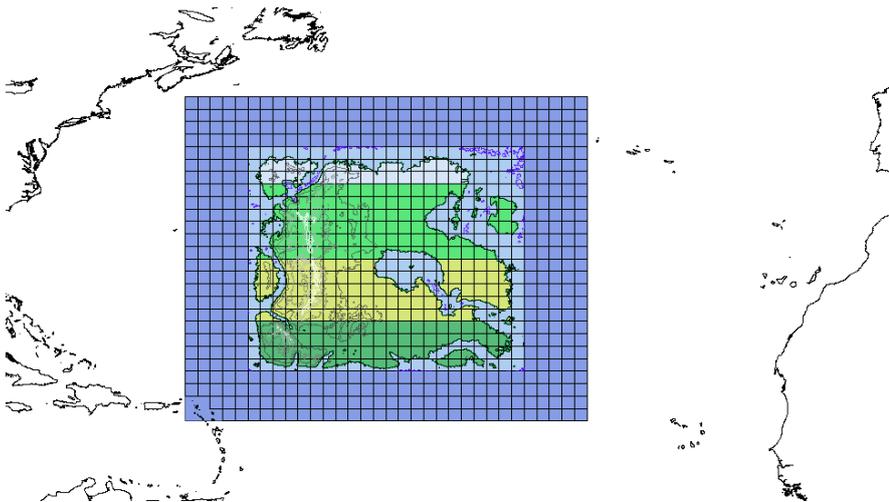




## Executive summary

# Missionland: A Virtual Continent for Mission Simulation



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### Problem area

Training via distributed mission simulation has the potential to enhance force readiness and operational effectiveness in coalition operation. An essential condition for an effective mission simulation environment is a correlating representation of the real-world natural and cultural environment in the distributed simulations. Correlating existing environment databases is costly, both in effort and in money, and the end result will always be hampered by technical incompatibilities. A generic and geo-unspecific, widely available simulation environment could overcome these problems.

### Description of work

In 2008 the NATO RTO task group MSG-071 Missionland started. Its prime objective is to construct a coherent dataset of the static environment, from which databases can be constructed for a wide scope of simulators. As first step the task group started a user needs analysis by sending out a questionnaire to the stakeholders in participating nations. The answers were elaborated and these formed the base for the Missionland design. A sketch of the complete Missionland continent was drawn. This sketch formed the starting point for experiments in generating parts of the dataset. Several methodologies and approaches for generating the elevation data, the vector data and

This report is based on a presentation held at the NMSG Annual Conference MSG-087, Bern, Switzerland, 13 October 2011.

the imagery have been tried out. Different tools have been assessed on their potential of supporting the data generation for Missionland.

### **Results and conclusions**

The task group created a design of the virtual continent Missionland and set a location in the North Atlantic Ocean for this new continent. The Missionland dataset will cover multiple climate zones, various elevation settings, coastal areas and large continuous land masses.

The task group has started to experiment with the Missionland data generation and has developed 30 meter resolution elevation data for the whole continent. As this data was not looking “natural” enough the task group enhanced this data by

blending in parts of real world elevation data. Some tests have been done for generation of the vector data and the task group will use here a mixed approach. Part of the vector data will be made by using algorithms or procedural tools. This will be complemented by blending in real world vector data.

### **Applicability**

The Missionland dataset will provide the users with terrain elevation data, vector data, 3D models, material coding and metadata. The users can construct environment databases from this dataset. These databases can be used for visual out-of-the-window and sensor views, as well as terrain servers and computer generated forces application.



NLR-TP-2011-482

## Missionland: A Virtual Continent for Mission Simulation

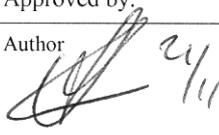
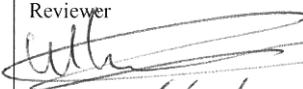
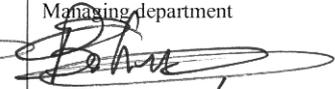
A.J.J. Lemmers and A. Gerretsen

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## Summary

Training via distributed mission simulation has the potential to enhance force readiness and operational effectiveness in coalition operation. An essential condition for an effective mission simulation environment is a correlating representation of the real-world natural and cultural environment in the distributed simulations. Correlating existing environment databases is costly, both in effort and in money, and the end result will always be hampered by technical incompatibilities. A generic and geo-unspecific, widely available simulation environment could overcome these problems.

In 2008 the NATO RTO task group MSG-071 Missionland started. Its prime objective is to construct a coherent dataset of the static environment, from which databases can be constructed for a wide scope of simulators. These environment databases are generally needed for visual out-of-the-window and sensor views, as well as terrain servers and computer generated forces applications. Based on inputs from military end users the Missionland task group has identified the user needs and requirements for a dataset of a virtual continent, named Missionland.

The task group created a design of the virtual continent Missionland and set a location in the North Atlantic Ocean for this new continent. The Missionland dataset will cover multiple climate zones, various elevation settings, coastal areas and large continuous land masses. This ensures a suitable environment for a large variety of applications, including training, tactics development, simulation based acquisition and concept development and experimentation. The Missionland dataset will provide end users with terrain elevation data, remote sensing imagery, ground imagery, vector data, 3D models, material coding and meta data. In support of the prime objective, there is the need to implement a deployment and continuation process to ensure proper use and continuation after the life of MSG-071. This includes guidelines and support in using Missionland.

This paper outlines the approach the Missionland task group takes in developing the dataset. It is discussed what an end user of Missionland can expect from the dataset and what kind of features and areas of interest the dataset will contain. It describes the process, technologies and tools the task group follows to develop the different kinds of data and shares the first experiences of the task group in generating the data.

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## **1 Introduction**

Imagine a whole new continent is planted in the middle of the Atlantic Ocean. It is a continent with a variety of climate and eco system types: arctic cold, tropical green, hot deserts and more are represented in this intriguing continent that is populated with a wide variation of cultures. The most interesting feature of this new continent is that it has a very enthusiastic and well-equipped Modeling & Simulation Geodata Office that is capable of delivering whatever data you need to enable simulated exercises on their continent. Everything is available – remote sensing imagery, ground imagery, terrain elevation data, detailed vector data and all required model libraries – to give your simulators a kick-start into (networked) simulation exercises on this continent.

The name of this new continent is Missionland and its creation was initiated in 2008 by the NATO Research and Technology Organisation (RTO) task group MSG(Modeling & Simulation Group)-071 Missionland. The aim of the Missionland task group is to create a common dataset of the static environment that can be used for simulation exercises. The focus is on the content itself, not on the way to store or represent it, as for example the Synthetic Environment Data Representation and Interface Specification (SEDRIS) addresses. For more information on the approach of the Missionland task group see [1].

