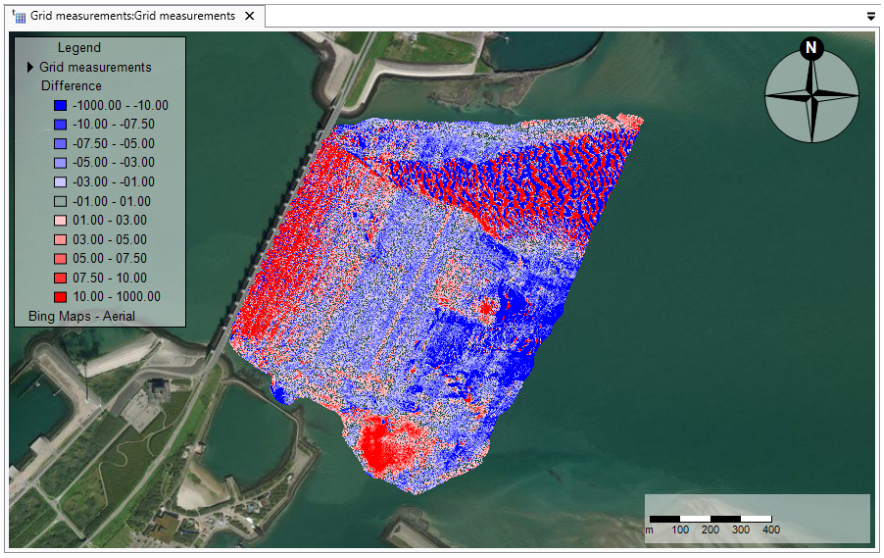


Figure 5.13: *Typical map display of the change in height between two moments in time.*

The difference in height between times t1 and t2 is calculated by subtracting the height of time t1 from that of time t2.
Use the Time Navigator (see subsection 3.2.9) to specify a time interval. The difference is calculated between the first and last measurement in the selected time interval.

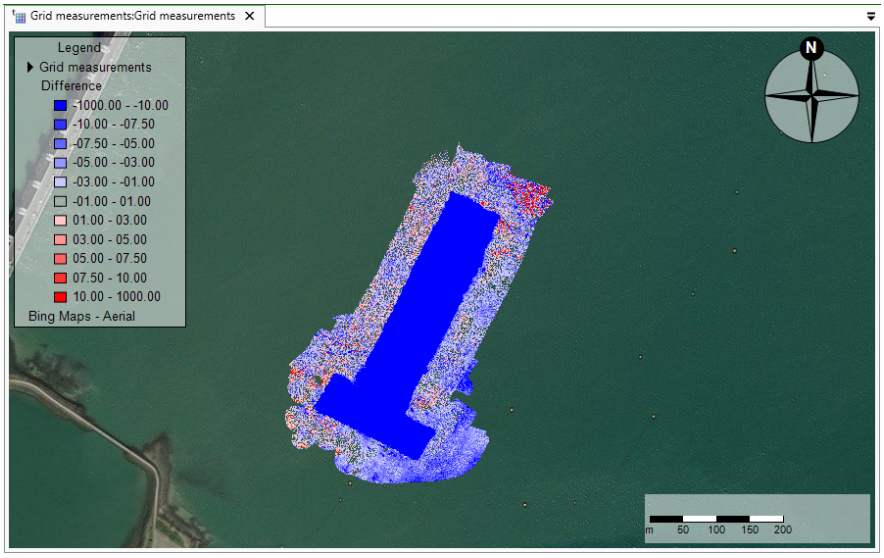


Figure 5.14: *Visualization of the difference in bed height due to a nourishment*

5.3.4 Show all grid measurements

It is also possible to display all height data from the various grid measurements on a single map. n the “Data” folder of a MorphAn workspace, right-click on the “Grid measurements” folder, then select “Open” in the context menu. A map will open showing all grid measurements.

6 Manage and edit data

Chapter 5 described various ways to analyze the data added to a MorphAn workspace. In our experience it is often also necessary to be able to edit data and assemble custom sets of transect measurements. This chapter addresses the features available in MorphAn for editing:

- Locations
- Boundary conditions
- Sets of cross-shore profile measurements
- Cross-shore profile measurements

6.1 Manage locations

When you double-click on the **Locations** Item in the **Data** folder of the MorphAn Workspace, a selection dialog will appear (see Figure 6.1). This dialog asks whether you wish to open the **Locations (filter)** view or the **Locations (manager)** view. The Locations (manager) view (see Figure 6.2) enables you to manage coastal locations. In this window you can add new locations, edit existing locations, or even remove locations. This section discusses this window in detail.

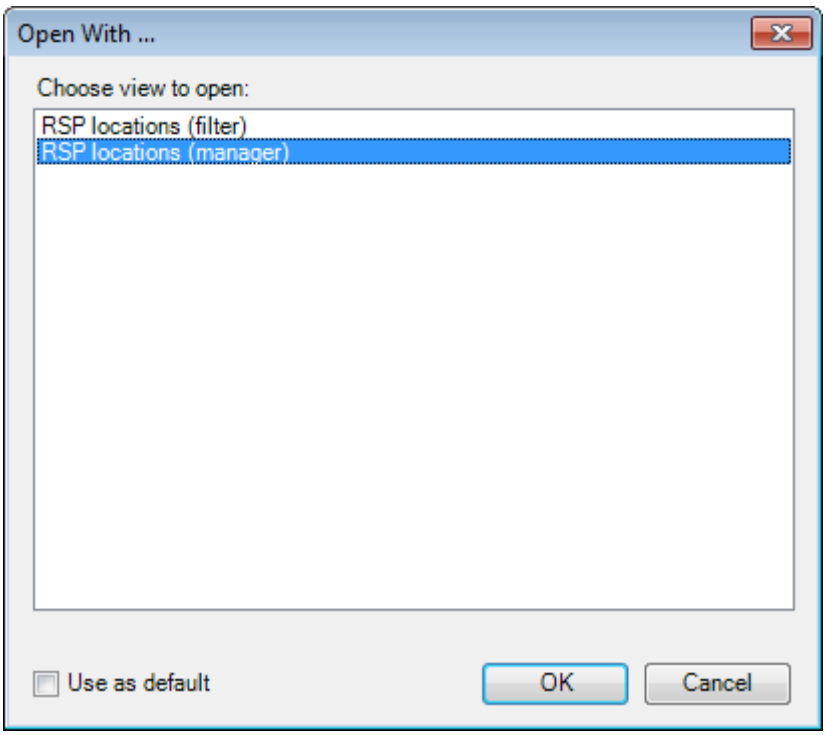


Figure 6.1: *The dialog in which the user can choose to open the Location (filter) or the Locations (manager) view*

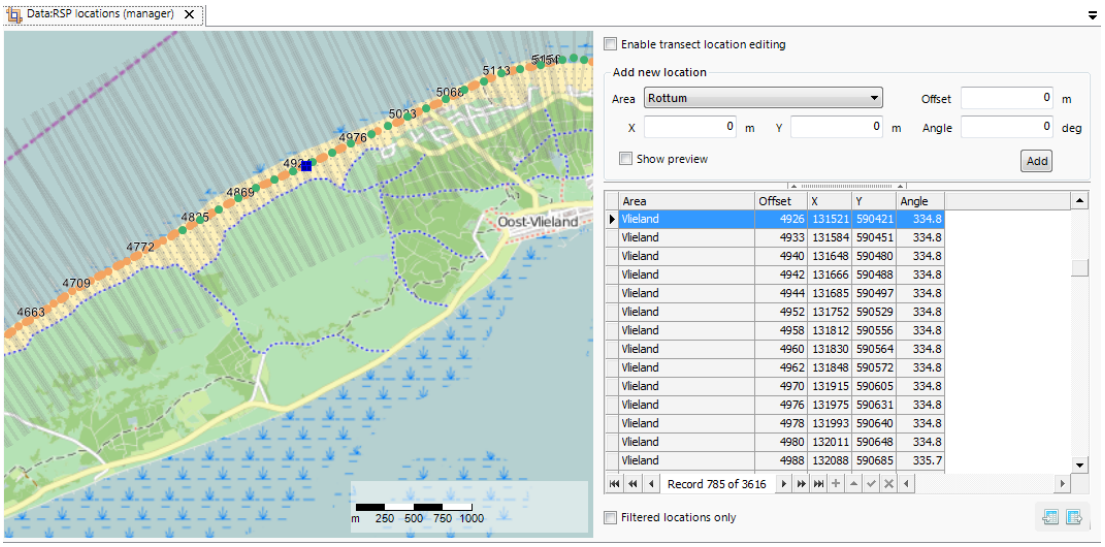


Figure 6.2: *Typical Locations (manager) window.*

When the screen first opens, locations can only be added. There are three ways to add locations:

◇ **Use the form in the window** - enter data directly in the “Add new location” form on the right side of the Locations (manager) view. You can enter the following information (see Figure 6.3):

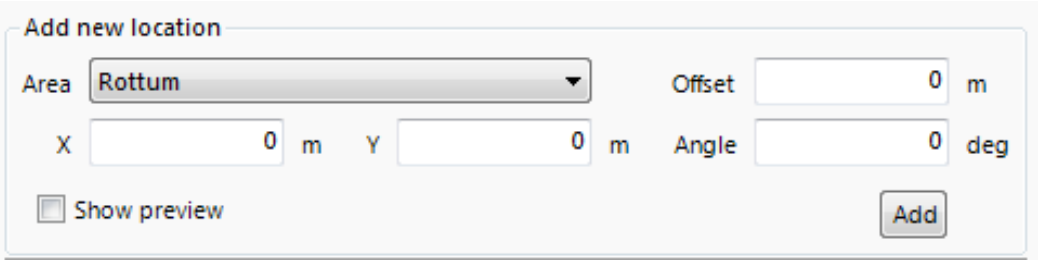


Figure 6.3: *“Add new location” form in the Locations (manager) window.*

- **Area** - coastal area to which the new location belongs
- **Offset** - offset of the new location from the zero point of the coastal area.
- **X** - The X coordinate (in RD) of the new location
- **Y** - The Y coordinate (in RD) of the new location
- **Angle** - The angle of the transect through the new location

When you click **Add**, the new location will be added to the coastal area.

◇ **Add single Location button** - Another method is to click on the “Location → Add Single Location” button in the **Map** tab of the ribbon. You can then click anywhere on the map. An entry dialog similar to Figure 6.4 will then open, showing the X and Y coordinates of the point clicked, with a coastal area, and an interpolated offset and angle of the transect. Edit this information as necessary, then click **OK** to add the new location.

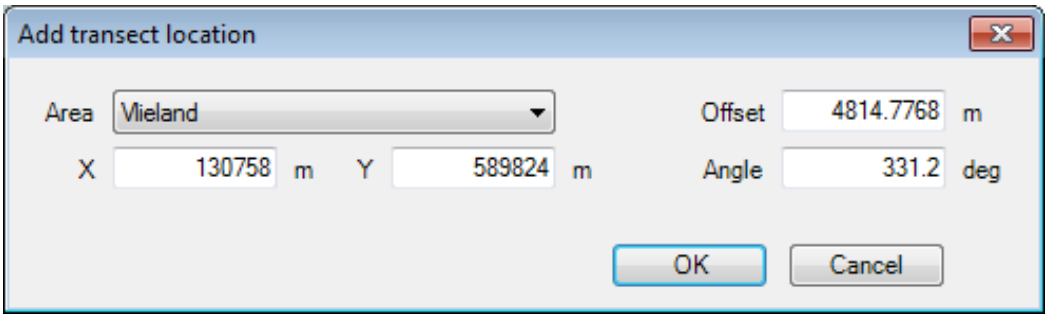


Figure 6.4: *Typical dialog that appears after clicking on the map using the shortcut: Add Single Location. This entry dialog allows you to edit the location data before it is added to the coastal area.*

◇ **Add Multiple Locations** - This method uses the second button in the "Locations" group of the **Map** tab of the ribbon to automatically generate interpolated transects. After you click "Add Multiple Locations", you will be prompted to select two locations on the map. After you have done this, a dialog like that in Figure 6.5 will appear. At this point you can still edit the selected locations if necessary. You can also enter either the number of locations to generate or the distance between locations, as well as how to handle duplicate locations (those whose coastal area and offset are identical to existing locations in the project). When you click **OK**, the locations are added to the workspace.

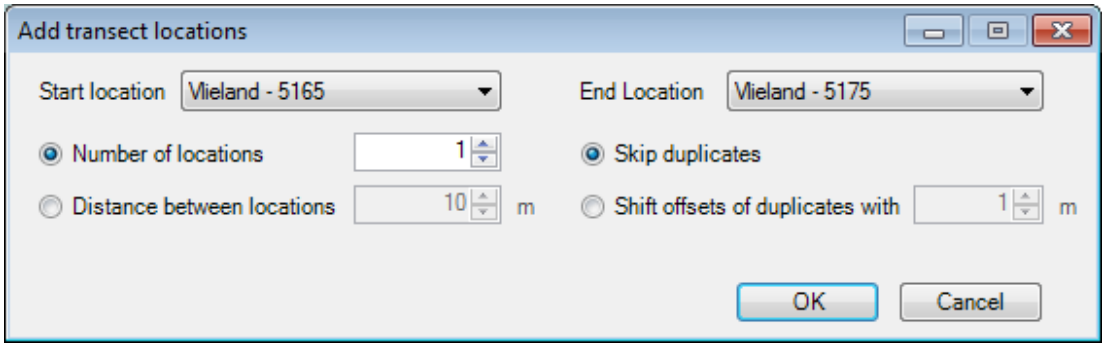


Figure 6.5: *Typical dialog that appears after selecting two locations on the map using the "Add Multiple Locations" shortcut.*

At the top of the window (Figure 6.2) you can choose whether locations may be modified or deleted. When you check this "Enable Location Editing" option, a dialog like that in Figure 6.6 will appear. This dialog warns you of the potential consequences of editing or removing locations. For example, it can cause the location filter to be updated, and related cross-shore profile measurements or nourishments could be removed. Moreover, editing locations can cause model results to be lost.

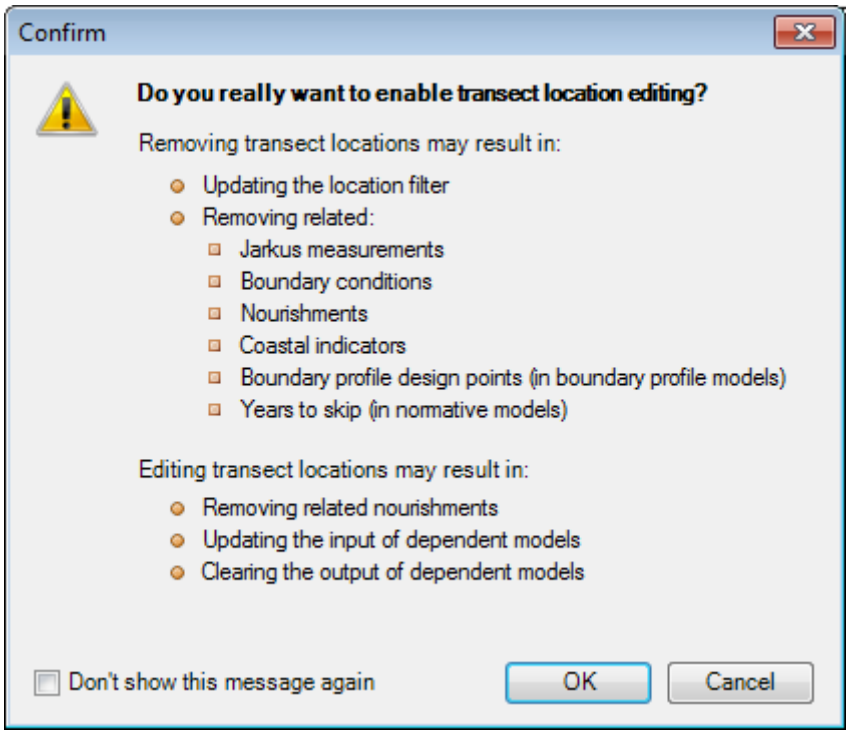


Figure 6.6: *Dialog that appears after checking the "Enable Location Editing" option. This dialog warns the user of the potential consequences of editing or removing locations.*

The last feature to be discussed here is the possibility to import and export locations using the buttons at the bottom of the window. This feature is similar to the Import and Export features described in section 4.4. Appendix A describes the file format for specification of transect locations.

6.2 Manage boundary conditions

The **Boundary conditions** folder in the **Project Explorer** window contains one or more sets of boundary conditions. When you add a model to the workspace, you can select boundary conditions from one of the sets in this folder. MorphAn provides features for organizing the existing sets. For example, you can create a new (empty) set, duplicate an existing set, rename a set, or add new boundary conditions to an existing set. These features work in the same way as those for organizing cross-shore profile measurement sets, as described in section 4.5.

6.3 Organize cross-shore profile measurements

The **cross-shore profile measurements** data folder in the **Project Explorer** window contains one or more sets of cross-shore profile measurements for use in models added to the workspace. The features you can use in the **Project Explorer** window to manage these sets were already described in section 4.5. When you double-click on the cross-shore profile measurements folder, the corresponding document window (see Figure 6.7) will open, with more options for managing sets of cross-shore profile measurements.

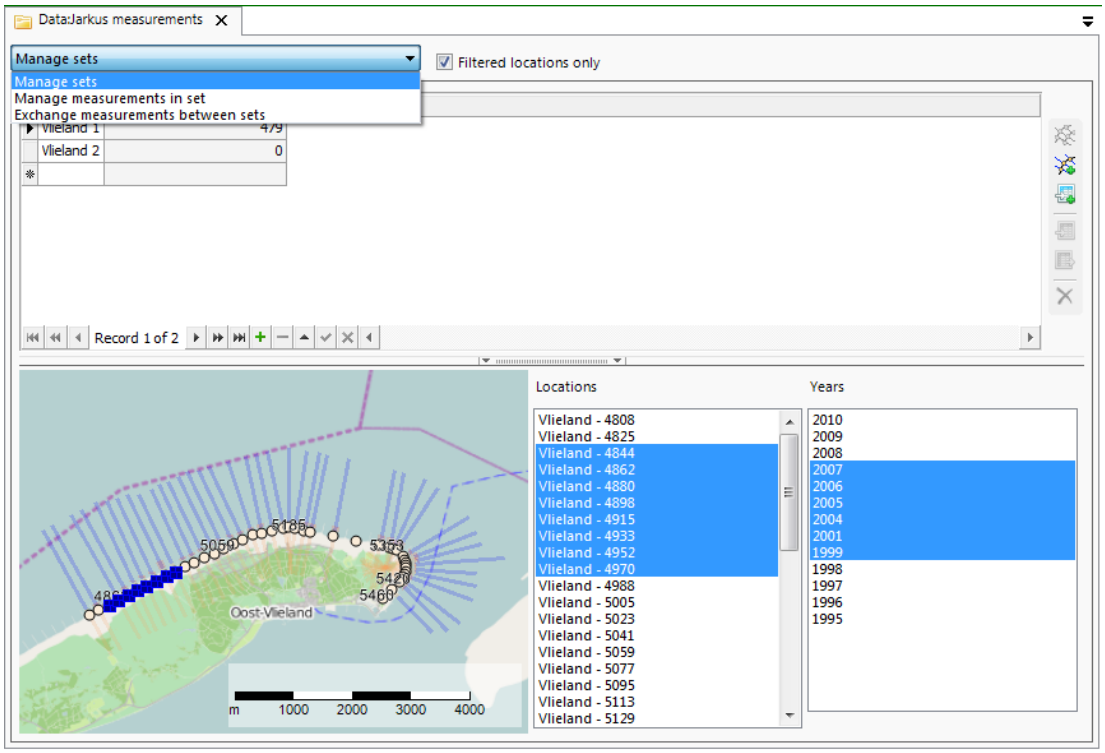


Figure 6.7: *Cross-shore profile measurements document window. In the upper left corner of the window is a drop-down menu from which you can choose the working mode of the window.*

In the upper left of this window is a drop-down menu that allows you to choose one of three working modes for the window:

- ◇ Manage sets - enables you to add, delete, duplicate or rename sets.
- ◇ Manage measurements in set - enables you to remove measurements from a set, extend a set with empty measurements, and import and/or export the coordinates of measurements.
- ◇ Exchange measurements between sets - enables you to copy individual measurements from one set to another.

These three different working modes are discussed further in the following subsections.

6.3.1 Manage sets

By default, the window opens in the “Manage Sets” mode (see Figure 6.8). In this mode, the user sees a table of the available cross-shore profile measurement sets, also stating the number of measurements present in each set. If the box “Filtered locations only” is checked, only those measurements compliant with the location filter (see section 4.4) are counted;

otherwise, the total is shown. On the right side of the screen you can see several action buttons (in certain cases they are active only when a set is selected). In addition, you can also rename a measurement set directly in the table. The buttons offer the following actions:

- ◇ **Duplicate selected set** → Adds a copy of the selected set of measurements.
- ◇ **Create empty set** → Adds a new (empty) set of measurements to the workspace.
- ◇ **Create set after import** → Imports measurements from a .jrk file (see Appendix A for a description of the format) and add a new set to the workspace with these measurements.
- ◇ **Import measurements to selected set** → Imports measurements from a .jrk file (see Appendix A) and adds these measurements to the selected (existing) set.
- ◇ **Export measurements from selected set** → Exports all measurements from the selected set to a .jrk file.
- ◇ **Remove selected set(s)** → Removes the selected set/sets from the workspace.

The lower part of the window shows a map for the selected set, together with the available cross-shore profile measurements. This screen works in a similar way to the analysis window of an individual measurement set (see subsection 5.2.1). It is therefore also linked to the **Time Navigator** (subsection 3.2.9), and after selecting one or more locations and years, you can open an analysis window from the **Data** tab in the ribbon.

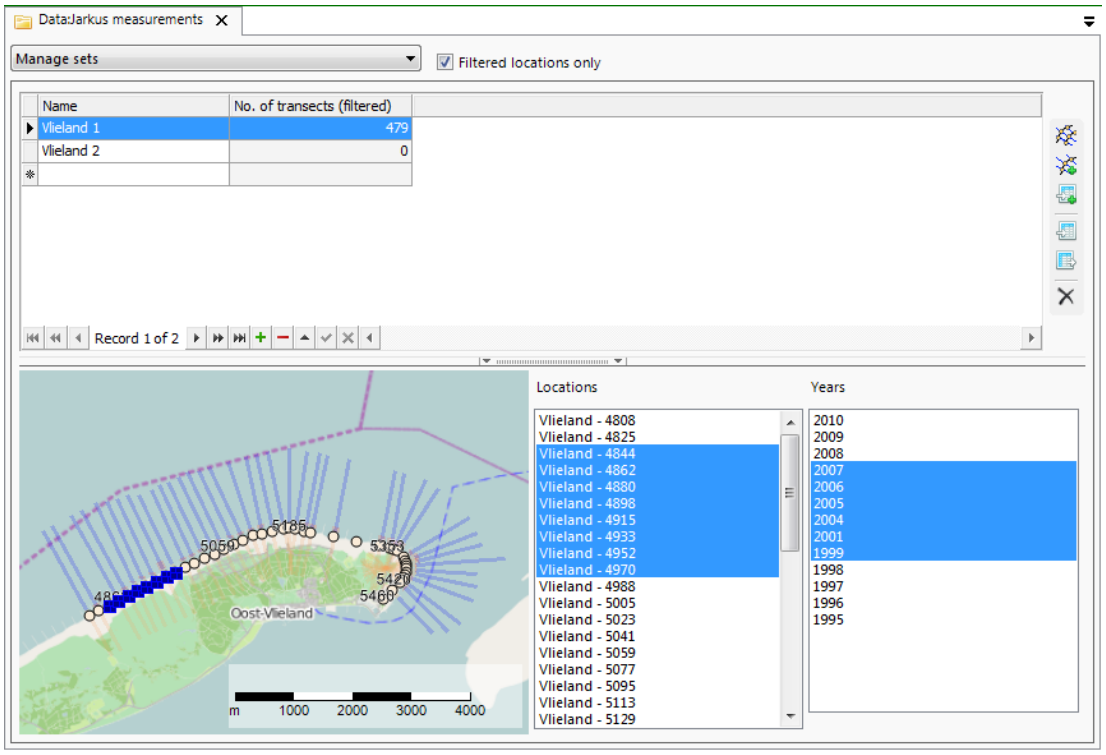


Figure 6.8: *Typical document window for the cross-shore profile measurements folder when "Manage sets" mode is set.*

6.3.2 Manage measurements in set

With the document window set to this mode, you can remove, add or replace one or more measurements in a set. The window then appears as shown in Figure 6.9. The window is now split horizontally, with a table of profile measurements below, and a preview of the selected measurement above. Above the preview you can select a cross-shore profile measurement

set from a drop-down list. The measurements from the selected set are listed in the table below. Depending on the selection in the table, buttons to the right of this table offer the following actions:

- ◇  **Extend set with empty measurement(s)** → Adds a new (empty) set of measurements to the workspace.
- ◇  **Import measurements from *.jrk** → Adds measurements to the set as defined in the *.jrk file (see Appendix A for more information regarding the format of the import file). This can cause “duplicate” measurements in the set (i.e. locations with multiple measurements for the same year). This in turn can give unexpected results during a model run. The removal of duplicate measurements is explained later in this section.
- ◇  **Import coordinates on selected measurement from *.csv** → Import coordinates from a *.csv file and apply them to the selected measurement. Any existing coordinates on that measurement will be discarded. The coordinates in the *.csv file must be specified in two columns (in meters). The columns must be separated by a semi-colon (;).
- ◇  **Export coordinates of selected measurement(s)** → Exports the coordinates of the selected measurements to a *.csv file. For each measurement, the file contains several headers that provide information about the measurement (location, year and measurement data) followed by two columns containing the X (distance) and Z (height) coordinates, both in meters. If multiple measurements are selected, then the next measurements are specified in the same way in the adjacent columns. Columns are separated by a semicolon (;).
- ◇  **Copy coordinates of selected measurement(s) to clipboard** → Replaces the contents of the Windows clipboard with the coordinates of the selected measurements. This has the same effect as e.g. the Copy (Ctrl+C) shortcut. You can then paste the coordinates directly into Excel (using the Paste button or Ctrl+V).
- ◇  **Remove selected measurement(s)** → Removes the selected measurement or measurements from the set of cross-shore profile measurements.

A set of cross-shore profile measurements might contain one or more duplicates. This means that two or more measurements are defined in the same location and for the same year. When MorphAn runs a model, it is assumed that there is only one profile measurement per year at the same location. Duplicate measurements can therefore lead to unexpected results. This window provides for the removal of duplicates. You first need to filter the measurements table to show only duplicate measurements. To do this, click the filter icon that appears when the mouse hovers over the heading of the “Duplicate” column. You now have the option to show only the rows in which this column is “Checked”. If this option is not available, then there are no duplicate measurements in the set. Next, sort the duplicate measurements by location (click on the heading above the “Location” column) or year. This simplifies the process of selecting the measurements that need to be removed. Lastly, click  **Remove selected measurement (s)** to discard the unwanted duplicates.

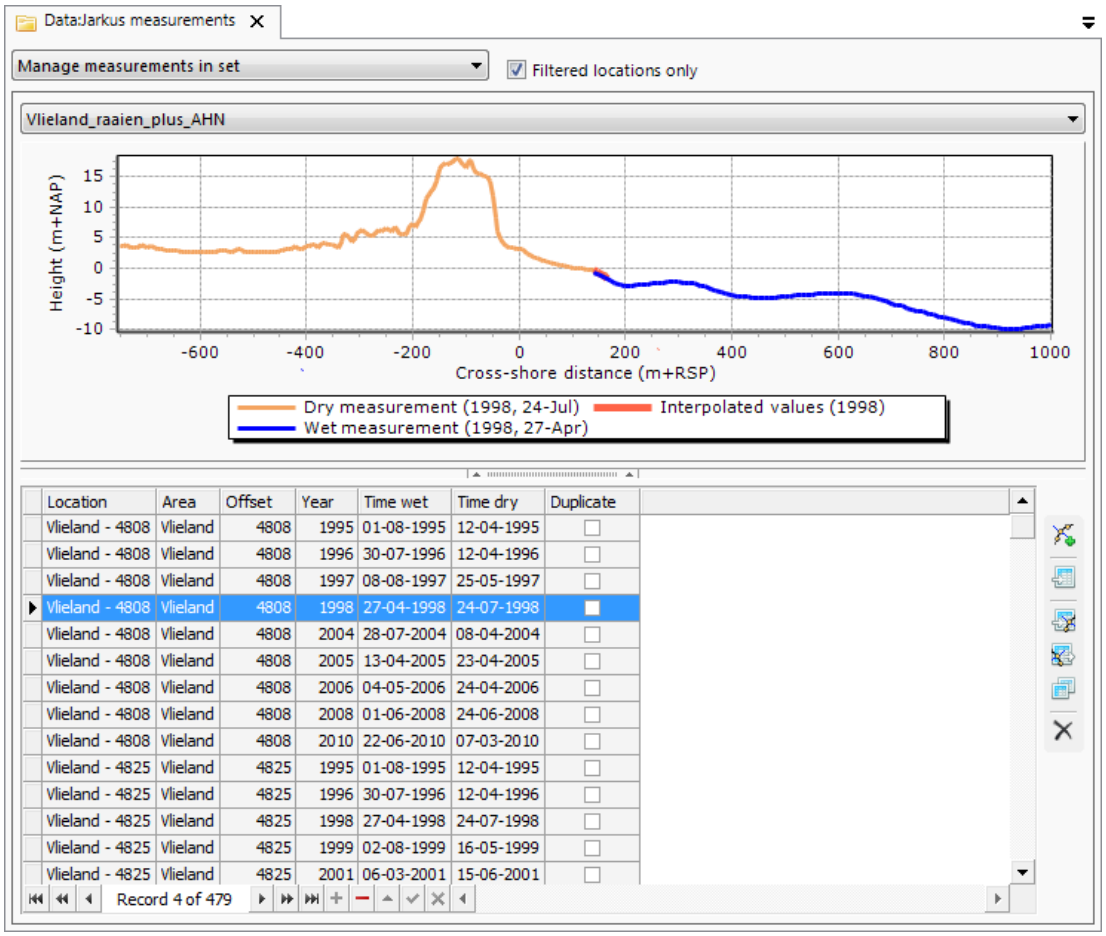


Figure 6.9: *Typical document window for the cross-shore profile measurements folder when "Manage measurements in sets" mode is set*

6.3.3 Exchange measurements between sets

The third mode of this document window enables you to copy measurements from one set to another. When this mode is chosen, the window appears as shown in Figure 6.10. The window contains two tables of measurements (two sets), each headed by a drop-down menu for selection of the displayed set. You can copy selected measurements from one set to the other (use the single arrow to copy left to right, or right to left); or you can copy *all* measurements from one set to the other (use double arrows).

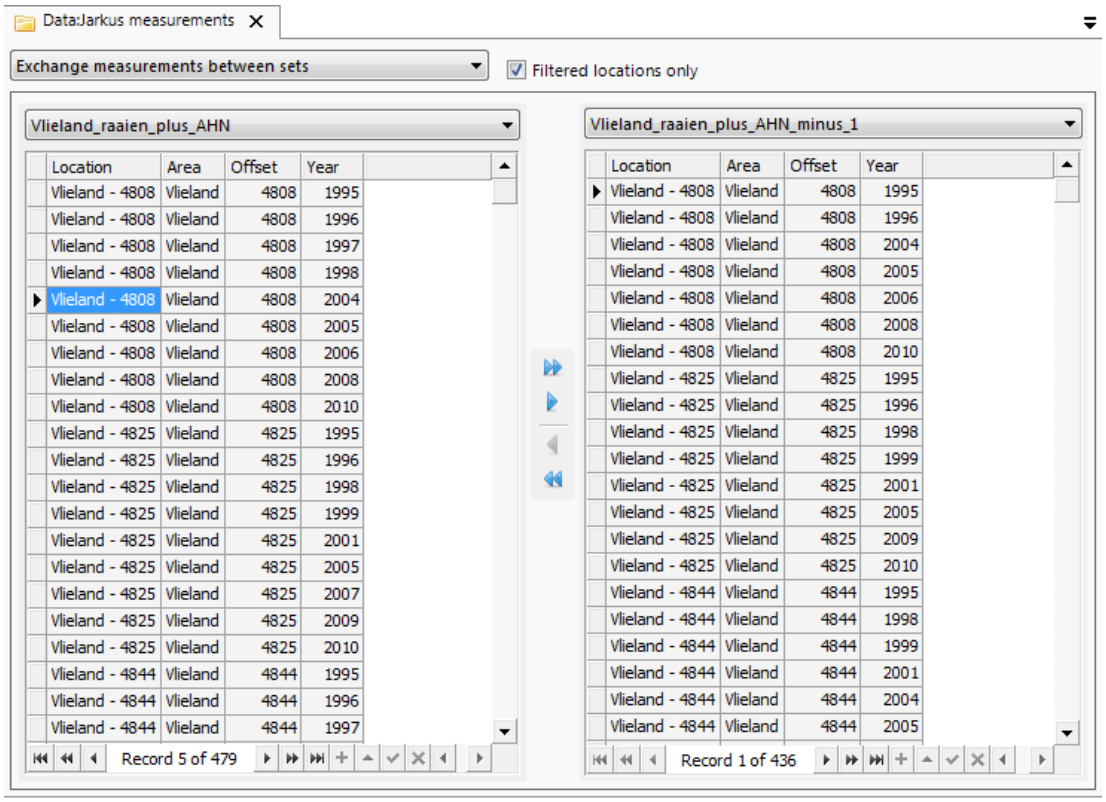


Figure 6.10: *Typical document window for the cross-shore profile measurements folder when "Exchange measurements between sets" mode is set*

6.4 Edit cross-shore profile measurements

The coordinates in individual profile measurements can be edited in an additional window that you can open when you have made a selection of measurement sets and years, e.g. for analysis (see Figure 5.1, subsection 5.2.1) . To do this, click the *Editor* button in the **Data** tab of the ribbon. Figure 6.11 shows an example of this window. The transect editor enables you to edit the data in several different ways. The editor can also be started when the "Cross-shore profile measurements" document window is opened in "Manage sets" mode (see subsection 6.3.1) and you have already made a selection of locations and years.

