

A Leitbild-based strategy for the development of railway vegetation with special consideration of treefall risk and nature conservation

I. Introduction

About 70 % of railroads in Germany are lined by trees^[1]. During storms, trees can uproot, fall, and potentially result in operational restrictions of train traffic. DB Netz AG is responsible for traffic safety on 33 400 km of railroads in Germany^[2] including the prevention of treefall. As part of the "This is green." initiative, Deutsche Bahn AG is committed to nature conservation and environmental protection^[3]. For this reason, vegetation management should not only ensure traffic safety but also contribute to nature conservation.

Research Question:

How can the vegetation management of DB Netz AG be refined to further decrease risk of treefall as well as increase the value of railway vegetation for nature conservation efforts?

II. Methods

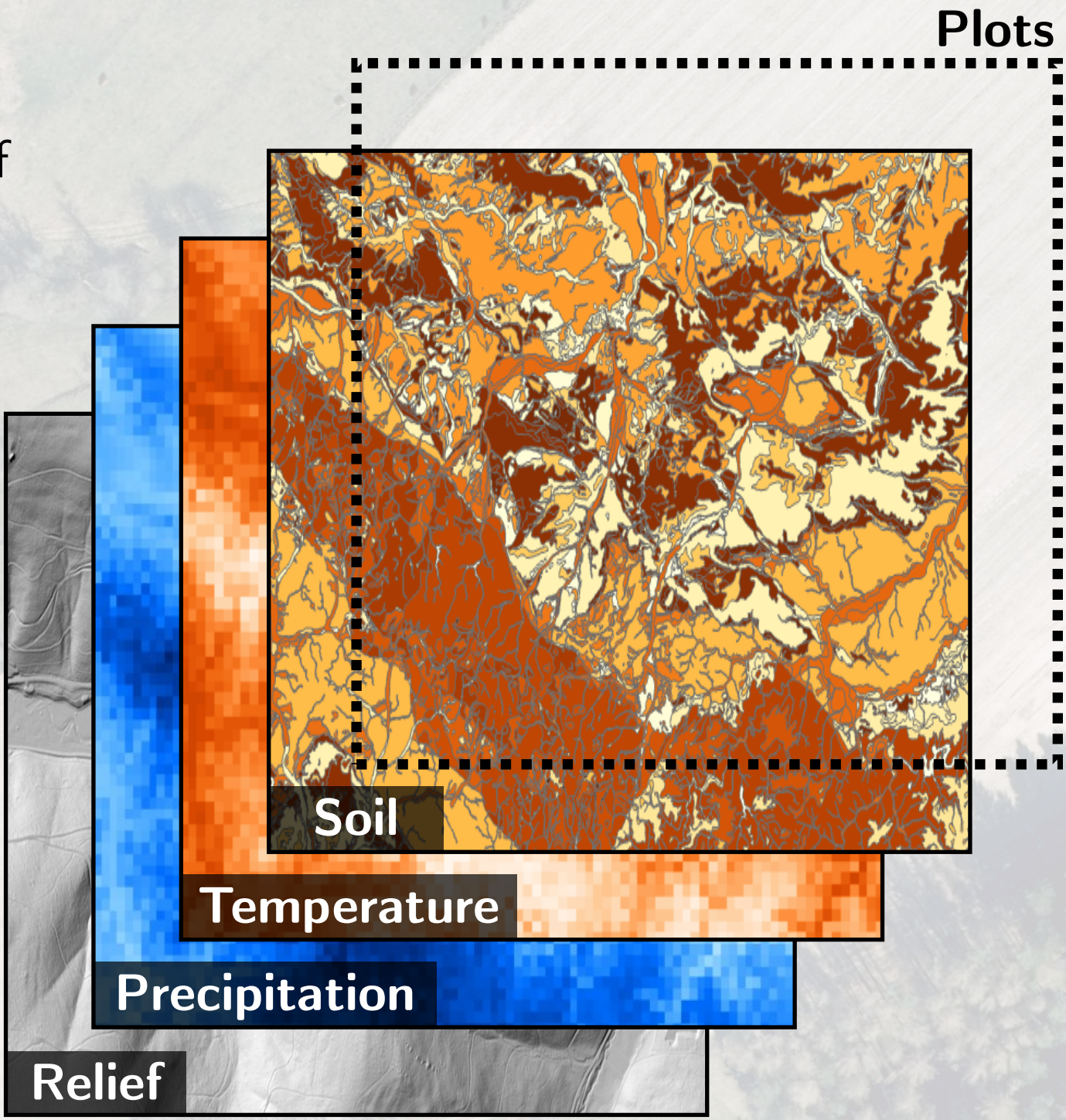
Focus of this study is the development of methods to identify ecological site types and to classify risk of treefall along railway tracks on the basis of widely available and free geodata. This ensures the applicability of the developed methods on a wide range of regions in Germany. The methods were tested on the Erfurt rail network in Thuringia (Germany). Additionally with the ArcGIS ModelBuilder a 110-step-model was developed to perform most parts of these methods automatically.

