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Asset Management

2nd IWA Leading-Edge Conference & Exhibition on

Strategic Asset Management

Sewer asset management: from visual inspection survey to dysfunction indicators

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indigau

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Sewer asset management: from visual inspection survey to dysfunction indicators

- Performance Assessment: sources of data
- From CCTV Inspections… to condition grades
- Dysfunction quantification versus expert's opinion
- Fixing thresholds: minimizing a cost function
- Discussion & perspectives

1 – Performance assessment

- Visual Inspections
- Network monitoring
- O&M data
- Data related to environment
- …

Segment

Catchment

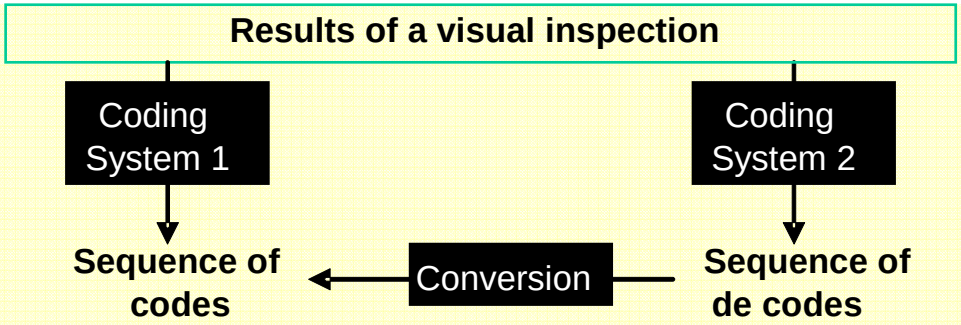
- Dysfunction indicators
  - Infiltration
  - Sand silting
  - Destabilization of the ground-pipe system
  - …
- Impact indicators
  - Surface water pollution
  - Damage to buildings
  - treatment plant operating surplus costs
  - …

- Criteria
  - Investigation
  - Rehabilitation

RERAU Program

2 – Focusing on CCTV inspections

1 – Inventory and coding of observations



2 – Synthesis

3 – Interpretation

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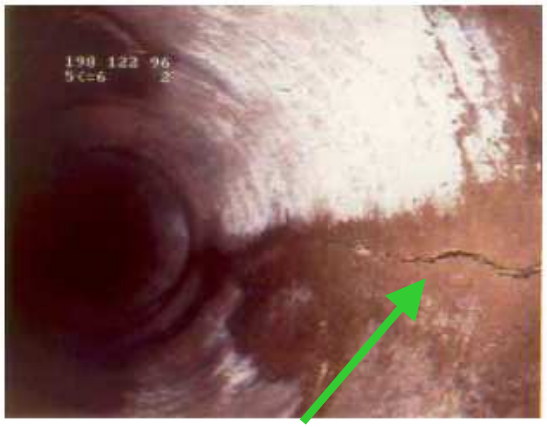
EN 13508-2 European coding system



BAB C A 03

Longitudinal fracture at 3 o'clock

BAC A … 11 02

Break between 11 and 02 o'clock

BAJ B

Displaced pipes

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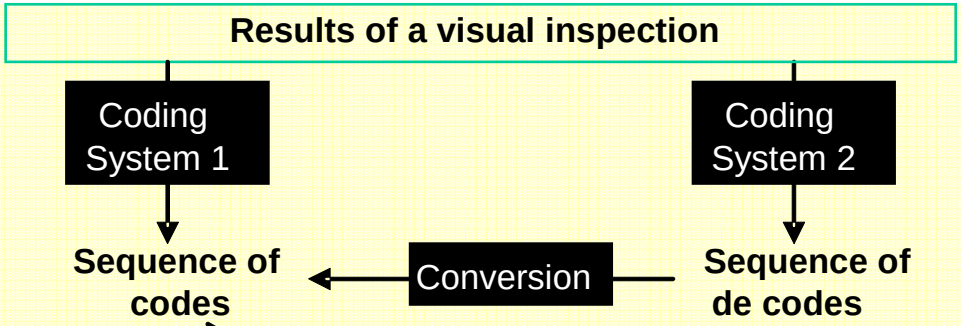
1 – Inventory and coding of observations