In the top left corner of the window shown in Figure 6.11, there is a drop-down list that enables you to choose from several different editing actions. Two tables are displayed on the left below the drop-down list. The upper table shows the locations you can choose for editing. The lower table shows the years that you can edit at the selected locations. To the right of these two tables, the upper part of the window contains an entry form (for most editing actions), while the lower part shows a list of selected measurements and a preview of the editing action. If you have made a selection of locations and years, this list will automatically be filled with the corresponding measurements that you can edit. When you click on one of these measurements, the preview shows the result of the editing action for this measurement. When you are satisfied with the new settings, click on the **Apply** button at the lower right of the window. The editing action will then be applied to all selected measurements. The drop-down list at the top left of the window provides you with a choice from the following methods for editing the coordinates in a measurement:

- ◇ Add/remove shape - Add (nourish) or remove (erode) different shapes to/from the measurement.
- ◇ Add/remove layer - Add or remove a uniform layer ("sediment layer") along the entire

profile above or below a reference level (e.g. to adjust for sea level changes, account for dynamic dune management, etc.).

- ◇ Remove above level - Completely remove one or more dune rows above a specified reference level.
- ◇ Extend - Augment measurement data with data from past years at the same location.
- ◇ Change individual points - Edit coordinates of individual measurement points on the profile.
- ◇ Revert edit action - Undo one or more edits.

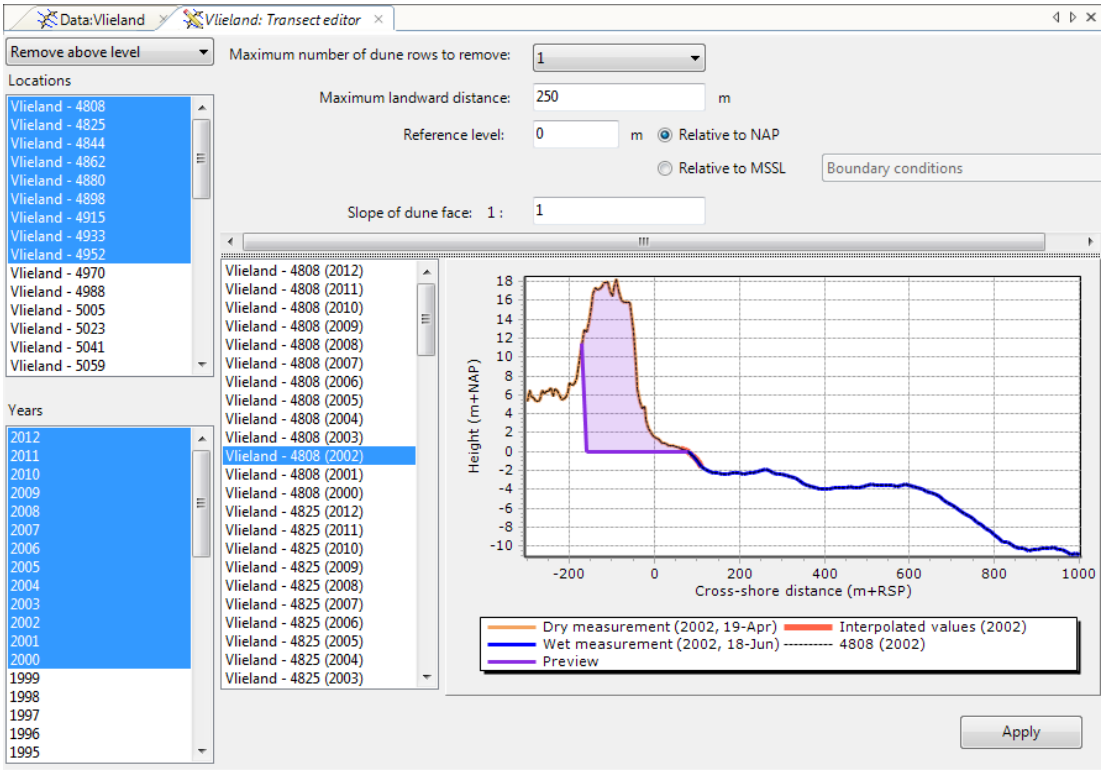


Figure 6.11: *Typical transect editor window.*

6.4.1 Add/remove shape

If you wish to add/remove a volume of sand to/from the profile, use the “Add/remove shape” editing action. Figure 6.12 shows an example of the screen that appears when this editing action is selected. Use this screen to enter the settings to be used (top of the screen) and the locations and years that you wish to adjust (tables on the left). A preview of the effect of the adjustment is shown in the middle of the screen for each selected profile measurement. The settings you choose determine the shape, volume and extents of the adjustment. The settings you can enter are:

- ◇ **Shape** - Choose this from the drop-down list at the top of the screen. There are three options:
  - □ **Block** - This is the simplest shape, which adds or removes an approximately rectangular block of sand.
  - □ **Sine** - This option specifies a semi-sinusoidal profile for the volume to be added or removed.
  - □ **Long** - This is a combination of the above two shapes. The central zone corresponds to a rectangular shape between the rising and falling sides of a semi-sinusoidal profile (of the same height).

- ◇ **Volume** - This specifies the size of the sand adjustment. The units are m^3/m
- ◇ **Thickness** - You can also specify the thickness of the volume to be added or removed. If you change the type of shape, the volume will remain the same and the thickness of the shape will be adjusted.
- ◇ **Minimum x** - This is the cross-shore distance to the start of the shape. xMin must always be a lower value than xMax. Moreover, the difference between these two must also be greater than 2x the “Corner radius”.
- ◇ **Maximum x** - This is the cross-shore distance to the end of the shape. xMax must always be a higher value than xMin. Moreover, the difference between these two must also be greater than 2x the “Corner radius”.
- ◇ **Add shape** - The specified shape is added to the height values in the profile.
- ◇ **Remove shape** - The specified shape is subtracted from the height values in the transect.
- ◇ **Corner radius** - When you select the “Long” shape, you can also specify here the radius (in meters) of the rounded corners of this shape.

If you have selected locations and years in the left side of the window, then you can see the effect of the adjustment on each measurement by clicking on individual profiles in the list beside the preview. The selected measurement is then visualized in the preview. When you click **Apply**, the adjustment will be automatically applied to all selected profiles.

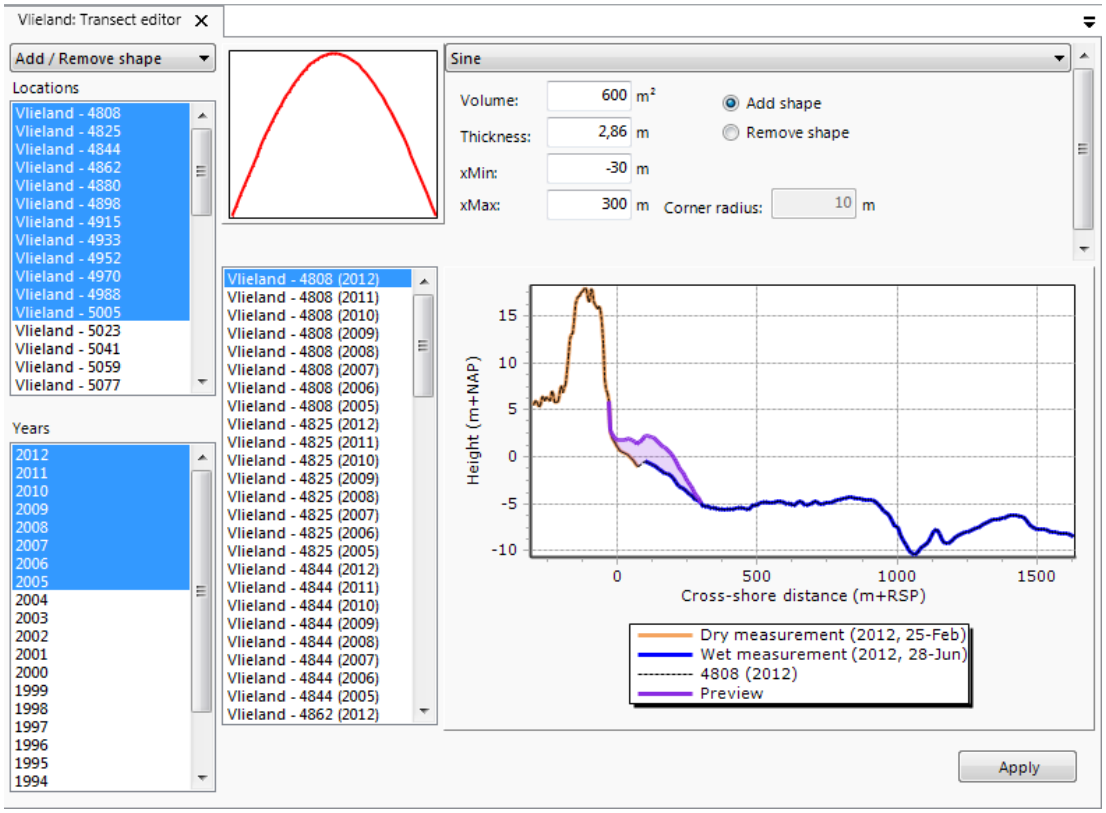


Figure 6.12: *Typical transect editor window with the “Add/remove shape” action selected.*

6.4.2 Add/remove layer

The “Add/remove layer” editing action allows you to raise or lower the profile above or below a predefined level with a specific thickness of sediment. Figure 6.13 shows how the window appears when this action is selected. You can edit several settings in the upper part of this screen:

- **Add sediment layer** - Raise the profile with the specified thickness.
- **Remove sediment layer** - Lower the profile with the specified thickness.
- **Thickness** - Thickness of sediment layer to be added or removed (i.e. how much is the profile to be raised/lowered).
- **Reference Level** - Height of reference for the add/remove action. This can be specified in two ways:
  - **Above** - Adjust the profile only above the specified reference level.
  - **Below** - Adjust the profile only below the specified reference level.
  - **Relative to NAP** - Reference level is absolute height relative to NAP.
  - **Relative to Rp** - Reference level is specified relative to the Rp parameter (maximum storm surge level) stated in one of the available boundary condition sets. When this option is selected, the drop-down list to the right is activated. You can then select the required boundary condition set. When calculating the adjustment, the value entered in the “Reference Level” box is added to the Rp value for this location in the specified boundary conditions file.

If you have selected locations and years in the left side of the window, then you can see the effect of the adjustment on each measurement by clicking on individual measurements in the list beside the preview. The selected measurement is then visualized in the preview. When you click **Apply**, the adjustment will be automatically applied to all selected measurements.

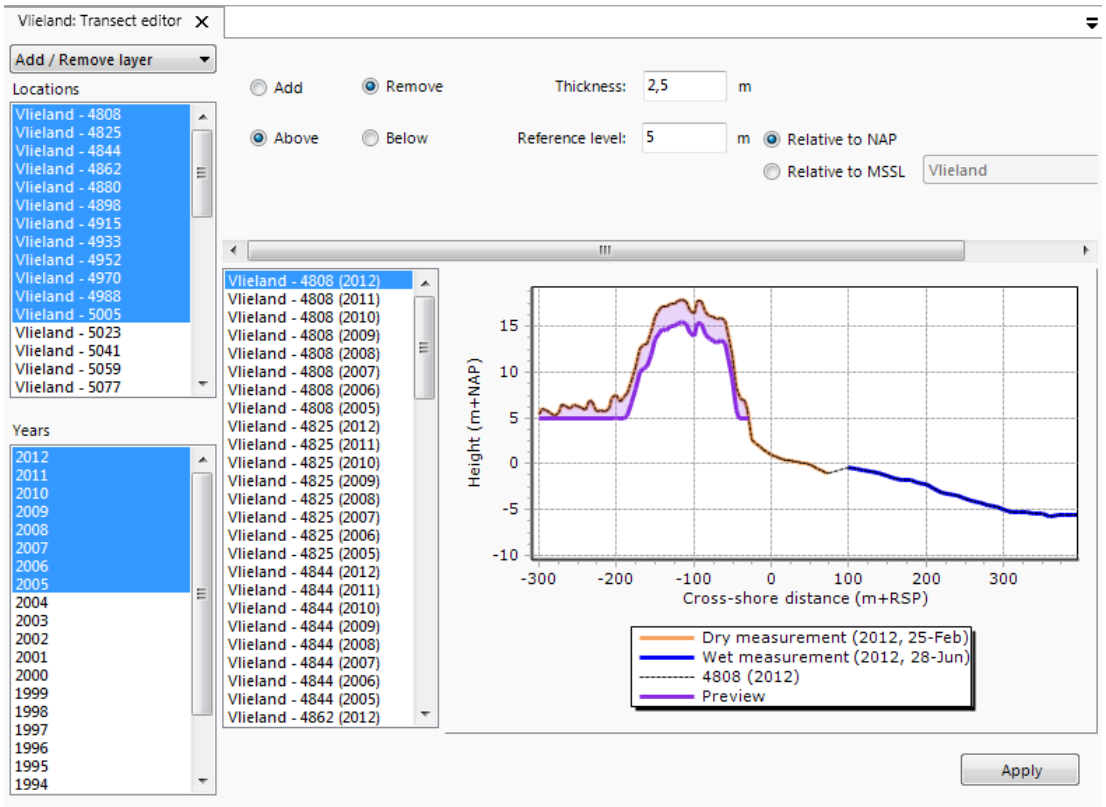


Figure 6.13: *Typical transect editor window with the “Add/remove layer” action selected.*

6.4.3 Remove above level

Use the “Remove above level” editing action when you need to remove one or more dune rows from the measured profile. Figure 6.14 shows an example of the screen that appears when this editing action is selected. In the upper section of the screen you can enter various settings for this action:

- **Maximum number of dune rows** - This sets the number of dune rows to be removed.
- **Maximum landward distance** - Here you can specify the maximum distance landwards for removal of dunes. Any time a setting is changed, MorphAn rechecks the effect at the given reference level (height). First, MorphAn determines the most seaward point where the dune face intersects the reference level. This will be the starting point for dune removal. Working landwards from this point, MorphAn then determines which “maximum” is met first: dune rows, or landward distance. The distance at which this happens is the effective distance over which sand is removed from the dune(s).
- **Reference Level** - Height of reference for the “Remove above level” action. This level can be specified in two ways:
  - **Relative to NAP** - Reference level is absolute height relative to NAP.
  - **Relative to Rp** - Reference level is specified relative to the Rp parameter (maximum storm surge level) stated in one of the available boundary condition sets. When this option is selected, the drop-down list to the right is activated. You can then select the required boundary condition set. When calculating the adjustment, the value entered in the “Reference Level” box is added to the Rp value for this location in the specified boundary conditions file.
- **Slope of dune face** - If the maximum landward distance is to be applied, a dune face is made from the reference level to surface level. The value entered here specifies the slope of this dune face.

If you have selected locations and years in the left side of the window, then you can see the effect of the adjustment on each measurement by clicking on individual measurements in the list beside the preview. The selected measurement is then visualized in the preview. When you click **Apply**, the adjustment will be automatically applied to all selected measurements.

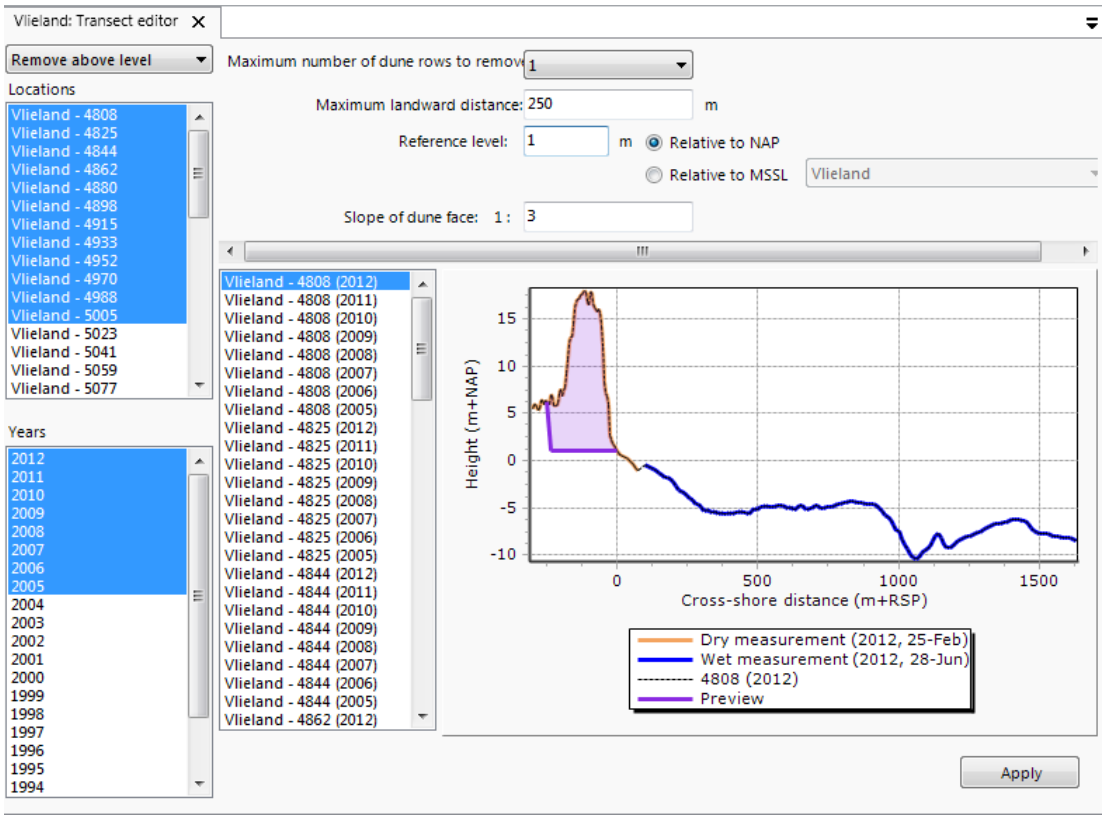


Figure 6.14: *Typical transect editor window with the "Remove above level" action selected.*

6.4.4 Extend

This transect editing action allows the user to augment a transect with additional landward or seaward measurements, by interpolation from other data. After selecting the required locations and years, the settings you enter in the **Extend** editing action specify the extent (in m from the local transect origin) within which measurements should be added. A value lower than that of the most landward measurement point will extend the transect landward. A value higher than the most seaward measurement point will extend the transect seaward. You have two options for adding data:

- **From map** - This makes use of the existing data on the map shown in the upper part of the window. You can use the "Map" tool window to add extra layers of grid data (e.g. .asc or .bil files) to the map (see also subsection 3.2.6). For a better view of the map, click on the icon in the top left of the map, and the map will occupy a greater area in the window. The map can be reduced in size the same way. Two parameters allow you to control the interpolation from map data:
  - **Dx** - This field indicates the distance interval in meters between interpolated points. For example, a Dx value of 10 means an interpolated value will be added to the existing transect until the entered extent is reached.
  - **Height factor** - A multiplier for the values derived from the map. This makes it easier to process and convert map height data recorded in e.g. centimeters to profile data in meters.
- **From other measurements** - The alternative method for adding data is to interpolate from profile measurements previously performed at this location. In the **Go back** field you can specify how many of the immediately preceding years to use for interpolation. Note that this interpolation method considers *all* measurements in the cross-shore profile measure-

ment set, and not just the measurements selected for editing. However, the interpolation source transects are not modified. They are used only to extend the selected profiles. You can also use more recent measurements for interpolation (**Go ahead**).

As with the other editing actions, you can click on the list of measurements to view the effect of the edits at different locations. The edits will be applied and saved only when you click the **Apply** button at the lower right of the window.

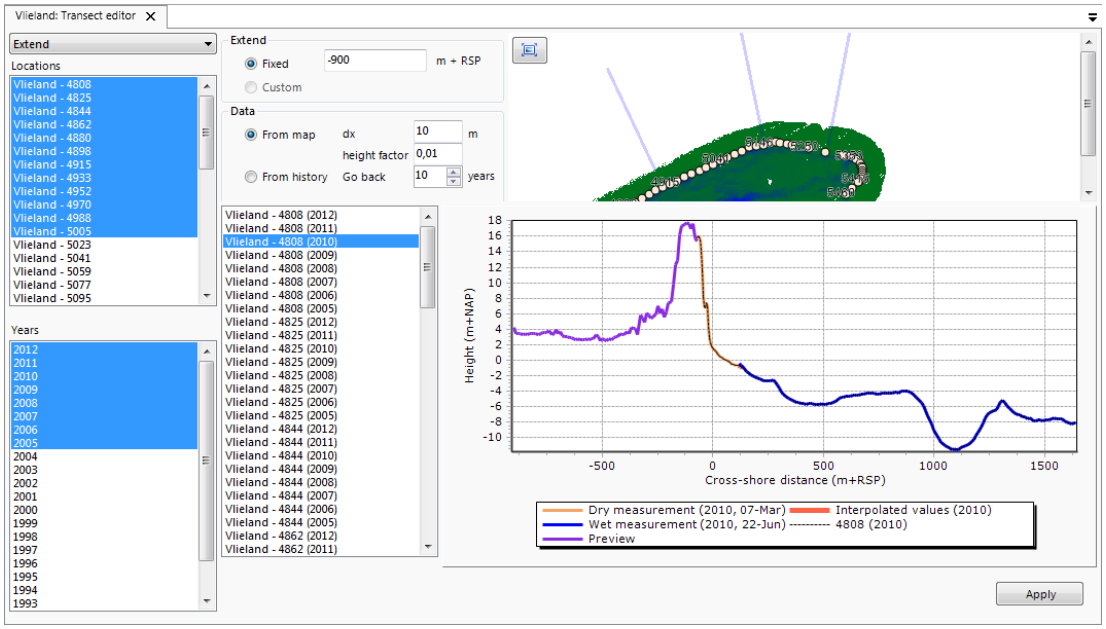


Figure 6.15: *Typical transect editor window with the "Extend" action selected.*

6.4.5 Change individual points

The "Change individual points" transect editing action differs somewhat from the other actions. When you choose this option, the window displays only a table of measurement points and a preview. Although you still see the two tables with locations and years (left in the window, see also Figure 6.16), you cannot select multiple locations and/or years. Only one measurement can be edited at a time. If one location and one year are selected, the measured profile will be displayed. You can then directly edit the Z values in the table of measurements, and the modifications will be previewed on the right. To save the edits, click the **Apply** button in the lower right of the window.

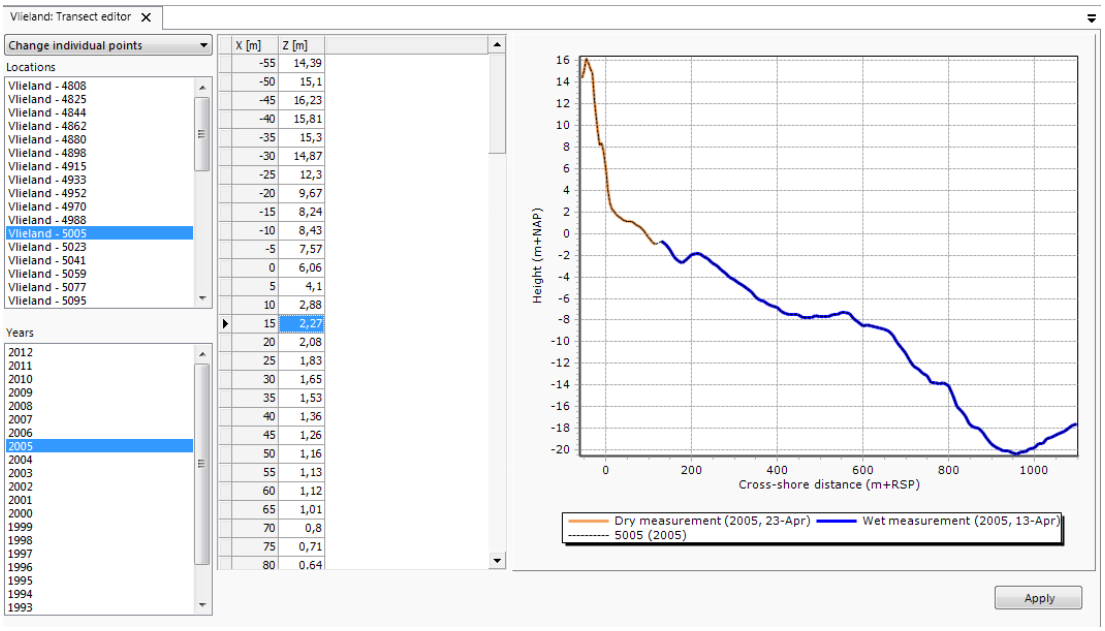


Figure 6.16: *Typical transect editor window with the "Change individual points" action selected.*

6.4.6 Revert edit action

The "Revert edit action" allows you to undo edits you have previously applied. Figure 6.17 shows an example of a location where 3 edits have been performed. In the settings panel at the top, you can select how many edits to revert using the counter, or select individual edits to revert. You can only revert edits in chronological order. When you click the **Apply** button, the selected edits will be reverted for the selected locations and years.

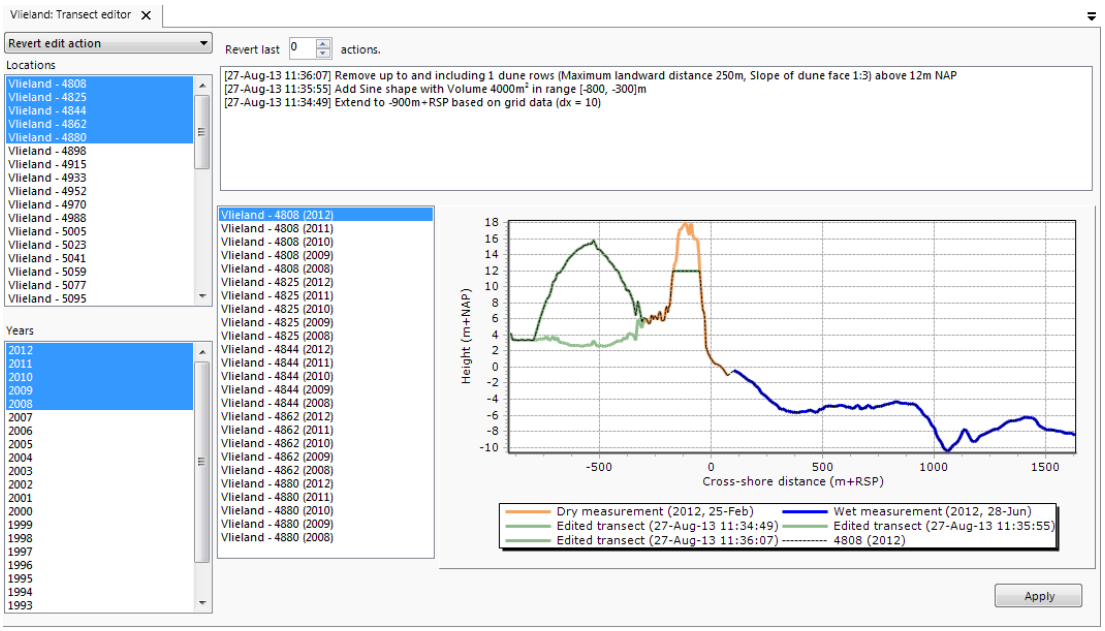


Figure 6.17: *Typical transect editor window with the "Revert edit action" selected.*

6.5 Automatically create profile measurements from one grid measurement set

Profiles with measurements can be generated from grid measurements. In the **Project Explorer**, right-click on a **Grid measurement** set, and select **Create profiles...** from the context menu. This starts a wizard which will prompt you to select profile measurement definition files. After selecting the files, click **Next** to go to the **Location details** screen where you can enter settings for the generation of profiles (see Figure 6.18). The following details can be entered:

- **Area** - Name of the coastal area
- **Name of new profile measurements set** - Name you wish to use for the new set of profile measurements
- **Remove current locations from filter** - If checked, then the current locations will be removed from the filter
- **Multiplication factor** - Factor to convert the imported height to meters. For example, if the imported Z values are in centimeters then you should enter 0.01 to convert these values to meters
- **Dx** - The desired transverse grid point interval in meters.

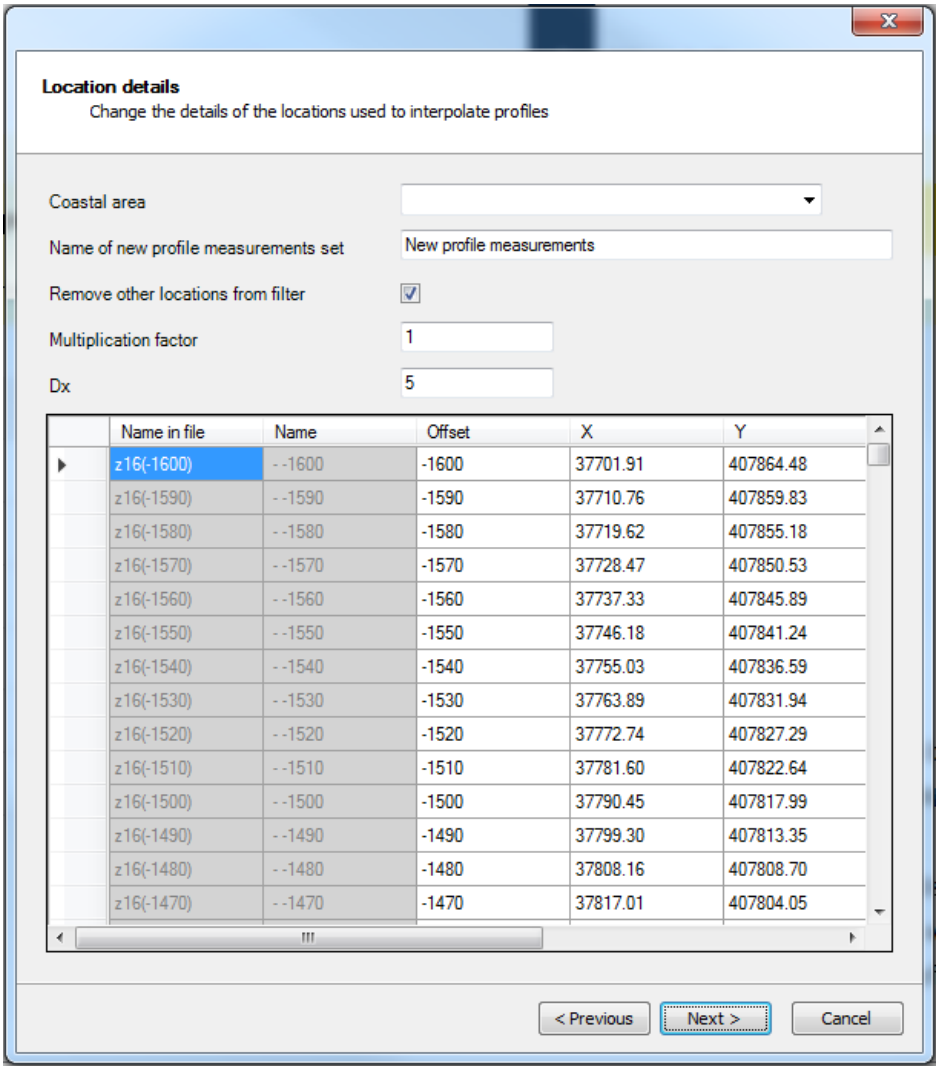


***Figure 6.18: Location details** page of the **Create profiles** wizard*

Once you have set the location details, click “Next” and MorphAn will start to interpolate profile

measurements. Progress is displayed in a list (see Figure 6.19). In this progress list, a green icon with a “V” indicates successful interpolation of a profile measurement at a particular location, while a red icon with an “X” indicates that the interpolation was unsuccessful. When the process has ended, click **Next** followed by **Finish** to close the wizard. Successfully created profiles can now be found in the **Cross-shore profile measurements** folder of the **Project Explorer**.

