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HYDROLOGICAL RISK AND ASSOCIATED SCOUR RISK
- CASE STUDY SENSITIVITY ANALYSIS -

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PRESENTATION OUTLINE

- **Introduction**
- **Case Study**
- **Hydrological Risk**
- **Scour Risk**
- **Sensitivity Analysis**

Introduction

Case Study

Hydrological Risk

Scour Risk

Sensitivity Analysis

Hydraulic Infrastructures Collapses

↓

Causes

↓

Levels of Risk

↓

Consequences

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Scour Risk

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Hydraulic Causes

- Floods;
- Scour; ⬅
- Hurricane;
- Ship collision.

Consequences

- Socio-economic disruption;
- Human fatalities;
- Increased greenhouse gas emissions resulting from detours and delays.

Levels of Risk

- From acceptable to unacceptable;
- Depends on the bridge’s typology, importance and dimensions as well as on the consequences of its possible collapse, including possible material damage and loss of human lives.

- Collapse of the Entre-os-Rios bridge, over Douro river, Portugal;
- Cause: Persistence of floods exceeding 8.000 m^3/s - scouring around its foundation.
- Consequences: Loss of 59 human lives; Traffic disruption; Construction of a new crossing.

- New Hintze Ribeiro bridge (May, 2002).
- Built 7.5 m upstream of the old bridge's position.
- The new bridge foundations have a pile-supported piers geometry.

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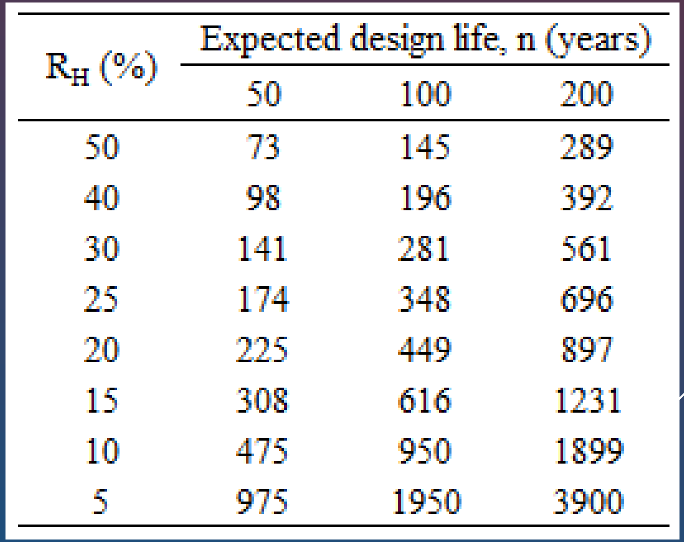
Hydrological risk is defined as the probability of occurrence of an event (i.e.: floods) at least once over a period of n successive years.

Return Period (T)

Design Life (n)

Hydrological Risk (R_H)

$$R_H = P(x \geq x_T) = 1 - \left(1 - \frac{1}{T}\right)^n$$



R_H (%)	Expected design life, n (years)		
	50	100	200
50	73	145	289
40	98	196	392
30	141	281	561
25	174	348	696
20	225	449	897
15	308	616	1231
10	475	950	1899
5	975	1950	3900

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Scour risk rating

(Highways Agency, 2012[1])

Relative Scour (D_R)
$D_R = D_T / D_F$

Priority factor (P_f)
$P_f = FHMT_RV$

- D_T - Total depth of scour, calculated for each design flood and associated return period;
- D_F - Foundation depth.

- F - Foundation type factor;
- H -History of scour problem factor;
- M - Foundation material factor;
- T_R - Type of river factor;
- V - Importance factor.

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[1] *Highways Agency. (2012). The assessment of scour and other hydraulic actions at highway structures. Design manual for roads and bridges, 3.*