The paper starts with a short explanation on the background of Missionland. Then it will outline the user needs for the Missionland data set and describe the design of Missionland. Next the paper will discuss the products that will be included in the dataset. The generation of the elevation data for the Missionland is described and some experiences and an approach to produce the vector data and imagery are discussed. The paper ends with some ideas, rules and guidelines for the deployment of the Missionland dataset at the end users.

## **2 Background of Missionland**

The NATO RTO task group SAS-034/MSG-001 demonstrated with the Exercise First WAVE that training via distributed mission simulation has the potential to enhance force readiness and operational effectiveness in coalition operations [2]. The task group created a distributed training environment in which flight simulators and other crew stations in the nations were linked across a secure wide area network. For four days, operational crews planned and briefed daily coalition air missions then flew them in a common synthetic environment and debriefed the outcome. Many technical, operational and training challenges were encountered and



addressed, providing a rich source of experience and lessons, with many deficiencies identified and consequential lessons learned.

One of the challenges for the Exercise First WAVE was to create a common virtual representation of the real-world natural and cultural environment for the participating simulations. Such an environment contains dynamic elements, for example weather, time of day and moving vehicles, as well as static elements, for example vegetation, buildings and infrastructure. When performing distributed (joint) simulations a number of problems exist concerning the selection and use of an environment representation. These problems can either be caused by the different requirements of the participating users or by different technical capabilities.

An example of such a problem, are the different requirements on the level of detail for different forces, while the databases these forces use should still be correlated for the joint simulation. But even if the requirements on the environment database are the same, the difference between the technical implementation in two simulators might still make the reuse of the same simulation environment impossible. Creating different environments for each simulator has its own problems, as it is then required that these databases are correctly correlated with each other. Other limitations arise from a political point of view. For example the distribution of high resolution geographical data of a specific real world area to other countries is often subject to export restrictions due to national security issues.

To ensure that the correlation issues between the simulator databases were minimised the First WAVE Technical Task Team decided to use a common terrain database source which was used to generate the dedicated visual databases for each of the facilities. Normally, this is the best way to ensure the correlation of environment databases, but it is costly, both in effort and in money. In First WAVE the Canadian organisation Defence Geomatics undertook preparation of the common database, supported by a specialist database working group from the Technical Team. This group addressed issues including the selection of projections and imagery resolution, though this was in fact limited by the availability of source data at the resolution required [2].

These problems with the environment representation should be addressed but also the limited availability of source data due to security and political limitations must be addressed. Therefore it is preferable to create a generic and geo-unspecific simulation environment. Using a geo-unspecific environment, would also overcome the objections that result from using a real world area as basis for the simulation environment. And besides that, it also offers the advantage of

combining geologically different environments in the same simulation environment. This makes a generic environment much more flexible in performing different types of missions within the same simulation environment.

### **3 Task group MSG-071 Missionland**

In 2008 the NATO RTO Task Group MSG-071 'Missionland' started. An RTO Task Group (RTG) technical team activity aims at allowing researchers in different NATO and NATO Partnership for Peace (PfP) countries to work together in order to solve a particular research and technology problem. In the MSG-071 Missionland activity the following countries and NATO bodies are participating: The Netherlands (chair), Belarus, Canada, Germany, Norway, Sweden, Turkey, United Kingdom and the NATO Joint Warfare Centre. The foreseen duration of the task group is 4 years.

The prime objective of the Missionland task group is to make available a shared coherent dataset from which environment databases can be constructed for a wide scope of simulators operating in air, sea and land domains. These environment databases are generally needed for visual out-of-the-window and sensor views, but also terrain servers and computer generated forces applications often make use of such databases. An open source development model will be used to ensure that participating nations have full access to the dataset and can feedback changes and improvements made to Missionland. In support of the prime objective, there is the need to complement a deployment and continuation process to ensure proper use and continuation after the creation of Missionland, which includes guidelines and user's support.

The task group has divided the Missionland development into three phases:

**Investigation phase:** In this phase the needs of potential end-users are investigated and captured in a user needs statement containing the user requirements and a prioritisation thereof. Investigation of standards and formats will take place with appropriate recommendations. A preliminary Missionland development model and design will be made and the objectives for the creation phase will be formulated and prioritised.

**Creation phase:** In this phase the envisioned Missionland development model is implemented and the creation of the dataset is initiated. An incremental and iterative process refines both design and dataset until the objectives for version 1 are completed.



**Refinement phase:** It is critical to the continued value of Missionland to put in place the means for continuous refinement of Missionland after the initial Task Group is finished.

The task group will address the first two phases and will prepare a Missionland organisation and deployment structure for the refinement phase.

## 4 User Needs

As a basis for the Missionland user needs analysis, the task group developed and issued a questionnaire. The purpose of the questionnaire was to identify potential users and their requirements for Missionland. To this end, the questionnaire was structured around four main questions:

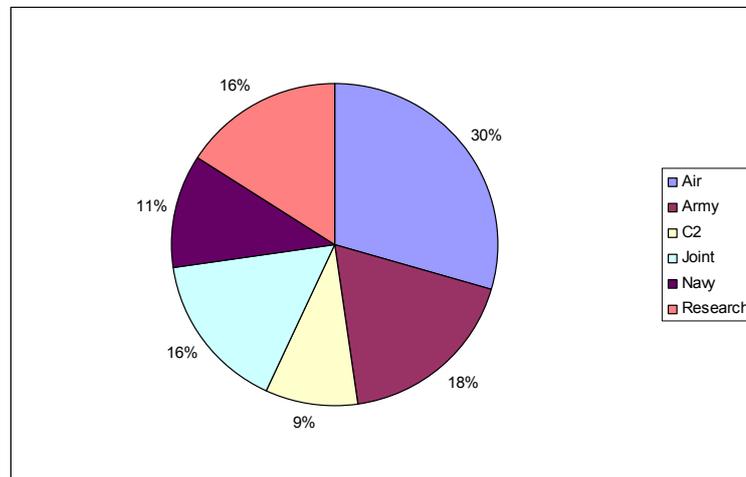
- Who will be the stake-holders and end-users of Missionland?
- How will Missionland be used?
- What are the requirements for Missionland?
- How is Missionland going to be developed and maintained?

The first question was meant to get an overview of the relevant people and programs in the countries for a possible use later in the program. The latter main question included items on the expected capabilities of countries to generate and contribute content for the Missionland data set. The answers to these questions should provide an impression of the feasibility of Missionland.

The Missionland questionnaire was sent out by the task group to relevant people within each country contributing to the project in February 2009. The national Point of Contact (POC) was responsible for collecting the questionnaire results received and ensuring as wide as possible distribution within their own military organization.