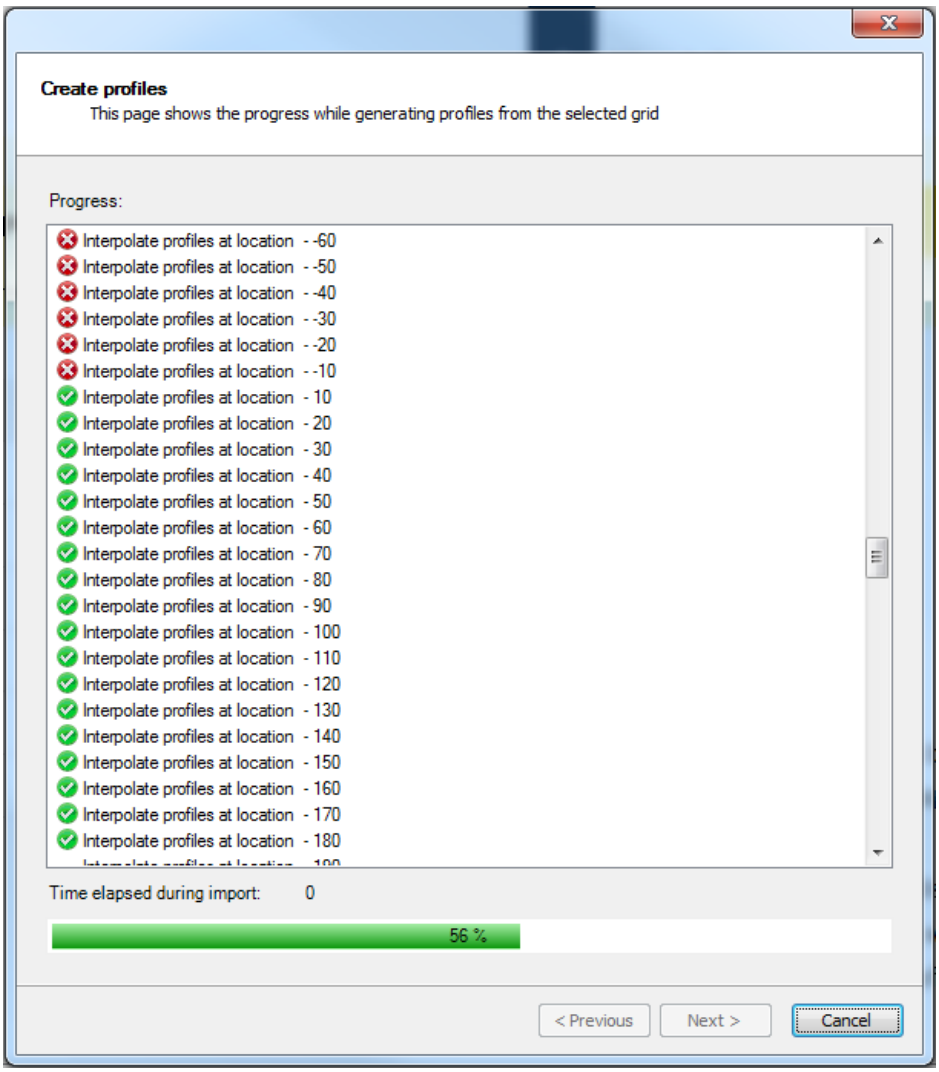


***Figure 6.19: Create profiles** interpolation progress page of the **Create profiles** wizard*

6.6 Generate intermediate transects

When determining coastal safety, it is sometimes desirable to define additional locations and profile measurements between two existing coastal locations. This enables a more detailed prediction of the safety to be made in the vicinity of a potentially weaker point in the dune massif. MorphAn supports the generation of these transects from grid measurements. This section describes the possibilities offered by MorphAn for generating profile measurements at existing locations or newly defined intermediate locations.

If you wish to create intermediate transects, you should first open the document window for the “Grid measurements” folder under the “Data” of a MorphAn workspace: either double-click on this folder, or right-click on the folder and select “Open”. The document window will open with a map showing all grid measurements. In addition, an extra “Profile” shortcut group appears

in the “Data” tab of the ribbon (see 6.20). When you click the button **Profile Generation**, the grid measurements document window is extended with additional capabilities for generating profile measurements based on the imported grid measurements (6.21). The other buttons in the “Location” group in the ribbon are also now activated, enabling you to add single or multiple locations when generating profile measurements.

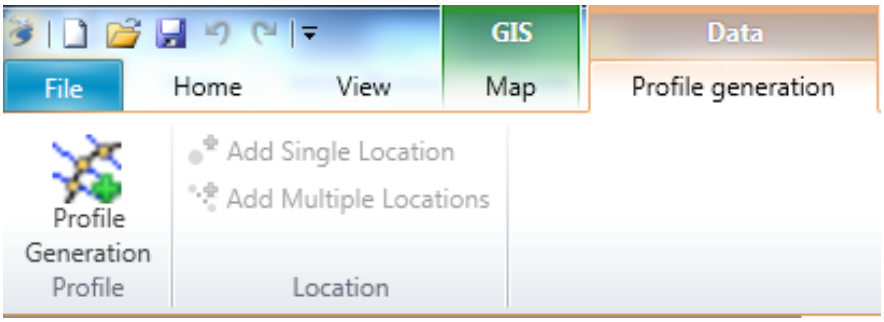


Figure 6.20: *Data tab in the ribbon when document window for all grid measurements is open.*

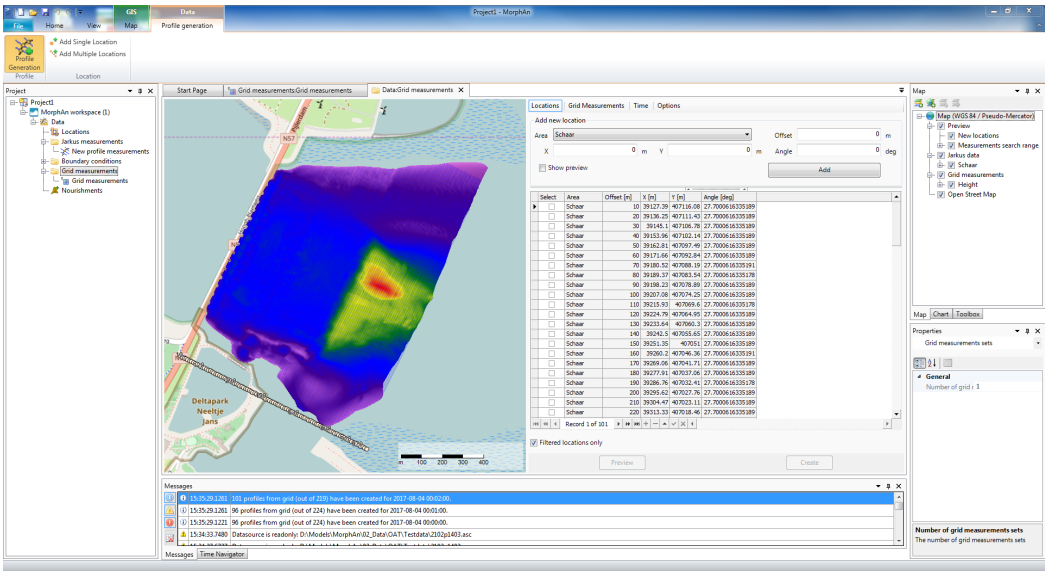


Figure 6.21: *Typical MorphAn application window when profile generation is active*

The panel in the upper right of the document window enables you to enter settings for profile generation. Using the tabs at the top of the panel, you can enter settings related to selected locations, selected grid measurements, the times for generated profile measurements, and other options. The following sections discuss these settings in more detail.

If locations and grid measurements are selected, the **Create** button at the lower right of the panel will be activated, and profile measurements can then be generated. MorphAn shows the profile measurement generation progress in a separate dialog. When profile generation is finished, the locations of newly-created profile measurements are automatically added to the workspace and location filter (section 4.4). Although you cannot edit the added locations in this screen, this is still possible as described in section 6.1. As long as new locations have not yet been added to the workspace, they can still be modified in this panel.

6.6.1 Add and select locations

To add and select locations, activate the **Locations** tab at the top of the settings panel (see Figure 6.22. The table shows all locations in the MorphAn workspace (or only the filtered locations, if this is selected at the bottom of the panel). There are three methods you can use to define new locations for generation of profile measurements:

- ◇ **Manually enter new locations.** The “Add new location” form at the top of the panel enables you to enter a new location manually. The items you must enter are the location, offset, X, Y, and transect angle. If the *Show preview* box is checked, then the specified location will appear on the map. If you are satisfied with the new location, click *Add* and the location will then be added to the table.
- ◇ **Indicate locations on the map.** In the “Location” group of the *Profile generation* Data tab, you will see a shortcut button to *Add Single Location*. After you click this button, you can indicate a location directly on the map by positioning the cursor, and confirming with left-click. You can then edit the data before the new location is added to the table. Use the “Esc” key to cancel this action if necessary. This action is otherwise identical to adding single locations as described in section 6.1.
- ◇ **Automatically insert locations between two existing locations.** In the “Location” group of the *Profile generation* Data tab, you will see a shortcut button to *Add Multiple Locations*. After you click this button, you can indicate two locations directly on the map. You can then edit the start and end location and other settings before the new locations are added to the table. After you click “OK”, the locations are added. You can use the “Esc” key to cancel this action if necessary. This action is otherwise identical to adding multiple locations as described in 6.1.

Until you actually create (generate) the new profile measurements from the data in the table, you can still always edit the data describing the new locations. After profile measurement generation, the locations are included in the workspace, and they can no longer be edited using this table. The first column of the table contains a check box for location selection. Profile measurements can be generated only when one or more locations have been selected, provided also that times and grid measurements have been selected (see next section). During measurement generation, MorphAn will attempt to generate cross-shore profile measurements for the specified locations.

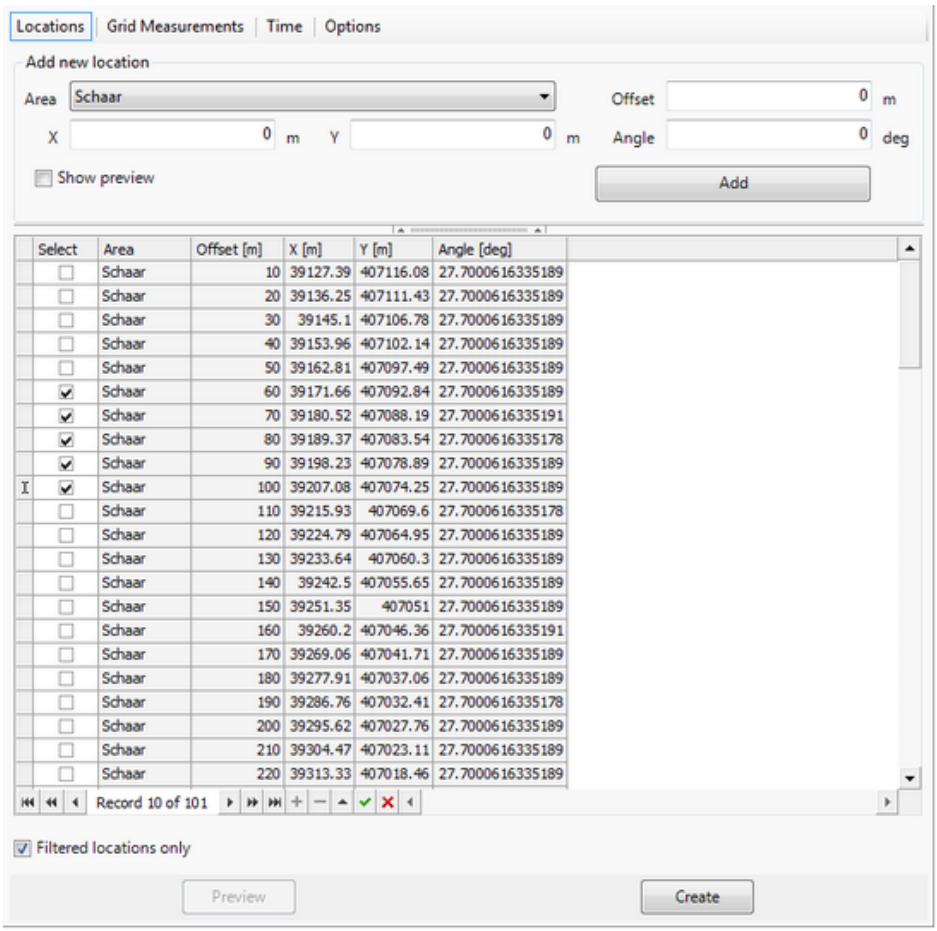


Figure 6.22: *Location selection tab for generation of intermediate transects*

6.6.2 Select grid measurements

To select grid measurements for profile measurement generation, activate the **Grid Measurements** tab at the top of the settings panel (see Figure 6.23). This table shows all grid measurements from the MorphAn workspace corresponding to the document window. The following items can be specified per grid measurement:

- ◇ **Select** - Check this box to set this grid measurement set for inclusion in the generation of profile measurements.
- ◇ **Landward boundary [m]** - The landward boundary indicates the minimum cross-shore distance (from the generated local profile origin) for generation of profile measurements from this set of grid measurements. This enables you to control the influence on profile measurement generation from grid measurement sets with differing levels of uncertainty.
- ◇ **Seaward boundary [m]** - The seaward boundary indicates the maximum cross-shore distance (from the generated local profile origin) for interpolation of data from this set of grid measurements. This enables you to control the influence on profile measurement generation from grid measurement sets with differing levels of uncertainty.
- ◇ **Height factor** - A multiplier for the values derived from the grid measurement set to convert to the height units of the generated profile measurements.
- ◇ **Type of measurement** - Indicates whether the generated profile measurements from this grid measurement set should be of type Dry, Wet or Interpolated. All profile measurements generated from the various grids together form the final set of cross-shore profile measurements that will be added to the workspace. When assembling the generated profile measurement geometry, MorphAn always first examines the interpolated data, then

augments the geometry with wet or dry measurements. This column enables you to specify the type of measurement to generate based on the selected grid measurement.

A separate profile measurement is generated for each grid measurement. A type is assigned to the profile measurement based on the *Type of measurement* specified for the grid set. All "sub-profile measurements" generated from the various grids together form the new profile measurement that will be added to the workspace. When assembling the generated profile measurement geometry, MorphAn always first examines the interpolated data, Dry and wet measurements are then added, based on the grid measurement set priority (position in the table). If necessary, use the buttons below the table to change the priority.

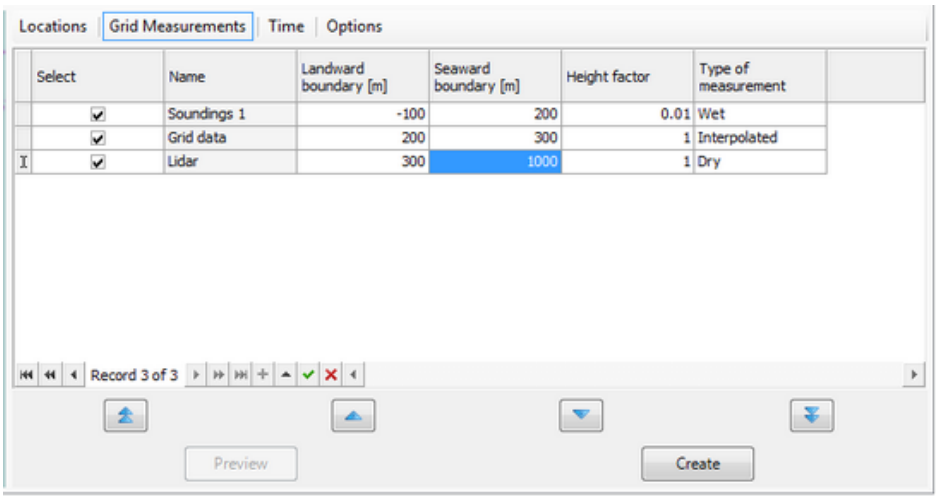


Figure 6.23: *Grid measurement selection panel for generation of intermediate transects*

6.6.3 Select times

MorphAn attempts to generate profile measurements based on the selected locations and grid measurements. If the grid measurements are time-dependent (multiple grid measurements over time), you can assemble multiple profile measurements for different times at a location with a combination of grid measurements. To generate profile measurements for specific times, activate the **Time** tab at the top of the settings panel (see Figure 6.24). This entry form allows you to specify the times for profile measurement generation. For each time-based grid measurement, MorphAn will then select the time closest to the time specified here. If the time stamp of a grid measurement is further from the specified time than the *Grid time margin* (entered below in the screen), then that measurement will be ignored during profile measurement generation (for the specified time). To add times for generated profiles, select the time in the drop-down calendar, and click **Add Time**. To delete times from the list, select a time in the table and press the "Delete" key.

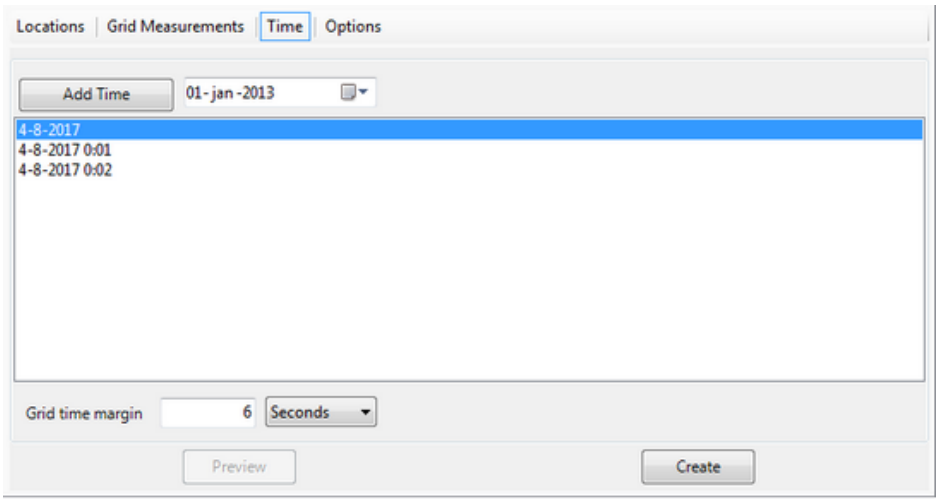


Figure 6.24: *Time selection tab for intermediate transect generation*

6.6.4 Options

Finally, there are a few other options you can specify for profile measurement generation. First, activate the **Options** tab at the top of the settings panel (see Figure 6.25). You can now set the following options:

- ◇ **Name of new created set of profile measurements**. Here you can choose a set of cross-shore profile measurements for addition of generated measurements. If you instead specify a new name, then a new set of profile measurements will be created.
- ◇ **Remove current locations from filter**. If this option is checked, MorphAn will remove all locations from the filter after generating profile measurements. Locations of all generated profile measurements are always added to the filter, and are immediately visible in other parts of the workspace.
- ◇ **Save new locations to file (*.grd)**. You can choose to save all newly added locations (that have generated profile measurements) to a * .grd file. Check the box beside “Save new locations to file (*.grd)”, then select a windows folder and file name for the new locations.
- ◇ **Save created profile measurements (*.jrk)**. Generated cross-shore profile measurements can also be automatically saved in a *.jrk file. Check the box beside “Save created profile measurements (*.jrk)”, then select a windows folder and file name for the new profile measurements.
- ◇ **Discretization resolution (dx)**. Lastly, you can specify the resolution (coordinate interval) for profile measurements interpolated from grid measurements. The resolution is often matched to the resolution of the grid measurements. Note that a finer resolution will increase the time required for interpolation.

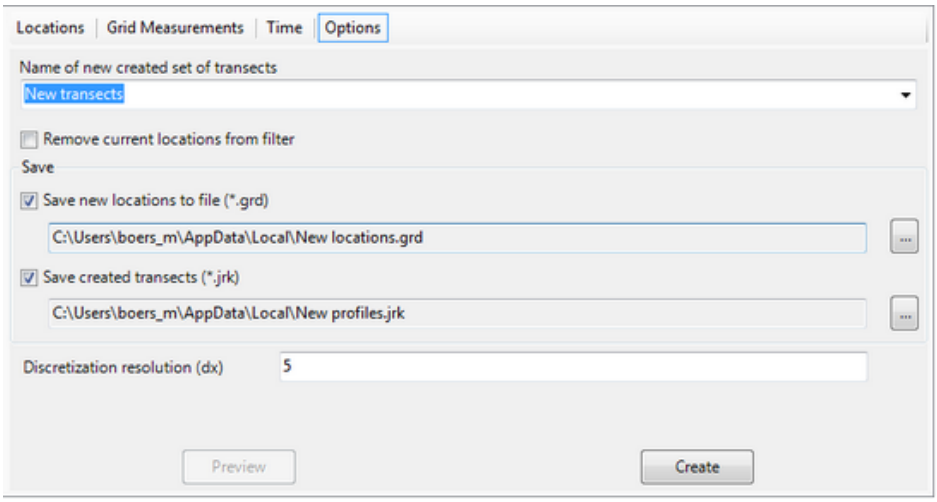


Figure 6.25: *General options for intermediate transect generation*

7 Working with models

MorphAn offers 4 models for determining dune safety or coastal development:

- ◇ Dune safety model
- ◇ Coastal development model
- ◇ Volume development model
- ◇ Bank analysis model

This chapter explains the general features for working with models, such as adding a model (section 7.1) or specifying the input (section 7.2), viewing the output (section 7.3), and exporting the output (section 7.4). Model-specific aspects, such as the algorithm used, or input/output screens, are explained in separate chapters: 8 Dune safety model; 9 Coastal development model; 10 Volume development model; and 11 Bank analysis model.

7.1 Add model

There are various ways to add a new model. If a specific model is checked while running the MorphAn setup wizard (see chapter 1 and Appendix B), then the selected model will be automatically added to the MorphAn workspace. Models can also be manually added after setup. One way is to right-click on the workspace, then select “Add new model”. Alternatively, with a workspace selected in the Project Explorer, click the *“New model”* shortcut in the **Home** tab of the ribbon. A model can be added only to a MorphAn workspace. Either method will cause a dialog to appear (as shown in Figure 7.1), from which you can choose the type of model to add. This added model is automatically pre-filled with all data previously loaded into the workspace.

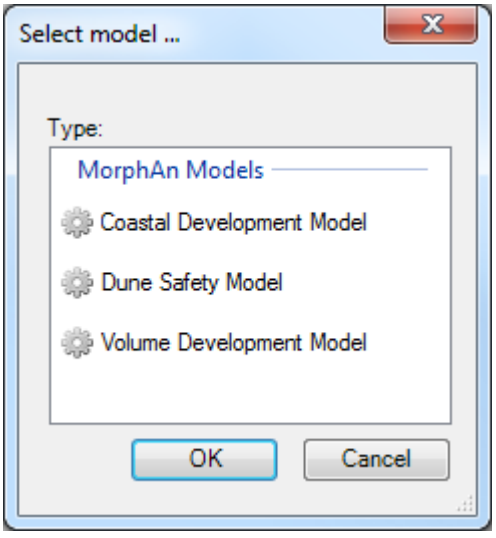


Figure 7.1: *Selection dialog for adding a new model to a workspace. You can choose from: three MorphAn models (Coastal Development, Dune Safety, Volume Development), a Bank Analysis model, or a Morphology model (not discussed here).*

7.2 Select input

Each of the MorphAn models contains an input section and three sub-models. These become visible when you expand the model (click "+") in the **Project Explorer** window. The **Input** folder contains the following items:

- ◇ **Selection** - This item determines the locations and years included when you run this model (and its sub-models).
- ◇ **Boundary conditions** - This item identifies the boundary condition set referred to by this model (and its sub-models) when you run the model. The name of this item corresponds to the selected boundary condition set (for an explanation of boundary condition sets, see section 4.6).
- ◇ **Cross-shore profile measurements** - This item identifies the cross-shore profile measurement set that will supply transect data to this model (and sub-models) when you run the model. The name of this item corresponds to the selected cross-shore profile measurement set (for an explanation of cross-shore profile measurement sets, see section 4.5).

To open the document window for any of these items, double-click on the item. You can then edit or visualize the related data.

7.2.1 Selection

Double-click on the **Selection** under a model to open the document window for selection of location and year (Figure 7.2). This window shows the filtered locations (see section 4.4), and enables you to define a selection of locations and years to be used when the model is run. To create a selection of transects, either: select on the map (with the aid of the selection toolbar, see also subsection 3.2.5); drag the cursor across the map with left button pressed; or click on one or more locations in the "Unselected" list. To copy the highlighted locations to the "Selected" list, use the buttons between the two lists. Once you have a list of selected locations, the "Unselected" years list will give you an overview of all years for which cross-shore profile measurements are available for the selected locations. To finalize the selection, select one or more years for the model to run with, and copy these to the "Selected" years list using the buttons between the lists.

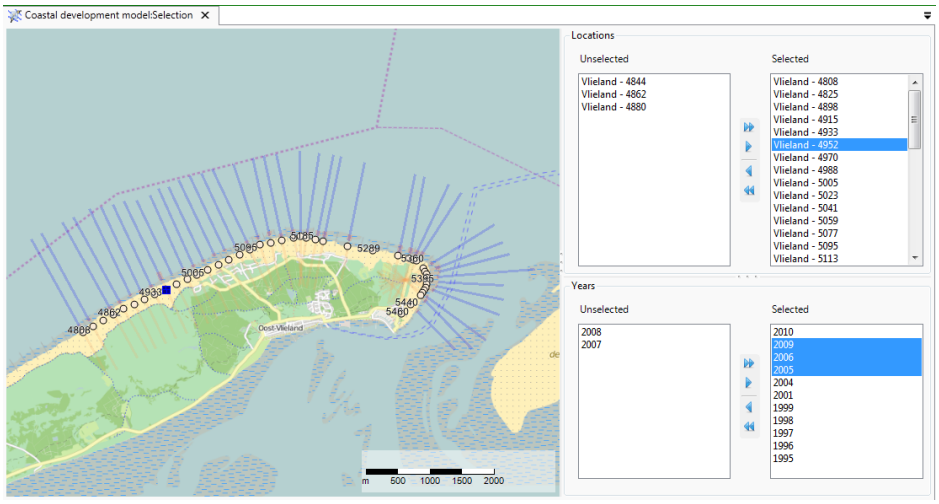
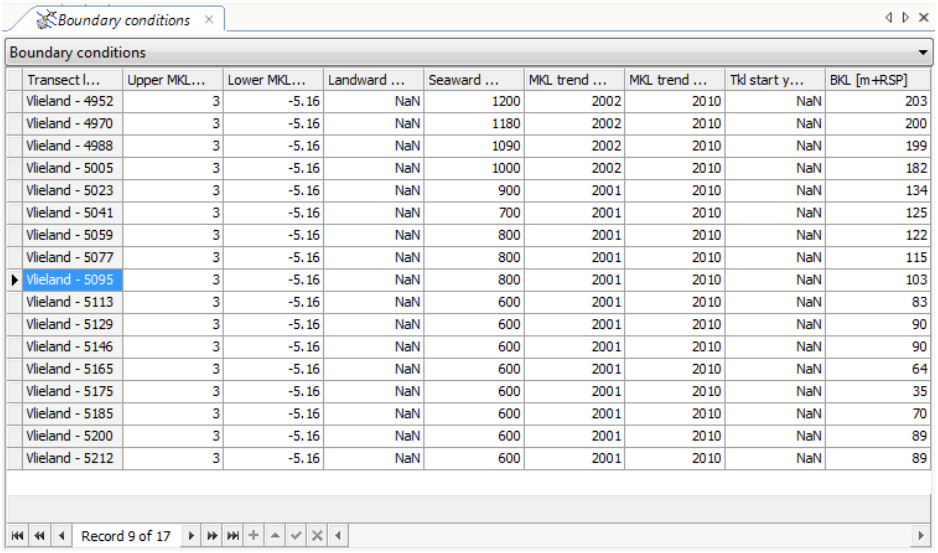


Figure 7.2: *Typical selection window for a main model. This screen enables you to select the locations and years that are considered when the model is run. All locations or years not selected in this window will be ignored by the model.*

7.2.2 Boundary conditions

Double-click on a model's **Boundary conditions** (which have the same name as the selected boundary condition set) to open a window for viewing and editing the relevant boundary conditions used in that model (and its sub-models). Figure 7.3 shows a typical boundary conditions window in the case of a Coastal Development model. The window consists of a table of all available boundary conditions in the selected set for the selected locations. A drop-down list at the top of the window makes it possible (if necessary) to quickly switch to one of the other boundary condition sets available in the workspace.



Transect l...	Upper MKL...	Lower MKL...	Landward ...	Seaward ...	MKL trend ...	MKL trend ...	Tkl start y...	BKL [m+RSP]
Vlieland - 4952	3	-5.16	NaN	1200	2002	2010	NaN	203
Vlieland - 4970	3	-5.16	NaN	1180	2002	2010	NaN	200
Vlieland - 4988	3	-5.16	NaN	1090	2002	2010	NaN	199
Vlieland - 5005	3	-5.16	NaN	1000	2002	2010	NaN	182
Vlieland - 5023	3	-5.16	NaN	900	2001	2010	NaN	134
Vlieland - 5041	3	-5.16	NaN	700	2001	2010	NaN	125
Vlieland - 5059	3	-5.16	NaN	800	2001	2010	NaN	122
Vlieland - 5077	3	-5.16	NaN	800	2001	2010	NaN	115
Vlieland - 5095	3	-5.16	NaN	800	2001	2010	NaN	103
Vlieland - 5113	3	-5.16	NaN	600	2001	2010	NaN	83
Vlieland - 5129	3	-5.16	NaN	600	2001	2010	NaN	90
Vlieland - 5146	3	-5.16	NaN	600	2001	2010	NaN	90
Vlieland - 5165	3	-5.16	NaN	600	2001	2010	NaN	64
Vlieland - 5175	3	-5.16	NaN	600	2001	2010	NaN	35
Vlieland - 5185	3	-5.16	NaN	600	2001	2010	NaN	70
Vlieland - 5200	3	-5.16	NaN	600	2001	2010	NaN	89
Vlieland - 5212	3	-5.16	NaN	600	2001	2010	NaN	89

Figure 7.3: *Typical document window for viewing and editing the selected boundary conditions for a main model. The drop-down list at the top of the window allows you to quickly switch to a different boundary condition set.*

7.2.3 Cross-shore profile measurements

Double-click on a model's **Cross-shore profile measurements** (which have the same name as the selected profile measurement set) to open a window for viewing the profile measurement set used. Figure 7.4 shows an example of such a window. The window consists of a list of selected locations and a profile view of the transect at that location for a certain time (year). You can view the same transect at different times using the Time Navigator (see section 3.2.9). When you highlight a different transect in the list on the left, the view changes. This window likewise has a drop-down list at the top of the screen for selecting a different set of cross-shore profile measurements from the sets loaded into the workspace.

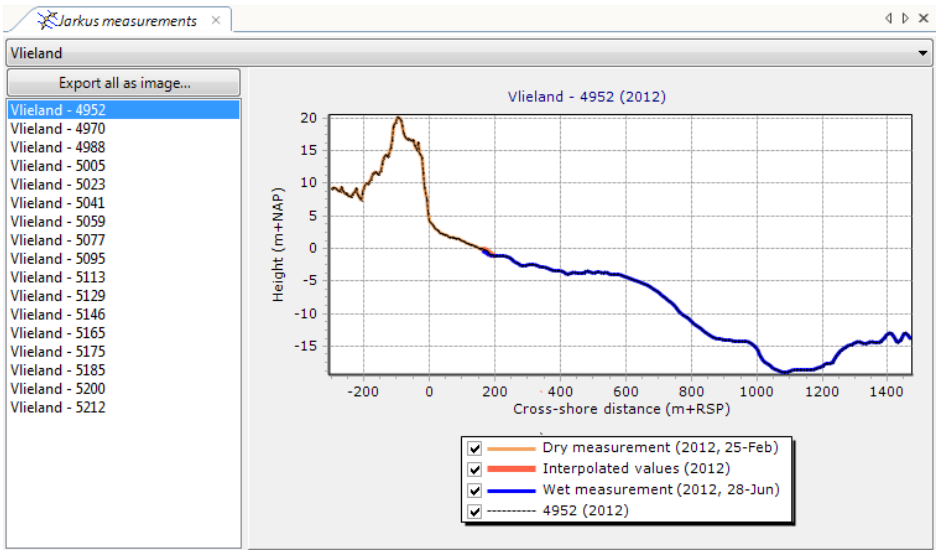


Figure 7.4: *Typical document window for viewing the selected set of cross-shore profile measurements. You can switch to a different measurement set for modeling at the top of the window.*

7.3 View output

After the successful completion of a modeling run, two new items are added to the **Output** folder of each sub-model. The first is a representation of the calculated values, for example, the MCL (momentary coastline) points in the case of the Momentary Coastline model. The second item is the Run Report, which is produced for each sub-model. This Run Report contains all messages that appeared in the message window while the model was running. The Run Report includes details of transects that were rejected for modeling (and the reason for this), as well as the transects that could potentially have generated a misleading result. In addition to the output from the individual sub-models, the **Dune Safety model** and the **Coastal Development model** also produce an overview map (Safety overview and Development overview respectively). These are the last items in the model folder (i.e. below the sub-models).

To visualize any output item, simply double-click on the relevant item. The output items of sub-models are often presented as a table of calculated values and a chart to visualize the results. An overview map is presented as a map that shows all results from the sub-models. If the window of the results of one of the sub-models is open at the same time, then when you click on a result in the map, the selected result then appears in the sub-model window, and vice versa. The overview map shows only one year at a time. However, you can use the Time Navigator (section 3.2.9) to display different times (years) in the map. You can modify the appearance of the overview map according to your visualization needs, by adding information or changing the styling of different layers. You can also export the results in shapefile format. This is described in sections 3.2.5 and 3.2.6.

7.4 Exporting output

In addition to visualization, the output from all sub-models can be exported. To do so, right-click on any output item and select *Export...*. Most items can be exported in a variety of formats. For example, all individual results can be saved in image format, while the modeling results can also be exported as tables (*.csv). The Dune Safety model also provides the option of exporting final profiles calculated by the model.

