Hydrological and Environmental Processes in Railways: Towards Sustainable Drainage System (Suds) Approaches

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1. Introduction

The poor performance of the drainage network results in delays and disruptions for the customers and also leads to additional maintenance and renewal costs for the railway infrastructure owners. Moreover, more frequent drainage failures, and therefore flooding events in rail track infrastructure, are likely to increase in the substandard drains due to climate change and fouling ballast.

This project will address the increasing disconnection between storm water management practices in railways and the current legislation on flood prevention and water quality protection.

***Figures 1,2, and 3**: Different flooding and disruptions in railways in the UK (Network Rail, 2014)*

2. Background

Findings from the literature review:

- Lack of empirical data.
- Most countries rely on the same drain design applied to highways or agricultural lands (UK).

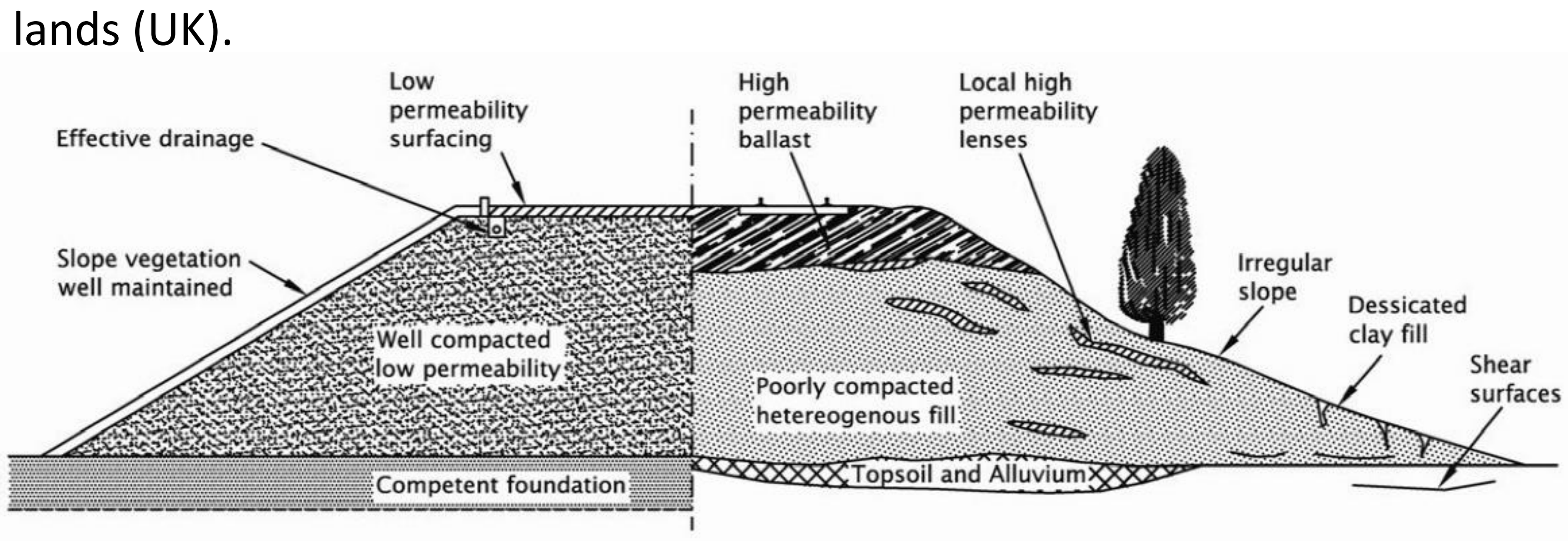

***Figure 4**: differences between railway and highway embankments (Briggs et al. 2016)*

- Poor understanding of the hydrological and environmental processes involved in railways.