A total of 40 questionnaire responses were received by the task group. Because the questionnaires were sent by email and we did not ask the questions personally, a few (< 5) of the responses were incomplete. However in most cases the incomplete responses were still helpful to the overall requirements analysis. The respondents of the questionnaire show a good coverage over the nations participating in the Missionland task group and over the different branches of the armed forces (including research institutes), see Figure 1. The level of experience with (international) distributed simulations varies a lot over the respondents, including novice and experienced users. Taking all the results together it can be concluded that

the respondents to the questionnaire form a representative group to derive the user needs for the Missionland dataset from.



*Figure 1: Respondents per branch*

The primary intended use of the Missionland dataset will be training, both in distributed and stand alone simulations. In addition, concept development & experimentation and doctrine study are also areas where Missionland can be used.

To satisfy the priorities of the different branches in the armed forces, Missionland should contain at least the following 5 terrain types:

1. Coast
2. Mountains
3. Urban, eastern
4. Sea
5. Urban, western

The size of Missionland will have to be at least 1000x1000 km to satisfy most of the potential users, although it should be noted that there is also a significant group demanding an even larger area. The preferred size of Missionland seems not to be affected by the technical capabilities of the simulators, since most of them support database paging.

It is no surprise that the users expect the Missionland dataset to provide a complete range of products. But to be useable the absolute minimum that should be provided is:

- Maps
- Vector data
- Terrain texture

- Medium resolution elevation data
- Medium resolution aerial imagery
- Terrain feature models

Also when looking at the spectra that should be available in the Missionland dataset it can be concluded that the users expect a truly multi-spectral dataset, including not only visual data, but also infrared, radar, night vision and the data required for Computer Generated Forces (CGF) applications.

The majority of users expect that the Missionland dataset will be supplied using industry standards (e.g. shapefiles, geo-tiff, etc), but there are also requests for Common Data Base (CDB), SEDRIS and compiled OpenFlight. It should also be noted that the format or formats in which the dataset is delivered, does not have to be the format used internally by the task group. For the preferred classification schema for the data SEDRIS Environmental Data Coding Specification (EDCS) was mentioned most often, however the majority of the respondents was either indecisive or did not provide a response.

More details about the user needs elicitation and the user requirements can be found in [2] and [3]

## **5 Missionland Design**

Based on the results of the user needs elicitation, the Missionland task group started to create the design of Missionland. The Missionland continent will be located in the middle of the Atlantic Ocean, because that is a real-world location that offers enough space for a new continent. Besides that the Northern Atlantic Ocean seems a suitable location for a NATO activity. Table 1 lists the details about the Missionland location and the grid cells used. Figure 2 gives a graphical representation.

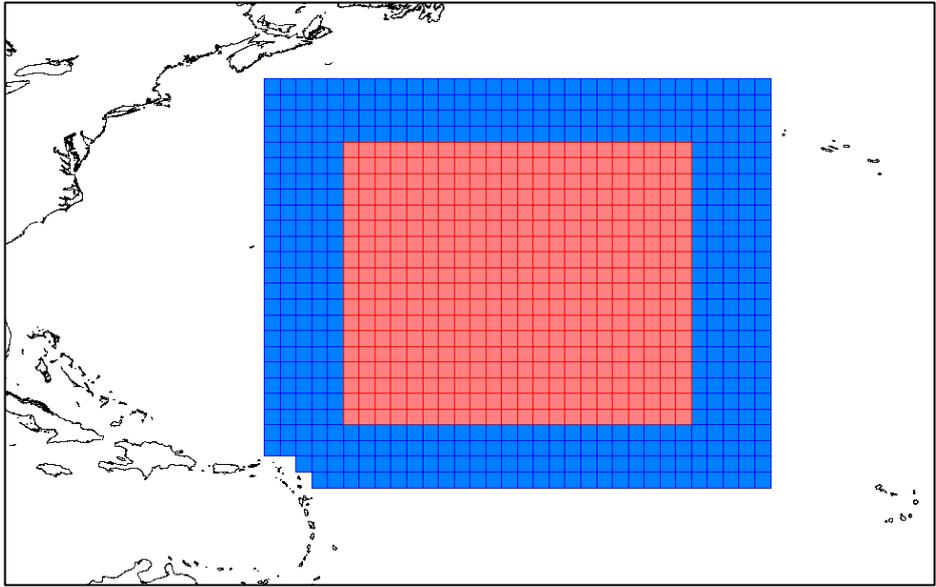


Figure 2: Missionland location

The outer ring of cells has been defined as ocean, to provide a gradual transition from the Missionland bathymetry to the real world bathymetry. In the latitudinal direction this ring is 4 cells in size, in the longitudinal direction 5 cells. Please note that in the south western corner a number of cells had to be removed due to the Caribbean islands located there. This results in an effective land area for the Missionland continent of circa 2000x2000 kilometres (red in Figure 2), with a sea zone around it of circa 400 kilometres in size (blue in Figure 2)

Table 1: Missionland size and location

Top left	N43 W64	Bottom right	N17 W32
Cell size	1 x 1 degree		
Cell width	81 – 106 km	Cell height	111 km
# cells width	32	# cells height	26
# land cells width	22	# land cells height	18

The Missionland continent should provide a wide range of climates. To ensure more realistic transitions between these different climate zones and to assist in positioning the different areas on the Missionland continent a high-level definition of the climate zones has been defined (see Figure 3). The following climate zones have been defined: arctic, temperate, arid and tropical.