8 Coastal safety assessment (the dune safety model)

The dune safety model is used to assess dune safety according to the principles in the following two documents: 2006 Technical Report on Dune Erosion (ENW, 2007), or TRDA2006; 2011 Report on Dune Water Defenses (Deltares, 2012), or RD2011. The calculations required for this model can be seen as three distinct steps: The dune safety model is used to assess dune safety according to the principles in the following two documents: 2006 Technical Report on Dune Erosion (ENW, 2007), or TRDA2006; 2011 Report on Dune Water Defenses (Deltares, 2012), or RD2011. The calculations required for this model can be seen as three distinct steps:

1. **Erosion calculation** - First, the erosion calculation must be performed using the Duros+ (or D++) model. This is done by running the **Erosion sub-model**.
2. **Boundary profile calculation** - Next, it is advisable to calculate the position of the boundary profile, based on the calculated erosion results or input parameters. This is done using the **Boundary profile model**.
3. **Regression analysis** - Lastly, a diagram of the normative results must be made, showing the calculated erosion results over time compared to the landward boundary of the flood defenses. The **Normative model** supports this analysis and produces the necessary result charts.

The selection of transects and years, and the specification of the profile measurements and boundary conditions of the Dune Safety model are both carried out based on the items in the **Input** folder of the Dune Safety model. For more details, please refer to section 7.2. In this chapter we discuss the settings and screens that are specific to the Dune Safety model. We will start by looking at how to set the model to calculate according to TRDA2006 (section 8.1), and the possibilities for deviating from that standard. We will then discuss the input and output per sub-model (sections 8.2 to 8.4).

8.1 Model configuration

Various kinds of settings can be modified when running the Dune Safety model. Some of these settings are prescribed in TRDA2006 (ENW, 2007). You can configure these settings automatically at any time by clicking on the TRDA2006 button in the **Home** tab of the ribbon (see also Figure 8.1). To edit the settings of the main model (or one of the sub-models), double-click on the model or sub-model. Figure 8.2 shows the settings window that appears when you double-clicking on a dune safety model. At the top left of this window are two "Calculation settings" buttons. Click on one of these to restore all calculation settings of the model to the standard settings for either TRDA2006 or RD2011. The other settings in this window are discussed in the following sections.

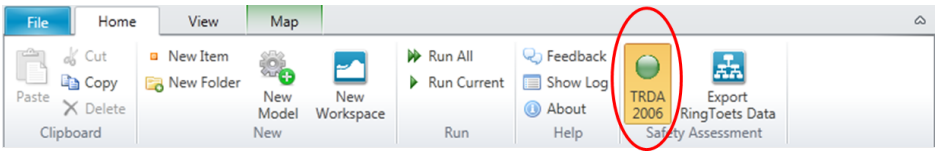


Figure 8.1: *Home tab of the ribbon when the TRDA2006 dune safety model settings button is active*

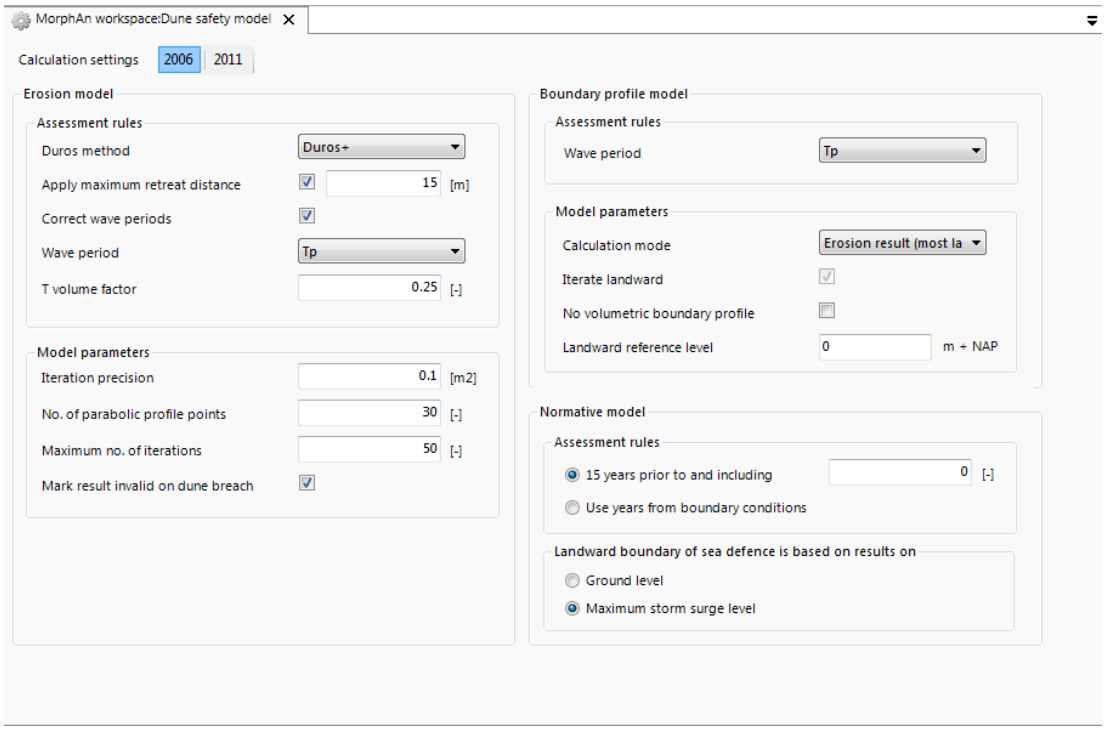


Figure 8.2: *Settings screen for configuration of a dune safety model (and its sub-models)*

8.2 Erosion model

This section discusses the settings and components of the “Erosion Model”. This model uses the Duros+ or D++ method to calculate erosion profiles.

8.2.1 Settings

To open the erosion model settings (see Figure 8.3), double-click on the Erosion model (the same settings can also be edited in the Dune Safety model settings window). This screen enables you to adjust various settings for the dune erosion calculations. The erosion model settings are displayed as two groups:

- **Assessment rules** - Settings derived from the TRDA2006(ENW, 2007).
- **Model parameters** - Settings of a more numerical nature. These settings influence the speed and precision of calculation, or how results are presented.

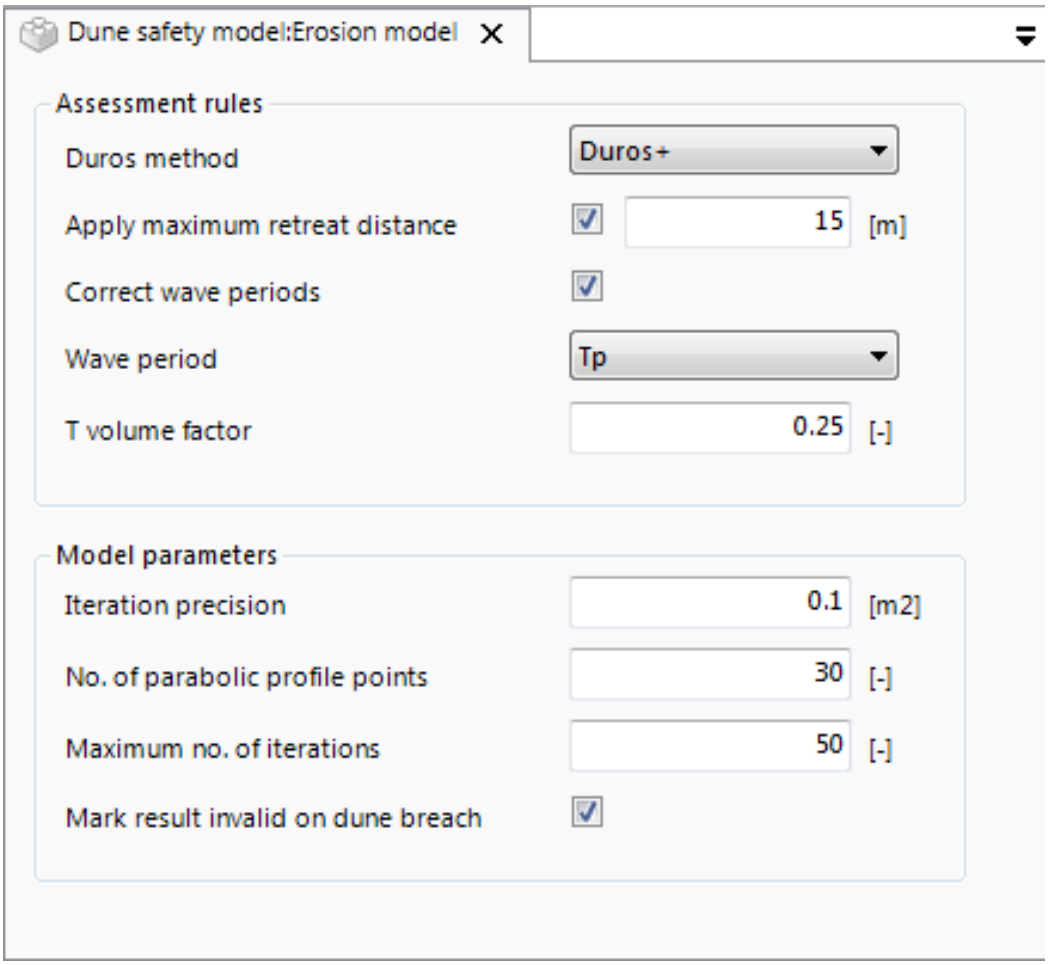


Figure 8.3: *Settings screen for configuration of an erosion model*

The Assessment rules are specified with the following settings:

- **Duros+ method** - Here you can choose from three calculation options: always use the Duros+ model (as specified in TRDA2006); always use D++; or use D++ for the Wadden Islands and Duros+ for the rest of the Dutch coast (as per RD2011).
- **Apply maximum retreat distance** - The TRDA2006 specifies that the additional retreat of the erosion line caused by the erosion volume may not exceed 15m. This option enables you to set this limit on or off. In the adjacent field you can optionally enter a retreat length other than the standard 15 meters (this is not mentioned in any technical report). If this limit is the prevailing factor for the model results, then this will be indicated by an icon in the top right corner of the visualization screen for the model output.
- **Correct wave periods** - The technical reports specify that the wave period used in modeling must lie within predetermined limits. When you check this box, wave periods outside this margin will be automatically corrected : to 12 or 20 seconds (in the case of T_p); or to 10.8 or 18 seconds (if modeled using $T_{m-1.0}$).
- **Wave period** - Select a wave period for the model from the drop-down list: model all locations using the T_p from the boundary conditions (as specified in the TRDA2006) or with the $T_{m-1.0}$; or (as specified in the RD2011) using the $T_{m-1.0}$ for the Wadden Sea, and the T_p for the rest of the Netherlands.
- **T volume factor** - a multiplier to calculate the erosion volume from the A volume. The TRDA2006 (ENW, 2007) specifies this value as 0.25. If the chosen Duros method is D++, then this factor must be 0.18.

The “Model Parameters” group contains the following settings:

- ◇ **Iteration precision** - This is the maximum difference between accretion and erosion that is considered to represent sufficient equilibrium between erosion and accretion when the Duros model parabola is aligned with the initial profile. A low value will yield a very precise result, but this requires an extremely long run time. A high value will yield a fast, but less accurate result.
- ◇ **No. of parabolic profile points** - This is the number of profile points that the model uses to describe the parabolic profile.
- ◇ **Maximum no. of iterations** - The Duros modeling process iteratively seeks to achieve an equilibrium between erosion and accretion. If no optimum is achieved after the specified maximum number of iterations, the calculation is considered unsuccessful, and the model is halted. This is done to keep the model from endlessly looping in a effort to optimize the result.
- ◇ **Mark result invalid on dune breach** - This last setting specifies how the model indicates situations in which the regular or additional erosion volume exceeds the available volume in the first dune row: checked box means “Invalid” (no result, no visualization); unchecked box means “Questionable” (but there *is* both a result and Visualization). The technical reports state that in the event of a dune breach, “further investigation is required”.

8.2.2 Input

The Erosion Model calculates the erosion results based on the parameters in the selected boundary conditions file. The transect selection is determined by the selection entered at the level of the Dune Safety model (see section 7.2). The single item in the **Input** folder of this model contains the boundary conditions that apply to this model for the selected transects. To edit the boundary conditions, double-click on this item. Any modifications will also take effect in the Data folder of the workspace. If these boundary conditions are used in any other model, then they will also be automatically modified in *that* model.

The table displays the following boundary conditions:

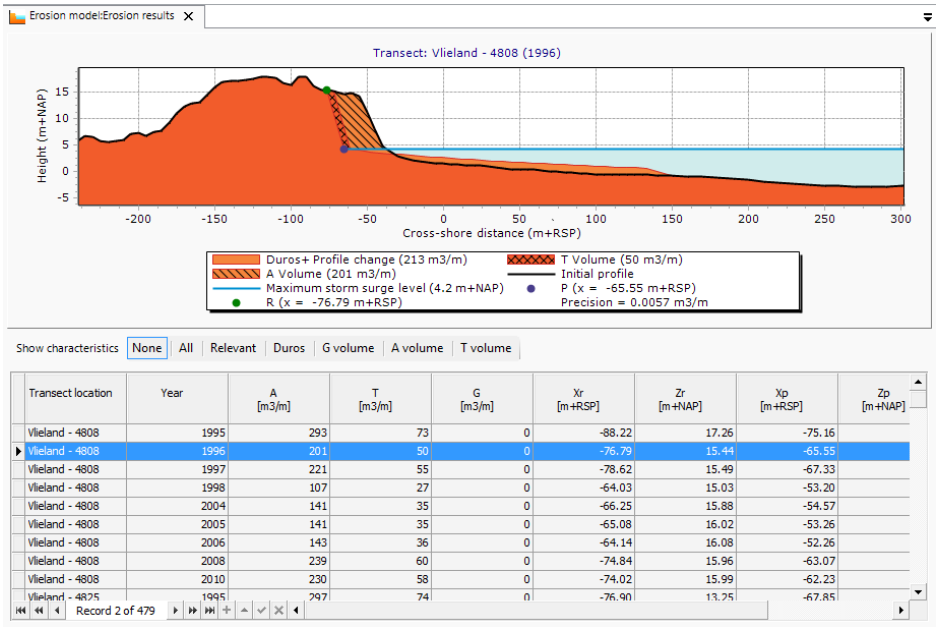
- ◇ **Hs [m]** - Significant wave height at the peak of the storm.
- ◇ **Tp [s]** - Peak wave period at the peak of the storm.
- ◇ **Tm-1.0 [s]** - Spectral wave period at the peak of the storm. In the TRDA2006 (ENW, 2007) this value is recommended at those points where no single-peaked JONSWAP spectrum is found. The model’s **Wave period** setting indicates whether to use this value or the Tp for modeling.
- ◇ **Rp [m NAP]** - Maximum storm surge level (for modeling).
- ◇ **D50 [μm]** - Median grain size at this location.
- ◇ **G0 [m^3/m]** - Basic sand volume for taking coast curvature into account during modeling (see also TRDA2006 (ENW, 2007)).
- ◇ **Depth [m]** - Depth at the point where the wave boundary conditions are derived (only used when the selected “Duros method” setting is D++ or TRD2011 and the transect is located on one of the Wadden Islands).
- ◇ **Dune row [m+RSP]** - This value ensures that dune valleys (profile points below storm surge level) seaward of this position are disregarded when the model checks for a dune breach. For example, you can use this input variable to prevent the model from detecting a dune breach in a small foredune just in front of the target dune row.

8.2.3 Output

After running the Erosion Model, there will be two new items in the model's **Output** folder in the **Project Explorer**:

- ◇ Erosion results
- ◇ Run report

When you double-click on the item **Erosion results**, a window like that in Figure 8.4 will be displayed. This window contains a table and a chart. The table shows all calculated transects and years as well as the most important properties and outcomes. The chart shows the result of the transect selected in the table. The row of buttons above the table can be used to change the information displayed in the table. While the model is running, MorphAn keeps track of any exceptional situations (characteristics). If applicable, these will appear in the chart. You can use the buttons above the table to choose which of these characteristics are displayed as extra columns in the table.



Transect location	Year	A [m3/m]	T [m3/m]	G [m3/m]	Xr [m+RSP]	Zr [m+NAP]	Xp [m+RSP]	Zp [m+NAP]
Vlieland - 4808	1995	293	73	0	-88.22	17.26	-75.16	
Vlieland - 4808	1996	201	50	0	-76.79	15.44	-65.55	
Vlieland - 4808	1997	221	55	0	-78.62	15.49	-67.33	
Vlieland - 4808	1998	107	27	0	-64.03	15.03	-53.20	
Vlieland - 4808	2004	141	35	0	-66.25	15.88	-54.57	
Vlieland - 4808	2005	141	35	0	-65.08	16.02	-53.26	
Vlieland - 4808	2006	143	36	0	-64.14	16.08	-52.26	
Vlieland - 4808	2008	239	60	0	-74.84	15.96	-63.07	
Vlieland - 4808	2010	230	58	0	-74.02	15.99	-62.23	
Vlieland - 4825	1995	297	74	0	-76.90	13.25	-67.85	

Figure 8.4: *Typical Erosion results screen following a modeling run*

Use the mouse to zoom in or out on the chart. Drag a selection rectangle down-right to zoom in; drag up-left to zoom out. You can also use ctrl+scroll wheel to zoom in or out. All input and output details of any selected result can be viewed in the comprehensive Properties tool window. Furthermore, you can adjust the styling of the figure using the **Chart** tool window (see also subsection 3.2.7), and you can navigate through the results as described in section 7.3.

8.3 Boundary profile model

The boundary profile model enables you to model whether a boundary profile can be iteratively fit to a particular location, based on a boundary profile at a predefined location on a map. It also enables you to "design" the position of a boundary profile. This section discusses the configuration screen, input and output of the model.

8.3.1 Input

Based on a boundary profile design, the Boundary Profile Model will iteratively fit profiles perpendicular to the coastline (in the profile measurements). The outcome of the model is treated as the landward boundary of the sea defense in the normative results, as produced by the normative model (see also section 8.4). The model has four input items:

- **Erosion results** - This is a link to the results from the Erosion model. This data can serve as input for modeling the boundary profile.
- **Boundary conditions** - This item has the same name as the selected boundary conditions, and enables you to adjust the period and years considered by the model when determining overruns of the seaward boundary of the sea defense.
- **Plan view geometry** - This item is used to specify the boundary profile on a map. By default, the boundary profile is always taken behind the most landward erosion point. However, in the document window of this item you can also choose to either assume the values from the boundary conditions file, position the boundary profile automatically at the back of the foredune, or manually draw or import a boundary profile (described later in this subsection).
- **Cross-shore geometry** - With this item you can check the boundary profile in a side view. You can set limits for the geometric fit, but you can also specify which point in the side view is specified by the line on the map in the plan view.

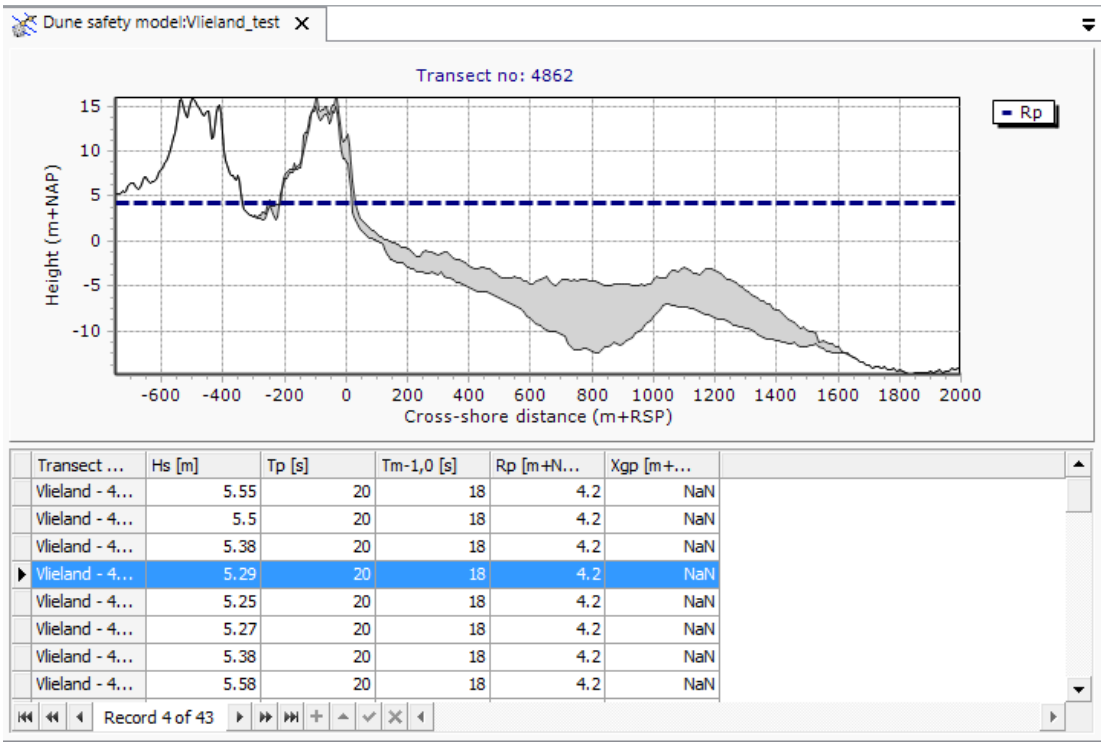
Erosion results

This item is a direct link to the results of the “Erosion model” (see also subsection 8.2.3).

Boundary conditions

The relevant boundary conditions can be edited in the same way as in the Erosion model. Double-click on the boundary conditions item in the “Input” folder of the “Boundary profile model”. The corresponding document window will open (see Figure 8.5), including a table in which the following boundary conditions can be changed:

- **Hs [m]** - Significant wave height at the peak of the storm.
- **Tp [s]** - Peak wave period at the peak of the storm.
- **Tm-1.0 [s]** - Spectral wave period at the peak of the storm. In the TRDA2006 (ENW, 2007) this value is recommended at those points where no single-peaked JONSWAP spectrum is found. The model’s **Wave period** setting indicates whether to use this value or the Tp for modeling.
- **Rp [m+NAP]** - Maximum water level during the storm (calculated value).
- **Xgp [m+RSP]** - The location of the boundary profile if supplied by the boundary conditions file. The “Plan view geometry” document window also enables you to specify the location of the boundary profile in a different way (see further in this section).



Transect ...	Hs [m]	Tp [s]	Tm-1,0 [s]	Rp [m+N...	Xgp [m+...
Vlieland - 4...	5.55	20	18	4.2	NaN
Vlieland - 4...	5.5	20	18	4.2	NaN
Vlieland - 4...	5.38	20	18	4.2	NaN
Vlieland - 4...	5.29	20	18	4.2	NaN
Vlieland - 4...	5.25	20	18	4.2	NaN
Vlieland - 4...	5.27	20	18	4.2	NaN
Vlieland - 4...	5.38	20	18	4.2	NaN
Vlieland - 4...	5.58	20	18	4.2	NaN

Record 4 of 43

Figure 8.5: *Typical document window in which boundary conditions of the boundary profile model can be edited*

Plan view geometry

The item “Plan view geometry” contains a design of the boundary profile on the map. In the **Project Explorer** window, double-click on the item to open a document window similar to Figure 8.6. The screen contains three panels:

- The “Geometry specification” panel on the left is where you specify how the boundary profile geometry is to be drawn.
- The upper right panel contains a map showing the boundary profile
- The lower right panel contains a chart that shows the following for each location in the selection for the model:
  - Height of the ground surface at that point on the boundary profile
  - Height of the maximum storm surge level at that location

This screen allows you choose from several methods to create a boundary profile. At the top of the “Geometry specification” panel, there are three buttons:

- **Erosion results** - Click on this button to make the boundary profile automatically pass through the most landward calculated erosion point at a given location.
- **Back of first dune** - This option likewise automatically calculates the position of the boundary profile, but in this case, at the back of the first dune row. This is determined as the point where, viewed from the sea, the cross-shore profile first crosses below the maximum storm surge level after it has risen above that level for the first time. If no such point exists but there is still a dune, then the most landward measurement point is used.
- **Manual** - This option enables you to manually specify the (fixed) path of the boundary profile. When this option is selected, the left panel of the screen will change (Figure 8.7). You can specify a fixed position of the boundary profile in two ways:
  - **From boundary conditions** - In this case, the values specified in the boundary con-

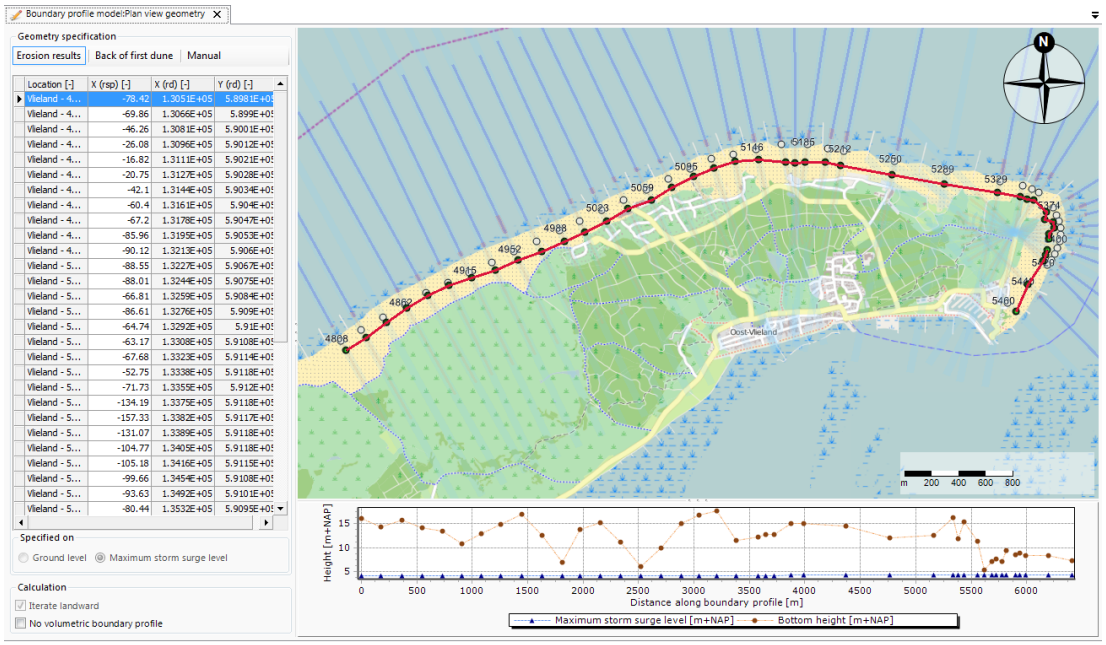


Figure 8.6: *Typical document window showing plan view geometry for boundary profile design*

dition set (Xgp) are used as the location of the boundary profile.

- **From map** - With this option you can specify the position of the boundary profile on the map (or in the table). When you select “From map”, three tools are provided in the box “Map specification”:
  - *Import .shp...* - You can select a shapefile that contains the specification of a boundary profile using a LineString or MultiLineString.
  - *Draw on map* - Enables you to draw a boundary profile directly on the map using the mouse. Click the mouse where you wish to add a point. Double-click on the final point of the boundary profile. The boundary profile and its position will then be calculated at all locations. You can also choose this tool in the **Map** tab of the ribbon.
  - *Draw on map (auto)* - This works similarly to the previous tool, but in this case you move the mouse with the left button pressed (free hand, rather than straight lines). The boundary profile is then calculated when the mouse button is released. You can also choose this tool in the **Map** tab of the ribbon.

  If you define the boundary profile by drawing on a map, then MorphAn will need to calculate where this line intersects with the transects to arrive at the boundary profile position per transect. You can specify an “Intersection range” to limit the distance from the transect origin for calculation of intersection points. If the model detects multiple intersections on a single transect, then the most seaward point always takes precedence.

The table in the lower part of the left panel shows the specified or calculated point of the boundary profile per transect (both as a cross-shore distance and as geographical coordinates). When the “Back of first dune” option is selected, the calculated position will be displayed for only the most recent profile. You can edit a calculated point on boundary profiles in the table at any time. The Geometry specification mode will then always change to “Manual $\rightarrow$ From map”. These are the positions that will be used as “anchors” when calculating the boundary profile.

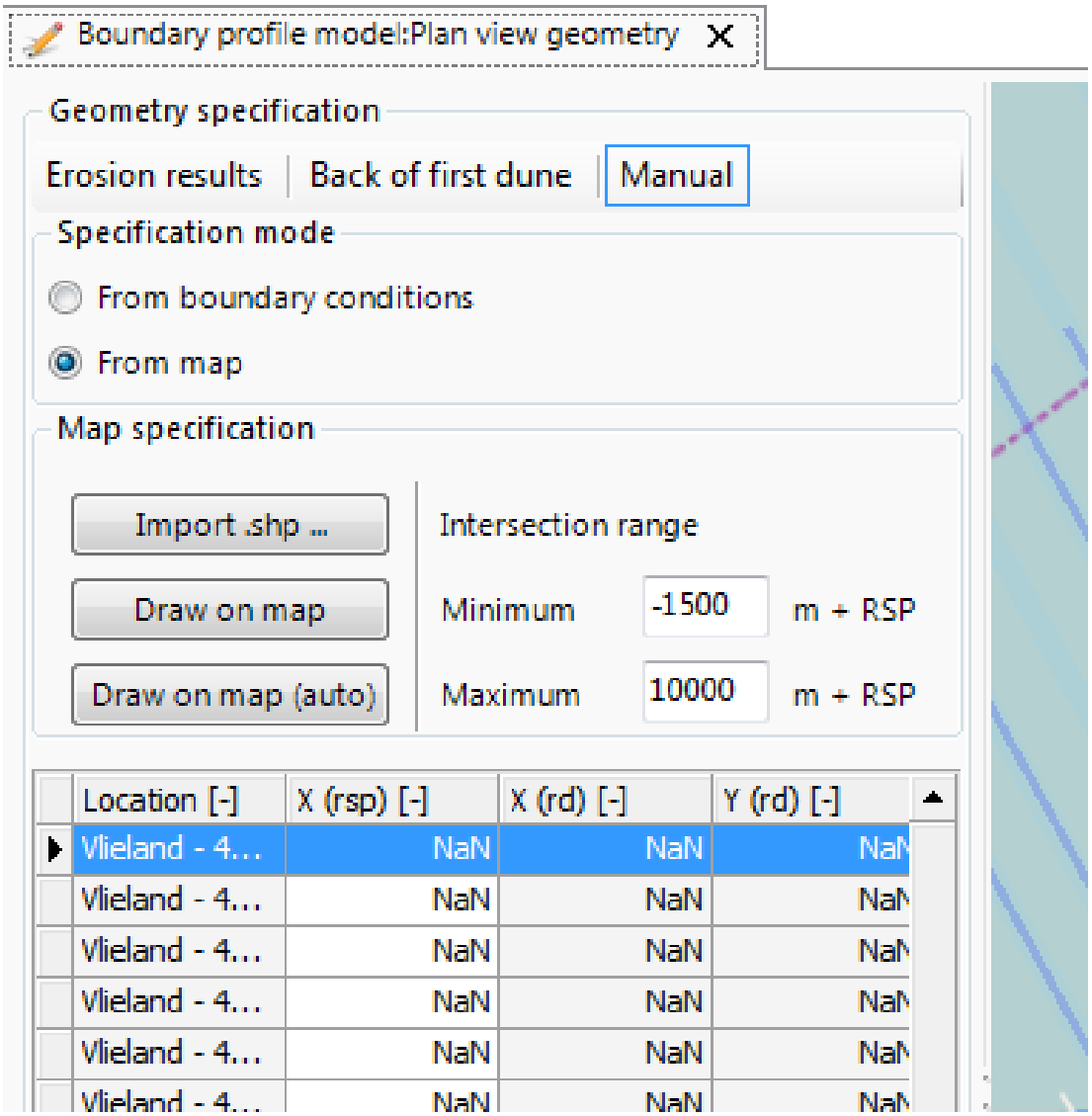


Figure 8.7: *View of the left panel of the document window for the Plan view geometry for manual positioning of the boundary profile on a map*

You will then be prompted to indicate whether the specified position is at “Ground Level” or the position entered in the table is at “Maximum storm surge level”. If a position is specified at maximum storm surge level, the front side of the boundary profile calculated by the model at that position will have a slope of 1:1 landward relative to ground level. However, if positions are specified as being at ground level, then the front side of the profile will be calculated as the line with a slope of 1:1 seaward from the specified point at ground level to a point at maximum storm surge level.

During manual editing of the boundary profile design, there are several tools available in the **Map** tab of the ribbon (see Figure 8.8). These tools are grouped according to their function. Three of these groups are important for the editing or design of a continuous boundary profile. In the figure, these are circled in red:

- **Select (Tools)** - The Tools group includes tools for selecting objects on the map. This can be done in two ways:
  - **Pointer select** - Select using the pointer. You can either select individual points on the map, or draw a rectangle within which everything is selected.

- **Lasso select** - Click and drag the mouse to draw a shape that encloses the objects you want to select.

◇ **Edit** - The tools in this group are used to modify the boundary profile. The following editing actions are possible:

- **Move geometry points** - Move all points of the drawn boundary profile simultaneously. This option keeps the start and end point in position, but adjusts all intermediate points.
- **Move a single geometry point** - Move one of the points on the drawn boundary profile (if a point is first clicked), or the entire boundary profile (if the line is first clicked).
- **Add point to geometry** - Insert an additional point on the drawn boundary profile.
- **Remove point from geometry** - Delete a single intermediate point from the drawn boundary profile.

