# Green Book One

Forest Fire Rating Systems –
Setting the Scene for a Macro-Regional Approach:
The Baltic Sea Region as a Case Study

# Editors’ Letter

This Notebook is one of nine in the Fourteen Point Three Notebooks collection brought together by the European Union Strategy for the Baltic Sea Region flagship project 14.3 (read: fourteen point three).

Eight Notebooks will present you with findings from our project’s four different working groups (named Task Groups C, D, E and F), and one Notebook will introduce a general overview of the whole project.

We hope that the collection as a whole will give you a sense of the unfolding diversity and complexity of the project, whilst retaining homogeneity as a single vision and ideal.

The singular Notebooks present concrete results (studies, workshop reports, developed methodologies and scenarios). The structure of the entire collection intends to act as a mirror for the project as a whole, and to reflect on the process as much as the output. Each of the books can be read singularly as a study presenting concrete findings from working groups, at the same time they can be read as a collection. Manifested together we view this as the symbolic added value brought to the macro-regional conversation by the project 14.3.

These values could be: the network, the will for cooperation in general terms, the challenges in finding a uniform language among different civil protection cultures and traditions, and the motivation to find commonality amongst the different departure points.

Green Book One and Two bring you the body of the Task E work. Task E was one of the three, as we call them, “thematic tasks” of the project 14.3. This means that the Task E working group focused on one thematic-hazard, namely Forest Fire. A precisely focused aim was determined by the group of six Baltic Sea region countries that participated in the Task. The declared aim from the beginning of the process was: to find out whether a macro-region in which every country uses a different forest fire rating and prediction system, would benefit by adopting a single system, and if so what would be needed to develop such a system.

The 18 project months were too short to draw definitive conclusions regarding such a demanding and complex matter. However, it was enough time for this one group of experts to discover that a common macro-regional approach may not necessarily mean the adoption and use of one management and prevention system only. It may also mean a common attitude towards the value of shared experiences between the countries in the region. This understanding could only be borne by the actual practice of this getting-to-know one another and gathering. Green Book One thus presents you with a series of captured documentations recorded throughout the Task E workshops.

It is our pleasure and honour to be sharing with you this vision of cooperation through our GreenBooks in particular, and the Fourteen Point Three Notebooks in general.

Editors of Fourteen Point Three Notebooks
Egle Obcarskaite – Anthony Jay Olsson

14.3 was a project implemented under the EU Strategy for the Baltic Sea Region (EUSBSR), Priority Area Secure (Priority Area 14 in the 2009 version of the EUSBSR Action Plan). The whole priority area calls for an insurance that contributions in the field of civil protection encompass the overall Strategy objectives (save the sea, connect the region, increase prosperity). The project 14.3 responds specifically to the objectives through addressing the necessities of bringing together and coordinating civil protection stakeholders and bolstering the capacity of individual countries, in order to ensure our region's uniform resilience to macro-regional risks.

**14.3 was developed from a belief that considering the nature of the world that we live in today, only by ensuring a proper level of resilience on a macro-regional level can we ensure a higher level of resilience and preparedness on the national level as well.**

Project 14.3 was a pioneering effort. →

Not only for addressing the topic of macro-regional risk in the Baltic Sea region (before this project there wasn't even a common concept discussed among the countries in the region), or for bringing up a complex all-hazards approach, but also for bringing together a partnership consisting of all countries in the region, to not only discuss and share but develop together a strategic approach to civil protection. As such, it thus constitutes a shift in the whole paradigm of the way civil protection may be conceived on a macro-regional level.

Why it is only now that 14.3 could have happened? →

Some say because there was previously never this level of openness in sharing information on civil protection tools and methods among different countries in the region; this could not have been imagined twenty or even five years ago. Others say it was because countries in our region finally openly recognized their individual vulnerability, as well as the fact that there may be situations to which even the most resourced country would face the need to ask for assistance from a neighbour. 14.3 partners came together admitting it straight: it is not enough to ask – you have to be ready to receive assistance.

Pioneering efforts also meant that 14.3 was a daring effort. →

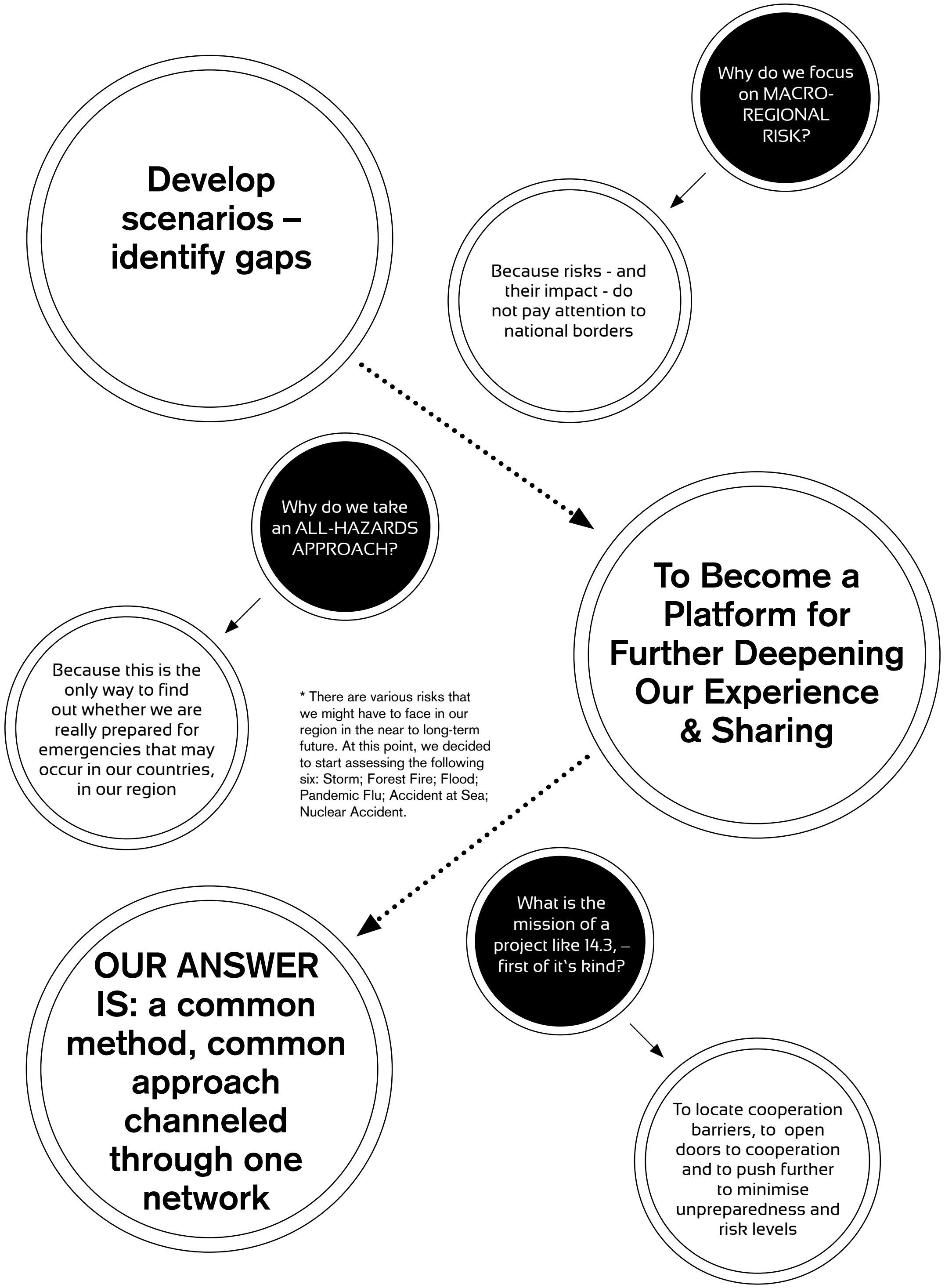
This was especially visible in how the all-hazards approach had to be adopted for the project. All-hazards approach is a challenging claim even on national level, as it requires crossing administrative and institutional boundaries. Which is the best way to achieve this? The answer is yet to be formulated.