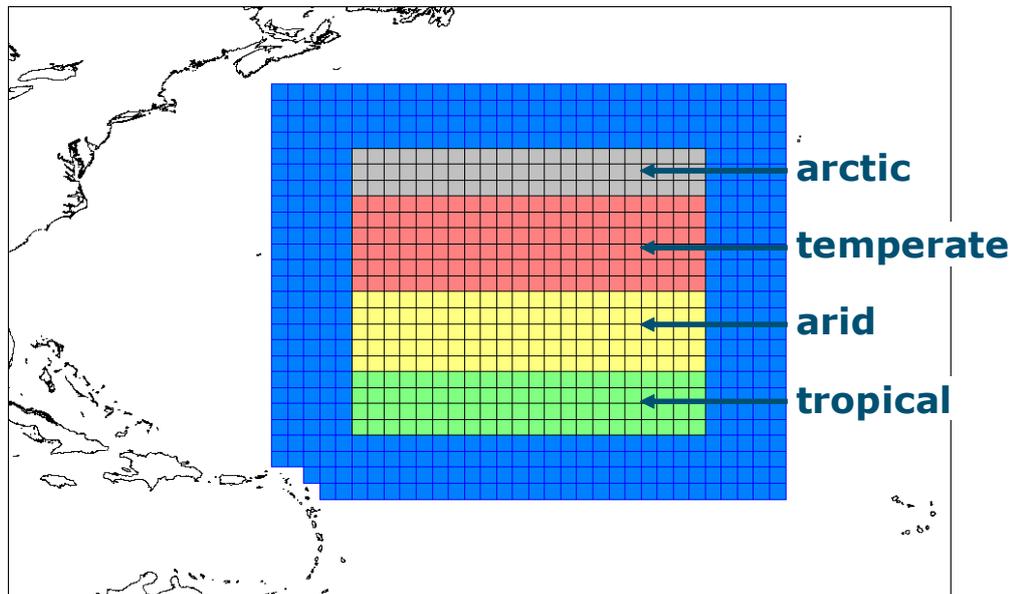


Figure 3: Missionland climate zones

The Missionland continent should provide a wide range of terrain characteristics. This is partly defined by the elevation profile of the terrain. To ensure that there is a realistic transition between the different elevation profiles, a high-level design of zones with a certain elevation profile has been defined (see Figure 4). The following elevation profiles have been defined: flat, hilly, mountainous and cliff/fjord.

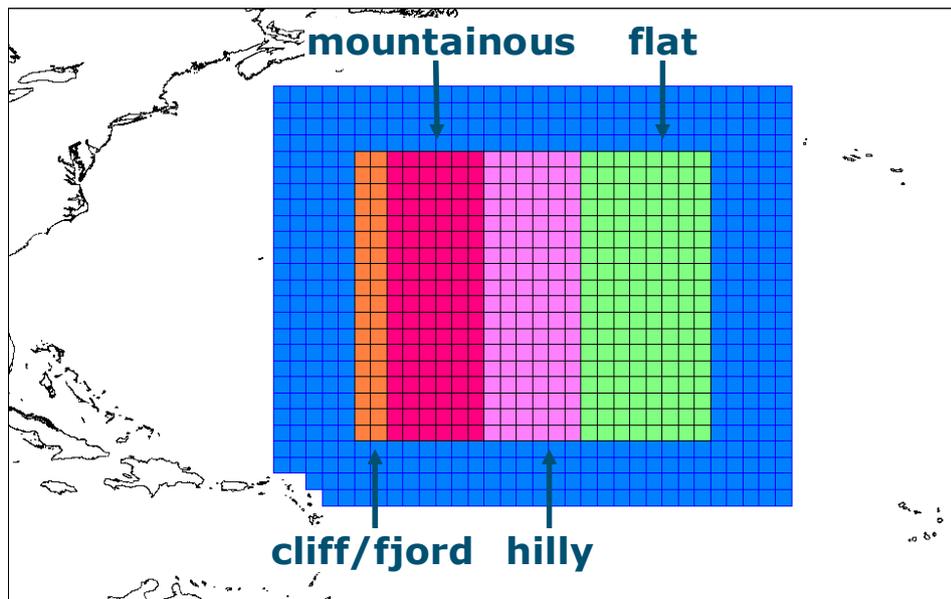


Figure 4: Missionland elevation profiles

The climate zones and elevation profiles give the basic outline for the Missionland continent. From this point the task group started working on filling in the zones with details. In this detailed design the requirements for the content of the dataset are included using the information gathered from the questionnaires. These requirements are stored in design diagrams.

Figure 5 gives an overview of the high level requirements on Missionland.

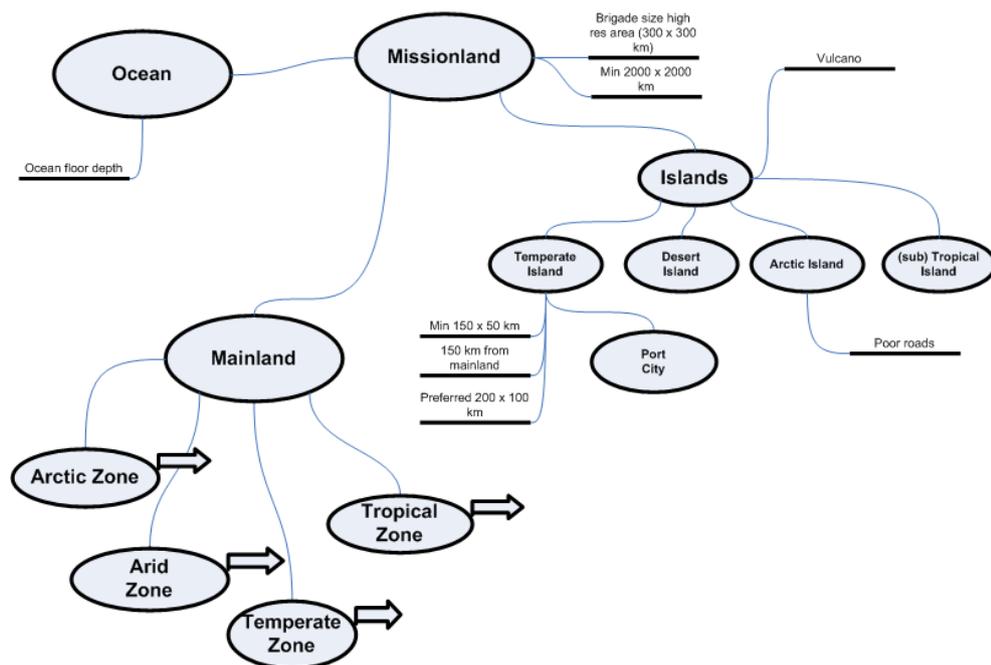


Figure 5: High level requirements

Some of the features in Figure 5 are an aggregation of more detailed features (e.g. temperate zone). Additional diagrams to zoom in on these requirements are available. The diagram for the temperate zone is presented in Figure 6. In this diagram the features that should be present in the temperate zone are represented. For some of the features more detailed requirements or constraints (minimum length, depth, etc) have been included.