Data

The following data sets were used for the identification of ecological site types and the classification of treefall risk.

- Raster Data:**
- DTM (spatial resolution 1m x 1m)
 - Vegetation height (spatial resolution 0.8m x 0.8m)
 - Multi-annual mean of precipitation in mm (1991-2020) (spatial resolution 1km x 1km)
 - Multi-annual mean of air temperature in °C (1991-2020) (spatial resolution 1km x 1km)

- Vector Data:**
- Active Railways
 - Soil types
 - Classified vegetation risk
 - Potential natural vegetation



Identification of ecological site types

For the ecological site type identification and treefall risk classification 81 000 plots each with an area of 1 000 m² were generated along the railways. Statistics were calculated for the area of each plot. That way each plot represents a data point that can be analyzed further. 48 individual site types were identified that subsequently were aggregated to 4 site groups.

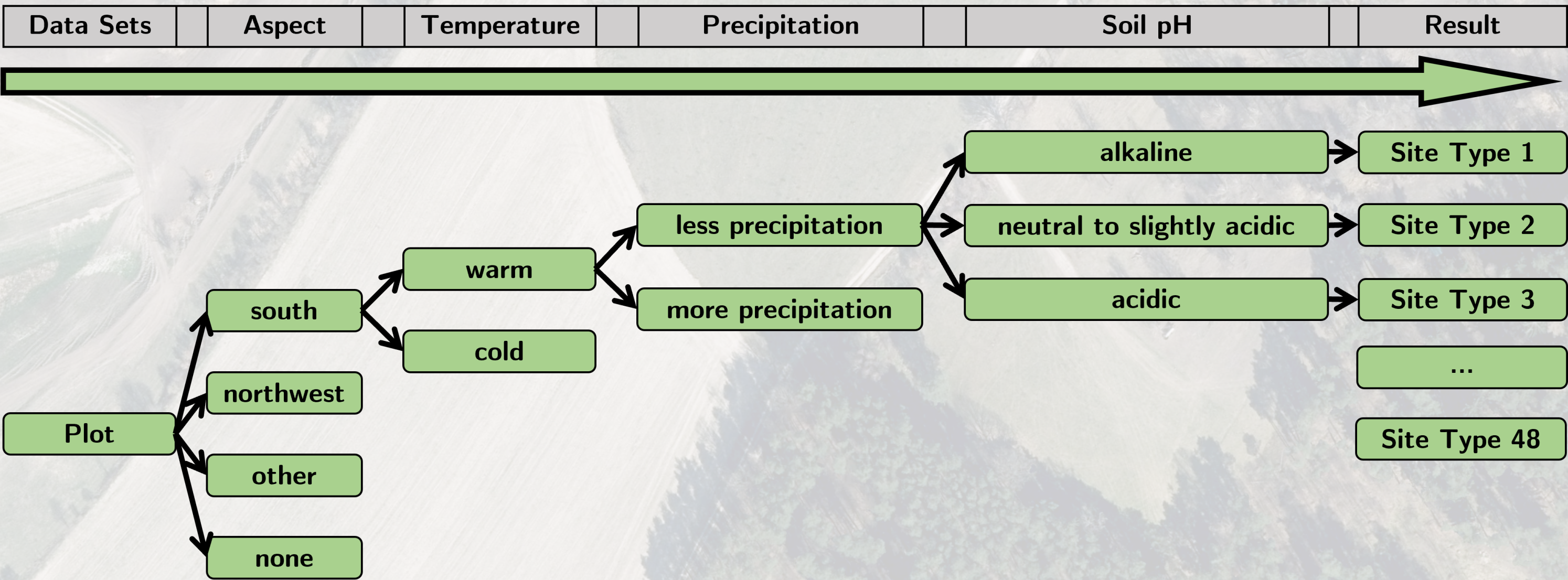


Figure 1: Decision tree for the classification of ecological site types

Classification of treefall risk

Similar to the ecological site types the treefall risk was derived for every plot. The "Overall Risk" of treefall at every plot can be described as the product of the "Site Risk" (determined by the site conditions) and the "Weighted Vegetation Risk" (determined by the vegetation structure). The overall risk is quantified by assigning point values for each plot. The assigned point values range between 0 and 100 points. The higher the point value the higher the risk. 4 risk classes were defined.

Overall Risk	Product of Weighted Vegetation Risk and Site Risk	
Site Risk	Sum of Base Risk and Sub-Risks	
Base Risk	1 point	
Sub-Risk - Soil conditions	favorable conditions 0 points	unfavorable conditions - 2 points
Sub-Risk - Relief	no slope - 0 points	moderate to steep slope - 1 point
Sub-Risk - Aspect	other - 0 points	west - 1 point
Weighted Vegetation Risk	Product of Vegetation Risk and weighting factor	
Vegetation Risk	1-10 points	
weighting factor	slope not in direction of railway - x1	slope in direction of railway - x2