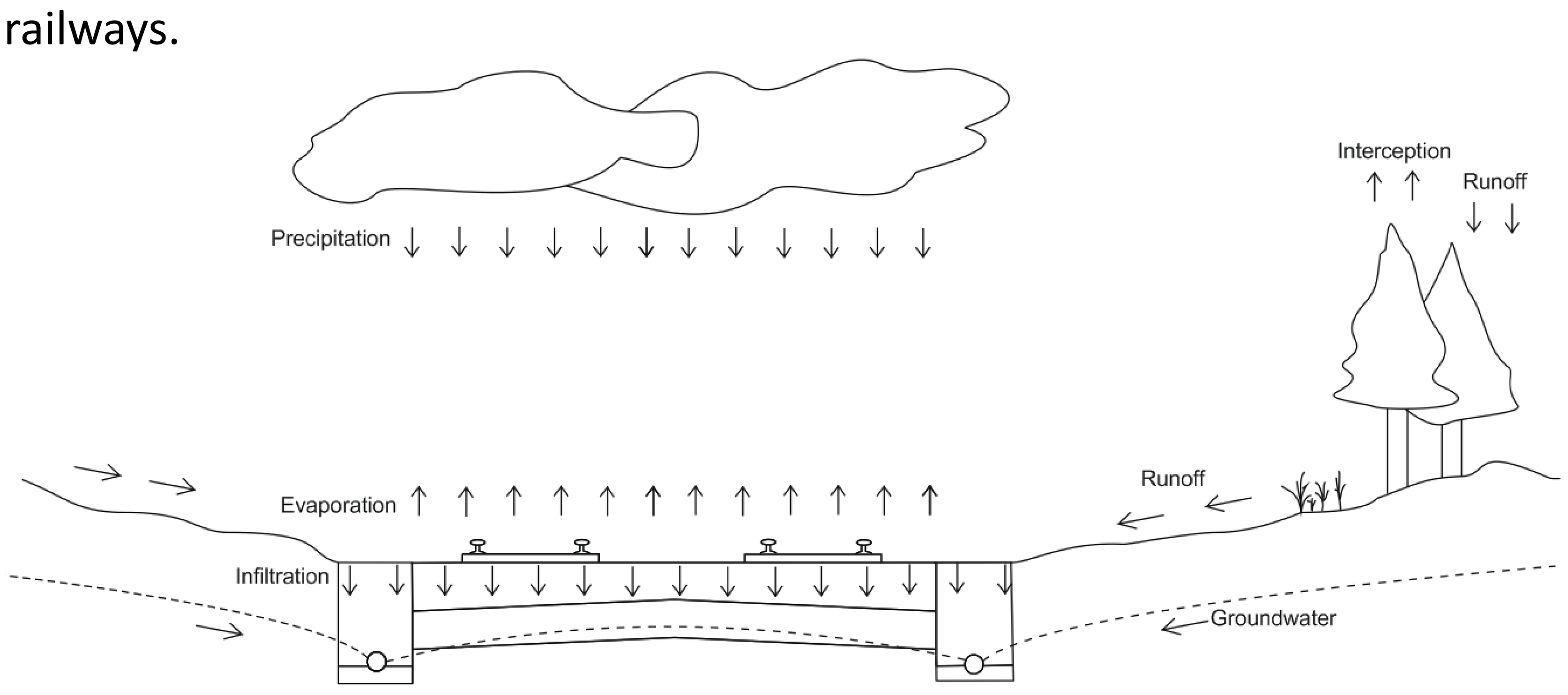

***Figure 5:** Hydrological processes in rail tracks (Briggs, 2012)*

- Lack of awareness of the water quantity and quality impact due to railway transportation.

***Table 1:** Accumulated emissions of the most important pollutants in the entire Swiss Railways SBB (Burkhardt et al. 2008)*

Substance	Emission		Pollution source
	t/y	g/km	
Iron	2176	302,000	Braces, rails, wheels
Copper	46.6	6480	Contact lines, brakes
Zinc	19.8	2750	Galvanisation
Manganese	15.5	2170	GG-brakes, rails, wheels
Chromium	6.9	960	Rails, GG-Brakes
Nickel	0.4	50	Wheels
Vanadium	0.06	8.5	Wheels
Lead	0.003	0.5	S-brakes
Antimony	0.003	0.5	S-brakes
Cadmium	0.002	0.3	Galvanisation
Binder	21	2900	C-brakes
Hydrocarbons	1357	176,800	Wooden sleepers, loss lubrication, track-switches, wheel flange
Glyphosate	3.9	540	Vegetation control

3. Aim and Objectives

The aim of this research is to investigate **the hydrological and environmental processes in railways** with the final goal of revising the current drainage design methods **assessing the potential for sustainable approaches (SuDS)**.

The objectives of this project are:

- To collect hydrological, hydraulic and runoff quality from railway areas.
- To simulate the hydrological and hydraulic responses in railway tracks and assess the potential causes of flooding by using numerical models.
- To assess the implementation of SuDS for the improvement of water quality and quantity in the railway environment.

4. Methodology

- The current design criteria applied in the railway sector will be critically reviewed
- Existing commercial hydrological and hydraulic model will be assessed (MicroDrainage) for drainage design.
- Preliminary results are being obtained using previous London Underground Drainage surveys as input for the hydrological and drainage design models

***Figures 5,6,7**: Trial pit investigations (London Underground)*

- A monitoring program will be implemented for hydrological, hydraulic and water quality data collection. A potential site was identified and will be the object of a detailed on site survey. This survey will provide information about the quality of the discharge as well as be used as an input for the models.

***Table 2**: Soil hydraulic characterisation*

Subsurface Hydraulic Parameters
Soil layer thickness
Soil layer depth
Saturated hydraulic conductivity
Specific Storage
Van Genuchten Parameters
Porosity

***Table 3**: Meteorological information needed*

Meteorological data
Rainfall
Evapotranspiration

***Table 4**: Drainage system characterisation at the monitoring station*

Drainage characterisation
Pipe invert level
Catchpit cover level
Spacing between drains
Distance from the surface to the impermeable layer
Initial depth to water table
Pipe gradient

***Table 5:** Drain runoff characterisation in railway areas*

Track drained wastewater characterisation
pH
Temperature
Turbidity
Fe, Mn, Cr, Cu, Ni, Mb, Va, Pb, Sb, Cd
TN
TP
TSS
COD
BOD

- The data collected will support the calibration and validation of the model currently used in the industry (MicroDrainage) and an integrated, physically based and distributed model able to simulate surface and subsurface flow processes (CATHY).
- A sensitivity analysis will be performed in order to address the deterioration of the track bed materials.
- The model will be used to assess the current performance of the railway drainage and it will be used to evaluate alternative approaches, i.e. SuDS. The model will be applied using historical rainfall data and 30 years rainfall projections (e.g. UKCP 09).

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