Project 14.3 proposed to take one step at a time and responded to the all-hazards challenge through structuring the project in four thematic tasks. There were three tasks dealing with the following hazards: floods, forest fire and nuclear accident. Whereas one task – Task C – engaged in an overall strategic discussion on how can risk be assessed and analysed on a macro-regional level, and how a common risk-discourse can decrease societal vulnerability of each singular country in the Baltic Sea region, as well as that of the macro-region as a whole.

Working Together on Macro-Regional Risk.

# Project 14.3

Was the First Time that the Countries Around the Baltic Sea Worked Together on Macro-Regional Risk*




* There are various risks that we might have to face in our region in the near to long-term future. At this point, we decided to start assessing the following six: Storm; Forest Fire; Flood; Pandemic Flu; Accident at Sea; Nuclear Accident.

Here are the types of questions we asked ourselves in workshops and expert groupings

# Fourteen Point Three Notebooks

Collection of Fourteen Point Three Notebooks is Set to Launch a CIRCULAR LOOP in which ONE PART Manifests The Whole and THE WHOLE Manifests One Part ⟶

Task C ↔

**Macro-Regional Risk**

What will it take for us to have a common approach to risk and a common method to assess it? Do we need it? Why?

→ RED BOOK ONE / TWO →

Task D ↔

**Floods**

How can we best share our experience in coping with floods? Could this help us to reduce the national costs associated with flood prevention, preparedness and response?

→ BLUE BOOK ONE / TWO →

Task E ↔

**Forest Fire**

What fire risk models are used already in the Baltic Sea region? How can these be bolstered? What kind of common system would we need and why?

→ GREEN BOOK ONE / TWO →

Task F ↔

**Nuclear Accident**

Would we be able to cope with a nuclear emergency which would impact several countries in the region? How can we create a common response and alertness mechanism?

→ ORANGE BOOK ONE / TWO →

### ... Red Books represent the contribution

from our Task C experts whose main concern centred on beginning a discussion on the risk-assessment challenges in the Baltic Sea Region; a discussion that, for the first time, would include all countries from the area. In their two Notebooks they bring to us an insight on how our countries meet the challenge of assessing overall risk. They also question and explain what methodology can be used together, and they bring us their first attempt to develop a common language by drawing six different risk scenarios.

### ... Blue Books represent the outcome

from the Task D Grouping who have discussed flood prevention practice in the Baltic Sea region. Floods are an annual occurrence for most of the countries in our region, and each one of them has developed a strong national know-how of coping with this type of emergency. However, the discussions focused on how can we increase the effectiveness of our actions in dealing with this emergency by sharing experiences of individual singular-country specific cases? The Blue Books give us a picture of various flood prevention experiences in the Baltic Sea region, as well as their conclusions and recommendations for further know-how sharing.

### ... The Green Books focus on our regions foliage,

vegetation and forest cover and what happens when fire occurs. As our Task E experts discovered, all countries that participated in the work of Task E have their own national fire risk systems. These systems are both, similar and different at the same time. The question asked of experts was whether the region needs to have one fire risk system for the whole region? What would that system entail and how would that system borrow elements from other systems already developed elsewhere? This is to be decided in the future. For now, we have made a first step in this process providing you with an overview of existing fire risk systems in the Baltic Sea region.

### ... Our Orange books investigate nuclear accidents

The nuclear question is probably one of those regional questions which we cannot afford to overlook in a macro-regional context judging by its potential impact. To show you why this is so, Task F experts developed a scenario for an hypothetical accident in Finland that may have severe consequences on other countries in the region. The second part of their task work was to assess this developed scenario and provide recommendations for further activities that would increase our preparedness towards accidents of this complex kind. The scenario and workshop report are both delivered to you in our Orange Books completing the circle.

The EUSBSR flagship project 14.3 was a novelty on various levels

## Two of the most important 'firsts'

**...partnership of diverse** civil protection actors from every country of the Baltic Sea region was built

**...the focus** of the project was concentrated on an all-hazards approach through a macro-regional lens

## The questions we asked ourselves were

How can we acknowledge and communicate the project's complexity, and capture it without reducing or subordinating it at the same time?

How can we talk about the methods and the substance of inquiry at once, whilst keeping both on an equal footing?

**Green Book One gives you an insight into how experts from the Baltic Sea region took their first steps to set a foundation for macro-regional forest fire prevention. It discloses the questions that need to be asked and answered as well as the hesitations that need to be overcome in order to lift the Baltic Sea region forest fire prevention onto a macro-regional level. →**

# Task E Fact Sheet

18 Months of...

**MEETING** →

Stockholm → Tallinn → Stockholm

The Task was led from Karlstad, Sweden

**WORKING together** →

Swedish Civil Contingencies Agency (MSB) – Frederikssund-Halsnæs Fire & Rescue Service (Denmark) – Estonian Rescue Board – Main School for Fire and Rescue Service in Warsaw (Poland) – State Fire and Rescue Service of the Republic of Latvia – Norwegian Directorate for Civil Protection (DSB)

**SHARING experiences** →

Leif Sandahl, Ulrika Postgård (SE) – Kim Lintrup (DK) – Katri Rüütel, Sven Jablonski, Teet Koitjärv (EE) – Agris Šūmanis (LV) – Heidi Vassbotn Løfqvist, Hans Kristian Madsen (NO) – Anna Szajewska (PL) (Consultant: Annie Johansson (SE))

## LEIF SANDAHL Task E Leader:

"When it comes to forest fire prevention, each country in the Baltic Sea region has its own way of managing it. They have thus far chosen their own system of how to monitor, predict and rate fire behaviour. We don't know yet whether it would be better for the region to have one common system. It is however very useful to have an established practice of sharing experiences from countries within the Baltic Sea region. Task E made a major step in bringing forward the idea of establishing such practice."

## TASK E Gave Us

→ A tailor made questionnaire on nationally used forest fire rating systems.
→ An overview of forest fire rating systems in six Baltic Sea region countries.
→ An understanding of the current gaps in the system – such as the lack of regional mapping of fuel grades and forest coverage.
→ A comparative demonstration of two forest fire behaviour analysis models currently used in the Baltic Sea region, including suggestions on their potential to become a basis for a common macro-regional model.
→ A first step in debating the need and demand for one common forest fire rating system in the Baltic Sea region.

Forest Fire Risk Systems in the Baltic Sea Region: An Overview

# Introduction from the Authors[1]

During the work of Task E – Forest Fire – of the EUSBSR flagship project 14.3, the participant countries have, through a questionnaire and workshops, described their current wildland fire danger rating systems, focusing on weather information, vegetation classification and system experience.

Denmark, Estonia, Latvia, Norway, Poland and Sweden[2] described eight different systems, all correlated to the preparedness of the responsible organization. There are some differences in the input data, but all are based on weather information. In four of the six countries the vegetation is mapped, however in different ways and for different purposes, and in three of those four countries vegetation as a factor in the risk system is included. The output information in all systems highlights dry conditions.

**Fire behaviour prediction systems or fire spread models are absent in all of the participant countries today.**

Advantages of a common fire danger rating system and fire spread models have been discussed in this project; it would be a useful operational tool in the fire management system for both prevention and preparedness, and should be used to develop appropriate suppression strategies. Some of the data needed for fire spread models are, among others; fuel type maps, topography and verified fire spread calculations. The agreed key properties required for a common fire spread model focused on the applicability of the system.

More sufficient documentations of wildfires in this area are needed to provide comprehensive fire behaviour analysis. It is possible that the system used by The European Forest Fire Information System (EFFIS), could be more thoroughly used in the Baltic Sea region.

1 This report is an analysis of a questionnaire and a workshop within the EUSBSR flagship project 14.3 Task E. It was compiled and finalised by Leif Sandahl and Ulrika Postgård (Swedish Civil Contingencies Agency MSB)

2 While the overall partnership of the EUSBSR flagship project 14.3 included ten Baltic Sea region countries, only six of them participated in the Core Group of Task E. For this reason, Green Book One and Green Book Two provide analysis, overview and recommendations based on cases and input from six countries of the Baltic Sea region (Denmark, Estonia, Latvia, Norway, Poland and Sweden).