◇ **Draw (Boundary Profile)** - This group contains two tools for drawing a new boundary profile. After using either of these two tools, the “Geometry specification” will automatically be set to “Manual”. The same drawing tools are also available in the “Plan view geometry” document window:

- **Draw Boundary Profile** - Use this tool to draw a new boundary profile as one or more straight line segments. Each mouse click adds a new point and line segment to the drawn profile. A double-click of the mouse inserts the final point and line segment.
- **Draw Boundary Profile (Auto)** - Use this tool to draw an entire boundary profile as a freehand line. Simply hold the left mouse button pressed while you drag the mouse, and the drawn boundary profile will exactly follow the mouse movement.

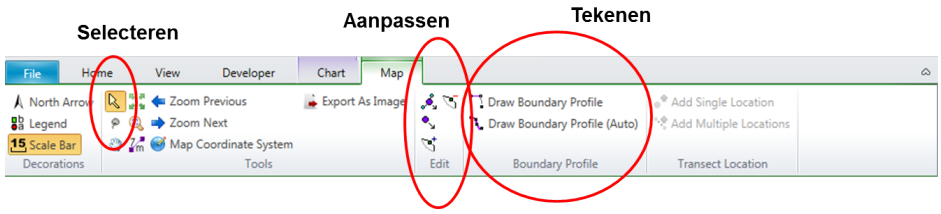


Figure 8.8: *The Map ribbon tab, showing the tools that are useful for boundary profile design circled in red*

Cross-shore geometry

The “Cross-shore geometry” item gives you more control over the cross-sectional shape of the calculated boundary profile. Moreover, this screen shows which position in the cross-sectional view corresponds to the specified location of the boundary profile in the “Plan view geometry”. Double-click on the item to open a document window similar to that in Figure 8.9. This screen allows you to specify or edit the following settings:

◇ **TRDA2006 geometric profile** - By default, TRDA2006 requires that a boundary profile should be modeled with a fixed shape. This requirement is met when the large button above the “Geometry specification” is pressed.

◇ **Geometry specification** - When the “TRDA2006 geometric profile” button is not pressed, further options are enabled for specifying the shape of the geometric border profile. If a non-standard specification is in effect, the required volume is calculated based on the “standard” geometric profile, and a shape with the same volume is then calculated based on the edited specifications. You can specify a non-standard geometric shape for the boundary profile by selecting one of the following:

- **Fixed crest width** - The specified crest width is maintained at all times. MorphAn only accepts crest widths of 0 to 50 meters.

- **Fixed crest height** - The height of the crest of the boundary profile is held constant, and the width is adjusted to the required volume. MorphAn accepts heights of 0 to 10 meters. Keep in mind that in the case of a fixed crest height lower than 1 meter, all calculated boundary profiles that fall below the required 1 meter will be kept above the maximum storm surge level.
- **Back slope** - Here you can adjust the back slope ratio by editing the horizontal component.

◇ **Base point specification** - These options are active only if manual geometry specification is selected in the plan view geometry item (see earlier in this subsection). In that case you can specify where the base point lies on the cross-section of the boundary profile (as entered at the given locations):

- **Ground level** - The entered position lies at ground level on a 1:1 seaward slope of the boundary profile down to the maximum storm surge level.
- **Maximum storm surge level** - The entered position lies at maximum storm surge level (or calculation level). This therefore indicates the most seaward point of the boundary profile.
- **Iterate landward** - When unchecked, this box indicates that the entered base position is on the back slope (most landward point) of the boundary profile; checked indicates a seaward boundary, in which case the user can choose between the preceding two options for the level. If the box is unchecked (base position on back slope), the point is automatically assigned a height at maximum storm surge level.

◇ **General** - Several general settings can also be entered:

- **Wave period** - You can select this setting for the model from the drop-down list: T_p, $T_{m-1.0}$ or a combination of both. The combined option means using $T_{m-1.0}$ from the boundary conditions for locations in the Wadden Sea, and T_p for all other locations.
- **Allow volumetric boundary profile** - If checked, this option means the boundary profile must achieve a volumetric fit, if a geometric fit with the specified geometry cannot be achieved.
- **Use minimum volume of 16.875** m^3/m - The TRDA2006 states that the boundary profile must be modeled with a minimum crest height of 2.5 m. Given the prescribed slopes and crest width, it follows that the minimum volume present is 16.875 m^3/m. This option enables you to disable the minimum height constraint (and therefore also the minimum volume), so that boundary profiles with a smaller volume can also be modeled.

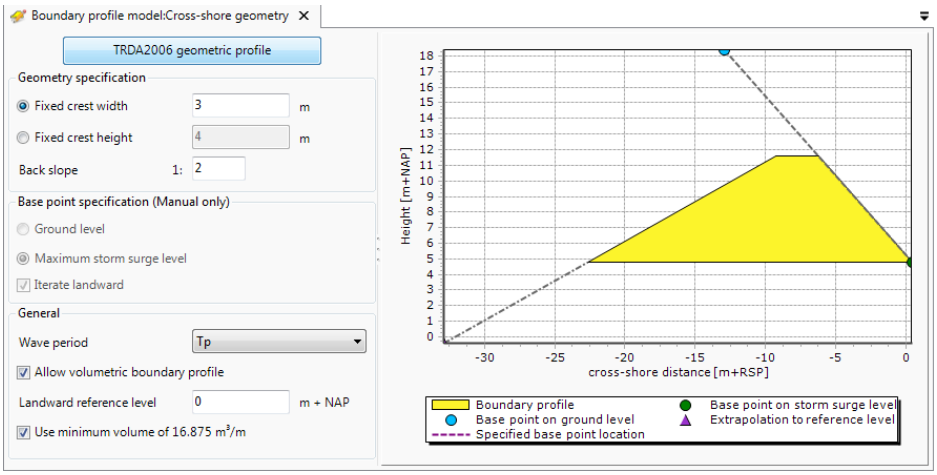


Figure 8.9: *Typical cross-shore geometry window in the boundary profile model*

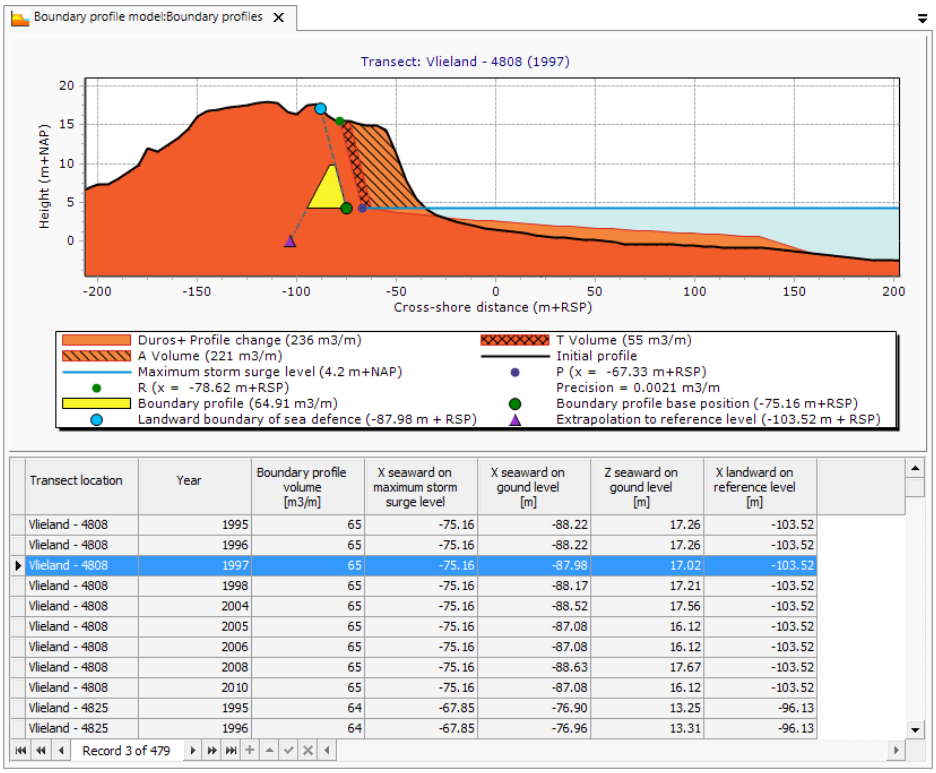
8.3.2 Output

After running the Boundary profile model, two new items are added to the **Output** folder of the model in the **Project Explorer**:

- ◇ Boundary profiles
- ◇ Run report

When you double-click on the item *Boundary profiles*, a window similar to Figure 8.10 will open. This window contains a table and a chart. The table shows all calculated transects and years as well as the most important properties and outcomes. The chart shows the result of the transect selected in the table. The chart also shows the calculated erosion result.

Use the mouse to zoom in or out on the chart. Drag a selection rectangle down-right to zoom in; drag up-left to zoom out. You can also use ctrl+scroll wheel to zoom in or out. All input and output details of any selected result can be viewed in the comprehensive **Properties** tool window.



Transect location	Year	Boundary profile volume [m3/m]	X seaward on maximum storm surge level	X seaward on gound level [m]	Z seaward on gound level [m]	X landward on reference level [m]
Vlieland - 4808	1995	65	-75.16	-88.22	17.26	-103.52
Vlieland - 4808	1996	65	-75.16	-88.22	17.26	-103.52
Vlieland - 4808	1997	65	-75.16	-87.98	17.02	-103.52
Vlieland - 4808	1998	65	-75.16	-88.17	17.21	-103.52
Vlieland - 4808	2004	65	-75.16	-88.52	17.56	-103.52
Vlieland - 4808	2005	65	-75.16	-87.08	16.12	-103.52
Vlieland - 4808	2006	65	-75.16	-87.08	16.12	-103.52
Vlieland - 4808	2008	65	-75.16	-88.63	17.67	-103.52
Vlieland - 4808	2010	65	-75.16	-87.08	16.12	-103.52
Vlieland - 4825	1995	64	-67.85	-76.90	13.25	-96.13
Vlieland - 4825	1996	64	-67.85	-76.96	13.31	-96.13

Figure 8.10: *Typical boundary profile screen showing results of a modeling run*

The following parts of the boundary profile are shown in the figure:

- ◇ **Erosion result** - This is a copy of the result as displayed in the output of the “Erosion model”.
- ◇ **Boundary profile** - The yellow shaded area shows the calculated boundary profile.
- ◇ **Boundary profile base position** - The green circle indicates the position of the boundary profile at the maximum storm surge level.
- ◇ **Landward boundary of sea defense** - The blue circle indicates the position of the boundary profile at ground level.
- ◇ **Extrapolation to reference level** - The purple triangle indicates the back slope of the boundary profile extrapolated to the reference level specified in the settings of the model.

8.4 Normative model

The normative model enables you to compile a normative results diagram based on calculated erosion results (erosion model) and boundary profile (boundary profile model).

8.4.1 Settings

When you double-click on the “Normative model”, a document window opens in which you can specify Assessment rules, i.e. for a normative point to be designated “Invalid” (see Figure 8.11). If you choose the rule “15 years prior...” and specify a year in the adjacent field, then the model will look back over the preceding 15 years. (A value of 0 means the model will take the most recent measurement point in the profile measurements). If there are more than 2 calculated erosion points (R points) landward of the specified seaward boundary of the sea defense, a normative point (the third-worst point) will be designated Invalid. Alternatively, if you choose the rule “Use years from boundary conditions”, then the model will search the boundary conditions of each location for a start and end year. This is further explained later in this section.

In this window you can also influence how the model determines the “Landward boundary of the sea defense”. The model bases this on the results of the “Boundary profile model”. There are two options: “Ground level” or “Maximum storm surge level”. The model will then determine the most seaward position of the selected locations from all calculations within the specified period (excluding the years it must disregard; see subsection 8.4.2).

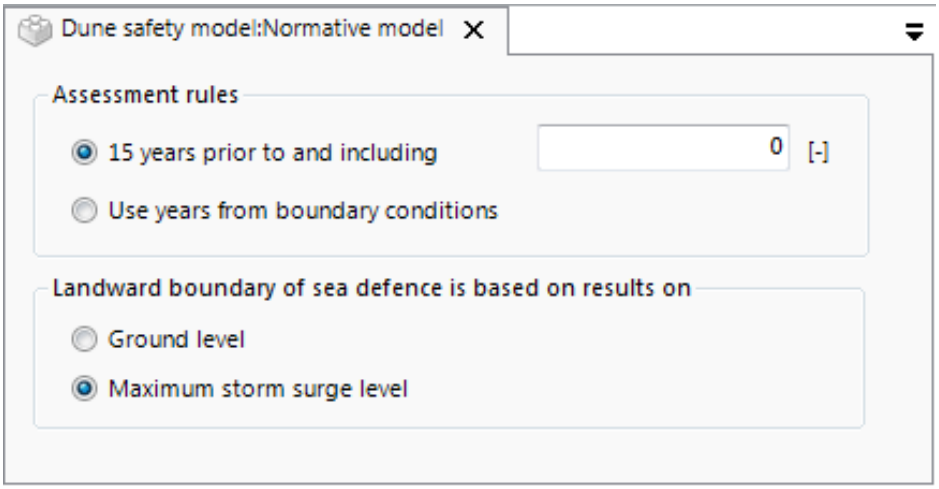


Figure 8.11: *Normative model settings window*

8.4.2 Input

The normative model calculates a normative result for each transect location based on the previously calculated erosion results and the boundary profile results. The assessment rules in the settings specify whether to determine R point overruns of the sea defense seaward boundary within a fixed period (15 years...) for all locations, or a specific period per location. In the “per location” case, a start and end year must be provided for each location. This information is obtained from the boundary conditions (see also Appendix A). As a result, the **Input** folder of this model contains three items:

- **Erosion results** - A reference to the outcomes of the erosion model
- **Boundary profiles** - A reference to the outcomes of the boundary profile model
- **Boundary conditions** - This item has the same name as the selected boundary condition set, and enables you to adjust the period and years considered by the model when

calculating the frequency of overruns of the seaward boundary of the sea defense.

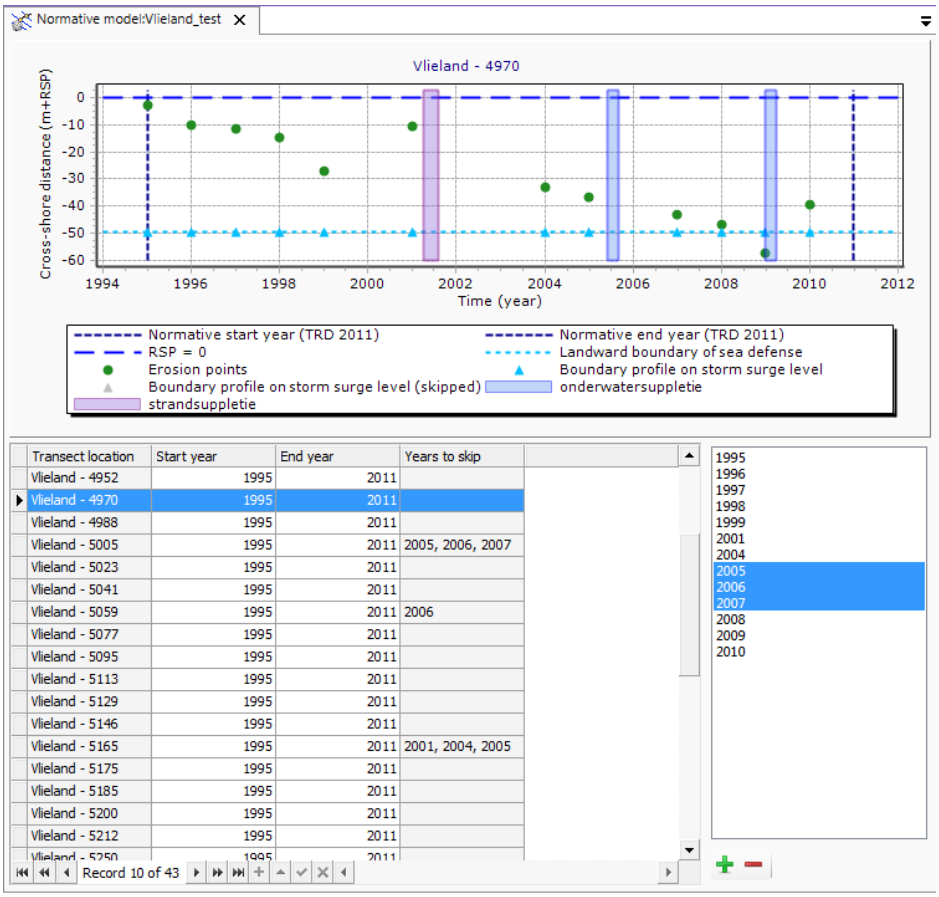


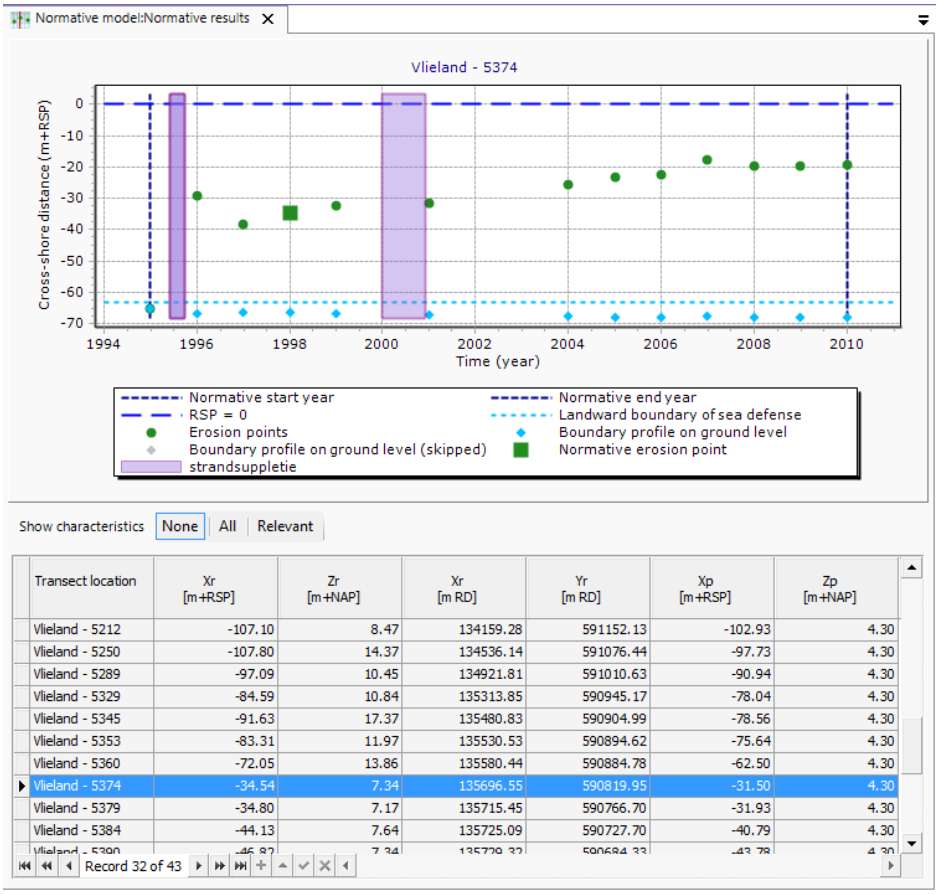
Figure 8.12: *Typical window with results of the normative model*

A double-click on the Boundary conditions item opens a window similar to that in Figure 8.12. In the lower part of the window you can specify a start and end year for individual transect locations, as well as the years that should be skipped when the model runs. These years are only included in calculations if the second assessment rule is selected in the settings screen (see Figure 8.11). To specify a start and end year for a location, enter a different year in the table. There are three ways to specify or edit the “Years to skip”:

- **Click on the chart** - First select a location in the table, then click on one of the green R (erosion point) dots. This will be added to the “Years to skip” for this location. To remove a skipped year from the list for a location, select the location, then click on the gray dot corresponding to the skipped year.
- **Using the + and - buttons** - To add or remove one or more years to skip to/from multiple locations, first select multiple locations in the table, then click on the desired years in the list on the right. Finally, click on the **+** button to *add* the years to the “Years to skip” lists. Otherwise, click on the **-** button to *remove* the specified years from the lists.
- **Import** / **Export** - When you right-click on the boundary conditions in the project explorer, the context menu gives you the option to *Import...* or *Export...*. This enables you to import or export the “Years to skip” as a csv file. The format of this csv file is described further in Appendix A.8.

8.4.3 Output

After the Normative model has run, the **Output** folder of the model in the **Project explorer** will contain the item **Normative results**. When you double-click on this item, a window similar to Figure 8.13 will open. This window contains a table and a chart. The table shows the most important properties and outcomes for each location in the model. The chart shows the normative results for the location selected in the table below.



Transect location	Xr [m+RSP]	Zr [m+NAP]	Xr [m RD]	Yr [m RD]	Xp [m+RSP]	Zp [m+NAP]
Vlieland - 5212	-107.10	8.47	134159.28	591152.13	-102.93	4.30
Vlieland - 5250	-107.80	14.37	134536.14	591076.44	-97.73	4.30
Vlieland - 5289	-97.09	10.45	134921.81	591010.63	-90.94	4.30
Vlieland - 5329	-84.59	10.84	135313.85	590945.17	-78.04	4.30
Vlieland - 5345	-91.63	17.37	135480.83	590904.99	-78.56	4.30
Vlieland - 5353	-83.31	11.97	135530.53	590894.62	-75.64	4.30
Vlieland - 5360	-72.05	13.86	135580.44	590884.78	-62.50	4.30
Vlieland - 5374	-34.54	7.34	135696.55	590819.95	-31.50	4.30
Vlieland - 5379	-34.80	7.17	135715.45	590766.70	-31.93	4.30
Vlieland - 5384	-44.13	7.64	135725.09	590727.70	-40.79	4.30

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Figure 8.13: *Typical normative results screen showing the results of a modeling run*

8.5 Dune safety overview

Finally, for an overview of dune safety in the modeled coastal area, double-click on the **Safety overview** item, which will open an overview map in the document window (see Figure 8.14). All calculated erosion results are visualized in this *Safety overview*. The map also shows the bandwidth of the calculated R points over the modeled period, plus all normative points. The map can only show data for a single moment in time. To view the results of another moment or to animate the entire modeled period, you can also work with the Time Series Navigator (see subsection 3.2.9 for more information). If you wish, you can show additional information on the map, e.g. from shapefiles. You can find more information on working with maps in subsections 3.2.5 and 3.2.6.

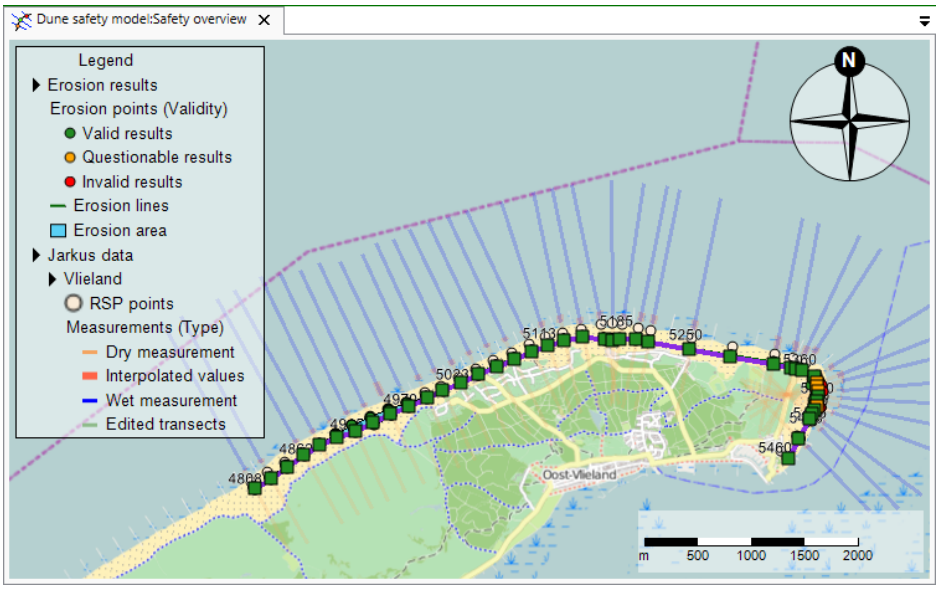


Figure 8.14: *Typical Dune Safety overview window showing results of a modeling run for Vlieland*

8.6 MorphAn as assessment tool within WTI2017

MorphAn is to become an approved assessment tool under the WBI2017 (*Dutch government water defense assessment*). Detailed calculations in conformance with assessment layer 2A will be done using MorphAn. The inspector will then translate these calculation results to a breach risk per section of the coastline. The breach risk for each section of coastline can subsequently be entered into Ringtoets.

9 Coastline assessment (Coastline Development Model)

This model is used to support coastline assessment within the coastline monitoring program. In the Netherlands, results are published in the atlas of coastal charts(Rijkstwaterstaat, 2012). The coastline development model comprises three sub-models. These sub-models are based on coastal management policies agreed in 1990. A predefined Base Coastline (BCL) has been in effect since that moment. The BCL specifies the minimum position of the coastline relative to the zero point of a coastal location. In 2001, the BCL position at certain locations was adjusted. Both the selection of transects and years, and the specification of the profile measurements and boundary conditions of the coastline development model, are carried out based on the items in the **Input** folder of the model. For more details, please refer to section 7.2. This input applies automatically to the three underlying sub-models:

- ◇ **Momentary coastline (MCL) model**
- ◇ **Trend period model**
- ◇ **Expected coastline (TCL) model**

9.1 Momentary coastline (MCL) model

The MCL model calculates the momentary coastline position (MCL) based on measurement data and boundary conditions for every coastal location, and every year. This section explains the inputs and outputs of this model.

9.1.1 Input

The MCL model calculates the momentary coastline based on the parameters in the selected boundary condition file. The transect selection is determined by the selection entered at coastline development model level (see section 7.2). The single item in the **Input** folder of this model contains the boundary conditions that apply to this model for the selected transects. To edit the boundary conditions, double-click on this item. Any modifications will also take effect in the **Data** folder of the workspace. If these boundary conditions are used in any other model, then they will also be automatically modified in *that* model.

9.1.2 Output

After running the MCL model, the **Output** folder of the model in the **Project Explorer** will contain two new items:

- ◇ Momentary coastline points (MCL)
- ◇ Run report

When you double-click on the item *Momentary coastline points (MCL)*, a window similar to Figure 9.1 will open. This window contains a table and a chart. The table shows all calculated transects and years as well as the most important properties. The chart shows the calculated momentary coastline position of the transect selected in the table. The MCL is indicated by a dark blue dashed line. The light blue shaded area indicates the calculated volume between the specified MCL limits (represented by light gray lines). Use the mouse to zoom in or out on the chart. Drag a selection rectangle down-right to zoom in; drag up-left to zoom out. You can also use Ctrl+scroll wheel to zoom in or out. All input and output details of any selected result can be viewed in the comprehensive Properties tool window.

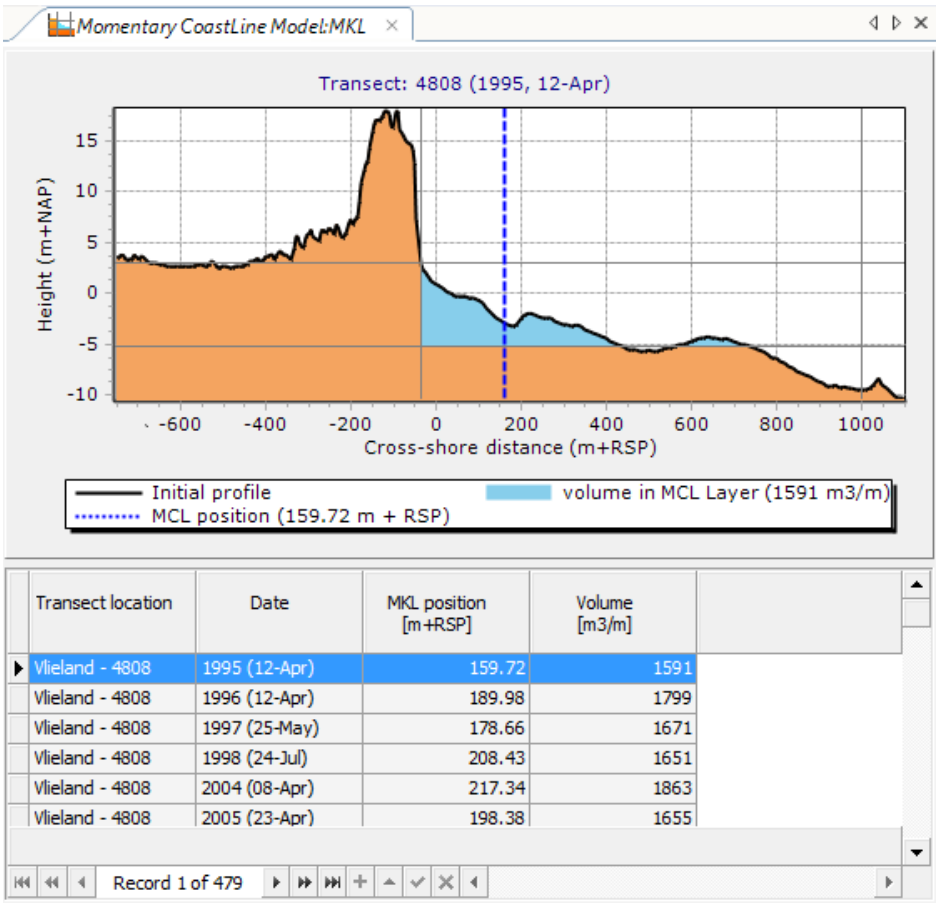


Figure 9.1: *Typical screen showing calculated momentary coastline points*

9.2 Trend period model

The purpose of the trend period model is to use nourishment data to make an initial estimate of a valid period for calculating a trend in the development of the MCL values. The TCL model will later use this trend to model the “Expected Coastline” (TCL).

9.2.1 Settings

To open the Trend period model settings window (see Figure 9.2), double-click on the model in the project explorer. This window allows you to adjust the following settings of the model:

- **Period of interest** - The first setting specifies a period between a start year and end year. Calculated MCL points outside this period will be disregarded when the model is run.
  - **Start year** - The first year of the period of interest. The analysis ignores momentary coastline (MCL) points outside this period.
  - **End year** - The final year of the period of interest. The analysis ignores momentary coastline (MCL) points outside this period.
- **Trend period length** - The model will search through the period of interest for a set of successive years in which no nourishment has occurred. The model always searches for the most recent period in which that was the case. It also takes into account the following:
  - **Minimum length** - The minimum number of years in a period. Periods shorter than this minimum are disregarded.
  - **Maximum length** - The maximum number of years in a period. In any period longer

than this maximum, only the last years of the period are included in the trend calculation.

- **Nourishment types** - Lastly, you can also specify the types of nourishment to include in the analysis. This can be done in two ways:
  - **Minimum volume per meter** - A minimum volume can be specified. Nourishments with a smaller volume will be disregarded in the calculation of the trend period.
  - **Nourishment type** - The table in the lower part of the settings window shows all types of nourishments present in the Data folder. In this table you can select the nourishment types to be included in the calculation (the unselected types will be disregarded). You can optionally use the two buttons above the table (**Select all types** and **Unselect all types**) to save mouse clicks when selecting all or none.

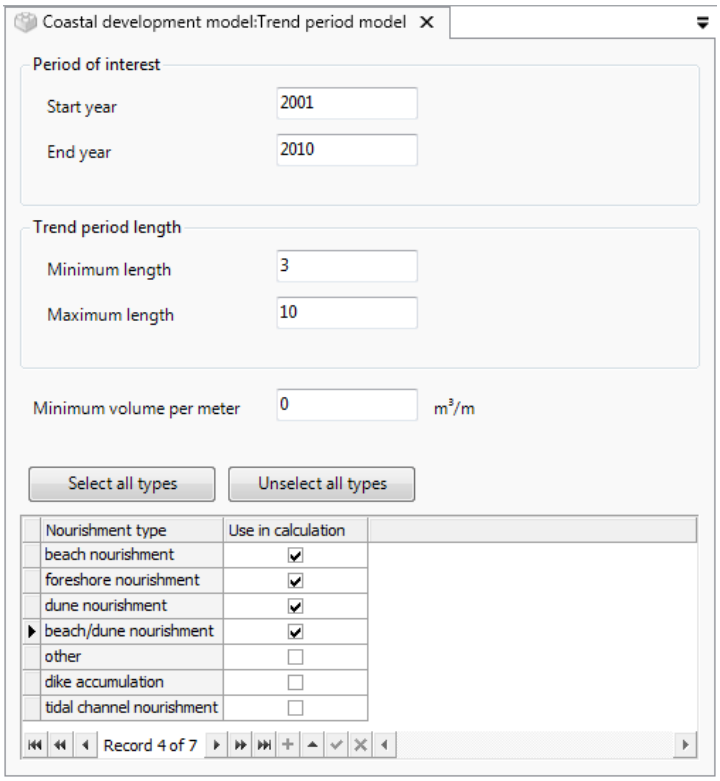


Figure 9.2: *Settings screen for the Trend period model*

9.2.2 Input

Because this model uses only the nourishment data, the **Input** folder of this model contains a single item that links directly to the nourishment data in the workspace Data folder (see also section 4.8).