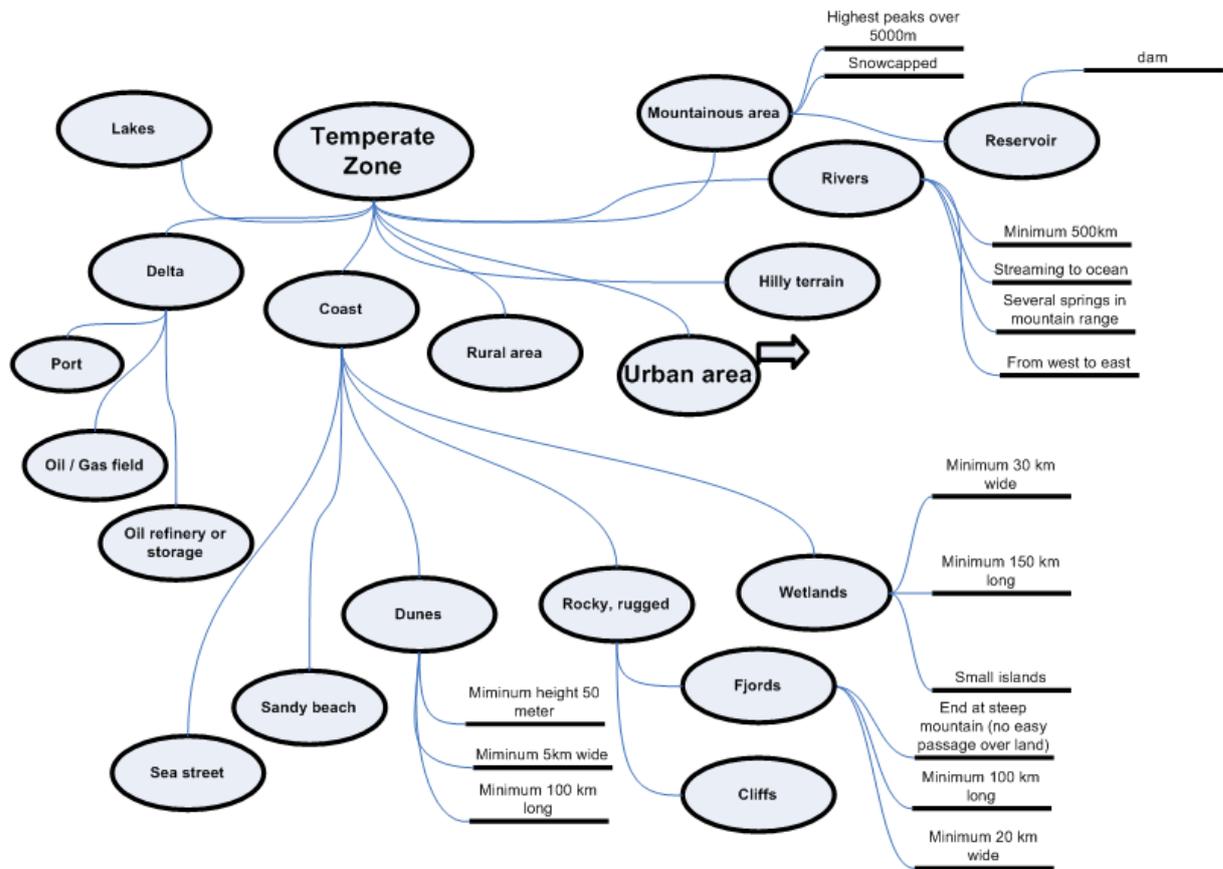


Figure 6: Temperate zone requirements

## 6 The Missionland Dataset

The Missionland dataset will contain a number of products:

- elevation data
- vector data
- 3D models
- material textures
- maps
- imagery

To ensure that all the different products in the Missionland dataset remain correlated with each other, it is important to define which products are the core or master products. These master products can be edited directly when new content is added to the dataset, while all other products are derived from them. For creating real world environment databases the imagery is

usually used as the master, from which other data, like vector data, is derived. But since Missionland is a fictitious continent there is no imagery to start with. Therefore it is more practical to create the vector data first and derive the (multi-spectral) imagery products from the vector data, using a material library. Another benefit of generating the imagery is that features can be drawn into the imagery as well.

A side effect of this approach is also that the total size of the core Missionland dataset is kept down, since it does not contain the high resolution imagery. This imagery can be generated at the desired resolution when required. This means that the elevation data, vector data, feature library and material library will be the core products of the Missionland dataset. All other products are derived from those. Figure 7 gives a graphical overview of the different products in the Missionland dataset. All data is stored using geodetic coordinates (latitude and longitude) in WGS84.

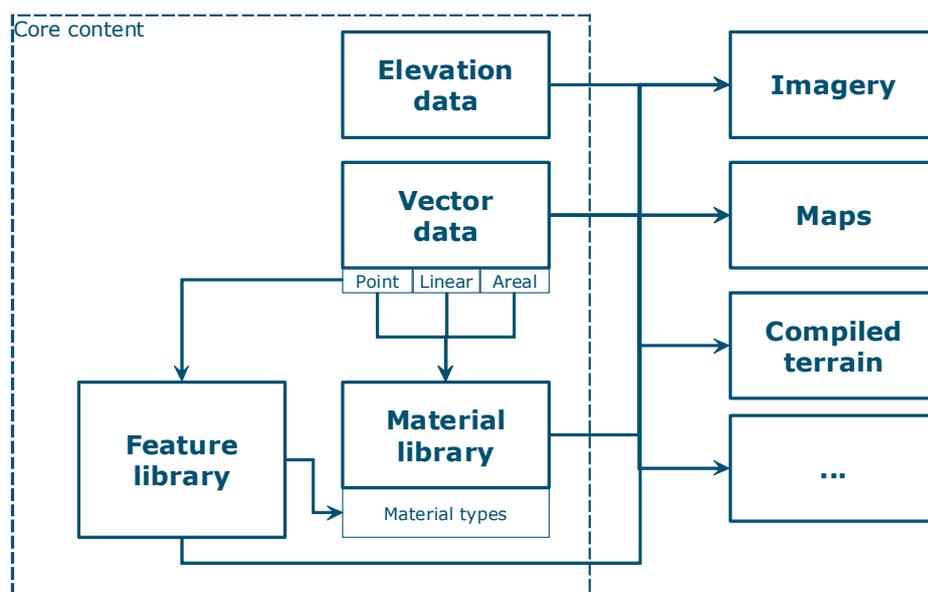


Figure 7: Missionland dataset

## 6.1 Elevation data

The elevation data defines the height of the terrain or the depth of the sea areas. The dataset contains different resolutions of the elevation data. The highest resolution elevation data is used for the areas of interest where land forces are employed, while areas of Missionland that are only observed from the air have a lower resolution. In future versions, the areas with high resolution data are expected to grow. Table 2 gives an overview of the resolution that is used for the different areas of Missionland. The elevation data is stored as one Geospatial Tagged Image File Format (GeoTIFF) file per geocell. The resolution of the GeoTIFF file varies between high and low resolution areas.



Table 2: Guidelines for resolution of elevation data

<i>Area</i>	<i>Resolution</i>
High resolution area	< 15 meter
Low resolution area	30 meter

**6.2 Vector data**

The vector data represents different features in the environment. Vector data consists of point, linear and areal features. The point features are used to define the location of objects, like a house. The linear features are used to define roads, rivers or power lines, while areal features are used to define areas with certain land cover types, for example forest or city, or to define the footprint of a building. Additional information of the feature is captured by the feature attributes. Examples of these feature attributes are the width of a road, the height of a building or the maximum load for a bridge. Table 3 gives examples of the different kinds of vector data that can be found in the Missionland dataset.