# Introducing Task E – Forest Fire

The work area of Task E in the project 14.3 was forest fire risk in the Baltic Sea region. The objectives given to the task working group were:

→ to organise dedicated workshops and expert meetings in order to get acquainted with elaborated forest fire scenarios of macro-regional impact;

→ to elaborate possible models making use of risk mapping as a supporting tool. This includes reviewing and evaluating existing simulation models for forest fire propagation and fire behaviour;

→ on this basis, to develop the use of instruments to enable risk analysis of forest fires and give increased knowledge on how to use simulation models in forest fire prevention and preparedness;

→ with consideration of the available results from the spreading models and simulation models to give suggestions which would lead towards a possible macro-regional tool and approach for forest fires, which would also have the possibility to be used in national risk assessments for purposes of prevention and preparedness.

This report describes the participant countries' [3] current wildland fire danger rating systems, focusing on weather information, vegetation classification and system experience. The results are based on the answers from a questionnaire and discussions from a workshop dedicated to this topic, which took place in Stockholm on 26 -27 June 2012.

3 Denmark, Estonia, Latvia, Norway, Poland and Sweden

## SETTING THE SCENE:
## Task E Data Collection Method, Questionnaire, References

To gather data from the participant countries about their fire danger systems; input data needed for the systems; experience of using the systems and ideas and possibilities for a common system - two methods were used. A questionnaire was sent to the participants and a workshop was held to discuss the existing systems. Results from these activities are complemented with a literature study for the two fire danger rating systems, the Canadian Forest Fire Danger Rating System (CFFDRS) and the U.S. National Fire Danger Rating System (USNFDRS). An overview of the European Forest Fire Information System EFFIS is also included.

### Drawing a Questionnaire

→ A questionnaire was sent to the participating countries to map the existing fire danger systems used today. The questionnaire was sent out the 29 May 2012. The purpose of the questionnaire was to gather information about existing forest fire danger rating systems or risk management systems for forest fires or grass fires that are used by partners working on Task E. The questionnaire included questions about input data for each countries' system. Each country described the weather data that is used.

→ Since vegetation is one of the main factors that affect fire behaviour and the inventories and classification can be done in many ways, information about vegetation was the focus of the questionnaire. It was also important to illustrate in what way the vegetation is included in the fire danger rating system; therefore questions about this were included.

→ Questions were then asked about how the systems are used in practice combined with an enquiry related to how important the system used was judged by an informed opinion based on experience of the system. Every country also had the chance to express their opinion about a common fire danger rating system for the Baltic Sea region. Needs, benefits of and demands on a common system were covered by the questionnaire.



→ The last questions focused on the advantages and needs for a fire spread model that could be used by the partners working in the project 14.3. The questionnaire ended with room for each country to give their information and data which could be used for the demonstration of fire spread models at the second workshop that was set to take place within the scope of Task E activities.[4]

### Collecting Data: Method and Aim of Workshop I

The first workshop of Task E (from here on referred to as Workshop I) took place in Stockholm 26-27 June 2012. During this workshop, each participating party was invited to present the risk system/s used in their country. These presentations were based on the questionnaire described above, yet they were complementary to it and provided all participants with an opportunity to enrich their initial understanding of the questionnaire results. Presentations at the workshop included charts on relevant organizations and their management, illustrated prevention plans, pictures of vegetation classes, fire danger rating maps and other illustrative images.

A significant part of the workshop was a discussion, initiated in order to collect views from all participants on selected questions. The questions invited participants to provide the group with proposals on whether the Baltic Sea region would need to have one common forest fire risk system, as well as what benefits and potential difficulties such a common system would bring. As a part of this discussion, reflections on the advantages of and needs for a common fire spread model programme were formulated. The question was asked, whether such a programme could be a useful risk assessment tool for a macro-regional forest fire risk management in the Baltic Sea region.

### Methodological References

The fire danger rating systems that were selected for inclusion as overviews to this this report are the Canadian Forest Fire Danger Rating System (CFFDRS) and the U.S. National Fire Danger Rating System (USNFDRS). These are two distinct systems, developed over a long time and are used internationally. The CFFDRS consists of two major subsystems – the Canadian Forest Fire Weather Index (FWI) System and the Canadian Forest Fire Behaviour Prediction (FBP) System (Taylor and Alexander 2006). The CFFDRS was developed in, and adapted to, the boreal forest which the participants

4 Overview of the systems presented at the second workshop are provided in Green Book Two.

in this project, concerning the Baltic Sea area, can recognize. Modules from this system have also been adopted in New Zealand (Fogarty et al, 1998) Indonesia and Malaysia (Groot et al., 2006) and CFFDRS is also used in Alaska since 1992 (Alexander, and Cole, 2001), which shows that this system is adaptable to other countries, including other fuel types. The overview is produced mainly from reference literature from the course Wildland Fire Behaviour Specialist held in Hinton, Alberta, Canada in Feb. 2012. An overview about the USNFDRS is presented as a summary of the report "Gaining an Understanding of the National Fire Danger Rating System" a publication of the National Wildfire Coordinating Group Fire Danger Working Team (Schlobom and Brain 2002).

# Forest Fire Risk Systems in The Baltic Sea Region



## AN OVERVIEW
## An Overview Based on the Results of the Task E Questionnaire and Workshop 1

Denmark, Estonia, Latvia, Poland, Norway and Sweden answered the questionnaire and presented their own forest fire danger rating system at Workshop 1. The results are presented below.

## Results of the Questionnaire

### 1 Existing Risk Systems

All the participating countries have at least one system that they use to rate forest fire risk.

#### Denmark

Denmark uses a risk management system, **Dryindex**, based on the water balance in the earth.

- The Danish Meteorological Institute calculates the risk of drought using Relative Humidity (RH), precipitation, evaporation and percolation as input factors. The index, that has four classes, is illustrated daily on a map open to the public. Vegetation is not included in the system.

#### Estonia

Estonia's system is called the **National Fire Danger Rating System**.

- Estonia´s National Fire Danger Rating System combines forest fire hazard with a fire hazard index, which thereby is a system that combines vegetation and weather.
- Estonian vegetation is divided into ten main forest type classes, based on tree species, the grass species under forest cover and soil type.
- Forest vegetation is also divided into five forest fire hazard classes classified by:
  - forest class;
  - relative humidity of forest;
  - forest age and dominant trees.

1
Existing Risk Systems

- Weather is included through the Estonian Meteorological and Hydrological Institute (EMHI), which calculates the fire hazard, using temperature, RH and precipitation.
- Fire hazard is divided into five classes marked by numbers from 1 to 5 (V – extremely hazardous, IV – big hazard, III – temporary hazardous, II – small hazard, I – very small hazard).

## Latvia

Latvia uses **Fire Weather Index**, (This is not the Canadian Fire Weather Index), calculated by the *State Limited Liability Company Latvian Environment*, *Geology* and *Meteorology Centre*.

→ Temperature, RH and precipitation are used as input data to calculate the fire weather index.
→ The index is divided in five risk classes that are illustrated on a map accessible to the public.
→ Vegetation in Latvia is classified into 23 forest site types, due to soil fertility i.e. the drainage of the soil that also reflects the dominating species.
→ Forest fire fighters adapt five fire risk classes to each of these 23 forest site types, based on the sites ability to dry and thus to become a risk. Five fire weather index classes and the five forest fire risk classes are not combined.

## Norway

Norway's Forest Fire Risk System is based on **Waldbrannkennsziffer**, (WBKZ).

→ The index uses temperature, relative humidity (RH), and precipitation as input data and the index expresses the level of dryness in the air. Vegetation is not included.
→ The system calculates a daily risk level for approx. one hundred locations and the results are illustrated in a table that is available to the public.



1
Existing Risk Systems

## Poland

Poland has developed a Fire Prevention System (Forest Fire Risk - KZPL) that includes a forest fire risk system and a fire growth simulation model.

→ The categories of forest fire risk are established based on the sum of points calculated from the following four parameters:

1. **how often fires happen** (the average annual number of fires in the last ten years for every 10 km2 of forest area);
2. **information about vegetation type** (species composition and arrangement);
3. **climate conditions** (RH and fuel moisture using average values from the last five years);
4. **anthropogenic factors** (the average number of residents for each hectare (ha) of forest area).