Table 1: Key for calculating the overall risk of treefall

III. Results

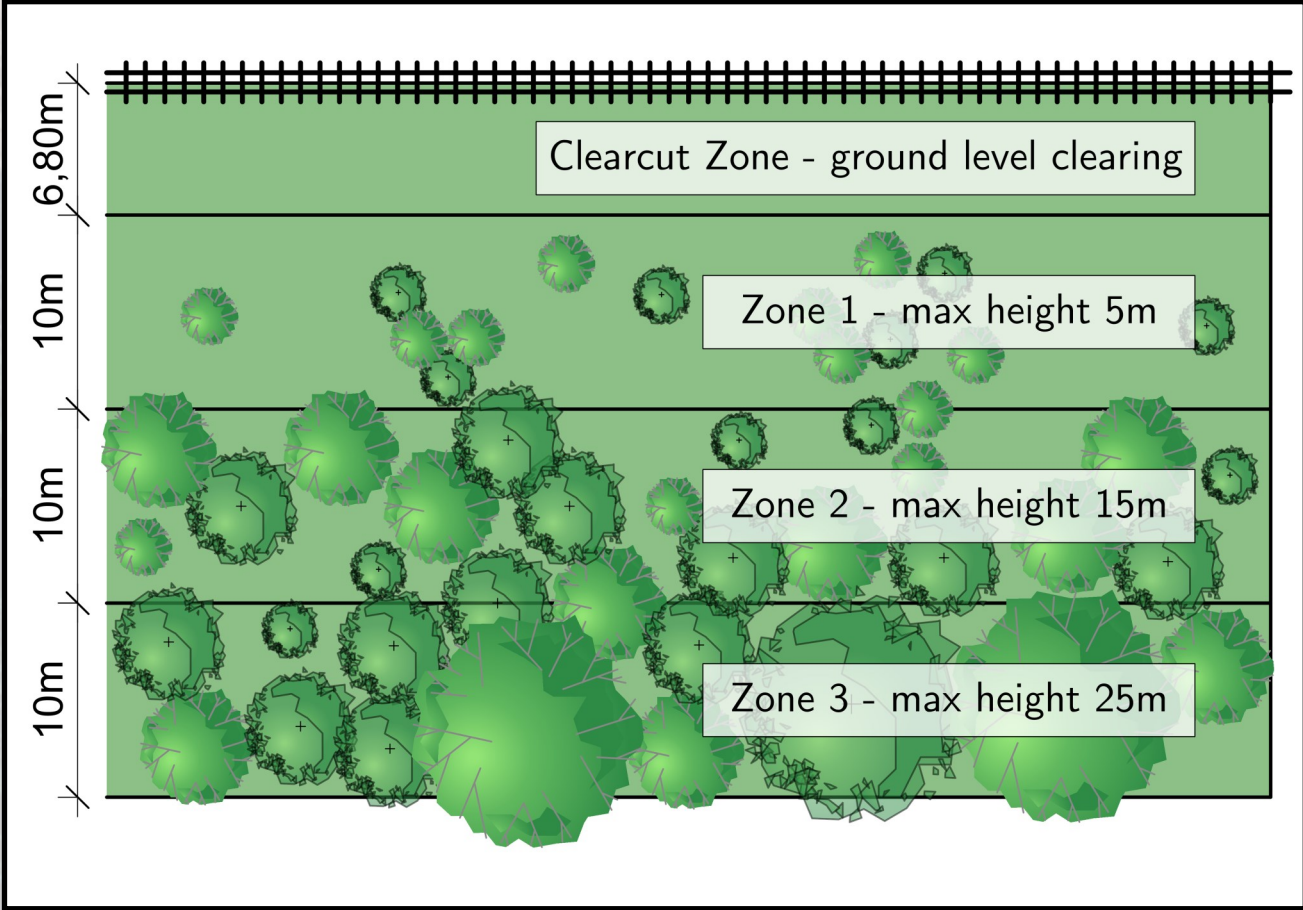