9.2.3 Output

After the model has run, there will be two output items:

- Trend periods
- Run report

When you double-click on the *Trend periods* item, a window will open showing a table with the calculated start and end year for every location. If you right-click on the *Trend periods* item,

you will have the option to export the calculated trend periods to a *.csv file.

9.3 Expected coastline (TCL) model

Based on the MCL points from the MCL model (section9.1) and a predefined trend period, the TCL model calculates the trend in the development of momentary coastline points. This trend is then used to calculate the expected position of the coastline at predefined times (plus the moment when the expected coastline intersects with the base coastline, if applicable).

9.3.1 Input

The model takes its input from the calculated MCL values. The model also depends on a specification of the trend data (trend period and base coastline or BCL). The model has two input items:

- ◇ **MCL points** (MCL calculation results, linking directly to the MCL model output).
- ◇ **Trend calculation definitions**

A double-click on the second item opens a screen similar to that in Figure 9.3. The upper part of this screen contains a chart showing the specified years and nourishments; the lower part has three tabs. The screen will open to the **Trend data** tab, which contains a table with the following columns:

- ◇ **Location and Offset** - Transects for which the input is defined in the adjacent columns.
- ◇ **Trend start year** - The first year of the period for which a trend of the MCL points is to be calculated.
- ◇ **Trend end year** - The last year of the period for which a trend of the MCL points is to be calculated.
- ◇ **TCL start year** - This is the first year for extrapolation of the trend. If no successful MCL calculation can be found for that year, the model will search back in time to the first successful MCL calculation. If this falls within the trend period range specified by the *Trend start year* and *Trend end year* , then the trend will be continued. Otherwise, the trend will be extrapolated from the MCL point found by searching backwards. This parameter is not mandatory. If you leave it unspecified in the table (NaN = Not a Number), the above extrapolation rule will automatically be applied from the most recent calculated MCL point. The initial entry in this column is derived from the selected boundary conditions.
- ◇ **BCL** - This is the predetermined base coastline at the specific location. This value is likewise taken from the selected boundary conditions.

This table is used to specify the start and end years for calculating the trend (first two columns). These values are not derived from the boundary condition set; they are directly linked to the model. There are two methods you can use to copy to another model (for example, another TCL model or a Trend model in a volume development model):

- ◇ **Export** / **Import** - To export the years to a csv file, right-click in the Project Explorer on *Input* -> *TCL calculation definitions*, choose Export... and select “Trend periods (*.csv)”. Import into another model works the same way (but then choose Import... rather than Export....).
- ◇ **Cut** / **Paste** - You can copy data directly from one table into another table using Copy (Ctrl+C) in the first table, and Paste (Ctrl+V) in the second table. Alternatively, you can click Copy or Paste in the context menu that appears when you right-click in a table with one or more cells selected.

You can use the button above the table to directly fill the table with all results (trend data)

calculated by the Trend model.

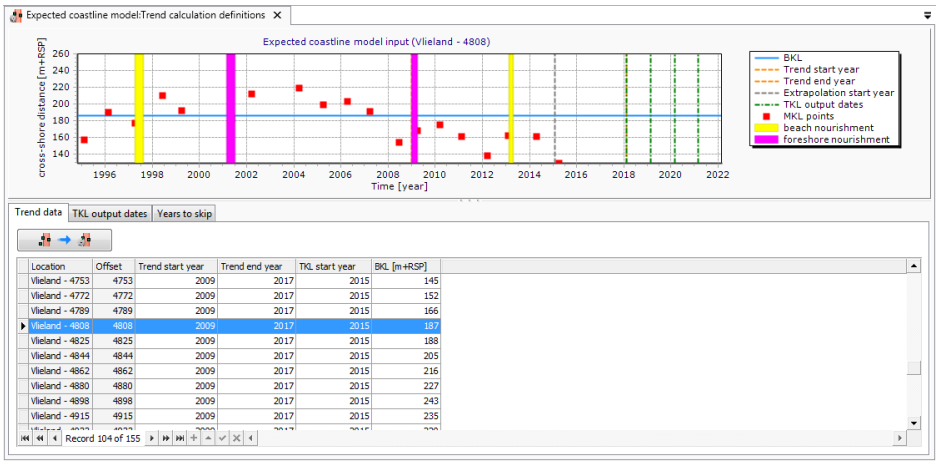


Figure 9.3: *Typical window for entry of trend data and base coastline (BCL).*

Apart from the trend data (trend period, TCL start year and BCL) in the first tab, you also need to specify the dates for which a TCL has to be calculated: click on the **TCL output dates** tab in the lower part of the screen. The window then appears as in Figure 9.4. To add dates, select a date in the calendar, then click the button “Add time”. To remove a date, first select it, then press the Delete key.

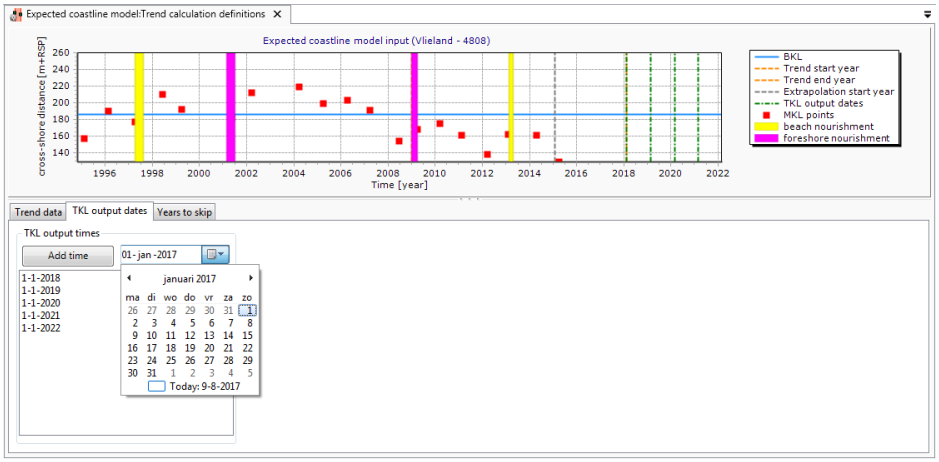


Figure 9.4: *Typical window for defining output dates for calculating TCL values.*

Lastly, for each location you can optionally specify any **Years to skip** in the trend calculation. When you click on this tab, the window appears as in Figure 9.5. As with the Normative model in the Dune Safety model (subsection 8.4.2), you have three ways to specify which years should be skipped for a location:

- **Click on the chart** - First select a location in the table, then click on one of the red MCL points. This will be added to the “Years to skip” for this location. To remove a skipped year from the list for a location, select the location, then click on the gray dot corresponding to the skipped year.
- **Using the + and - buttons** - To add or remove one or more years to skip to/from multiple locations, first select multiple locations in the table, then click on the desired years in the list on the right. Finally, click on the **+** button to *add* the years to the “Years to skip” lists. Otherwise, click on the **-** button to *remove* the specified years from the lists.

◇ **Import** / **Export** - When you right-click on the boundary conditions in the **Project Explorer** window, the context menu gives you the option to *Import...* or *Export...*. This enables you to import or export the “Years to skip” as a *.csv file. The format of this *.csv file is described further in Appendix A.8.

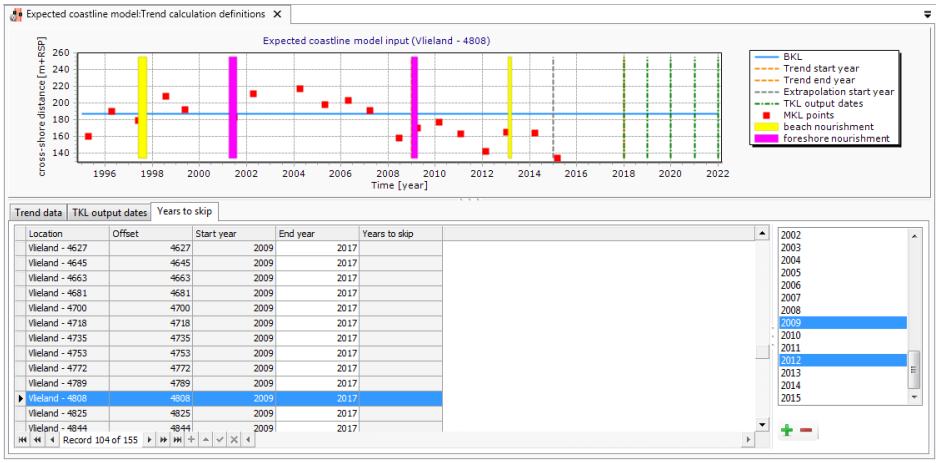


Figure 9.5: *Typical window for specifying years to skip during calculation*

9.3.2 Output

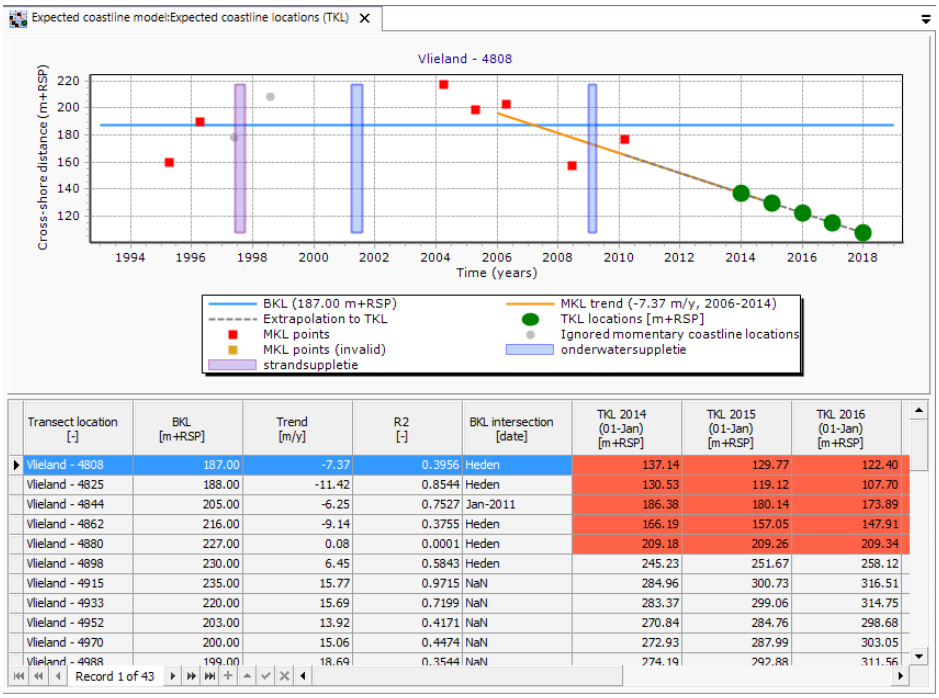
After running the Expected coastline (TCL) model, two new items are added to the **Output** folder of the model in the **Project Explorer**:

◇ Expected coastline locations (TCL)
◇ Run report

When you double-click on the Expected coastline locations (TCL) item, a window will open similar to that in Figure 9.6. The calculated trend and expected coastline locations (TCL) are shown both as a chart and in a table. The following values are displayed for each transect (location):

◇ **BCL** - The base coastline position used to determine the moment that the calculated trend line intersects with the BCL.
◇ **Trend** - The calculated trend for momentary coastline (MCL) development.
◇ **R2** - A measure of the precision with which the trend line describes the MCL development. A value of 1 represents perfect precision; the closer to 1, the better.
◇ **BCL intersection** - Date that the calculated trend line intersects the BCL position. The value in this column of the table can take the following forms:
  - **Heden** - (“Now”) Indicates that the trend line intersects the BCL *before* the TCL start year.
  - **NaN** - (“Not a Number”) Indicates that the trend line intersects the BCL *after* the TCL start year and the trend is *positive*.
  - **MMM-yyyy** - If the trend line intersects the BCL *after* the TCL start year and the trend is *negative*, this column shows the month and year of BCL intersection.
◇ **TCL yyyy** - Calculated TCL positions (one column per TCL output date).
◇ **TCL - BCL yyyy** - The difference between each calculated TCL position and the BCL position (one column per TCL output date).

If you wish to adjust the styling of the lines and markings on this chart, select an item in the



Transect location [-]	BKL [m+RSP]	Trend [m/y]	R2 [-]	BKL intersection [date]	TKL 2014 (01-Jan) [m+RSP]	TKL 2015 (01-Jan) [m+RSP]	TKL 2016 (01-Jan) [m+RSP]
Vlieland - 4808	187.00	-7.37	0.3956	Heden	137.14	129.77	122.40
Vlieland - 4825	188.00	-11.42	0.8544	Heden	130.53	119.12	107.70
Vlieland - 4844	205.00	-6.25	0.7527	Jan-2011	186.38	180.14	173.89
Vlieland - 4862	216.00	-9.14	0.3755	Heden	166.19	157.05	147.91
Vlieland - 4880	227.00	0.08	0.0001	Heden	209.18	209.26	209.34
Vlieland - 4898	230.00	6.45	0.5843	Heden	245.23	251.67	258.12
Vlieland - 4915	235.00	15.77	0.9715	NaN	284.96	300.73	316.51
Vlieland - 4933	220.00	15.69	0.7199	NaN	283.37	299.06	314.75
Vlieland - 4952	203.00	13.92	0.4171	NaN	270.84	284.76	298.68
Vlieland - 4970	200.00	15.06	0.4474	NaN	272.93	287.99	303.05
Vlieland - 4988	199.00	18.69	0.3544	NaN	274.19	292.88	311.56

Record 1 of 43

Figure 9.6: *Typical expected coastline locations (TCL) screen showing calculated trend and TCL values*

Chart tool window, then edit the properties of that item in the Properties window (see also subsection 3.2.7). To omit certain details from the chart, uncheck the box for those details in the Chart tool window.

9.4 Development overview

When you double-click on the **Development overview** item below the sub-models in the Project explorer, an overview map will open in the document window (see Figure 9.7). This combined map+chart shows the calculated development over time on all transects of both the MCL and TCL points (use the Time Navigator to move through the time series; see subsection 3.2.9). The map also shows the BCL and the coastline development trend, in a similar way to a coastline chart. Lastly, the map can also show the profile measurements for each transect (in this figure, the “Jarkus data” map layer). For a detailed description of the possibilities for visualization of results on the map, see section 7.3.

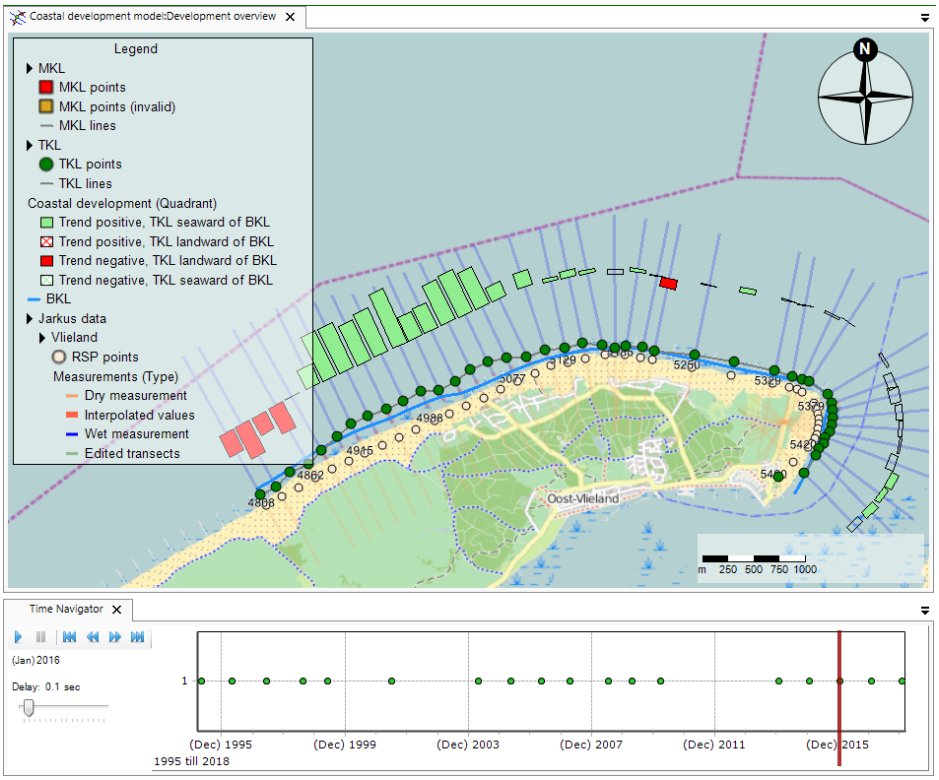


Figure 9.7: *Typical development overview screen showing results from the coastline development model. The Time Navigator window can be seen below the map.*

10 Volume Development Model

The volume development model calculates the volume development in the cross-shore profile at the specified location, within predefined vertical and horizontal boundaries on the transect. The model has much in common with the coastline development model. This chapter will therefore mainly focus on those aspects that differ from that model. As with the coastline development model, the input items and their use are described in section 7.2. Unlike the coastline development model, the volume development model will not result in an overview map. However, it likewise consists of three sub-models:

- **Volume model**
- **Trend period model**
- **Trend model**

10.1 Volume model

This model essentially makes identical calculations to the MCL (momentary coastline) model (section 9.1). The difference is that this model offers more flexibility in specifying and working with the boundaries of the slice of coastline for which a volume is calculated. For example, in the volume model you do not need to specify an upper boundary (or you can specify a boundary above the dune crest), and instead of using the boundary conditions in the boundary conditions file, you can replace one or more of the default values with a manually entered value. On the other hand, the calculated volume does not result in a geographic position such as the MCL point on a transect.

10.1.1 Settings

You can specify per boundary whether an identical value must be used for all calculations, or that the boundary per location should be supplied by the selected boundary conditions. To change the settings, first double-click on the “Volume model” in the Project explorer to open the settings window (see Figure 10.1). Now you can enter the required boundaries. In each case, a *checked* box indicates that the value in the adjacent field must be used. An *unchecked* box means the boundary values will be supplied by the boundary conditions file.

- **Seaward boundary** - Seaward boundary (as cross-shore distance) to be used during calculation. If you check the box for this option, the value entered in the adjacent field will be used, instead of the boundaries supplied in the boundary conditions file. An entry of NaN (“Not a Number”) tells MorphAn to calculate the most seaward boundary for which all selected profiles have data.
- **Landward boundary** - Landward boundary (as cross-shore distance) to be used during calculation. If you check the box for this option, the value entered in the adjacent field will be used, instead of the boundaries supplied in the boundary conditions file. An entry of NaN (“Not a Number”) tells MorphAn to calculate the most landward boundary for which all selected profiles have data.
- **Upper boundary** - Upper boundary to be used during calculation. If you check the box for this option, the value entered in the adjacent field will be used, instead of the boundaries supplied in the boundary conditions file. An entry of NaN (“Not a Number”) means there is no upper boundary (or the boundary is infinitely high).
- **Lower boundary** - Lower boundary to be used during calculation. If you check the box for this option, the value entered in the adjacent field will be used, instead of the boundaries supplied in the boundary conditions file. An entry of NaN (“Not a Number”) means the lower boundary will default to -50.

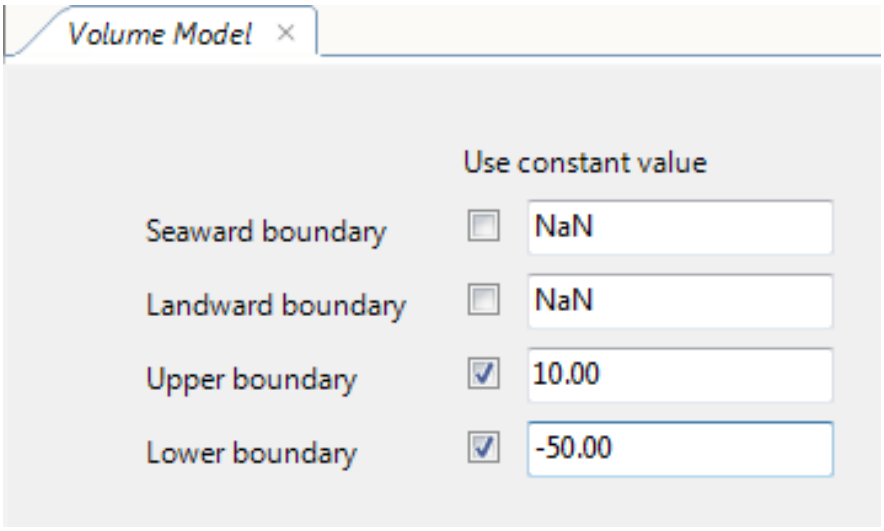


Figure 10.1: *Volume model boundary conditions general settings screen*

10.1.2 Input

If the settings of any boundary do not specify use of a uniform value, the model will use the data from the selected boundary conditions. The **Input** folder of the volume model in the **Project explorer** contains only one item: the boundary conditions. You can use this file to provide the seaward, landward, upper and lower boundaries of individual transects for the volume model. To open a window in which you can view and manually edit these values, double-click on the *Boundary conditions* item.

10.1.3 Output

After running the Volume model, two new items are added to the **Output** folder of the model in the **Project Explorer**:

- **Volumes** - This item contains information about the calculated volumes.
- **Run report** - The run report contains all messages generated by the model when it was run.

When you double-click on the *Volumes* item, a window will open showing the results for each transect in both chart and table form (see Figure 10.2). The calculated volume is shown as a blue area on the cross-shore profile per transect and year. For each selected transect, the *Properties* window shows the values actually used by the model for each boundary.

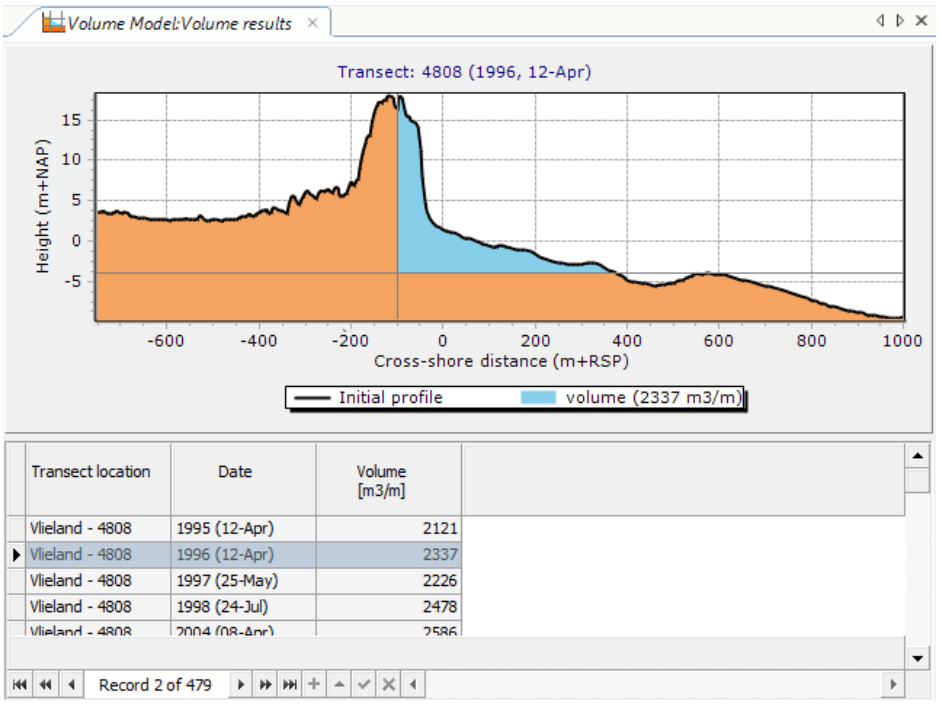


Figure 10.2: *Typical results visualization screen for the Volume model*

10.2 Trend period model

The trend period model included in the volume development model is identical to that in the coastline development model. For more information on this model and its use, see section 9.2.

10.3 Trend model

The Trend model calculates a trend in the development of the calculated volumes per location, and is therefore more or less identical to the expected coastline (TCL) model, as described in section 9.3. However, unlike the TCL model, no intersection is calculated between this trend and a reference value. In general therefore, the calculation definitions input screen of the trend model resembles that of the TCL model. The main difference is that there is no equivalent input tab for “TCL output dates”. For more information on the principles and use of this type of model, see section 9.3.

11 Bank Analysis Model

MorphAn offers a bank analysis model for the analysis of depth data. The tool uses soundings, grid measurements, real and generated (see section 6.5) cross-shore profile measurements, plus a predefined critical slope value, to create a chart and a map that show where the seabed slope exceeds the critical value. This model also enables you to import and visualize “landfills” (seabed fill areas) and “bottom protections” (seabed protection material).

You can add a bank analysis model to your MorphAn workspace at any time. In the **Project explorer**, right-click on the **MorphAn work space**. A context menu appears. Click the option **Add new model**, and the “Select model” screen will appear. Select **Bank analysis model**, then click **OK**, and a bank analysis model will be added below the last model in the workspace (see Figure 11.1). We will now review the model’s settings, input and output.

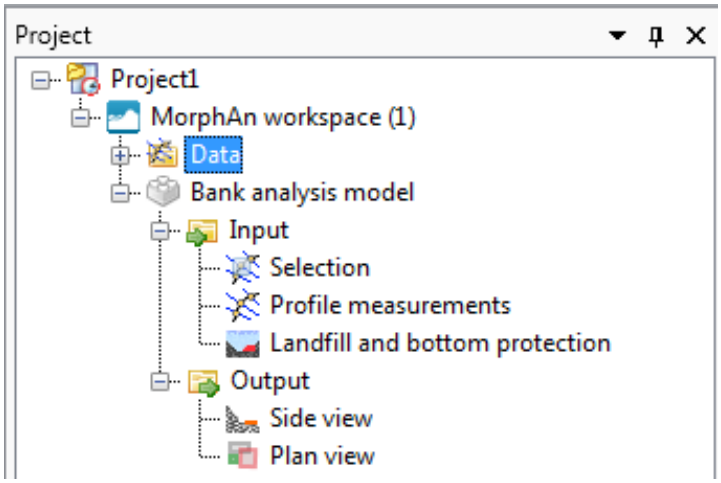


Figure 11.1: *A bank analysis model in the project explorer*

11.1 Settings

Each bank analysis model has its own settings. To edit these settings, select a bank analysis model in the project explorer. In the **Properties** window (see Figure 11.2), you can now view and if necessary modify the **Critical slope** and selected cross-shore profile measurement set used by the model. Seabed slopes that exceed the critical slope will be highlighted in the output of the bank analysis model (see Figure 11.6). The **Critical slope** is a positive (absolute) value. This makes it plain whether a slope is excessive, regardless of whether the slope is upward or downward.

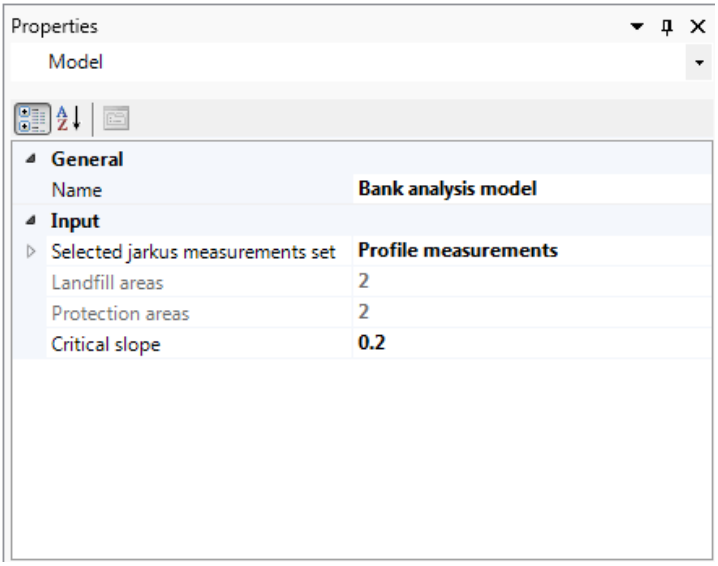


Figure 11.2: *Properties of a bank analysis model*

11.2 Input

11.2.1 Selection and profile measurements

The input to a bank analysis model comprises the profile measurements that are to be analyzed. These profile measurements and the selection for the analysis are specified as described previously in section 7.2. For **Selection**, see subsection 7.2.1; for **Profile measurements**, see subsection 7.2.3.

11.2.2 Landfill and bottom protection

In a bank analysis model, the landfill and bottom protection areas can be displayed on an interactive map and in a cross-sectional view. To import landfill and bottom protection areas into the model, in the **Project Explorer** right-click on **Landfill and bottom protection** in the Input folder of the model, then select **Import...** in the context menu (see left side of Figure 11.3).
You will then be prompted to select the type of data: **Bottom protection area (*.txt)** or **Landfill area (*.txt)** (see right side of Figure 11.3). Select the data type, click **OK**, and after you have selected the necessary files, they will be imported.
See Appendix A.11 for the required file format.

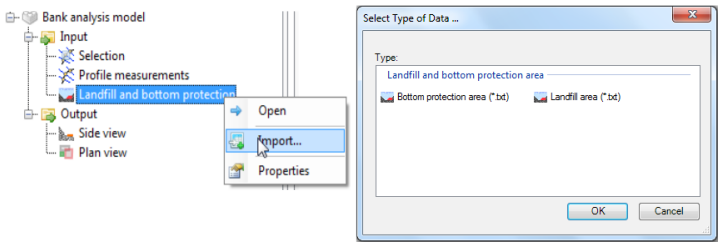


Figure 11.3: *Landfill and bottom protection area Import dialog.*

For a plan view of the landfill and bottom protection areas imported into the model, double-click on the **Landfill and bottom protection** item in the **Project explorer** (see Figure 11.4). These areas are also displayed in the output (see section 11.3).

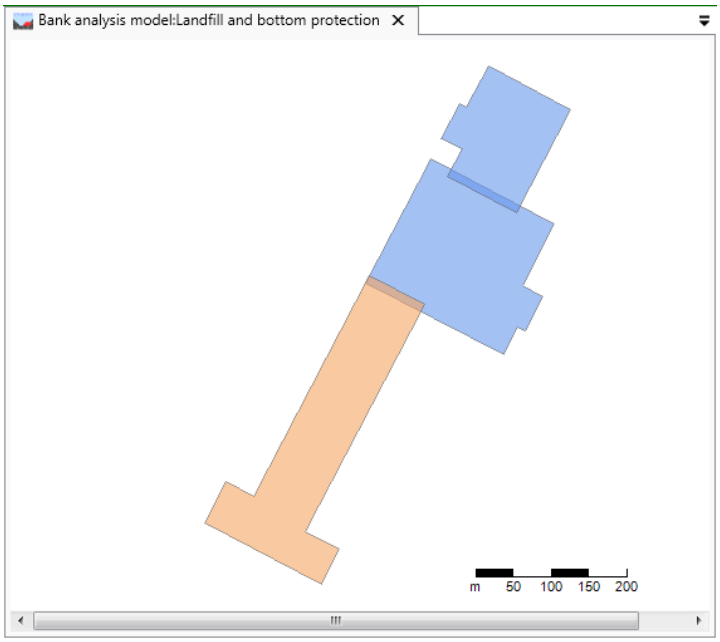


Figure 11.4: *Plan view of landfill (orange) and two bottom protection areas (blue).*

11.3 Output

Once the input is in order (see section 11.2) the model can be run. To run the model, right-click on the bank analysis model in the **Project explorer** and select **Run model** in the context menu (see Figure 11.5).

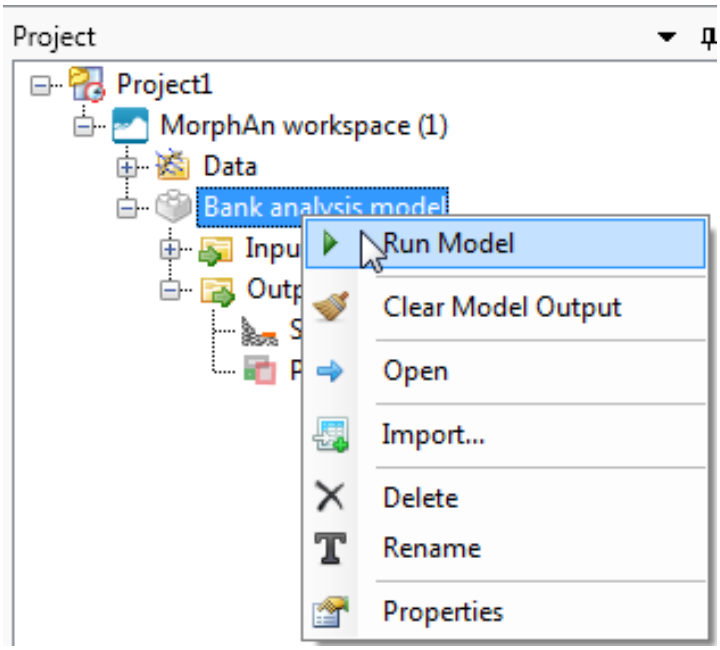
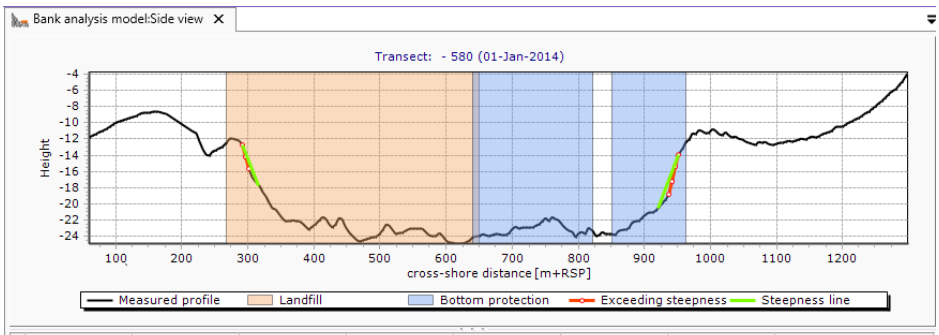


Figure 11.5: *Selecting the **Run model** option from right-click context menu for the **Bank analysis model**.*

11.3.1 Side view

When the bank analysis model has run, you can display the side view: double-click **Side view** in the **Project explorer**.