→ The value from the four parameters above puts the area into one of three categories of fire risk.
→ As the next step, Poland established degrees of fire risk considering actual weather conditions, using temperature, RH and precipitation as input data.
→ There are four degrees of fire risk in Poland's risk system

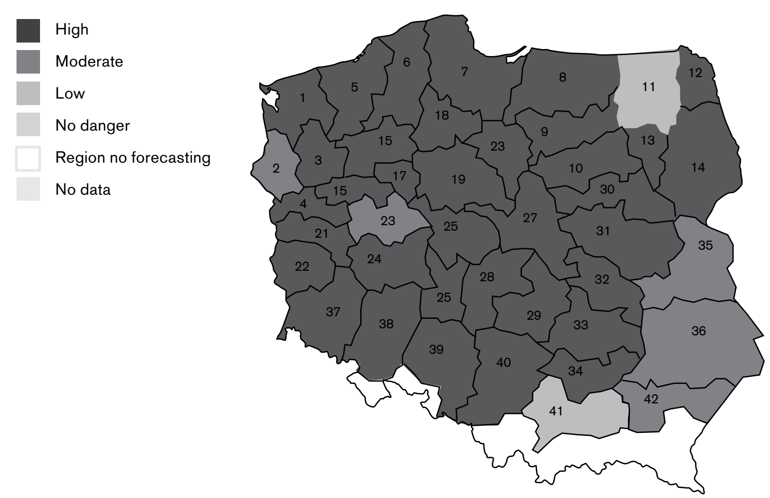



Figure 1 A Forest Fire Danger Map over Poland, shown as an example over how the results in a fire risk system are illustrated.

1
Existing Risk Systems

- Poland is developing a model for fire spread specifically for Polish conditions.
- The fire front rate of spread, flame height and demands for water are some of the outputs in this system.

## Sweden

Sweden is using three different systems; **Grass Fire Risk**, **HBV** that is a hydrological model and the **Canadian FWI System**.

- **The hydrological model HBV is a soil dehydration model that is based on the humidity of two soil layers.** This model calculates infiltration from rain and melting snow into the upper layer of the soil. A maximum, potential evaporation is calculated, based on air temperature that together with the level of soil moisture governs how much water actually evaporates. The model runs daily and uses precipitation and temperature as the only time-varying input data. The weighted soil humidity value is divided into six dryness indexes.

- **The Grass Fire Risk System in Sweden is used when the snow cover disappears and the dead grass from the year before appears.** In the model the increase of temperature over time is used to calculate the amount of new green grass that has grown up, in order to decide during which period it influences the grass fire risk and when the grass fire season has ended. This system uses temperature, RH and calculated soil moisture in a thin top layer as input data and the result is expressed in six risk classes illustrated on a map open to the public.

- **The FWI System is based on the moisture content of three classes of forest fuel plus the effect of wind on fire behaviour.** The system consists of six components: three primary subindexes representing fuel moisture, two intermediate subindexes representing the rate of spread and fuel consumption, and a final index representing fire intensity as energy output rate per unit length of fire front. Its components are determined every day from noon weather readings and the input data is; temperature, RH, wind speed measured at a height of 10 m in the open, and the 24-h precipitation total. The results are illustrated on a map accessible to the public. The results are also available in a simplified version through a mobile phone application. Vegetation is not included in any of the Swedish systems.

All eight above described systems use different input data. Table 1 shows the different data that is used in the respective systems.



1
Existing Risk Systems

Table 1 **Data usage in eight systems analysed by the Task E**

| Country | Name of fire risk system | RH | Temp | Precipitation | Wind speed | Vegetation | Fuel load | Soil drainage | Present evaporation | Present percolation | Humidity of forest bedding | Nb residents / area | Fire history / statistics | Dew point |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Poland | Forest Fire Risk (KZPL) | ● | ● | ● | | ● | | | | | ● | ● | ● | |
| Denmark | Day Index | ● | | ● | | | | | ● | ● | | | | |
| Norway | Forest Fire Index, WBKZ | ● | ● | ● | | | | | | | | | | |
| Latvia | Fire Weather Index | ● | ● | ● | | ● | | ● | | | | | ● | ● |
| Estonia | National Fire Danger Rating System EMHI | ● | ● | ● | | ● | | | | | | | | |
| Sweden | Grass fire Index | ● | ● | ● | | | | | | | | | | |
| Sweden | HBV | | ● | ● | | | | ● | ● | ● | | | | |
| Sweden | FWI The Canadian Fire Weather Index | ● | ● | ● | ● | | | | | | | | | |

2

## Classification of Vegetation

In Estonia, Latvia, Norway and Poland vegetation for the entire country is mapped. The purpose of vegetation maps, inventory methods and the classification systems are however different for each of those countries.

### Estonia

Vegetation in Estonia is classified by national forest inventories that describe dominant tree species for every forest parcel with the average area of 1,5 ha. National forest inventory is based on aerial photos and field inventories.

The ten main forest type classes are: Alvar forest, Heath forest, Mesotrophic pine forest, Meso-eutrophic spruce forest, Nemoral forest, Herb-rich mixed forest, Dwarf-shrub-sphagnum paludified forest, Grass fen forest, Bog moss forest, Full-drained swamp forest (main trees are: Scotch pine, Norwegian spruce, Birch, Aspen, Black alder, Gray alder, and other species). The forest is then divided into five forest fire hazard classes. Main tree species and forest danger classes are in correlation. See middle forest danger classes in Table 2.

2

Classification of Vegetation

Table 2 **The correlation between the main tree species and forest hazard classes in the National fire danger rating System used in Estonia**

| Main tree species | Forest hazard class | Relative error (+- %) |
|---|---|---|
| Scotch pine | 2.6 | 1.9 |
| Norwegian spruce | 3.0 | 2.8 |
| Birch | 4.4 | 1.2 |
| Aspen | 4.1 | 2.9 |
| Black alder | 4.8 | 3.9 |
| Gray alder | 4.2 | 2.9 |
| Other species | 3.9 | 5.1 |

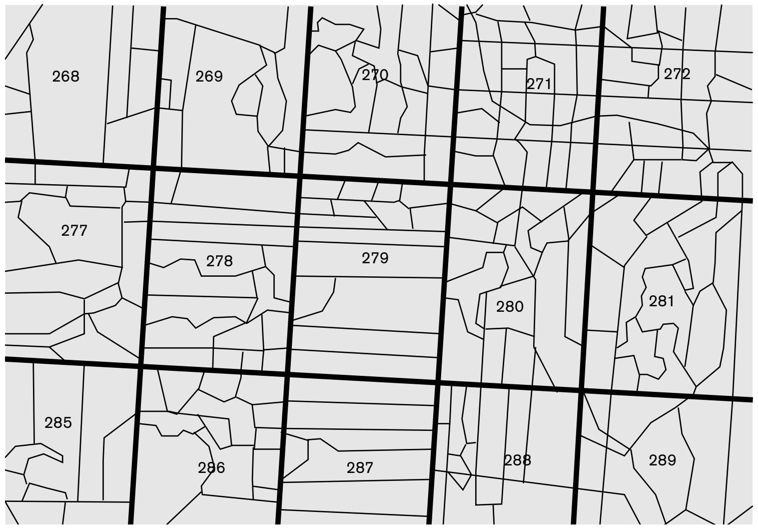



Figure 2 A Latvian example of how the vegetation can be mapped

The forest inventory in Latvia is based on aerial photos, improved by field inventory. Vegetation is classified into 23 forest site types, classified for forest management purposes. The criteria for the different classes are based on soil fertility and soil humidity, as this factor reflects the productivity on the site and of the species (on ground-vegetation and tree species). The size of forest site types varies, but normally forest sites with different site types are from 0.1 ha. An example is shown in Figure 2.



2

Classification of Vegetation

## Norway

Norway uses ECOCLIMAP to classify their vegetation into currently two (low vegetation and forest), soon nine, classes with a resolution of 1 km2. The nine classes are:

- deciduous forest
- conifer forest
- evergreen broadleaf trees
- C3 crops
- C4 crops
- irrigated crops
- grassland (C3)
- tropical grassland (C4)
- gardens and parks

The vegetation is not presently included as part of the data in their fire risk system.

## Poland

In Poland the vegetation classes are based on species, arrangement, percentage of individual species, forest stands and age of the forest. Vegetation is classified by field inventory.

The classes are divided due to the topography:

- lowlands (15 classes)
- uplands and piedmonts (8 classes)
- mountains (12 classes)

Some examples of vegetation type for lowlands are:

- dry coniferous forest
- fresh coniferous forest
- wet coniferous forest

In the Polish system the forest fire risk is based on the species composition of forest stands, arrangement and percentage of individual species are considered.