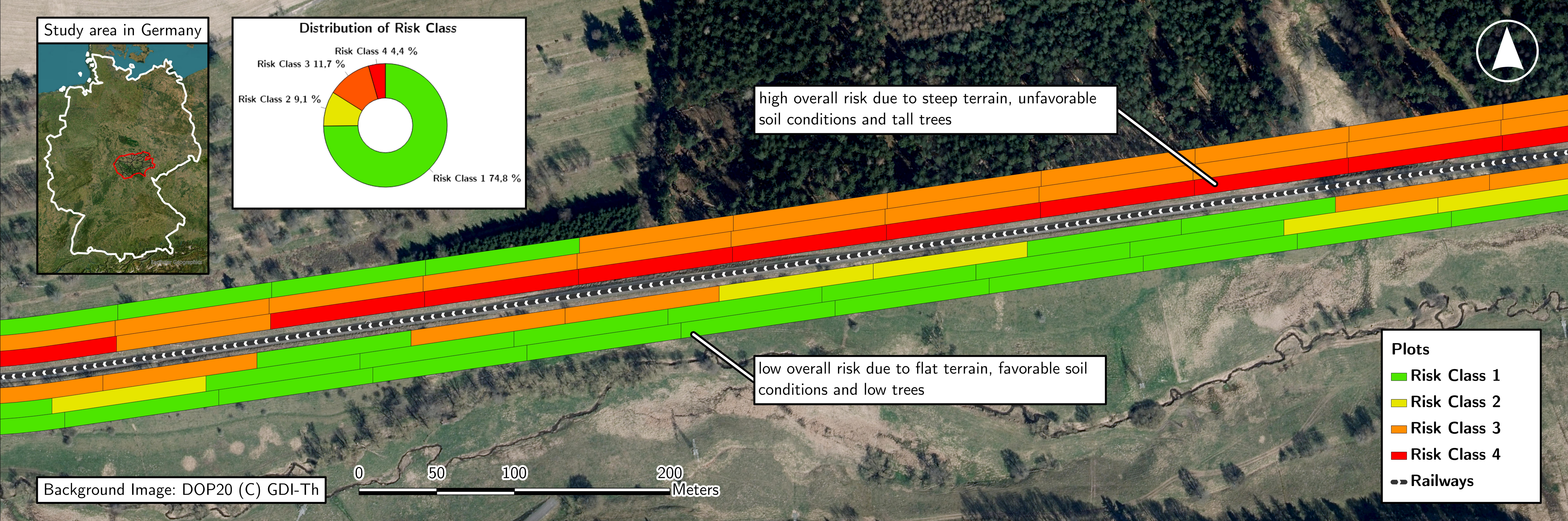


Figure 2: Schematic Leitbild for the structure of forest edges with edges with high nature value