Figure 11.6 shows the side view of a successfully run model. The colored areas represent the landfill and bottom protection areas. In this example it is clear that the critical slope is exceeded in two places. With the information in this chart on where the critical slope (here in green) is exceeded, you can now determine whether the problem is serious.
The table below the side view gives for each location (transect) the date, plus a count of: segments exceeding critical slope; critical slope lines; landfill crossings; and bottom crossings.



Location	Offset	Date	Segments exceeding critical slope	Critical slope lines	Landfill crossings	Bottom protection crossings
- 580	580	01-Jan-2014	5	2	1	2
- 580	580	01-Jan-2015	5	2	1	2
- 580	580	01-Jan-2016	6	3	1	2

Figure 11.6: *Side view of a cross-shore profile measurement in the bank analysis model.*

11.3.2 Plan view

When the bank analysis model has run, you can display the plan view: double-click **Plan view** in the **Project explorer**.
The left side of Figure 11.7 shows the plan view of a successfully run model. The colored areas represent the landfill and bottom protection areas. You can also clearly see which profile measurements have excessive slopes.
The right side of the figure shows the corresponding side view that appears after selecting a profile in the plan view (in this case 790; the selection is visible as a blue square at the bottom of the profile).

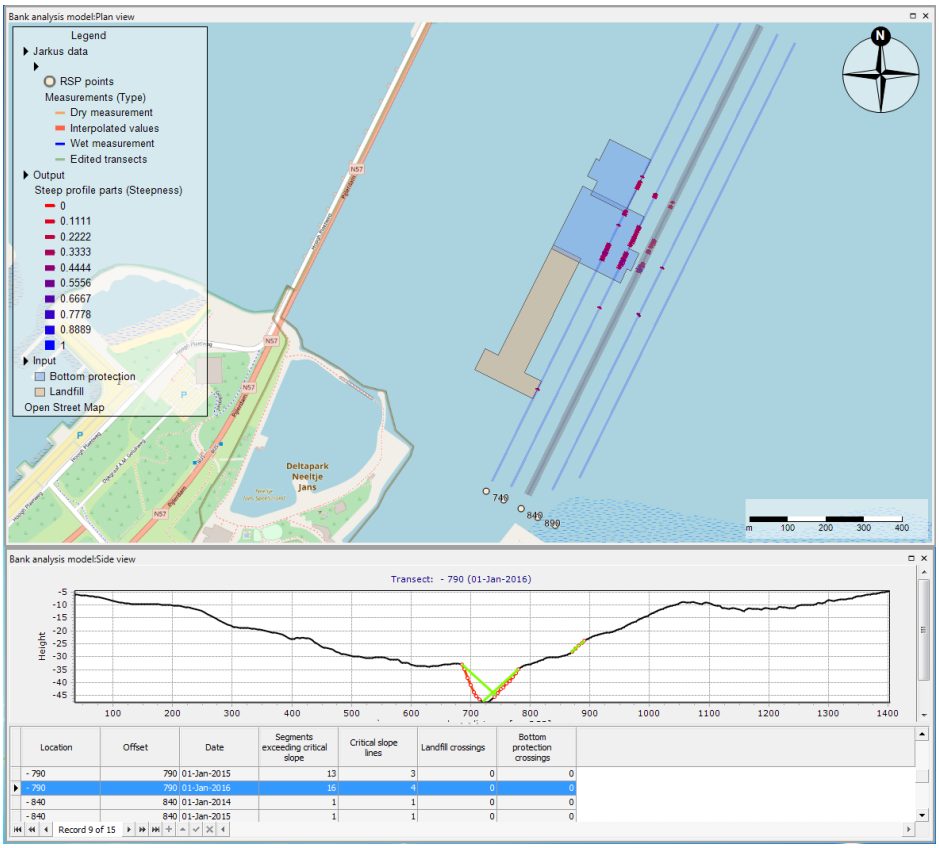


Figure 11.7: *Typical visualization of results of a bank analysis model, showing both plan and side view.*

12 Installation options

Your MorphAn installation offers three optional features that are not automatically present in the default installation. Two of these optional features are available in prototype form. The optional features are:

- ◇ Scripting
- ◇ XBeach 1D
- ◇ Bank analysis tool

Because XBeach 1D and Scripting are still in the prototype phase, this manual does not include a complete description of their functionality. However, a brief explanation of these features is provided below. The added functionality provided by the Bank Analysis tool is described in section 6.5 (creation of profiles measurements from a grid measurement set) and chapter 11 (bank analysis model).

12.1 Scripting

The scripting plug-in enables you to write MorphAn scripts in Python programming language. In theory you can run any function that is already programmed in the software but has no command (icon or shortcut) in the user interface. For example, it is possible to add measurement data to graphical output, compare results between different models, or export data in a format not yet defined in MorphAn.

If the scripting plug-in has been added to MorphAn, then the corresponding items will be visible in the **Toolbox** tool window. This window is where you manage your scripts. You will also see a **Scripts** tab in the MorphAn ribbon. This tab contains many tools to ease the process of writing, editing and running scripts. Under the Scripts item in the toolbox you will also find several example scripts that can help you get started with writing your own scripts.

12.2 XBeach 1D

The XBeach plug-in installs an initial (prototype) version of the XBeach model (1D transverse to the coast). When activated, this plug-in adds a new model to the project. The **Input** folder of this model contains the following items:

- ◇ **Profile** - Specifies the input profile (and optionally the structure). In this item you can also edit the definition of the calculation grid.
- ◇ **Waves** - Contains a time series of wave conditions (specified in the form of a spectrum).
- ◇ **Tide** - Specifies the periodicity in the water level. The document window of this item also enables you to generate or import a tide.
- ◇ **Parameters** - Specifies data such as the total duration of the model cycle, and material characteristics of the sand and water.
- ◇ **Output specification** - Specifies the required output variables, as well as the time intervals and locations where they must be output.

The **Output** folder contains the following items:

- ◇ **Cross-shore** - Shows in cross-section the results of the model (for a specific moment in time).
- ◇ **Time series** - Charts the development of the results of the model at a single location against time.
- ◇ **Point(s)** - Charts the development of the modeled point against time.
- ◇ **Runup** - Charts the movement of the waterline during the model run.

Apart from the individually-specified model, you can also generate a model from within an existing MorphAn workspace. There are several places where this is possible:

- **From the analysis selection screen** - If the XBeach 1D plug-in is installed, there will be a button in the **Data** tab of the ribbon that you can use to create XBeach 1D models. First, select the required locations and years, just as you do when opening an analysis window (see subsection 5.2.1), then click on this button. MorphAn will then create an XBeach 1D model for each selected measurement.
- **Transect selected on the map** - When you have opened a map from the analysis window (see subsection 5.2.2), you can select individual transects directly on the map. With a selection activated, the context menu enables you to generate an XBeach 1D model for each selected profile. The context menu appears when you right-click with the cursor on the map.
- **Erosion points** - After running the erosion model, open the “Erosion results” in the document window (see subsection 8.2.3). In the results table, select one or more transects and right-click above the selection. The context menu then offers the option to create XBeach 1D models based on the calculation result. In this case, in addition to the input profile, the water level, D_{50}, wave height H_s and wave period are automatically filled.
- **Erosion result on the map** - With the Safety overview open in the document window (see section 8.5), you can select one or more results on the map. Right-click above the selection to open the context menu, and select the option to create XBeach 1D models for the selected results. Just as with the erosion points method, the created models contain all required parameters.

13 Troubleshooting

13.1 FAQ (frequently asked questions)

What is the difference between a filter and a selection (of locations) in a model?
A MorphAn workspace can contain a very large number of defined locations (the standard grid file included with the software has more than 3600 locations). To save you from having to scroll through dozens of coastal areas, in the **Data** folder you can set a **Locations filter**. With a filter active, any information displayed in the workspace is then restricted solely to the locations that are included in this filter. When analyzing a profile measurement set or running a model, you can specify a separate selection for each model or analysis tool (i.e. a selection from the filtered locations). The corresponding action (running a model or opening an analysis window) is performed solely for the selected locations. See also section 4.4 for more information.

I am missing a window; how can I restore it?
You can close any window by clicking on the cross in the top right corner. If you are not sure how to restore a closed window, bear in mind that there is a difference between document windows (which visualize an item that is listed in the **Project explorer**), and tool windows (such as the Project Explorer, Map, Properties, Messages, Time Navigator, Chart and Toolbox). To retrieve a tool window, click on the **View** tab in the ribbon, then click on the desired tool window. To retrieve a "lost" document window, double-click on the corresponding item in the **Project explorer**. See also section 3.2.

My boundary conditions file is not correctly imported. What should I do?
If the boundary conditions are not correctly imported, you should first check the warning and error messages that were generated during the import process. In most cases, these messages contain important information about problems with the import. In general, it helps to consider the following possible causes:

- ◇ Are the data columns in the file separated by a tab?
- ◇ Are decimal numbers entered with a period (.) rather than a comma?
- ◇ Is the column Kv (coastal area) present?
- ◇ Is the column Nr (offset) present?
- ◇ If a column sequence other than the default is used: does the file begin with a line that defines the column sequence with the correct keywords in the corresponding order, without * in front, and separated by a tab?

My model generates a "NaN" result. What does this mean?
The results can sometimes contain NaN values. This can have various causes. Sometimes you can trace the cause by examining the output image (in the case of erosion results), and in particular the icon at the top right of the chart. You can also check the messages that are generated during calculation, as these often indicate the cause of a NaN result. The messages can be found in the Output folder of the model (Run report). Some common causes are:

- ◇ Incomplete boundary conditions.
- ◇ The input profile contains insufficient data. For example, a height or depth measurement is missing, or the measurement does not extend far enough landward (or seaward). This can make it impossible for MorphAn to perform the required calculations.
- ◇ The value you seek does not exist, or the situation does not occur (e.g. the intersection of the trend with the base coastline in the Expected Coastline model).
- ◇ The specified boundaries are beyond the profile (e.g. in the Volume model).

Can I also import winkust files?
The formats of import files for MorphAn closely resemble those for winkust. Most winkust files can be imported into MorphAn after a minor adjustment. For a more detailed explanation, please refer to the MorphAn 1.1 manual.

13.2 Support

If you have questions about MorphAn for which you cannot find an answer in this manual, please contact MorphAn@deltares.nl or the Water help desk at Rijkswaterstaat.

Please have the following information available:

- ◇ the full MorphAn version number (visible in the "About" window that can be opened from the Home tab in the ribbon);
- ◇ the type of hardware you use, including network hardware (if applicable);
- ◇ the operating system and version that you use;
- ◇ in the event of a “Fatal error”, the exact text of the message that appeared on the screen (copy the text, write it down, or make a screen copy);
- ◇ a description of what you were doing, and what happened when the problem occurred;
- ◇ a description of how you tried to solve the problem yourself;
- ◇ whether you are able to reproduce the problem by repeating what you did when the problem occurred.

It may also be necessary to send the project data. The best way to do this is to close MorphAn, zip the corresponding project folder, and send it by e-mail. If the project is too large to send as a mail attachment, MorphAn Support can guide you to an ftp site where you can upload the data.

14 Release notes

14.1 MorphAn 1.5

14.1.1 Modifications

MorphAn 1.5 makes it easier to generate intermediate transects for the purpose of safety assessment The new version also includes many improvements and optimizations. These are summarized below.

General

- ◇ Improved rendering of grid data on maps
- ◇ Improved refreshment rate for several tables to improve speed
- ◇ Offset column (optional) added to tables with coastal locations, to make it easier to sort and filter.
- ◇ Bug fix for critical error that sometimes occurred when importing grid data.
- ◇ Ability to split boundary condition files
- ◇ Inclusion of new HR (WTI2017) draft figures and HR for coastline care

Generation of profile measurements

- ◇ Map view added for all imported grid measurements
- ◇ Simplified the generation of profile measurements based on grid data (for a detailed description see section 6.6). This tool can use various grid measurements to create sets of profile measurements. The tool also supports the process of defining intermediate transects and using these to generate profile measurements. The user can specify the moment in time for which the new profile measurements are to be generated. Any resulting new locations or profile measurements can be stored directly in a file.
- ◇ The tabs in the Ribbon have been modified to replace references to “JARKUS” with “Data”. A new “Profile generation” tab has been added to the ribbon to further simplify the generation of profile measurements.

Safety assessment

- ◇ Take the first dune row into account when calculating a boundary profile.
- ◇ Bug fix to improve synchronization between results.
- ◇ “Export to Ringtoets” button has been removed. This no longer worked after modifications to Ringtoets.

Coastline care

- ◇ Expected coastline (TCL) model now runs for default period of 5 years instead of 1 year.
- ◇ Initially hide erroneous results in time-dependent charts (e.g. change in calculated MCL over time).
- ◇ Bug fix to prevent error message when editing the start or end year for determining the trend in a volume development model.
- ◇ Modified default colors for nourishments.
- ◇ The calculated trend in volume development has been removed from the export results of the TCL model due to the many issues it raised.

14.1.2 Compatibility issues

- **Opening old projects** - This version of MorphAn can also open projects saved with earlier versions of MorphAn (MorphAn 1.1 or later).

14.2 MorphAn 1.4

14.2.1 Modifications

MorphAn 1.4 contains a **bank analysis tool**. The major difference in this version is the ability to analyze seabed slopes in MorphAn. Several new features have been added for this purpose:

- The first is the ability to import **Grid measurements** into the Data folder of a MorphAn workspace. These measurements can be analyzed on the basis of the measured height, the difference between the measured heights at two moments in time, and the seabed slope between two adjacent grid cells.
- Another new feature is the **automatic generation of profile measurements** based on the imported grid measurements. These profile measurements can then be evaluated and analyzed using the regular tools.
- A new model has also been added to identify points in a set of profile measurements where a slope angle is exceeded, based on a pre-specified maximum seabed slope criterion, plus (if applicable) the position of existing seabed protection and/or seabed fill areas. The results are visualized in both a cross-section and plan view.

MorphAn 1.4 has also been extended with the ability to read data directly from PDOK services (government mapping data services). Three types of web services are available via the PDOK website. These are comparable to the services that will be available after the Landelijke Opslag Lodingen (national hydrographic database) is made accessible to the public. A link is provided to two types of services:

- **WMS** (Web Map Service). The user invokes the WMS by specifying a geographical area. The WMS then provides an image that visualizes the requested information. MorphAn 1.4 incorporates a link to the following WMS representations on PDOK (although entering a different WMS link will also give a result). These complement the existing links with OpenStreetMap, Bing layers and the Rijkswaterstaat geoserver:
  - National topographical map (AHN1)
  - National topographical map (AHN2)
  - National topographical map (AHN3)
  - BAG (*national basic register of addresses and buildings*)
  - Protected nature conservation areas
  - Administrative boundaries
  - CBS Bestand Bodemgebruik 2008 (*land use data*)
  - CBS Bestand Bodemgebruik 2010 (*land use data*)
  - CBS Bevolkingskernen 2008 (*population centers*)
  - CBS Bevolkingskernen 2011 (*population centers*)
  - CBS Gebiedsindelingen (*administrative boundaries to municipality level*)
  - CBS Provincies (*provinces*)
  - CBS Wijken en Buurten 2009 (*districts and neighborhoods*)
  - CBS Wijken en Buurten 2010 (*districts and neighborhoods*)
  - CBS Wijken en Buurten 2011 (*districts and neighborhoods*)
  - CBS Wijken en Buurten 2012 (*districts and neighborhoods*)
  - CBS Wijken en Buurten 2013 (*districts and neighborhoods*)
  - CBS Wijken en Buurten 2014 (*districts and neighborhoods*)
  - Rural cycling routes

- Long-distance hiking routes
- Mussel and oyster habitats
- Mussel seed
- Natuurmeting Op Kaart 2010 (*map of natural landscape*)
- Natuurmeting Op Kaart 2011 (*map of natural landscape*)
- Natuurmeting Op Kaart 2012 (*map of natural landscape*)
- Natuurmeting Op Kaart 2013 (*map of natural landscape*)
- Natuurmeting Op Kaart 2014 (*map of natural landscape*)
- NWB Spoorwegen (*national railway map*)
- NWB Vaarwegen (*national waterway map*)
- Surface water bodies
- Town and country planning
- Dredging disposal sites
- Vaarweg Informatie Nederland (*waterway information*)
- Road data
- Wetlands

◇ **WCS** (Web Coverage Service). A WCS is similar to a WMS, but it provides numerical data, rather than images. MorphAn 1.4 includes an initial implementation of the link between MorphAn and the PDOK WCS. This method enables grid measurements to be added to the project directly from the service. The user must indicate which service is to provide the data to be downloaded, and then specify the required area. The grid data is then downloaded. After the grid data has been added to the workspace, the user can start using the grid measurement as if it were imported from a file.

14.2.2 Compatibility issues

◇ **Opening old projects** - This version of MorphAn can also open projects saved with earlier versions of MorphAn (MorphAn 1.1 or later).

14.3 MorphAn 1.3

14.3.1 Modifications

◇ **Dutch-language interface** - The principle modification in MorphAn 1.3 is the translation of the interface into Dutch. This is reflected in all visible parts of the interface, but also in e.g. the message log.

◇ **Modification of the boundary profile model** - in addition to the plan view, MorphAn 1.3 also contains a side view for designing a boundary profile. This extends and improves the functionality in two ways (see section 8.3 for more information):

- **More control over the profile shape** - First of all, the user now has more control over the shape of the geometric boundary profile. In addition to the default shape, there is now a choice of a fixed crest height, a fixed crest width, or a specific back slope. The geometric boundary profile will then be made to fit while maintaining this custom definition, but with the same volume. If this proves impossible, then there remains the option to fit the boundary volumetrically.
- **Clearer definition** - The side view now also includes a visualization of the cross-shore profile of the specified boundary profile. Among other things, this visualization indicates the location of the transect in the plan view. This makes it easier to interpret the significance of this anchor point (does it lie on the back side of the boundary profile, or in fact on the front side at ground or storm surge level?).

14.3.2 Compatibility issues

The following considerations apply to compatibility between versions:

- **Opening old projects** - This version of MorphAn can also open projects saved with earlier versions of MorphAn (MorphAn 1.1 or later).
- **Opening old projects in Dutch** - If MorphAn is launched in Dutch, then it is still possible to load old projects. These will have been saved with an older, English version of MorphAn. Some parts of the project tree (e.g. model names) will probably still be in English. However, model settings be preserved, and the results of calculations will be unchanged.
- **Opening projects with a boundary profile model** - Projects saved with an older version of MorphAn can also contain boundary profile models. In the new version, the specification of the boundary profile is divided into a side view and a plan view specification. Old settings will be transferred to the right place, and settings that were not previously present will be assumed such that the calculation results are unchanged (the default geometric profile as described in TRDA2006 will be assumed).

14.4 MorphAn 1.2.3

- **Various bug fixes**
  - No more error messages when MorphAn is installed on a computer with other software that uses the same version of GeoAPI.
  - Units are displayed in a consistent way in the various screens.
  - The “BCL intersection date” will now be displayed correctly in the properties tool window.
  - The normative results now show the correct points on the boundary profile.
- **Improved loading of old projects** - When loading an old project, MorphAn now prompts for whether that project needs to be converted into a newer version. If the user confirms this, the project will immediately be saved. This will prevent unexpected results due to the project not being fully compatible with the software.
- **Improved location selection** - All screens where locations can be selected now have two columns showing selected and unselected locations (instead of all locations).
- **Improved synchronization of output screens** - When selecting an MCL or Erosion result, the corresponding TCL point or normative result is also displayed.
- **Automatic nourishment type selection removed** - The option to “automatically” select nourishment types has been removed from the settings screen for the “Trend Period Model”. New buttons have been added to “"Select all types” or “Unselect all types”. See also subsection 9.2.1
- **Modified trend period definition screen for the Expected Coastline Model** - The “Trend period definition” screen has been modified to show only one table. Trend period start and Trend period end are no longer part of the boundary conditions. The trend period is now part of the model, and it can be exported or imported into other models (e.g. other “Expected Coastline” models or “Volume trend” models). See also subsection 9.3.1
- **Ruler tool in charts** - Virtually all charts now have a “Ruler” as a distance guide when viewing the charts.

14.5 MorphAn 1.2

- ◇ **Profile measurements manager**
- ◇ **RSP location manager**
- ◇ **Boundary profile model**
- ◇ **Export results to Ringtoets**
- ◇ **Coastal development model** - years to skip, exporter
- ◇ **Scripting - prototype**
- ◇ **XBeach 1D prototype**

14.6 MorphAn 1.1

- ◇ **Transect editor**
- ◇ **TRDH2011 / TRDA2006 settings**
- ◇ **Nourishments database**
- ◇ **Trend period model**

14.7 MorphAn 1.0

First official release

References

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Rijkstwaterstaat, 2012. *Kustlijnkaarten 2013*. Rijkswaterstaat.

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A Imported file formats

A.1 Coastal area names (*.csv)

The coastal area names file is used when importing transect data from the coastal locations file (*.grd, Appendix A.2) or when importing profile measurements (*.jrk, see Appendix A.4). The coastal area numbers specified in these files are resolved to a meaningful name using the contents of the “coastal area name” file. If no name can be found for a coastal area number, the name *‘Custom area’* will be used. The file contents can be formatted in different ways. For each record in the file, MorphAn will attempt to find a pattern that matches to a <number>, then a <space, tab or ;>, then a series of characters (letters/numbers). The first of the following examples shows a coastal area name file with space separators; the second example shows a coastal area name file with semicolon separators (csv format).

```
  Nr  Naam
  1   Rottum
  2   Schiermonnikoog
  3   Ameland
  4   Terschelling
  5   Vlieland
  6   Texel
  7   Noord Holland
...
```

```
Nr;Naam
1;Rottum
2;Schiermonnikoog
3;Ameland
4;Terschelling
5;Vlieland
6;Texel
7;Noord Holland
...
```

A.2 Coastal locations (*.grd)

The grid file contains transect data specified as the geographic (RD) coordinates of the zero point and the orientation of the transect. The file has 5 columns:

Name	Unit	Description
Kustvaknummer	Number of coastal area of the position	[-]
Metrering	Longshore offset of a transect relative to the zero point of the coastal area	decameter
X-coordinaat	X coordinate of the location in RD coordinate system	[m]
Y-coordinaat	Y coordinate of the location in RD coordinate system	[m]
Raaihoek	Transect bearing relative to north in which clockwise is positive	in .01 degrees

For a coastal location file to be successfully imported, it must conform to the following speci-

fication:

- ◇ The file contains a table of 5 columns separated by *tabs*
- ◇ The first record in the file contains the column names “Kustvak Metrering X-coordinaat Y-coordinaat Raaihoek, in .01 graden”
- ◇ Subsequent records will only be imported if they consist of 5 columns (separated by tabs)
- ◇ The decimal symbol is a period (.) and not a comma (,)
- ◇ The transect angle is specified in hundredths of a degree (0.01 degree)
- ◇ The X and Y coordinates are specified in centimetres (0.01 metre)

Below is an example of a grid file of coastal location specifications:

```
Kustvak        Metrering        X-coordinaat        Y-coordinaat        Raaihoek, in .01 graden
3        46000        17255300        60367100        22590
3        46200        17241400        60381500        22590
3        46400        17227500        60395900        22590
3        46600        17213700        60410300        22590
3        46800        17199800        60424700        22590
3        47000        17185900        60439100        22590
3        47200        17172000        60453500        22590
3        47400        17158200        60467900        22590
...
```

A.3 Location filter (*.csv)

A location filter consists of a table with two columns. The first column specifies the coastal area number. The second column specifies the offset. The two columns are separated by a semicolon (;). An example is given below:

```
Kv;Nr
5;4808
5;4825
5;4844
5;4862
5;4880
5;4898
5;4915
5;4933
5;4952
5;4970
5;4988
5;5005
5;5023
5;5041
5;5059
...
```

When preparing the file, take account of the following points:

- ◇ The number in the first column specifies the coastal area number
- ◇ The number in the second column specifies the transect number
- ◇ Values must be separated by “ ; ”
- ◇ Spaces and tabs are ignored
- ◇ Records that do not consist of two numbers separated by a “ ; ” will be ignored
- ◇ Empty records, or records that start with an asterisk (*) will be skipped

A.4 Profile measurements (*.jrk)

A profile measurements file contains annual coastal measurements. An annual coastal measurement can consist of three sub-measurements (a depth sounding, a height measurement and possibly an interpolated segment to link these two to each other). MorphAn adds a fourth type of measurement: a modified profile segment. This makes it possible to save modified profiles in profile measurement format, and re-import them at some point in the future, without losing the original data. Below is an extract from the contents of a profile measurements file.

```
5 1995 4808 0 1204 108 285
-750        3561        -745        3701        -740        3851        -735        3631        -730        3431
-725        3391        -720        3421        -715        3541        -710        3801        -705        3651
-700        3411        -695        3691        -690        3711        -685        3431        -680        3141
-675        3081        -670        3071        -665        2971        -660        2981        -655        2941
-650        2901        -645        2831        -640        2781        -635        2751        -630        2741
-625        2741        -620        2731        -615        2721        -610        2731        -605        2701
-600        2651        -595        2621        -590        2641        -585        2661        -580        2691
-575        2711        -570        2701        -565        2811        -560        2851        -555        2801
-550        2781        -545        2751        -540        2711        -535        2781        -530        3201
-525        3111        -520        2791        -515        2581        -510        2571        -505        2641
-500        2731        -495        2721        -490        2691        -485        2601        -480        2581
-475        2651        -470        2701        -465        2641        -460        2671        -455        2641
-450        2781        -445        2931        -440        3111        -435        3161        -430        3111
-425        3321        -420        3521        -415        3111        -410        3211        -405        3451
-400        3631        -395        3721        -390        3791        -385        3911        -380        3431
-375        3681        -370        4121        -365        4111        -360        3921        -355        3771
-350        3751        -345        3561        -340        3361        -335        4471        -330        5601
-325        5661        -320        5041        -315        4441        -310        4791        -305        5621
-300        5961        -295        6291        -290        5681        -285        5521        -280        5311
...
```

A file contains multiple sets of records, with each set comprising a profile attribute record containing seven values, followed a block of records with profile data. Below is an example of a profile attribute record:

```
6 2008 900 0 1904 205 219
```

The profile attribute record contains the following values:

Coastal area number	In the example, this is coastal area number 6, which corresponds to the coastal area name *Texel* (when the default coastal area names are in effect, see section 4.3).
Year	This is the year the profile was recorded. In this example: 2008.
Transect number	This is the offset of the location in decameters. In this example: 900 decameters.
Profile code number	This code indicates the measurement type. The possible codes are: 1 an annual cross-shore measurement profile 2 a groyne transect (aligned with the groyne) 3 an auxiliary groyne transect (immediately beside the groyne)
Date of height meas.	Date of height measurements of beach and dune in format ddmm. In this example: 1904, which means April 19.
Date of soundings	Date soundings were taken in format ddmm. In this example: 205, which means May 2.
Number of Points	The number of XY measurements for this profile. In this example: 219.

The profile attributes record is followed by a block of profile data, i.e. XY measurements. The XY measurements are provided in the sequence: X[1], Y[1], X[2], Y[2], etc. X is in meters

with respect to the beach post or *Rijsstrandpaal* (RSP, zero point of a coastal location), with a positive value indicating seaward, and negative being landward direction (any decimals must be entered with a period as decimal point). Y is in centimeters with respect to NAP. A code number is appended to the Y value. 7001 means Y = NAP 700 cm with code number 1. This code number indicates one of the following:

1 Height measurements (by optical leveling).
2 Height measurements, for which sounding data from the same area is also present in the file.
3 Manually-added interpolated values in the zones where leveling and sounding data overlap.
4 Soundings, for which height measurements from the same area are also present in the file.
5 Soundings.
6 Modified coordinate.

For the file to be correctly imported, it is important to take account of the following points:

◇ There is no fixed number of XY values per record. The number of XY pairs can also vary per line. However, it is important that both the X and Y value of any pair are in the same record.
◇ XY-values with code numbers 1 and 2 are imported as individual measurements. The same applies to XY-values with code numbers 4 and 5. When creating the composite profile, XY values with code 2 or 4 are ignored.
◇ Empty records are allowed.
◇ X values may be decimals with a period as decimal point.

A.5 Boundary conditions file (*.bnd)

The boundary conditions file contains a table with boundary conditions per transect. An example of a typical boundary conditions file is shown on the next page. When creating a boundary conditions file, take account of the following points:

◇ All records that begin with an asterisk (*) will not be imported (and are therefore treated as comments).
◇ MorphAn will attempt to interpret the first record that does not begin with * as a list of keywords. This list defines the column order for the boundary conditions provided in the table.
◇ There is no predefined column order.
◇ The table must contain at least the columns **Kv** and **Nr**. Without these columns, boundary conditions cannot be linked to a location.
◇ An asterisk (*) is treated as “undefined”. In that case, the existing value in a boundary conditions set will not be modified.
◇ Decimal values must have a period as decimal point.
◇ All columns must be separated by a tab.
◇ A value for the D50 can be supplied in [m], but also in [μm]. Any value less than 1 is assumed to indicate a grain size value specified in [m].

If no keyword record is supplied in the file (or this record begins with *), then the default column order is assumed:

Kv Nr Hs Tp Rp D50 Go Dvt Xgp Xgp200 Xkz Xbzz S1 S2 L Ho La Jr1 Jr2 BKL Xafkap Xzeemkl X1 Xz Yo Yb Xp d

Table A.1 provides a summary of the possible keywords in a MorphAn boundary conditions

file. Beside each keyword, the table gives the name of the boundary condition as used in the interface, plus a brief explanation.

Kv	Nr	Hs	Tp	Rp	D50	d	Go	Xgp	Ho	La	Jr1	Jr2	JrEx1	BKL	Xlandmkl	Xzeemkl	X1	Xz	Yo	Yb
5	4000	10.7	17.1	4.2	197	*	*	*	3	-5.16	2001	2010	*	60	*	*	-420	1200	*	*
5	4020	10.7	17.1	4.2	197	*	*	*	3	-5.16	2001	2010	*	60	*	*	-480	1200	*	*
5	4040	10.7	17.1	4.2	197	*	*	*	3	-5.16	2001	2010	*	70	*	*	-460	1200	*	*
5	4060	10.7	17.1	4.2	197	*	*	*	3	-5.16	2001	2010	*	100	*	*	-220	1200	*	*
5	4082	10.7	17.1	4.2	197	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4084	10.7	17.1	4.2	197	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4086	10.7	17.1	4.2	197	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4098	10.7	17.1	4.2	197	*	*	*	3	-5.16	2001	2010	*	105	*	*	-190	1200	*	*
5	4111	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4113	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4115	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4128	10.7	17.1	4.2	193	*	*	*	3	-5.16	2001	2010	*	108	*	*	-165	1000	*	*
5	4140	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4142	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4144	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4158	10.7	17.1	4.2	193	*	*	*	3	-5.16	2001	2010	*	76	*	*	-160	1000	*	*
5	4170	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4172	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4174	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4187	10.7	17.1	4.2	193	*	*	*	3	-5.16	2001	2010	*	64	*	*	-170	900	*	*
5	4200	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4202	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4204	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4217	10.7	17.1	4.2	193	*	*	*	3	-5.16	2001	2010	*	51	*	*	-170	900	*	*
5	4227	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4229	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4231	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4239	10.7	17.1	4.2	193	*	*	*	3	-5.16	2001	2010	*	37	*	*	-170	900	*	*
5	4242	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4244	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4246	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4253	10.7	17.1	4.2	193	*	*	*	3	-5.16	2001	2010	*	29	*	*	-180	800	*	*
5	4256	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4258	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4260	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4266	10.7	17.1	4.2	193	*	*	*	3	-5.16	2001	2010	*	4	*	*	-180	800	*	*
5	4268	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4270	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4272	10.7	17.1	4.2	193	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4279	10.7	17.1	4.2	193	*	*	*	3	-5.16	2001	2010	*	18	*	*	-160	800	*	*
5	4283	10.7	17.1	4.2	192	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4285	10.7	17.1	4.2	192	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4287	10.7	17.1	4.2	192	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4293	10.7	17.1	4.2	192	*	*	*	3	-5.16	2001	2010	*	66	*	*	-160	800	*	*
5	4297	10.7	17.1	4.2	192	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4299	10.7	17.1	4.2	192	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4301	10.7	17.1	4.2	192	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4307	10.7	17.1	4.2	192	*	*	*	3	-5.16	2001	2010	*	81	*	*	-150	800	*	*
5	4312	10.7	17.1	4.2	192	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	4314	10.7	17.1	4.2	192	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

...