2
Classification of Vegetation

**A quantitative basis for rating fire behavior is possible with mathematical models based on descriptions of fuel properties as inputs to the calculations.** Proper selection of fuel models is a critical step in the mathematic modeling of fire behavior and fire danger rating (Anderson 1982). In none of the countries examined is vegetation classified into fuel types.

### Latvia

Latvia includes fuel structure and composition of site conditions into their system, and describes the fuel in terms of ground, surface or crown fuel. Using the inventory in Latvia it is possible to add some notes about the vegetation that can impact the fire behavior. This is not the case in Denmark, Estonia, Norway, Poland, or Sweden.

## 3 Usage of Existing Systems

The countries examined use their systems at different levels and with different aims. However, the risk level from the respective system, in all countries, is directly correlated with the preparedness for the responsible organization.

### Denmark, Norway and Sweden

In Denmark, Norway and Sweden the system is used on national, regional and local levels. In Norway, for example, the system is used to evaluate the forest fire danger locally and to organize resources on national level.

### Estonia

In Estonia, the system is important for the Rescue Service, forest owners and local municipalities. The Estonian Rescue Board uses climate maps that describe the levels of forest fire risk to define the restrictions of using open fires in the forest. If the level of the forest fire risk class is very high, the Estonian Rescue Board is authorised to deny the public use of open fires in natural surroundings. It is also used for media campaigns (in case the risk level is high), as well as for educating the public.

### Latvia

In Latvia, the main user of the system is the State Forest Service at the national level.



3
Usage of Existing Systems

### Poland

In Poland, the category of forest fire risk is established on the basis of Regulation of the Minister of Environmental Protection. The procedures of establishing forest fire risk are included in the Instruction of Forest Fire Protection and its users are on national level.

### Sweden

The three systems in Sweden are used for prevention work, which aim to inform different organizations and the public about the risk of forest fires. It is also used to plan and perform prescribed burning for natural conservation, and to introduce bans against making fires. Examples of organizations that are using the systems today are the Swedish Civil Contingencies Agency (MSB), Rescue Service Agencies, County Administrative Boards, Airplane companies that monitor forest fires, Universities, forestry companies and prescribed burning companies.

**All systems are used during the fire risk season (mainly from April until September). The countries also express the importance of using the system as information to the public.**

## 4 Country Satisfaction with the Systems in Use

### Estonia

Estonia is satisfied with their system since it is sufficient for collecting the necessary information in order for the Estonian Rescue Board to react to incidents on time.

### Latvia

Latvia makes use of their knowledge of forest site types to predict forest fire behaviour under different metrological conditions. They express the importance of this knowledge when making tactical decisions in fire suppression actions.

4
Country Satisfaction with the Systems in Use

## Norway

Norway expressed that their system works rather well in dry conditions, but variably in wet conditions.

## Poland

Poland expressed that The Polish Forest Fire Risk System is very useful. It includes all the necessary data used by their Forest Services and Fire Service.

## Sweden

In Sweden the systems are very useful and beneficial for many users. The experience with the FWI System is that it is a reliable risk system. Most of the users need general information and do not use all the different sub-indexes in detail. Some users would like to have prognoses of higher resolution on a more local scale. In the Spring of 2012 an application for mobile phones of the Fire Weather Index was introduced to the public; its usability has not yet been evaluated.

# 5 Possibilities for a Common Fire System

## Denmark, Norway, Poland and Sweden

Denmark, Norway, Poland, and Sweden are positive about a common system that can be used for both prevention and preparedness on a large geographical basis. This is motivated by the interest to establish an operational on-going procedure of sharing resources and expenses between countries. A common system would be specially designed to suit the vegetation in the Baltic Sea region. It would be a useful tool for fighting forest fires which can spread across national borders. This would also make it easier to benefit from the experience of other countries in the region. There is also an economic benefit in using a common system instead of developing individual systems.

Another benefit of a common system could be a fast and proper response to international assistance: it would unify and simplify the collection of common experience, as well as it would function as a common statistical database. It could be used for trans-boundary activities in forest fire prevention and operational work, and would be a common risk management tool.



5
Possibilities for a Common Fire System

## Estonia

Estonia has indicated that their existing system is sufficient. They use their system both for prevention and operational work. A common system, however, would be useful for sharing experiences and exchanging best practices.

## Latvia

Although Latvia´s average size of forest fire is less than 1 ha, they have expressed interest in the benefits of having a forest fire spread model.

# 6 What is Needed in Order to Develop a Common Fire Risk System for the Baltic Sea Region?

The participant countries noted factors that could be important input information in a risk management system for forest fires.

**The most important factor is common meteorological information, with standard readings as input data into a model that can be used to identify the risk level.**

In a more advanced system, vegetation needs to be mapped with standard methods in all countries. Other important factors that are possible as input data are:

- fuel classification,
- fire history,
- fire causes,
- activities in the forest or in connection to the forest.

Population density and its variation during the year together with infrastructure were also noted as factors influencing the risk of occurring forest fires.

**Participants identified that it would be possible to use the existing European Forest Fire Information System, EFFIS (Camia et al 2006) as a Common Fire Risk System for the region.**

## 7 Demands on a Common Fire Risk System

In terms of key required properties, participating countries agreed upon the following focus: applicability of the system.

It must be uncomplicated to use, updated and maintained.

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It will be a cost effective web-based universal tool that will help us all to calculate the risk of forest fire.

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Special attention should be given to highlight dangerous areas of the landscape. This is needed both within the country and between countries. This will make it easier to prevent risks and fight fires.

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The system should be multi-lingual.

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Sources for ignition (e.g., human causes and lightning) to estimate risks of ignition potential should be included.

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Some properties need further discussion and investigation. For example, to identify whether it will be an open system for all civil protection and security users, forestry users and the public, or whether accessibility should be limited. It was discussed also, whether these properties should include recommendations and prevention information for users. Among further discussed elements were levels of resolution, a minimum standard of common interface and GIS-applications.

## 8 Development of a Fire Spread Model as a Risk Management Tool

In order to develop and run a fire spread model, information about weather, fuel and topography has to be defined, standardized, produced in the correct format and then used as input data on the fire environment.

- The technical infrastructure has to be developed, in order to support the delivery of the system.
- All the vegetation has to be mapped and classified into verified fuel classes.





- The landscape should be produced on topographic maps that include fire breaks, such as roads and lakes.
- Standard weather readings are needed as input and the fire spread model should then account for the diurnal weather.
- The model should allow users to modify fuels and weather data.
- The fire spread model would use verified spread equations to simulate fire growth.
- Each country should be able to make adjustments and complements to their maps in order to identify high risk areas.

In Poland, a fire spread model is currently under development, specifically tailored for Polish conditions. This model, however, when verified, could be a potential alternative for a fire spread model to be commonly used across Europe.

## 9 Advantages of a Fire Spread Model

Countries participating in the Task E Workshops indicated various advantages of a common fire spread model.

First of all, a common model would be a useful tool to **plan fire suppression actions**.

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Such a system would support **tactical decision making** in wildfire suppression actions and would **facilitate trans-boundary actions during wildfire emergencies.**

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It could also help **determine locations in the forest where special attention should be paid and where fire would be especially dangerous.**

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Through a shared program, which stores all information about wildfires, **second hand experience could be gained.**

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A fire spread model can be used not only by fire management agencies, but also by other interested stakeholders, such as landscape modellers, university researchers, forest management planners, municipal planners, and educators. Another use of fire growth modelling is the analyses of fire regimes and potential impacts of climate change (Nitschke and Innes 2008).

## 10 Data for Demonstrations of Fire Spread Models

Countries that participated in the activities of Task E, provided information about the following wildfires, as a potential case material for planned demonstrations:

**Denmark:** Information from various smaller fires in vegetation from 2012;

**Estonia:** (north of lake Tänavjärv), 24 May 2008;

**Latvia:** Garkalne fire, 30 April 2006;

**Norway:** Myklandbrannen, 9 June 2008;

**Poland:** Białostocki-Nadleśnictwo Waliły, 24 June 2008;

**Sweden:** Bodträskfors, 11 August 2006.

## 11 Identified Risks and Gaps

Wildland fire behaviour is dependent on three factors: weather, fuel, and topography.