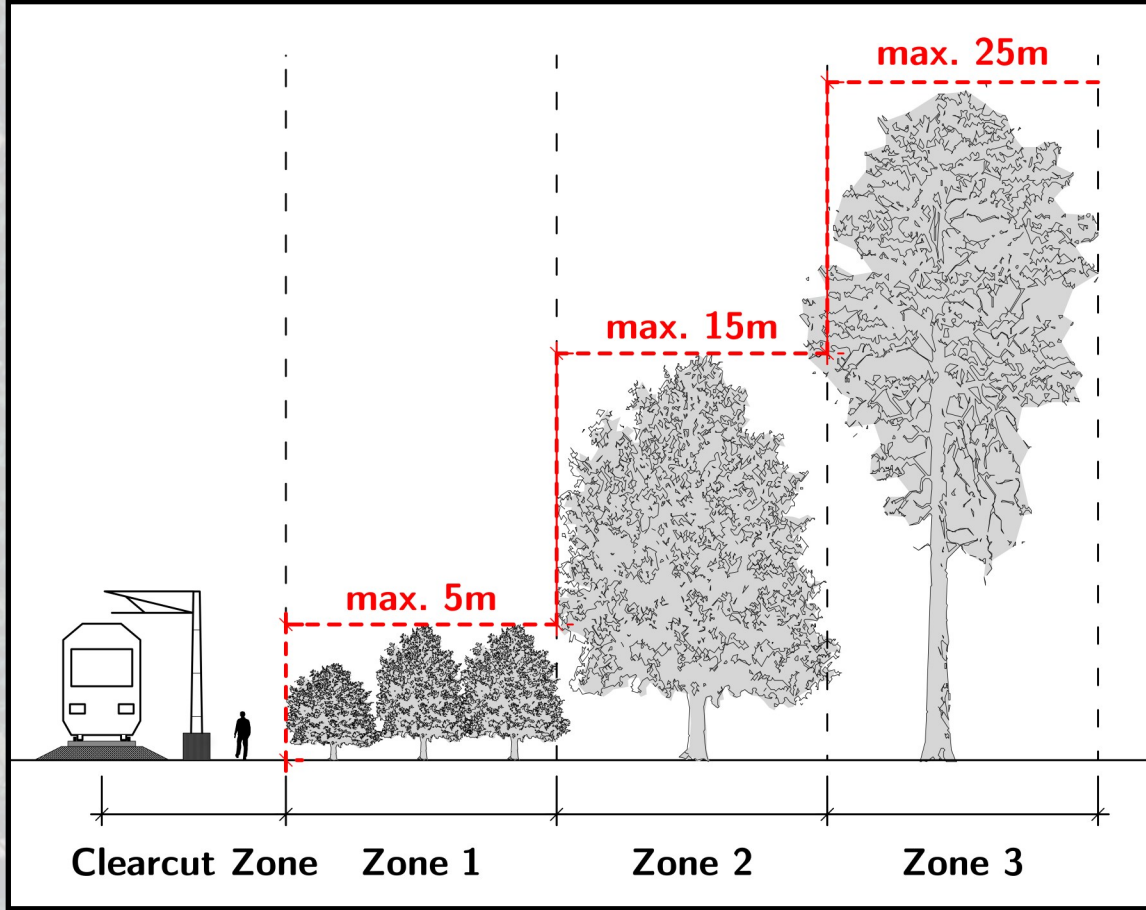


Figure 3: Stepped vegetation profile of forest edges with maximum permissible heights for high traffic safety

Literature

- [1] Felix Gerhardt (2022): Vegetation an der Bahn. Inspektion, Baumstürze & der §24 AEG. Aachen [2] Deutsche Bahn AG (2022): Deutsche Bahn. Daten und Fakten 2021 [3] Deutsche Bahn AG (o. J.): Grüne Transformation - Naturschutz [4] Finck P., Heinze S. et al. (2017): Rote Liste der gefährdeten Biotoptypen Deutschlands. Bundesamt für Naturschutz; BfN-Schriftenvertrieb - Leserservice - im Landwirtschaftsverlag GmbH. Bonn - Bad Godesberg: 637 S.

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