Table 3: Examples of vector data

<i>Point</i>	<i>Linear</i>	<i>Areal</i>
Feature model placement	Road	Land usage
Location of point of interest	Railroad	Water (lakes, sea)
	Country border	Administrative regions
	River	
	Coastline	
	Communication line	
	Pipe line	
	Contour line	

Vector data is stored as ESRI Shapefile (SHP). For the attribution a Missionland specific schema will be used that relates features to a material texture, a 3D feature model and maps to common schemas as SEDRIS EDCS, Features and Attributes Coding Catalog (FACC) and Data Format Design Document (DFDD).

**6.3 Feature and material library**

Man-made features, like buildings, bridges and light posts are represented by geometric 3D models in the Missionland dataset, as is also the case for vegetation objects like trees and bushes. The feature library contains all 3D feature models and their textures that are used within the static Missionland environment. 3D moving models are not part of the Missionland dataset. The positioning of these models at the locations where they are used in the environment is done

using point vector features. 3D features are stored in the OpenFlight format and their textures in the Silicon Graphics Image RGB format. The material properties for the multi-spectral representation of the 3D feature models should be stored in accordance with the guidelines of the material library.

The material library contains the textures and additional sensor information for the different feature types in the vector data. Material textures are used to give the environment and objects the right representation. This can be in the form of a texture used by the visualization, but also by providing the right parameters to be able to generate a sensor image. The textures are stored in SGI RGB format. The format for storing the non-visual material attributes still has to be defined.

#### **6.4 Derived products**

Besides the core products, the end users of Missionland also require a number of products that can be derived from these core products.

The most important derived product for Missionland is the imagery. The imagery of Missionland will be generated from the core products. The land usage as defined in the vector data and the textures from the material library are the main inputs into this process. But also the elevation data is needed to make sure the effect of varying elevation is represented in the imagery. The same applies to the 3D feature models, they also need to be included in the generated imagery. If real world data is used as the basis for a contribution to the Missionland dataset, real imagery might be available of this area. This imagery could then be used instead of generating imagery from the vector data.

The maps of Missionland will be generated mainly from the vector data. Elements like contour lines can be derived from the elevation data. Since real world maps are also generated from vector data, the process to generate the Missionland maps should be roughly the same. Different types of end-users might require different types of maps, for example nautical or aerial charts. When creating the vector data it has to be ensured that the different kind of data required for these map types is available.

## **7 Missionland dataset generation**

A major and challenging task for the task group is to generate the first version of the Missionland dataset. For real world environments geographical data is gathered by recording



imagery and measuring the elevations in an area. From this data additional information, like vector data, is then derived. But since the Missionland continent is fictitious this approach of obtaining geographical data for the continent will not work. Therefore, one of the biggest challenges for the Missionland task group is to generate the data for this vast continent.

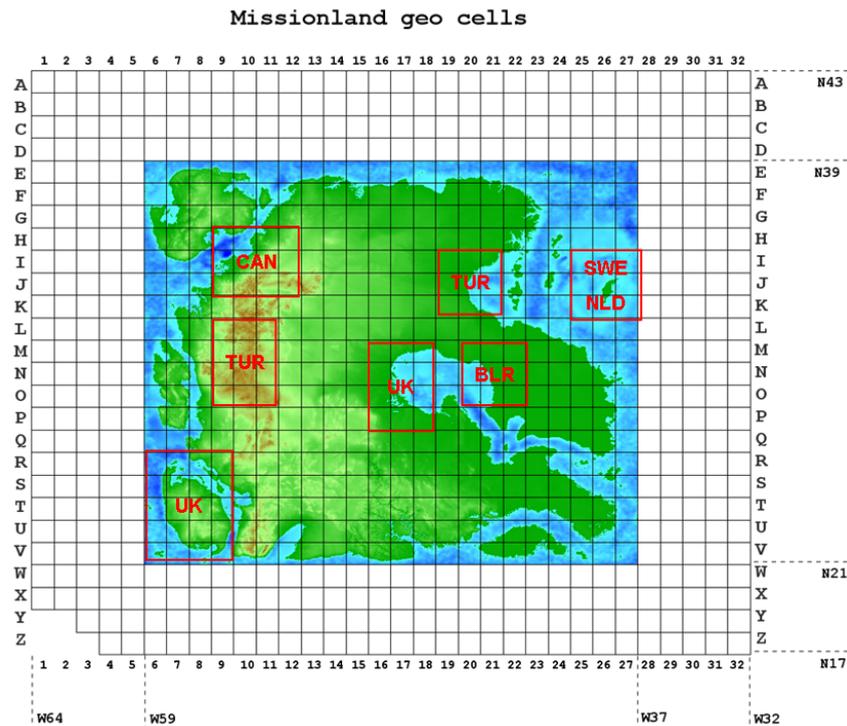
The task group adopted a basic data generation process for Missionland that starts with the generation of the elevation data. Next the vector data is generated, which has to conform to the elevation data. This helps to ensure that for example rivers are not flowing uphill or that large cities are not located on steep mountains. After both the elevation and vector data have been generated, the next step in the process is the production of the imagery data from these two products. So in a sense the Missionland data generation process is partly the reverse of the data generation process that would be used for real world areas.

The approach the task group has chosen is to generate data with a low level of detail for the whole continent and to fill some dedicated areas, spread out over the different climate zones, with more detailed data. These areas are divided between the participating countries for generating the high level of detail data to spread the work effort. In Figure 8 this distribution is reflected.

### **7.1 Elevation data generation**

The task group first evaluated the possibilities to use procedural terrain generation techniques for the generation of the elevation data. The advantages of such techniques are that elevation data can be generated for a large continent using a limited amount of parameters in a relatively small amount of time, that elevation data can be generated at any desired resolution and that no political or IPR restrictions apply to the data.

The experience of the task group however was that there are not many tools available to generate procedural elevation data at the scale of an entire continent. Current procedural terrain elevation methods are hard to configure and control, which makes it hard to produce the intended results [4][5]. Another drawback with current methods is that the resulting elevation data do not provide realistically looking areas for the different terrain characteristics of the Missionland design. For example the mountainous areas were not mountainous enough, while flat areas were still too hilly. Besides that, the generated procedural elevation data also does not represent large area geographic features, like valleys or rivers, well.



*Figure 8: Distribution of high resolution areas*

To overcome the downsides of the procedural elevation data, the task group investigated using a blending technique. This means that pieces of real world elevation data are blended into the elevation data. If an appropriate sample of the real-world elevation data is used, this results in much more realistic elevation data with the large area geographic features represented. However, this blending is a manual process and therefore requires more effort. The public domain elevation data from the United States Geological Survey (USGS) is used as the basis for this, so that there are no IPR restrictions. More details about using these blending techniques can be found in [6].