All countries participating within Task E have a system, the main output of which is the risk of fire, or more "dry conditions", or "risk of ignition", whereas it does not include neither fuel nor topographical factors.

The research carried out during the project 14.3 indicated that one country - Poland - is developing a system that includes topography as a factor. After the development process is completed and the system will be evaluated, Poland will be the only country that can predict fire behaviour in the Baltic Sea region. Sweden uses the Canadian FWI that provides probable fire behaviour prediction in the form of relative numerical ratings. The FBP System accounts for variability in fire behaviour amongst fuel types for a given slope steepness in quantitative and descriptive terms (Van Nest and Alexander, 1999). The FBP System is used to predict actual fire behaviour. However, the FBP System fuel type classification has yet to be adapted or verified for Sweden (Jönsson and Linåker, 2010). Today, none of the studied countries have an adopted model to predict actual fire behaviour (e.g., rate of fire spread in meters per minute).





Four of the participant countries have mapped their vegetation and have divided the vegetation into different classes. None of them have divided vegetation into fuel types, which specify the ground, surface, crown and ladder fuel characteristics based on verified fire behaviour observations.

During the preparation process for the simulations, all the participant countries were asked to send documentation on fires that had occurred in their respective countries. Various factors may be important and necessary in order to enable evaluation of the observed fire behaviour simulations' results. The following elements may be listed as an example of important information for such evaluation: detailed information about spread rates, the type of fire, fuel types, topography, on-site weather, and the perimeter at different stages.

However, the Task group identified that standard routines for this kind of documentation are missing, and many of these factors are not documented at all. The reports on fires are often focused on logistics and the personnel working with the suppression action, while descriptions of the actual fire behaviour in most cases are sparse or absent. Proper documentation of wild fires is necessary for model evaluation, training, and future risk assessment. Descriptions of how wildland fire behaviour case studies and analyses can be executed are, however, available (Alexander and Thomas, 2003). Information from fire analyses will be valuable if a fire behaviour prediction system will be introduced in the region.

The current status of the fire training programs, knowledge and experience in fire behaviour for each country as a topic was not included in the project 14.3, but is an important part of fire management.

**The questionnaires proved that each country's fire danger system is used at both national and local levels. For each country's own purpose, it would be necessary to investigate if the data and information from the system matches the needs of the users, how is it used, and how can it be improved. It is quite likelythat in each case there are flow gaps from risk data collection to utility.**

## Forest Fire Risk Systems Relevant to the Baltic Sea Region: PRESENTATIONS

### Canadian Forest Fire Danger Rating System (CFFDRS)

The research in Forest Fire Danger Rating was initiated by the Canadian federal government in 1925. Canada has used field experiments and empirical analysis and has since 1968, by the Federal Forestry Service of Canada, developed five different systems for rating fire danger and predicting fire. As indicated earlier on, the current system, the Canadian Forest Fire Danger Rating System (CFFDRS) consists of two major subsystems; **The Canadian Forest Fire Weather Index (FWI)** and **The Canadian Forest Fire Behaviour Prediction (FBP) System**.

The FWI System

The FWI System is based only on weather information. The daily measurement that is used as input data in the FWI System is: dry-bulb temperature, relative humidity, 10-metre open wind speed and 24-hour accumulated precipitation, recorded at noon (Van Nest and Alexander, 1999). The FWI System provides numerical ratings of relative fire potential for a standard fuel type on level terrain. The FWI System includes three fuel moisture codes that follow daily changes in moisture contents of three classes of forest fuel. Higher values represent lower moisture contents and hence greater flammability(CIFFC, 2010). The three moisture codes combined with the effect of the wind represents three fire behaviour indexes, numerical rating of fire spread rate, total amount of fuel available for combustion and fire intensity. The FWI component itself is a good indicator of wildfire activity (e.g., fire size), but is developed to rate fire potential in a generalized standard fuel type at level terrain, expressed as relative numerical ratings (Van Nest and Alexander, 1999).

The FBP System

The FBP System is a systematic method for assessing quantitative wildland fire behaviour predictions. The FBP System has 14 primary inputs that can be divided into five general categories: fuels, weather, topography, foliar moisture content, and type and duration of prediction. The FBP System uses certain FWI System components as well as weather information. The input data is used to calculate four primary and 11 secondary outputs. The four primary outputs are rate of spread, fuel consumption, head fire intensity and fire description (i.e. Crown fraction burn and type of fire (Hirsch, 1993).

The FBP System, according to Hirsch (1993) is used primarily by fire management agencies in Canada for the prediction of large fire behaviour, and secondarily for preparedness planning systems where resources can be pre-positioned based on the potential fire behaviour. The FBP System is a systematic method for assessing wildland fire behaviour potential and a field guide was prepared to assist field staff in making first approximations of FBP System outputs. The fire behaviour predictions are intended to assist in decision making, and "are not substitutes for experience, sound judgment, or observation of actual fire behaviour" (Taylor et al, 1997). In the field guide the assumptions for the



model are listed. The FBP System assumes for example that fuel conditions are similar to one of the 16 benchmark fuel types and that the fuel moisture codes used are representative of the site conditions. It also assumes that the fuels are uniform and continuous, topography is simple and homogenous, and the wind is constant and unidirectional.

Applications of the CFFDRS

A fire danger rating system that includes risk of forest fire and a fire spread model program can be used in fire behaviour training, and for prevention planning (e.g., informing the public of impending fire danger, regulating access and risk associated with public and industrial forest use). It is also an important factor for preparedness and detection planning for example by adjusting the level of readiness and pre-positioning of suppression resources. A fire danger rating system is the base for suppression tactics and strategies on active wildfires, including escaped fire situation analysis. It is also decisive for prescribed fire planning and execution. (Van Nest and Alexander, 1999).

An evaluation of how well the Canadian FWI System works in Sweden was made by Granström and Schimmel (1998). Various tests were performed to test the applicability of the system to Swedish conditions. The fuel moisture codes were compared to actual moisture contents in four fuel types, and the observed rate of spread was compared to the Initial Spread Index (ISI) component of the FWI System. The results of those tests showed that the correlation between index-levels and observed spread rates was relatively good for the ISI and differed little between fuel types.

For further technical information on the CFFDRS, see Van Nest and Alexander (1999).

### U.S. National Fire Danger Rating System (USNFDRS)

In the United States research on fire danger rating began in about 1922 and continued by building a danger rating system based on science and engineering principles. The first version of the USNFDRS was released in 1972, it was revised during a 3-year project and finally reissued as the 1978 USNFDRS. It was designed around four basic guidelines; it would be:

- Scientifically based
- Adaptable to the needs of local managers
- Applicable anywhere in the country and
- Reasonably inexpensive to operate.

The system was again modified in 1988. The current USNFDRS, according to Schlobohm and Brain (2002) is utilized by all federal and most state agencies to assess fire danger conditions in the United States.

This USNFDRS is based on physics of combustion and the relationships between various fuels, weather, topography and risk conditions. Previous weather events are tracked by their effect on live and dead fuels and the USNFDRS can also adjust them accordingly based on future or predicted weather conditions. The structure of the USNFDRS is based on three major parts: scientific basis, user controlled site descriptors, and data (both weather and non-weather).

The scientific basis are the mathematical models that are used to calculate fire danger and represent basic principles of combustion physics. The ignition temperature of woody material, rates of combustion and heat energy potential are some of the factors that are incorporated.

In the “user controlled site description”, the area for which the fire danger ratings are calculated for is described. The guiding principle is that each fire danger rating area is an area of uniform fire danger where unique fire related decisions are made. It is a geographical area of generally homogenous fuels, weather, and topographic features. The fire danger area is also described by fuel type based on physical properties of the fuel bed. The USNFDRS groups all fuel beds into six general classes based on the predominant surface fuels, brush, shrubs and tree reproduction, trees and slash. Several of these are broken into sub-classes thus producing a total of 20 different groupings or fuel models. Slope class, grass type, climate class and annual precipitation are also described in the user controlled site description.

Daily weather observations are the first of the two components in the data that are used to calculate daily fire danger. The second is the parameters that the user must input periodically for the outputs to be truly representative of their local conditions. These factors that control the actual calculations within the NFDRS processor are the state of Herbaceous vegetation, shrub type code, staffing index and display class breakpoints, measured woody fuel moisture and season codes and greenness factors.