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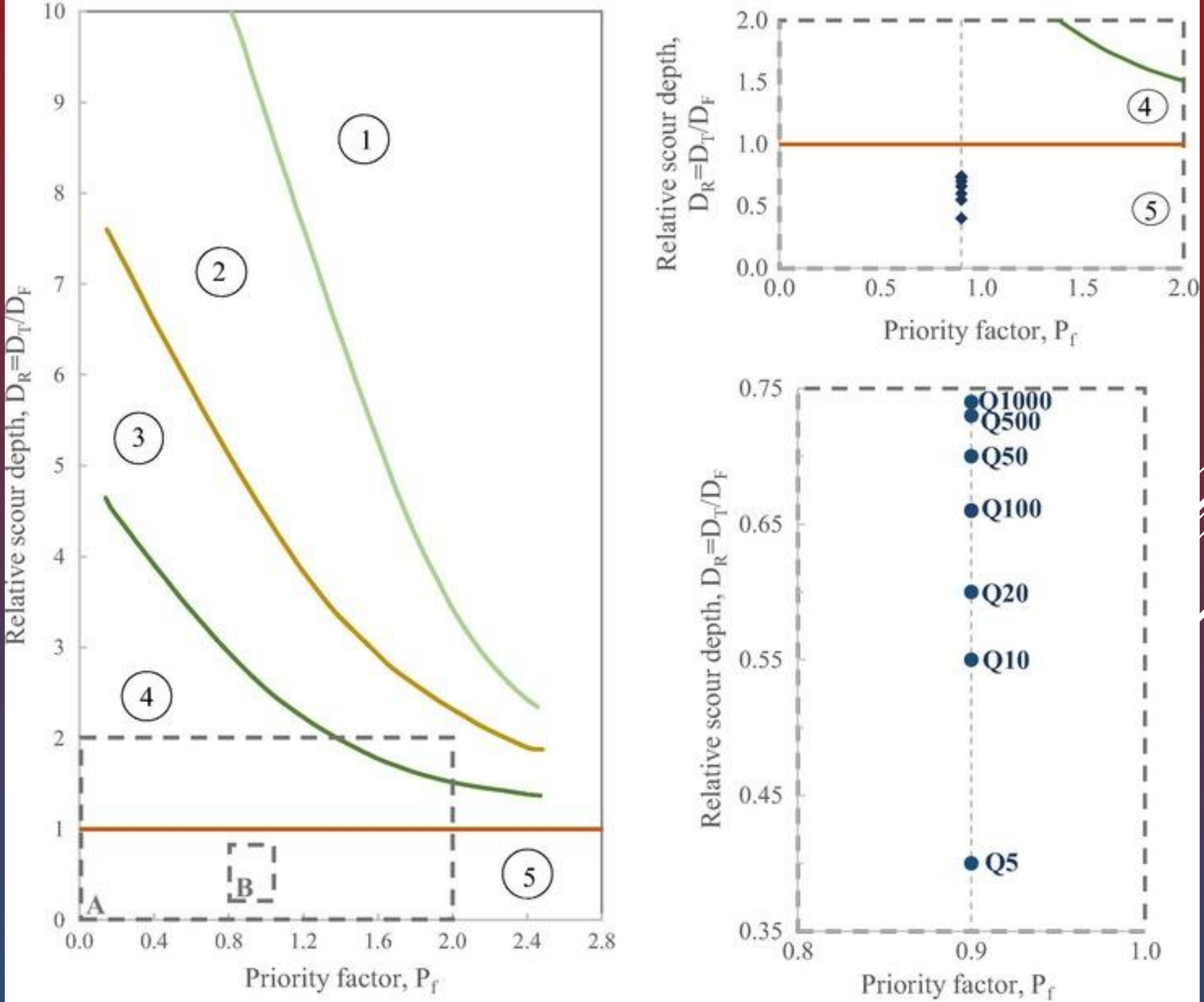
So…

- ➢ D_F=17m (IP, 2019);
- ➢ P_f=0.9 (calculated);
- ➢ T ranges between 5 and 1000 years;
- ➢ Design Floods (Statistical Method);
- ➢ D_T (HEC-RAS).



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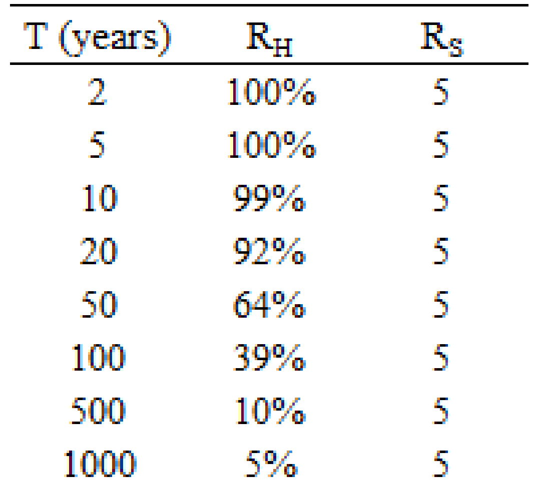
Hydrological Risk (R_H) ↔ Scour Risk (R_S)

Assuming n = 50 years



T (years)	R_H	R_S
2	100%	5
5	100%	5
10	99%	5
20	92%	5
50	64%	5
100	39%	5
500	10%	5
1000	5%	5

- A 100-year return period corresponds to a hydrological risk of 40%;
- A hydrological risk of 10% corresponds to a 500-year design flood;
- The level of risk does not depend on design life (n);
- R_H↓ Design Floods↑ R_S↑

While Q500 is associated with a lower hydrological risk, the water level regarding that design flood reaches the bridge deck, which adds other sources of instability in addition to the inherent scour risk.

THANK YOU FOR YOUR ATTENTION

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