Using the approach described above the task group has generated a set of 30 meter resolution elevation data for the entire continent using the Large 3D Terrain generator (L3DT) commercial tool. The task group enhanced this dataset further with the blending approach. For this the Norwegian Defence Research Establishment FFI has developed a dedicated tool, Interactive Terrain Editor (ITED). ITED is not a procedural terrain generator, but it provides a user the ability to produce fictitious terrains with use of real-world elevation data [7].

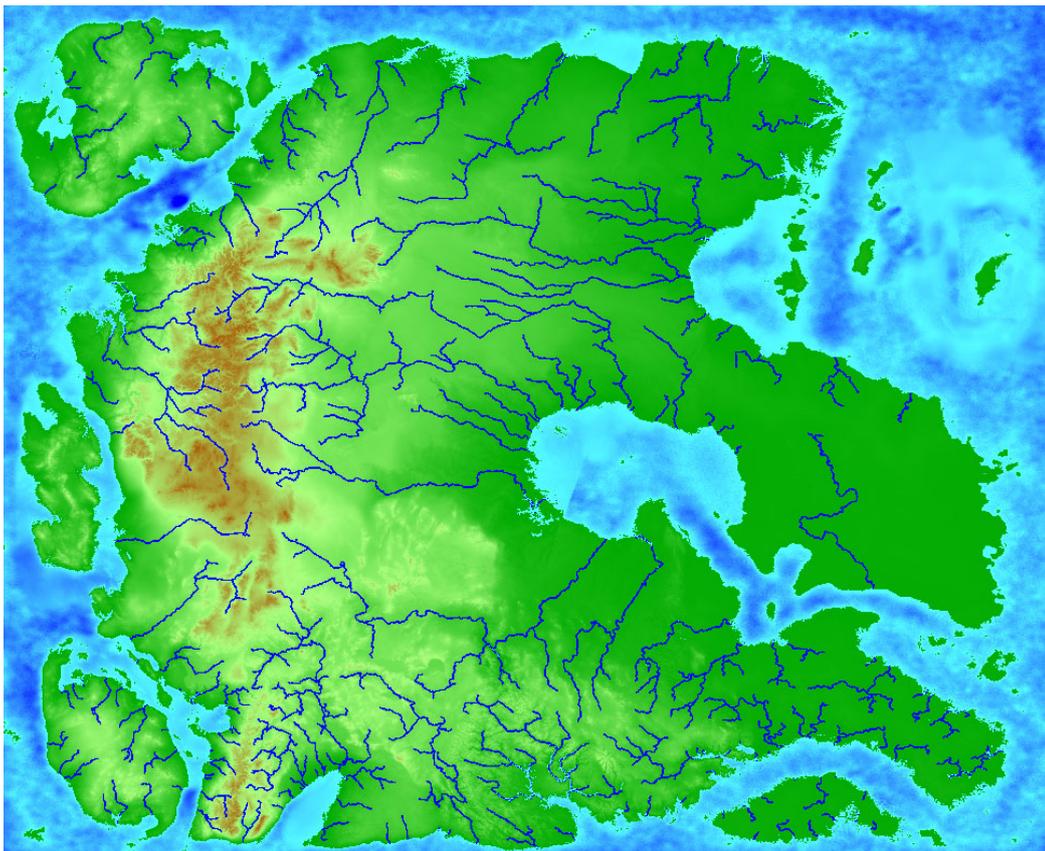
## 7.2 Vector data generation

When it comes to the vector data of the Missionland continent, two types of vectors should be considered. First there are global features that cover a big part of the continent. Examples of

these are rivers or main road networks. The second type of vector data are the highly detailed features used to represent the areas of interest, for example a city, harbour or airport.

For the global features it is important that they follow the elevation profile correctly. For example a river should take a natural path down from the mountains into the sea. Although these features do not have to be represented in very high detail everywhere, they do cover long distances over the entire continent. Drawing them manually would require a lot of effort. Therefore the task group is looking into the possibilities of generate such features with algorithms, based on the elevation data of the continent.

Figure 9 shows the results of some experimentation with this approach. It shows a river system for Missionland that has been generated from the elevation data using the GRASS plugin for QGIS [8]. Similarly, the task group will also try to use GIS tools to generate a basic road network for the Missionland continent.



*Figure 9: Rivers for Missionland generated from the elevation data*

For generating the second type of vector features, the high detailed features representing areas of interest, the use of algorithms is also one of the options that the task group is looking into.

There are for example multiple tools available that can create a random city using a set of rules. The road network and buildings for the city are then generated by the tool.

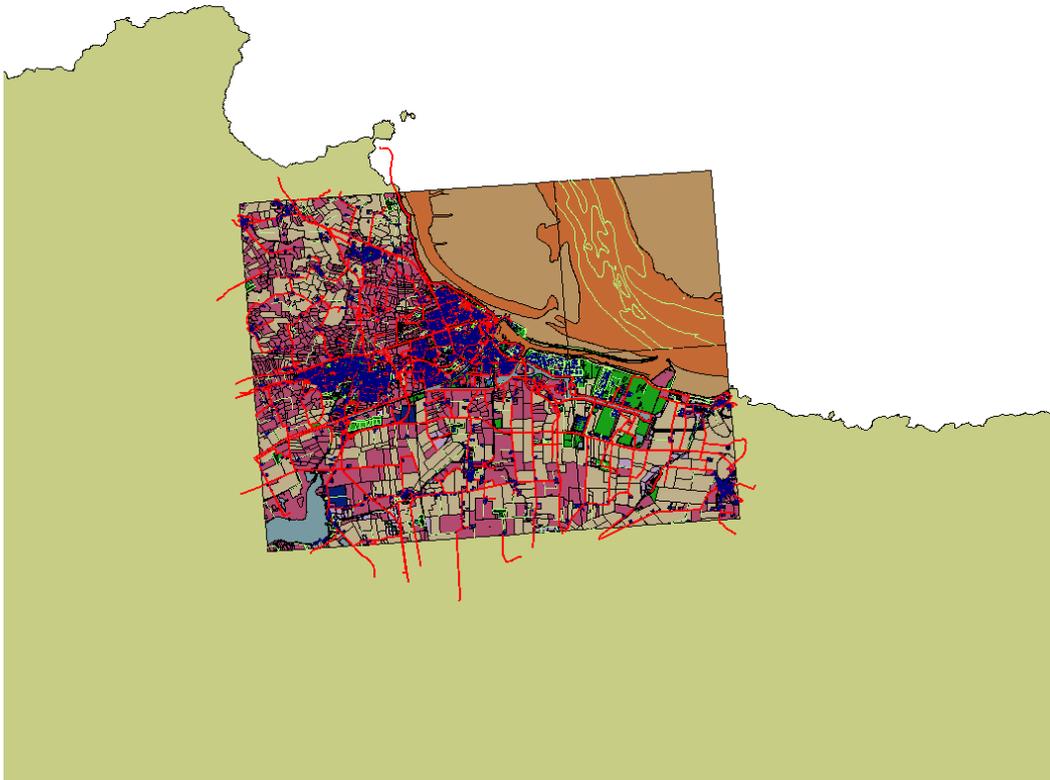
However, such tools do not exist for all types of areas of interest. For example a harbour is harder to generate with this approach. Besides that another drawback of such tools is that resulting cities will often look relatively similar. Since the Missionland continent provides a wide range of climate zones and terrain types, the vector data of the areas of interest is expected to differ in these different zones.