**USNFDRS outputs**

There are two types of outputs in USNFDRS. First, the **intermediate outputs** that are needed for the next day´s calculations. Second, **indices and components** related to today´s assessment of fire danger.

**Intermediate outputs**

The intermediate outputs are the calculated fuel moisture values for the various classes of live and dead fuels. These values are used to produce the final indices and components. One of those values is the herbaceous fuel moisture that represents the approximate moisture content of live herbaceous vegetation. Another intermediate output is the woody fuel moisture that is a calculated value of the approximate moisture content of the live woody vegetation. The USNFDRS processor also models dead fuel moisture. There are four time lag fuel classes; 1-, 10-, 100- and 1000 hour fuel moisture content.



**Indices and Components**

The fire danger rating is expressed, based on the fire behaviour description, through the following outputs:

**The Ignition Component (IC)**
(IC) is a rating of the probability that a firebrand will cause a fire requiring suppression action.

**Spread Component (SC)**
(SC) integrates the effect of the wind, slope and the moisture content of live and dead fuels to give an indication of rate of spread of the head fire.

**The Energy Release Component (ERC)**
(ERC) is a number related to the available energy per unit area within the flaming front at the head of a fire and is used as an indicator of effects of more long term drying and curing of the forest fuels and is thus a good reflection of drought conditions.

**The Burning Index (BI)**
(BI) is a number related to the contribution of fire behaviour to the effort of containing a fire. This index is derived from a combination of the SC (how fast it will spread) and the ERC (how much energy produced). This index reflects local weather and is used for evaluating the daily fire danger.

**Applications of the USNFDRS outputs**

This fire danger rating system can be useful in many ways and some of them are mentioned below.

Fire management decisions are linked to the fire danger information and the readiness level, expressed as staffing level. The staffing level is based on the expected wildland fire workload potential on the unit and the difficulty of the fire suppression effort.

Daily Adjective Fire Danger Ratings are determined from standard adjective descriptions for five levels of fire danger for use in public information releases and fire prevention signing. NFDRS can also be used to Preplan Dispatch Actions and in the daily decision process that Guide Restrictions of Industrial Activity. The initiation of public use restrictions and Support Severity Requests are two other applications of the system. It is also an important tool when taking the critical decision to allow an ignition to burn under prescribed conditions. Based on NFDRS the National Advisory Group for Fire Danger Rating have developed the “Fire Danger Pocket Card for Fire-fighter Safety”, which is a tool for briefing those concerned on expected conditions at local levels. By using terms from the NFDRS on these cards, a common terminology will be applied and fire fighting personnel unfamiliar with the local area can use these cards as a tool to better understand local conditions and expected fire behaviour.

For more technical information on the USNFDRS, see Schobohm, and Brain (2002).

## European Forest Fire Information System (EFFIS)

In 1998 a research group was set up by the Joint Research Centre (JRC) of the European Commission (EC). This group started work on “the development and implementation of advanced methods for the evaluation of forest fire danger and mapping of burnt areas at the European scale”. The same year EU Member States convened the first “Forest Fire Experts Group”. Since then EFFIS has been continuously expanding and the EFFIS network includes today 24 countries. EFFIS has during the last years, among other things, established the EU fire database, introduced a web map viewer, set up an interface called “up-to-date situation” and adapted a unified fire danger assessment method.

EFFIS provides information through several modules, namely:

- Fire Danger Forecast
- Active Fire Detection
- Rapid Damage Assessment
- Fire Damage Assessment
- Daily MODIS (Moderate Resolution Imaging Spectroradiometer)
- European Fire Database

The European Fire Database contains a selection of forest fire information compiled by EU Member States and other European countries since 2004. Post-fire vegetation regeneration and Post-fire soil erosion risk are modules under development.

The Fire Danger maps are created by using 5 classes (very low, low, medium, high, and very high) with a spatial resolution of about 45 km (MF data) and 36 km (DWD data).

This system supports the services in charge of the protection of forests against fires in the EU countries and provides the European Commission services and the European Parliament with updated and reliable information on wildland fires in Europe. The system is based on the Canadian FWI System, that expresses ignition potential and probable fire behaviour in the form of relative numerical ratings and issued as a measure of general fire danger. During a test phase of five years - different fire danger methods have been implemented in parallel. In 2007 the EFFIS network has finally adopted the FWI System as the method to assess the fire danger level in a harmonized way throughout Europe. During the fire season, EFFIS produces maps of Europe that includes daily meteorological conditions as well as fire danger maps and also forecasts for up to 6 days, daily updated satellite images from the last 7 days. Maps of the latest hot spots and fire perimeters are also updated daily by EFFIS (2012).



## Running a Fire Spread Model

A fire spread model is a comprehensive additional process compared to the risk of ignition. A fire spread model must include information and integrate all the individual factors influencing wildfire behaviour. The three main factors in the fire environment; weather, fuel and topography must be included to cover the probability of the fire to spread over the landscape and also identify risk of dangerous fire behaviour, both in terms of high intensity fires and fires with fast rates of spread Canadian Interagency Forest Fire Centre (CIFFC, 2012). To run a fire spread model and simulate fire growth, the input data have to be well defined and standardized for all countries. In the CFFDRS the rate of fire spread model was based on results from outdoor experimental fires supplemented by well-documented wildfires occurring under more severe burning conditions than would be possible to undertake with experimental fires (Van Nest and Alexander, 1999).

One of the fire spread models that is internationally used today is called Prometheus. Prometheus is a deterministic wildland fire growth simulation model based on the FWI System and FBP Systemmodules of the CFFDRS (Tymstra, 2010).

# Discussion

One of the objectives of the EUSBSR flagship project 14.3 Task E was to map existing fire risk systems, as well as gather an understanding of what information is used as input values.

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Task E objectives, among others, also included an aim to present the participant countries with experiences from the systems used in their respective countries. Participating countries (Estonia, Denmark, Latvia, Norway, Poland and Sweden) are collectively using eight different fire danger rating systems. Seven of those are unique for each respective country. One country is using the Canadian FWI System. Many of the systems are used to warn the public of the high risk of fire but they are also used for a wide variety of other purposes. The systems used today are mainly to forecast the risk of ignition and do not consider other aspects of fire behaviour (e.g., rate of spread, flame size, spotting).

The words "risk", "fire risk" and "fire danger" have different meanings for different people and should be well defined.

The protection of life, property and natural resources from wildfires requires effective wildland fire management. Effective use of fire behaviour prediction systems requires a high level of accurate fire weather forecasting, data collection and information handling capability. This project is an important step to identify the existing forest fire risk systems, the input data and the different facets of system experience.

One part of this project was to discuss the need for a common fire risk system/fire danger rating system.

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The majority of the participants were very positive about the idea of a unified reliable system that could increase the possibilities of international support, training and cost sharing. The countries were also positive to the development and the implementation of a common fire spread model. This project highlights both the potential and benefits of using a system and the multitude of research and scientific information that is required before the end-user can properly apply the system´s outputs.

Another aspect of this project was to increase knowledge and understanding with regard to the possibilities of use and potentials of integration of each countries vegetation maps into a single common fire risk system.

Four of the participating six countries have mapped vegetation in their countries. As it was identified during the project, Estonia, Latvia and Poland have collected detailed information about their vegetation. The inventory methods are however different in each respective country. In some cases the inventory is not done with the purpose of being used for fire management, but rather for forest management. In the case of a common fire spread model, standard fuel types need to be established i.e. standard inventory methods to acquire information about the vegetation, which will be classified into fuel types after being systematically verified.

None of the countries have classified their vegetation into fuel types (i.e. verified how the differentiated vegetation acts as fuel and contribute to the fire behaviour in relation to the fire environment).

To receive reliable information about vegetation and fuel types over a large area like this, means extensive costs, but with new technology and cost sharing the investment will be more cost effective.