Table A.1: *Explanation of keywords in the .bnd file*

	Keyword	**Name in interface**	**Explanation**
	Kv	Coastal area number	Number of the coastal area to which the transect belongs
	Nr	Transect Location	Transect number (in decameters)
Dune erosion	Rp	Rp	Storm surge level [*m + NAP*]
	Hs	Hs	Significant wave height [m]
	Tp	Tp	Peak wave period [*s*]
	Tm	Tm-1.0	Spectral wave period [s]
	D	Depth	Water depth at position of Hs and Tp [m]
	D50	D50	Sand grain diameter at which 50% of the weight of a sample is fine [μm or *m*]
	XDnRij	Dune row	Position of first dune row. Dune breach seaward of this position will not cause the calculation to fail. [*m*]
	Go / G0	G0	Reference value for the transport difference of different classes of coast curvature [*m3/m*]
	Xgp	Xgp	Position of calculated fit of boundary profile [*M*]
	NrmJr1	Start year	Start year of Rt period of normative model
	NrmJr2	End year	End year of Rt period of normative model
MCL/TCL	Ho	Upper MCL boundary	Upper boundary of MCL slice in [*m + NAP*]
	La	Lower MCL boundary	Lower boundary of MCL slice in [*m + NAP*]
	Xlandmkl	Landward MCL boundary	Landmark boundary of MCL slice in [*m*]
	Xzeemkl	Seaward MCL boundary	Seaward boundary of MCL slice in [*m*]
	JrEx1	TCL start year	Start year from which the trend line is extended.
	BKL	BCL	Base Coastline [*m*]
Volume	Yb	Upper volume boundary	Upper boundary of volume calculation in [*m + NAP*]
	Yo	Lower volume boundary	Lower boundary of volume calculation in [*m + NAP*]
	Xl	Landward volume boundary	Landward boundary of volume calculation in [*m*]
	Xz	Seaward volume boundary	Seaward boundary of volume calculation in [*m*]

A.6 Nourishment database (*.csv)

Nourishment data can be added by importing the data from a csv file. This section describes the format required for this file. The csv file contains a table in which each record in the file represents a new row, and the columns are separated by a comma (,). All decimal values must use a period (.) as decimal point. MorphAn will not import any record starting with a hash (#). When importing a file, MorphAn assumes that the first record that starts without a hash contains keywords, indicating what value the corresponding column represents. The keywords in this record (separated by commas) must be the same as shown in table A.2. MorphAn assumes that all keywords are present, and will refer to the keyword record for the sequence of the data columns in the file (so there may be other columns in the file). The file is then imported one record at a time. Any record containing an empty column will result in the value “Undefined” being assigned to the nourishment.

Table A.2: *Explanation of the keywords in the .csv file for import of nourishment data*

Keyword	Name in interface	Explanation
JaarBeginUitvoering	Start date	Year nourishment started
MaandBeginUitvoering	Start date	Month (number from 1 to 12) nourishment started
JaarEindUitvoering	End Date	Year nourishment ended
MaandEindUitvoering	End date	Month (number from 1 to 12) nourishment ended
Volume	Volume [m3]	Total volume of nourishment
KustVakNummer	-	Nourished coastal area number
BeginRaai	Start location	Transect number (in decameters) of the first transect of the nourishment
EindRaai	End location	Transect number (in decameters) of the last transect of the nourishment
Lengte	Length [m]	Actual length of nourishment in longshore direction
Type	Type	Description of type of nourishment
Opmerkingen	-	Free text field for comments regarding the nourishment

An example of a typical nourishment csv file is shown on the next page.

```
#This is a sample file with several nourishments
#These first two records will not be imported by MorphAn
n_code,MaandBeginUitvoering,JaarBeginUitvoering,MaandEindUitvoering,JaarEindUitvoering,BeginRaai,EindRaai,Lengte,Type,Volume,Opmerkingen,KustVakNummer
612,4,1952,10,1952,34.00,34.40,400,underwater nourishment,50000,foreshore nourishment,16
611,1,1952,12,1952,32.60,33.40,800,beach nourishment,775000,,16
532,1,1953,12,1953,100.50,101.50,1000,beach nourishment,70000,,9
498,1,1962,12,1967,57.00,57.00,,beach nourishment,1500000,during extension of harbor groyne,7
581,1,1966,12,1966,15.00,17.00,2000,dune reinforcement,150000,"laying sand dyke with crest at NAP +6.0 m; temporary measure",12
613,1,1966,3,1966,34.00,34.40,400,underwater nourishment,32000,foreshore nourishment,16
582,1,1968,12,1968,13.00,15.00,2000,landward dune reinforcement,800000,,12
533,9,1969,10,1969,100.00,101.50,1500,beach nourishment,45000,,9
583,11,1969,3,1970,15.01,16.01,1000,beach nourishment,401000,1st nourishment: (R20),12
584,1,1970,12,1970,4.00,6.00,2000,dune reinforcement,200000,,12
534,1,1971,12,1971,115.70,118.75,3050,beach nourishment,18940000,,9
586,5,1971,9,1971,15.01,16.01,1000,beach nourishment,610000,2nd nourishment: for preservation of sand dyke 1965,12
654,5,1971,11,1971,0.40,0.85,450,beach nourishment,206000,,17
587,1,1972,12,1972,16.50,17.25,750,dune reinforcement,100000,,12
588,1,1972,12,1972,18.75,19.00,250,dune reinforcement,100000,,12
589,10,1973,2,1974,14.50,17.50,3000,beach nourishment,2300000,"see dune reinforcement 14,50-17,50;3rd nourishment; beach nourishment and dune reinforcement; loss (0.3)",12
687,10,1973,2,1974,14.50,17.50,3000,dune reinforcement,1000000,"see beach nourishment 14,50-17,50;3rd nourishment; strand and dune reinforcement; loss (0.3)",12
608,1,1973,12,1973,1.80,2.20,400,beach nourishment,210000,,15
568,1,1973,12,1973,10.50,12.50,2000,beach nourishment,250000,temporary measure,11
572,4,1974,4,1974,12.60,13.60,1000,beach nourishment,110000,temporary measure (1973-1975),11
571,9,1974,12,1974,12.60,13.60,1000,dune reinforcement and beach nourishment,110000,temporary measure (1973-1975),11
573,1,1974,12,1974,12.60,15.20,2600,beach nourishment,150000,,11
535,4,1975,8,1975,98.50,101.50,3000,beach nourishment,700000,with erosion buffer to NAP+3.3m,9
599,4,1975,4,1975,17.00,17.41,410,beach nourishment,112000,,13
615,1,1975,12,1975,34.00,34.40,400,beach nourishment,45000,,16
536,1,1976,12,1976,115.70,119.00,3300,beach nourishment,1500000,,9
590,1,1976,12,1976,18.50,19.00,500,dune reinforcement,50000,,12
499,9,1976,9,1976,12.98,13.75,775,dune reinforcement,342000,,7
537,1,1977,12,1977,115.70,118.75,3050,beach nourishment,870000,,9
591,11,1977,10,1979,5.75,9.75,4000,landward dune reinforcement,1600000,relief applied in 1979-1980,12
592,4,1977,7,1977,14.50,17.50,3000,beach nourishment,1267000,4th nourishment,12
575,10,1977,12,1977,8.80,12.50,3700,beach nourishment,1045000,"see depot 8,80-12,50",11
684,10,1977,12,1977,8.80,12.50,3700,depot,55000,"see beach nourishment 8,80-12,50",11
594,4,1978,6,1979,9.75,11.25,1500,landward dune reinforcement,2000000,relief applied in 1979-1980,12
471,6,1979,9,1979,1.60,2.20,600,beach nourishment,300000,,9
560,1,1979,12,1979,11.50,13.40,1900,beach nourishment,150000,,10
500,1,1979,12,1979,11.15,12.80,1650,dune reinforcement,470000,reinforcement of sea barrier - Callantsoog,7
485,9,1979,11,1979,25.60,31.20,5600,beach nourishment,3089668,with erosion buffer to NAP+4.5m,6
472,10,1980,12,1980,10.00,16.00,6000,seaward dune reinforcement,2200000,,3
538,1,1981,12,1981,99.00,101.00,2000,beach nourishment,10000,,9
539,1,1982,12,1982,99.00,101.00,2000,beach nourishment,15400,,9
576,10,1983,12,1983,11.60,14.40,2800,beach nourishment,440000,,11
595,8,1984,12,1984,14.50,17.50,3000,beach nourishment,330000,"5th nourishment; work halted",12
486,7,1984,12,1984,18.13,24.00,5870,beach nourishment,3021115,with erosion buffer to NAP+4.5m,6
577,1,1984,12,1984,8.00,14.00,6000,seaward dune reinforcement,3400000,"depot for seaward dune reinforcement; relief applied before June 1986",11
616,4,1984,4,1984,9.50,10.45,950,landward dune reinforcement,150000,,16
617,5,1984,6,1984,22.75,23.56,810,seaward dune reinforcement,90000,,16
540,3,1985,4,1985,98.75,101.25,2500,beach nourishment,250000,"see erosion buffer 98,75-101,25",9
681,3,1985,4,1985,98.75,101.25,2500,erosion buffer,80000,"see beach nourishment 98,75-101,25",9
...
```

A.7 Nourishment database (*.nc)

Besides the csv format, it is also possible to open a nourishment database saved in NetCDF format. This functionality has been added to facilitate the exchange of databases. Much data is available within the OpenEarthTools database (only in NetCDF format). It is not yet possible to use all this information generically in MorphAn. However, the nourishment database can be loaded. For a description of that format, please refer to http://www.openearth.eu. The NetCDF file with nourishments is produced using matlab code which is stored in a repository:

https://svn.oss.deltares.nl/repos/openearthrawdata/trunk/rijkswaterstaat/suppleties/convertSuppleties2nc.m

Access to this code requires a password that can be obtained via http://www.oss.deltares.nl

A.8 Years to skip (*.csv)

In the Normative Erosion model (part of the Dune Safety model, see section 8.4) it is possible to specify per location which calculated erosion results (i.e. years) should be omitted from the visualization of the normative results. This data can also be exported and/or imported. The file format for saving these specifications is described below. The file is csv type with 3 columns separated by a semicolon (;):

- ◇ **Kv** - Coastal area number
- ◇ **Nr** - Transect number (in decameters)
- ◇ **Kv** - Specification of years separated by commas (,)

The first record of the file must contain only the following string: Kv;Nr;Years to skip
The records that follow must all contain at least two semicolons.

```
Kv;Nr;Years to skip
5;4988;
5;4808;2001,2004,2005,2006
5;4825;2001,2005,2006,1995
5;4844;2001,2004,2005,2006
5;4862;2001,2005,2006
5;4880;2001,2004,2005,2006
5;4898;2005,2006
5;4915;2001,2004,2006
5;4933;2001,2004,2005,2006
5;4952;2005,2006
5;4970;
5;5005;
```

A.9 Grid measurements (*.asc)

Grid measurements can be added by importing the data from an asc file. This section describes the format required for this file. The first records of the asc file specify the grid properties, and the subsequent records provide all the height values of the grid. All decimal values must use a period (.) as decimal point.

The following grid properties are specified:

- ◇ **ncols** - Number of columns containing height values (only integers)
- ◇ **nrows** - Number of rows with height values (only integers)
- ◇ **xllcorner** - x-position of the first height values in the rows
- ◇ **yllcorner** - y-position of the height values in the last row
- ◇ **cellsize** - Distance between two adjacent grid points (same in both in x and y direction)
- ◇ **nodata_value** - This value means “treat this height measurement as non-existent”

The height values immediate follow the grid property records. Each record contains 4 columns separated by spaces. The height value of the grid point with x-position (xllcorner) and y-position (yllcorner) is the first value of the last record. The x-position of the grid point of the second to last record is (xllcorner + cellsize). The y-position of the grid point of the second value on a record is (yllcorner + cellsize).

Below is an example of the contents of an asc file with grid measurements.

```
ncols        4
nrows        3
xllcorner     39890.00
yllcorner     407280.00
cellsize      0.50
nodata\_value  -9999
-9999 2 3 4.0
5 6 7 -9999
1 2 -9999 -9999
```

A.10 Profile measurement definition (*.txt)

Profile measurements can be generated from grid measurements. In the **Project Explorer**, right-click on a **Grid measurement** set, and select **Create profiles...** from the context menu. This starts a wizard which will prompt you to select transect definition files. The format of these files is shown below. This is a plain text (txt) file of 7 columns separated by spaces, and with a period as decimal point. Records that start with " # ", " $ " or " > " are ignored.

- ◇ **raai** - Name of transect. MorphAn will try to use this name to determine the offset, by using the value in brackets, or in the absence of brackets, max. 6 digits from this value. Periods and commas are ignored.
- ◇ **Xb** - x-position of the starting point of the transect
- ◇ **Yb** - y-position of the starting point of the transect
- ◇ **offset1** - Distance between the starting point of the transect and the origin of the location
- ◇ **Xe** - x-position of the end point of the transect
- ◇ **Ye** - y-position of the end point of the transect
- ◇ **offset2** - Distance between the end point of the transect and the origin of the location

An example of a profile measurement definition import file is shown below:

```
#-------------------------------------------------------------------------------
#Export at 7-9-2012 13:37:35
#Linedatabase D:\USERDATA\...\OSK\General data\LineData\2002p_2102p_TOW.pro
#-------------------------------------------------------------------------------
#
#SINGLE LINES:
# column 1    2        3         4   5        6         7
#       Name Easting1 Northing1 KP1 Easting2 Northing2 KP2
#
# Axis Schaar (south-north)   :  z16 39118.54 407120.73 0.000 39769.32 408360.28 1.400
#
# e.g. longshore transect z16(-1600) = longshore transect 1600 in south-north direction, west of SKO
# e.g. longshore transect z16(1600)  = longshore transect 1600 in south-north direction, east of SKO
#
#Cross-shore transects Schaar
\$ -9999 [3223223]
>raai
>Xb
>Yb
>offset1
>Xe
>Ye
>offset2
z16(-1600) 37701.91 407864.48 0.000 38352.69 409104.03 1.400
z16(-1590) 37710.76 407859.83 0.000 38361.54 409099.38 1.400
z16(-1580) 37719.62 407855.18 0.000 38370.40 409094.73 1.400
z16(-1570) 37728.47 407850.53 0.000 38379.25 409090.08 1.400
z16(-1560) 37737.33 407845.89 0.000 38388.11 409085.44 1.400
z16(-1550) 37746.18 407841.24 0.000 38396.96 409080.79 1.400
```

A.11 Landfill and bottom protection areas (*.txt)

The Bank Analysis model allows the import of Landfill and bottom protection areas. The format of these files is shown below. This is a plain text (txt) file of 3 columns separated by spaces and/or semicolons (;), and with a comma as decimal point.

- ◇ **X** - x-position of a polygon vertex (all decimal values must have a period " . " decimal point)
- ◇ **Y** - y-position of a polygon vertex
- ◇ **ID** - An integer that identifies the polygon

The polygons are composed of lines between the successive vertices with the same ID number. For the polygon to be closed, it is required that the first and last vertex of the same polygon have identical x and y positions. The first vertex is the record after the header record, or the first record with a different polygon ID number. The last vertex is determined when a different polygon ID number is encountered, or if end of file is reached.

Below is an example of a landfill or bottom protection areas file:

```
X; Y; ID;
39704,49; 407118,12; 21;
39855,02; 407039,12; 21;
39878,24; 407083,37; 21;
39833,97; 407106,61; 21;
39987,35; 407398,74; 21;
39916,52; 407435,93; 21;
39767,79; 407152,65; 21;
39732,37; 407171,24; 21;
39704,49; 407118,12; 21;
```

B Importing data and models

By default, MorphAn always starts with a new, empty project. Within this project you can work with various folders, items and models. These can be either created or imported, depending on your requirements (see chapter 3). Before you can use MorphAn, you first need to import the necessary data and models using a wizard. This appendix describes the various steps taken by the wizard. To start the setup wizard, click the *New Workspace* button in the *Home* tab of the ribbon (see Figure B.1). This wizard will then guide you through the process of importing data and selecting the required models.
When the welcome screen appears, click *Next*.

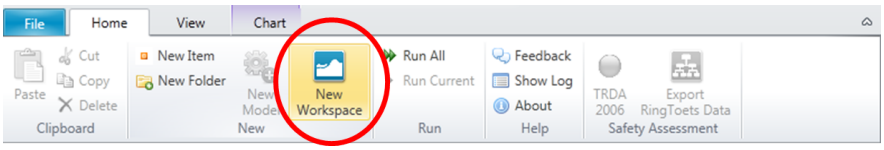

Figure B.1: *Home tab button to start the setup wizard and add a new Workspace plus the necessary data and models*

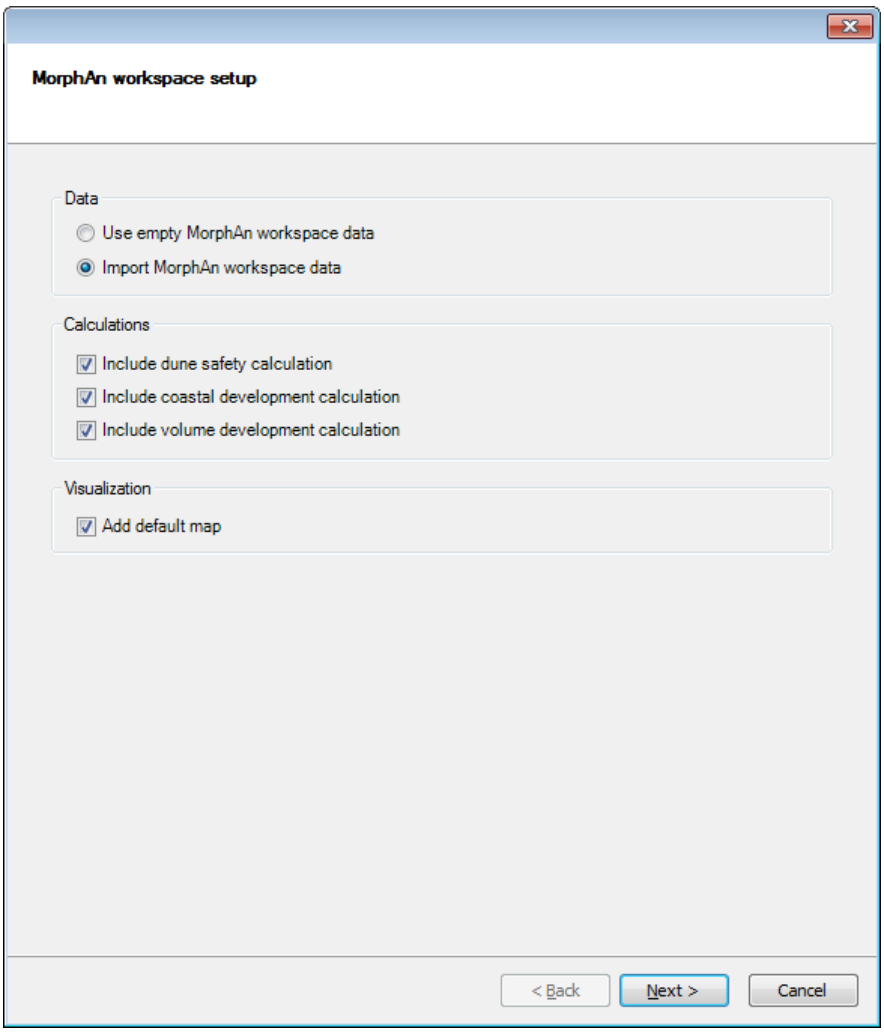

Figure B.2: *MorphAn setup wizard, 2nd screen - options for importing data and adding different models.*

The MorphAn setup wizard (Figure B.2) allows you to choose the data to use, and the models (calculations) to be added to the project. Under “Data” you can choose between an empty dataset or the automatic import of the default dataset. Under “Calculations” you can choose any or all of the available models for your project. The options are:

- ◇ **Dune safety model** - for coastal safety assessment
- ◇ **Coastal development model** - for determining the expected coastline over time (MCL and TCL)
- ◇ **Volume development model** - for calculating sand volume development within predefined boundaries

The last option on this screen chooses whether to add a “Default Map” to the project. This is a topographical map that is stored in the project. Layers added to this map will be shown in all other map or plan view visualizations produced during analysis or modeling (see subsection 3.2.5).

If you choose to import data, then after you click *Next*, a new selection window will appear (Figure B.3). This is where coastal area names and grid data for the project are specified. The MorphAn installation includes the default files for both the coastal area names and grid data for the most commonly-used locations in the Netherlands. However, it is also possible to specify or add coastal area names or locations using a custom grid data file or coastal area definition file. The required format of import files is explained in detail in Appendix A.

At the bottom of this screen you also have the option to specify the coordinate system for the imported locations. In most cases this will be the Dutch RD coordinate system. This step is important for ensuring that information appears in the right place, especially when maps are overlaid with layers that have a different coordinate system (for example, an aerial photo from Bing maps). Click *Next* to show the next screen.

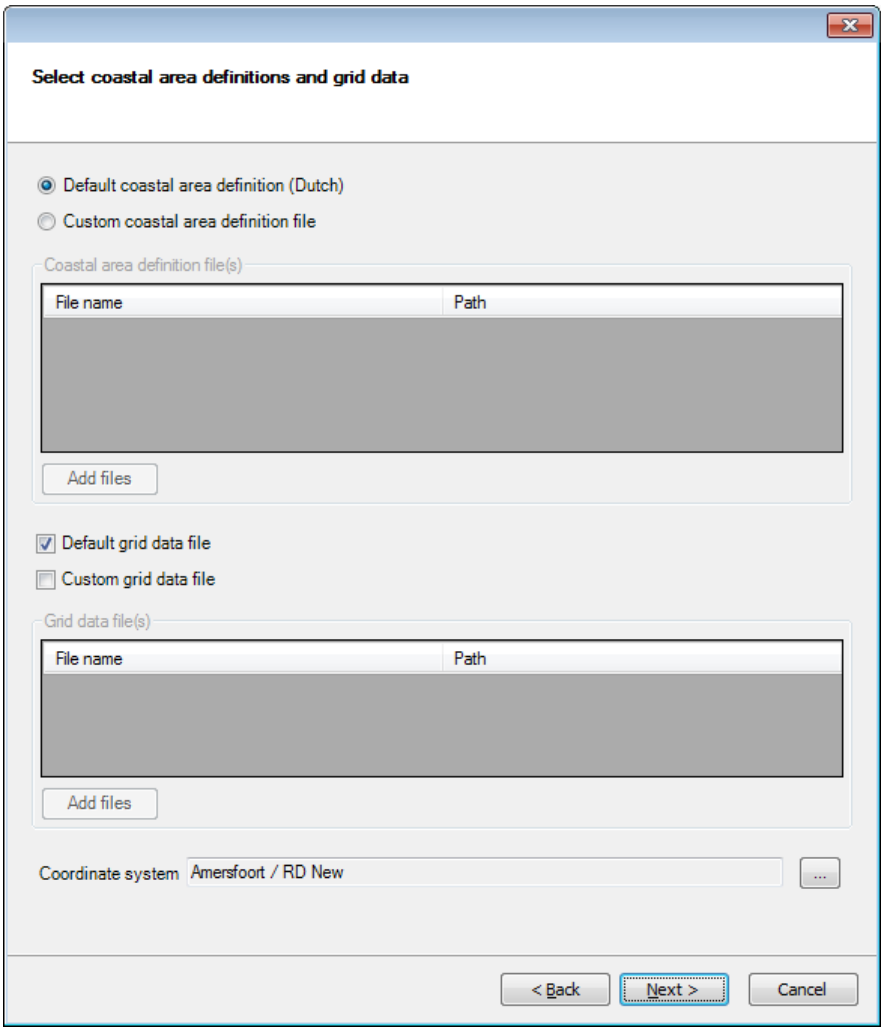

Figure B.3: *MorphAn setup wizard, 3rd screen - choosing the grid file and coastal area definition file*

The next screen allows you to select cross-shore profile (Jarkus) measurement and boundary condition files (Figure B.4). To use one or more of the default profile measurement or boundary condition files included in the MorphAn installation, check the corresponding box or boxes. The default files comprise profile measurements (.jrk files) made between 1965 and 2012, plus boundary conditions (.bnd files) from HR2006 (Rijkswaterstaat, 2007) and TRDA2006 (ENW, 2007). You can also (or alternatively) specify your own files (both .jrk and .bnd) in the lower part of the screen. See Appendix A for a detailed explanation of the required format of profile measurement and boundary condition files. Click *Next*, and the wizard will then proceed to import the specified grid (.grd), profile measurement (.jrk) and boundary condition (.bnd) files, and if required, a coastal area definition file.

A progress screen appears. When the files have been imported, again click *Next*. In the final step of the setup wizard, you have the option to define a filter (Figure B.5). The default grid file contains 3616 locations. The location filter enables you to reduce this very long list to just those locations that are important for your project. The interface will subsequently only show those filtered locations during the analysis of profile measurements or when running one of the models. A filter can always be added, modified or deleted at a later time, even when no filter is specified in the setup wizard. You can also set a filter by importing a saved filter (.csv) file or by means of filter rules. Section 4.4 explains in more detail how to set a filter.

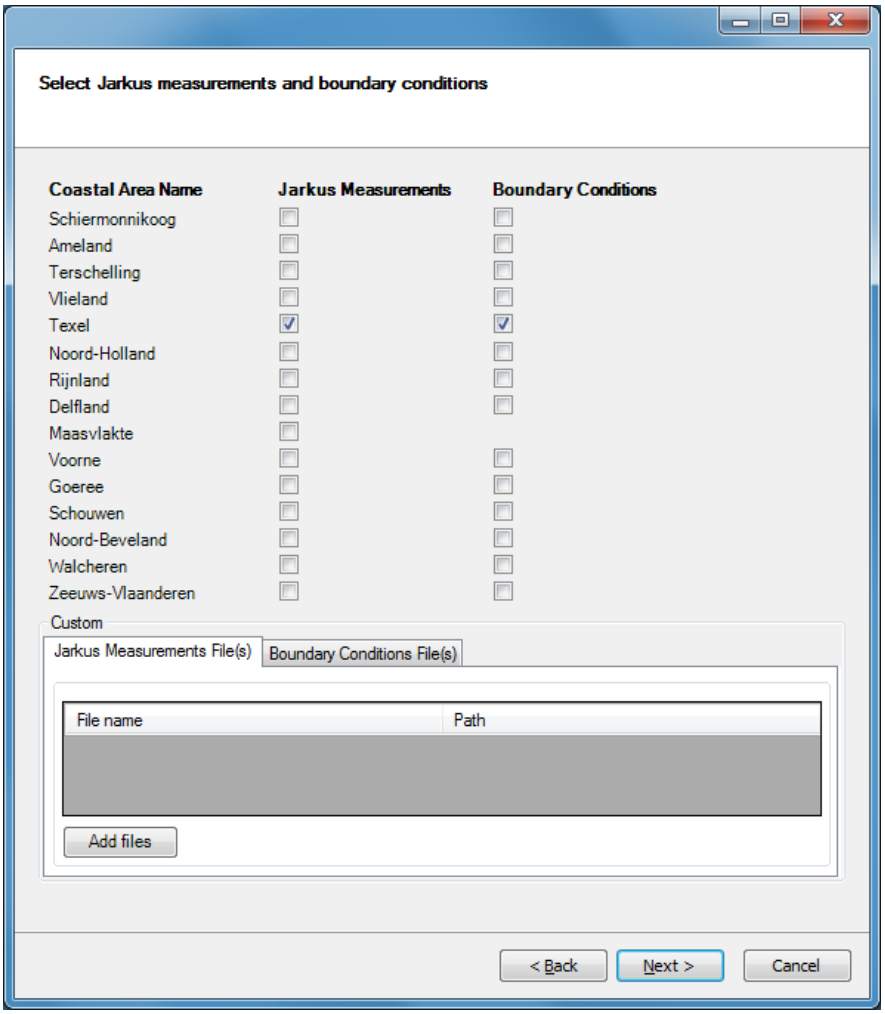

Figure B.4: *MorphAn setup wizard, 4th screen - choosing profile measurements and boundary conditions*

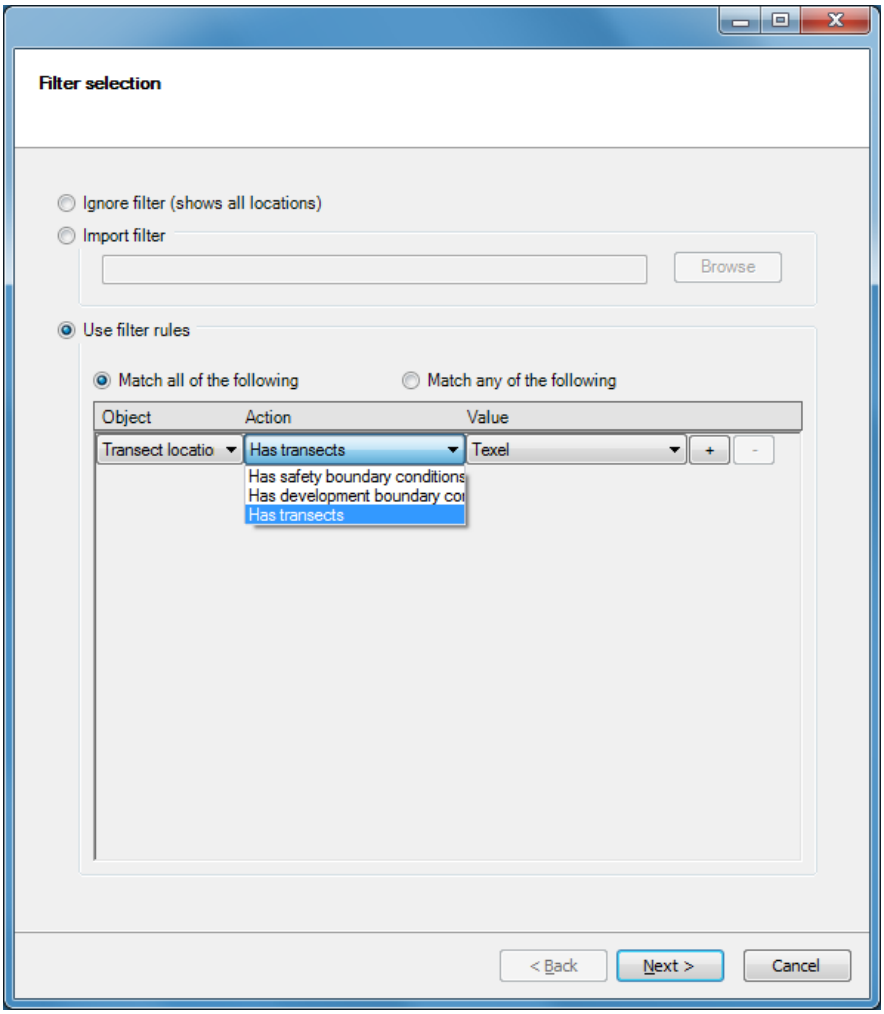

Figure B.5: *MorphAn setup wizard, 5th screen - specifying a location filter*

The “Finish wizard” screen appears after this step. Click *Finish* to close the wizard. A new *MorphAn workspace* will now be visible in the tree structure of the **Project explorer** (Figure B.6). The workspace contains all the required data (in the **Data** folder), plus the specified models. You can always import additional data files to this folder at a later moment (see chapter 4).

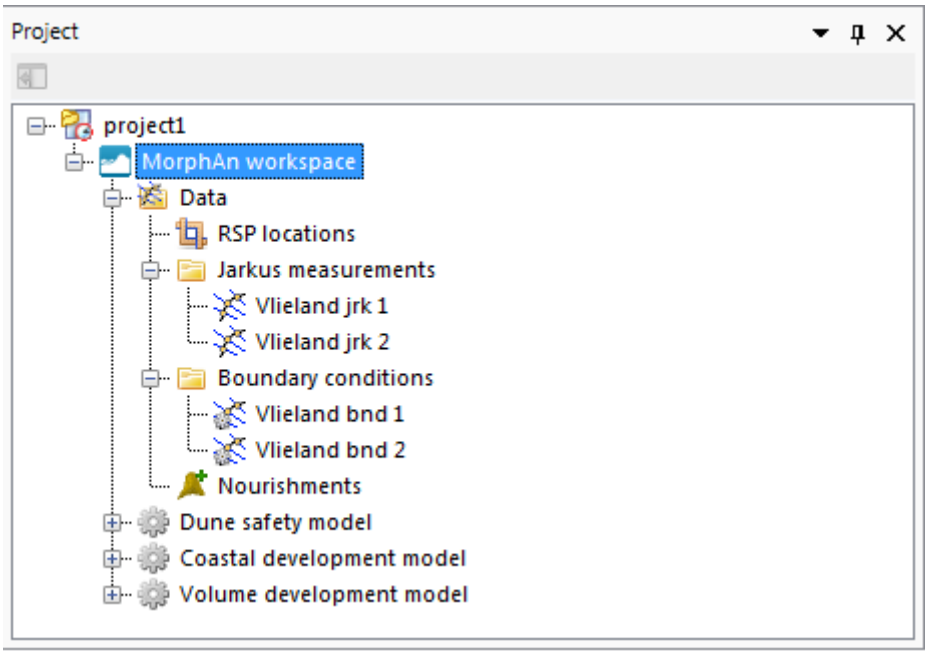

Figure B.6: *Project explorer after running the MorphAn setup wizard*

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