Therefore, the task group is also looking at alternative approaches to generate the vector data of the areas of interest. Manually drawing them is not an attractive solution, since these areas are typically very rich in features. Using pieces of real world vector data seems a suitable approach though. Real world vector data is usually already rich in features, so using it will ensure realistically looking areas. See for an example Figure 10.

Like for the elevation data there is a risk of political restrictions on sharing the vector dataset, when pieces of the Missionland continent are recognisable as a certain real world area. But when only a town or airport is used from a certain real world area and placed within the Missionland context it is expected this will not prove to be a big problem.

When using real world vector data and fictitious elevation data, there is by definition a mismatch between the two components. For example when a city from a flat region is placed in a mountainous area the result will not be very realistic because the vector data does not conform to the natural constraints of the elevation data. The hillier the area is, the bigger the problem becomes. One approach is to manually edit the two data components to obtain correlation, but this is potentially a difficult and time consuming process.

Another approach is to locally blend in the real world elevation data that matches the vector data used. A case-study with the real world data of the Swedish island of Gotland has shown that using real world data is a feasible approach to create a feature rich environment dataset for Missionland. Two important lessons learned from the case-study is that one has to ensure that the distortion is minimized when moving real-world data to the Missionland location and that the feature attributes have to be translated to be consistent with other features in the Missionland dataset. Another lesson learned from the case-study is that the Missionland task group will have to utilize a combination of the approaches to achieve its objectives. For each product in the dataset the most suitable combination of these approaches will be selected to generate the data. The use case is discussed in more detail in [7].



*Figure 10: Example of blending real world vector data into Missionland*

### **7.3 Imagery generation**

The task group has not started the work on the imagery of the Missionland dataset yet. The reason for this is that the imagery needs to correlate with the elevation and vector data. Therefore it can only be generated once these products have been finished.

The approach for generating the imagery will most likely use rule-based sets to generate imagery based on vectors and elevation data. For each land usage type, as defined in the vector data, a representative material texture will be used to fill the imagery for that area. The information from the elevation data will be used to further enhance the resulting imagery, for example by ensuring that on high altitudes or on slopes different terrain characteristics are displayed. This approach to generating imagery is used in some computer games [9] and also companies in the modelling and simulation world are starting to use this technology. However, such an approach is not widely available in COTS tools yet. This approach for generating the imagery seems very suitable for the Missionland needs. But until the right tools are available, the task group might have to decide to use other approaches which produce imagery with less quality.



It is expected that little use will be made of real world imagery for the Missionland dataset. Technically it would be possible to include the imagery for a real world area that has been used in the vector data. But doing so will make the area much more recognisable and is therefore more likely to result in political restrictions. Besides that the approach of generating the imagery from the vector data, also has the advantage to ease the process of generating multi-spectral representations of the area. To enable the generation of such a presentation, one would also need material information for the other regions of the electro-optical spectrum. The material library of the Missionland dataset aims to provide such information as well.

## **8 Missionland Deployment and maintenance**

Generating the Missionland dataset is one major step, but to ensure the deployment and maintenance of Missionland for a longer term a set of rule and guidelines will be necessary.

During the life of the task group, the task group controls the distribution of the Missionland dataset. The initial dataset will be deployed by the task group at a selected group of first users to test the utility of the dataset. The task group is guiding this deployment and helps the users in the actual construction of runtime databases for their specific simulators from the dataset. Together with these first users the task group will develop documentation and guidelines to enable the future users to build a runtime database in a structured manner and thereby ensure that optimal correlation maintains between different databases build from the Missionland dataset. After the life of the Missionland task group it is foreseen that the Missionland users are self-supporting in deploying the Missionland dataset.

After the life of the Missionland task group the Missionland dataset has to be accommodated by a organisation or group that can control and monitor the distribution of the dataset. For this the task group proposes to install a Missionland Data Authority (MLDA). This MLDA could be placed under the umbrella of MS3 (Modeling and Simulation Standards Subgroup) which is a permanent subgroup of the NMSG. To keep control over the use of the dataset the task group has developed a set of use conditions that each user has to agree with. This will ensure that the data will only be used by the NATO countries and NATO PfP countries and that no commercial profits will be made of the voluntary efforts of the participating MSG-071 countries. These use conditions also provide a robust framework for accepting new data, making changes and establishing ownership of the data so that it is freely available to use for NATO purposes.



## 9 Conclusions

In 2008 the NATO RTO task group MSG-071 Missionland started. Its prime objective is to construct a coherent dataset of the static environment, from which databases can be constructed for a wide scope of simulators. These environment databases are generally needed for visual out-of-the-window and sensor views, as well as terrain servers and computer generated forces applications. Based on inputs from military end users the Missionland task group has identified the user needs and requirements for a dataset of a virtual continent, named Missionland.

The task group created a design of the virtual continent Missionland and set a location in the North Atlantic Ocean for this new continent. The Missionland dataset will cover multiple climate zones, various elevation settings, coastal areas and large continuous land masses. This ensures a suitable environment for a large variety of applications, including training, tactics development, simulation based acquisition and concept development and experimentation. The Missionland dataset will provide end users with terrain elevation data, remote sensing imagery, ground imagery, vector data, 3D models, material coding and metadata.

The task group developed 30m resolution elevation data for the whole continent using the L3DT tool. As this data was not looking “natural” enough, the task group enhanced this data by blending in parts of real world elevation data. For doing this Norwegian FFI developed a dedicated terrain editor tool ITED. Some areas in the continent have been identified which are provided with higher resolution, at least 15 meter, elevation data. Some tests have been done for generation of the vector data. The task group will use here a mixed approach. Part of the vector data will be made by using algorithms or procedural tools, for example the rivers. This will be complemented by blending in real world vector data.

Some non-technical issues have also been considered by the task group. The team has put together a document of the Use Conditions for the data set which provides a robust framework for accepting data, making changes and establishing ownership of the data so that it is freely available to use for NATO and PfP purposes.

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