**A fire management system consists of two parts: firstly, a fire danger rating system is adapted to local conditions and, secondly, it should be combined with a training program to obtain highly qualified and experienced fire managers. Task E of the project 14.3 inquired into the first of these two parts and was a very important step forward in the process of achieving a reliable fire danger rating and management system. The result will be a system that will always need further additions and improvements. This will require continued research, empirical data and tests from the field for its continued developments.**

EFFIS is the existing fire danger rating system (based on the FWI System) which has been used in all of Europe for the last six years. This system works today on a large scale and does not give detailed information. It, however, gives daily fire danger maps that cover all Europe. Participants from the project 14.3 suggested a deeper introduction and utilization of EFFIS fire danger maps to expand the application of an already existing common system. It was also suggested that further development of this system could be a possibility to quantitatively predict fire behaviour, including the rate of spread. In the CFFDRS certain output components of the FWI System serve as inputs in the FBP System, which leads to quantitative outputs of fire behaviour for specific fuel types. The FBP System approach or framework allows for adaptation, which has been done in other countries with severe fire problems such as New Zealand (Fogarty et al. 1998). Similarities between the boreal forests of Canada and northern Europe also support a further evaluation of the applicability of using the CFFDRS in the Baltic Sea region.

# Conclusions

Each one of the six countries that participated in Task E activities has a fire risk system that, in some way, is correlated to the preparedness of the responsible organisation. There are some differences in input data, but all systems are based on weather information and the output information highlights dry conditions. Four of six participating countries also have mapped their vegetation and three of them are using their classified vegetation as a factor in the fire risk system. All the systems are used for different purposes and by many different levels of society - the participants expressed positive experiences from many different users. However, none of the risk systems used today includes weather, topography and fuel i.e., none of the participant countries have a fire danger rating system or fire growth models that can be used to predict fire behaviour at landscape level.

A unified fire danger rating system is an important part of fire management and if introduced in the Baltic Sea region, advantages are expected.

## By introducing a common fire risk system and a fire spread model in the Baltic Sea region expected advantages are, among others:

- a common means of communication,
- prevention and preparedness on a large geographical basis,
- shared resources and expenses.

To run a fire spread model more factors in the fire environment have to be included. Mapping all vegetation and classifying them into verified fuel types would be necessary, together with topographic maps. When using a system that is based largely on weather information, all countries would have to adhere to standards for weather observations (Lawson and Armitage 2008).
Since all of the participating countries are using different risk systems today, it might be possible to use one of those systems, develop a system anew or adopt another existing system. If the Baltic Sea region were to adopt an existing fire danger rating system, deeper analyses and tests would have to be done in order to be able to determine which one is the most applicable for the region. Currently, EFFIS generates daily fire danger maps based on the Canadian FWI System. By using this information the countries have available data for the daily fire danger on a large scale. It would be possible to apply the same system in a more detailed version as a common risk system. The Canadian FWI System forms the basis for a larger CFFDRS that has been adopted in whole or in part by other countries. This means that

an evaluation of its suitability to the conditions found in the Baltic Sea region is an opportunity. The fire spread model that is under development in Poland should also be evaluated for all parts of the Baltic Sea region. It would be cost-effective to learn from other countries that have gone through the implementation process.

In the process of collecting data to be used for simulation for previous instances of wildland fires it has been shown that the documentation about fire behaviour today is incomplete. It is not possible to make fire behaviour case studies or correct fire behaviour analyses based on available documentation. This information goes hand in hand with evaluations of suppression effectiveness and fire-fighter safety. Should all countries document their fire behaviour, it would be possible to analyse the behaviour and continuously improve the safety levels. Descriptions of how to produce wildland fire behaviour case studies and analyses are available (Alexander and Thomas, 2003). Each country should also evaluate their current training programs in wildland fire behaviour to ensure that the knowledge level matches each country's requirements.

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# APPENDIX

## Forest Fire Risk Systems Questionnaire for the EUSBSR Flagship Project 14.3 Task E Partners

# Guidelines for Completion and Submission

## Purpose of the questionnaire

The purpose of this questionnaire is to gather information about existing forest fire danger rating systems or risk management systems for forest fire or grass fire that are used by partners contributing to the work implemented by the Task E Work Group of the EUSBSR flagship project 14.3. All partners will complete and submit a copy of this questionnaire to the Leader of Task E, Swedish Civil Contingencies Agency (MSB). MSB will collect all completed questionnaires as well as the results from the Task E workshops and will produce a report documenting current forest fire danger rating systems and possibilities to develop a common system around the Baltic Sea region. The end report will be a key deliverable of Task E of the EUSBSR flagship project 14.3.

## Structure of the questionnaire

The questionnaire begins with questions about existing forest fire danger rating systems or risk management systems for forest fire or grass fire that are used in participating countries. It continues with questions about the need of developing a common system in the Baltic Sea region, as well as what possible advantages such a system may have.

## Completing and submitting the questionnaires

The partners are asked to provide the name and contact details of a person who can provide further information/clarification of the answers. Please consider that partners should supply names and contact details which can appear within the publicly available report.

# Forest Fire Questionnaire

Some of the questions can be answered by a yes or a no. Mark the answer with an x after yes or no. Other questions need longer answers. Fill in as much information as possible.

1

Date:

Country:

Organization:

Contact person:

2

What kind of forest fire danger rating system or risk management system for forest fire or grass fire do you use in your country? (Do you for example use Fire weather index (FWI) or Fire behavior prediction (FBP)?)

3

Which input data are needed in the system? Mark the answer with an x after yes or no.

| | | |
|---|---|---|
| Temperature? | Yes | No |
| Relative humidity? | Yes | No |
| Wind speed? | Yes | No |
| Wind direction? | Yes | No |
| Precipitation? | Yes | No |
| Topography? | Yes | No |
| Other? (Exemplify) | | |

4

| | | |
|---|---|---|
| Is vegetation incorporated in the system? | Yes | No |
| • Is the vegetation in the entire country mapped? | Yes | No |

5

How is the vegetation classified (e.g. by aerial photos, satellite analysis, field inventory)?

6

What are the vegetation classes based on?

How many classes do you use?

Which classed do you use (list the different classes)?

In which resolution is the vegetation classified?

**Forest Fire Questionnaire**

7

How do you classify mapped vegetation into different fuel classes?

8

Are any of the following fuels described in your system?

| | | |
|---|---|---|
| Ground fuel | Yes | No |
| Surface fuel | Yes | No |
| Ladder fuel | Yes | No |
| Crown fuel | Yes | No |

9

If answered yes on any of the above mentioned fuels describe how it is classified

10

Are fuel structure, composition or site conditions included in your system?

Yes No

11

If vegetation is not incorporated in the forest fire danger rating system, is there any other information or database available to classify the vegetation into different fuel classes?

12

If vegetation is not incorporated in the forest fire danger rating system, what are the classes based on?

How many classes do you use?

Which classes do you use (list the different classes)?

13

How is/are the system/systems used today?



**Forest Fire Questionnaire**

14

During which period/periods of the year is/are the system used?

15

Do you include sources of ignition in your risk assessment on forest fire?

16

If you include ignition in your risk assessment on forest fire, how do you receive information about high risk of ignition?

17

Which kind of organizations uses the system?

| | | |
|---|---|---|
| Is it used at national level? | Yes | No |
| Is it used at regional level? | Yes | No |
| Is it used at local level? | Yes | No |

18

How is the system used by different actors?

19

What are the experiences of using the system?

20

Are there any needs or possibilities for developments of the system?

21

Does your country see any need of developing a common system in the Baltic Sea area?

22

What can be the benefit of a common system?

## Forest Fire Questionnaire

23 Which developments do you think are needed in your country in order to develop a common system?

24 Which developments do you think are needed in the Baltic Sea region in order to develop a common system?

25 What are the demands of a common system?

26 What is needed to develop a fire spread model and a risk management tool?

27 What advantages do you think a fire spread model program could have for your country?

28 Do you have any available fire data in your country from major past fires that can be used for demonstration during workshop 2? (including information about cause, size, time and area)

29 Contact details of person (s) who can provide further information/clarification of the answers

Name(s)

Organization (s)

Email address (es)

Postal address (es)

Notes

This publication was conceived as part of the EU Strategy for the Baltic Sea Region EUSBSR Flagship Project 14.3 (January 2012 – June 2013); the project aimed to develop macro-regional risk scenarios and, based on their analysis, to identify capacity gaps in Baltic Sea region preparedness to cope with potential risks on macro-regional level.

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Norwegian Directorate for Civil Protection and Emergency Planning (DSB)
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