2 – Synthesis

Elementary score (for 1 obs.): $N_i = \alpha^n \times P \ (or \ L_i)$

INF4	*Seriousness*:	1	α	α²	α³	
Significance of disorder						*extend*
Fissure (crack, fracture):		BAB B	-	BAB C	-	L_obs
Break/collapse:		-	-	BAC A	BAC B/C	P
Defective connection:		-	-	BAH B/C/D	-	P
Soil visible through defect:		-	-	-	BAO	P
…						…

Example:
α = 3
P = 5 m
➔ BAH B = 45

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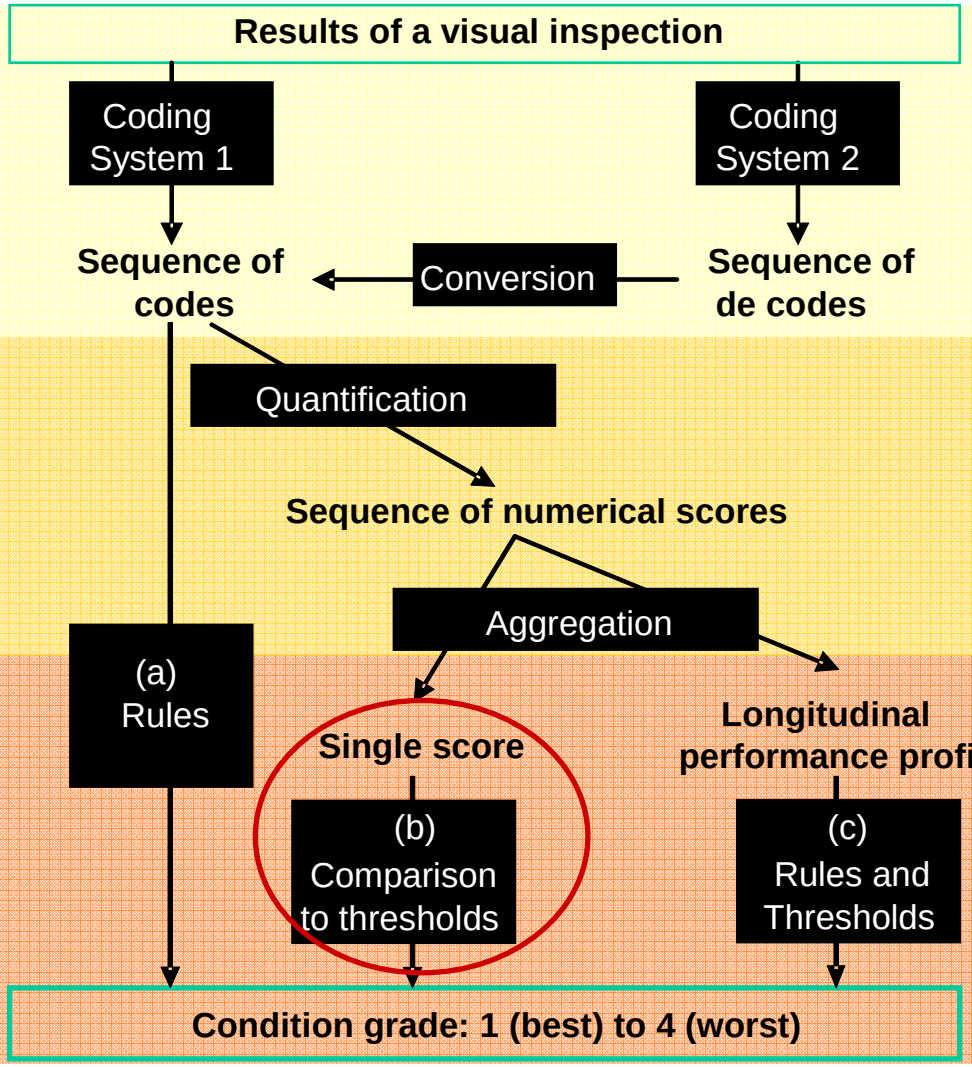
1 – Inventory and coding of observations

2 – Synthesis

3 – Interpretation

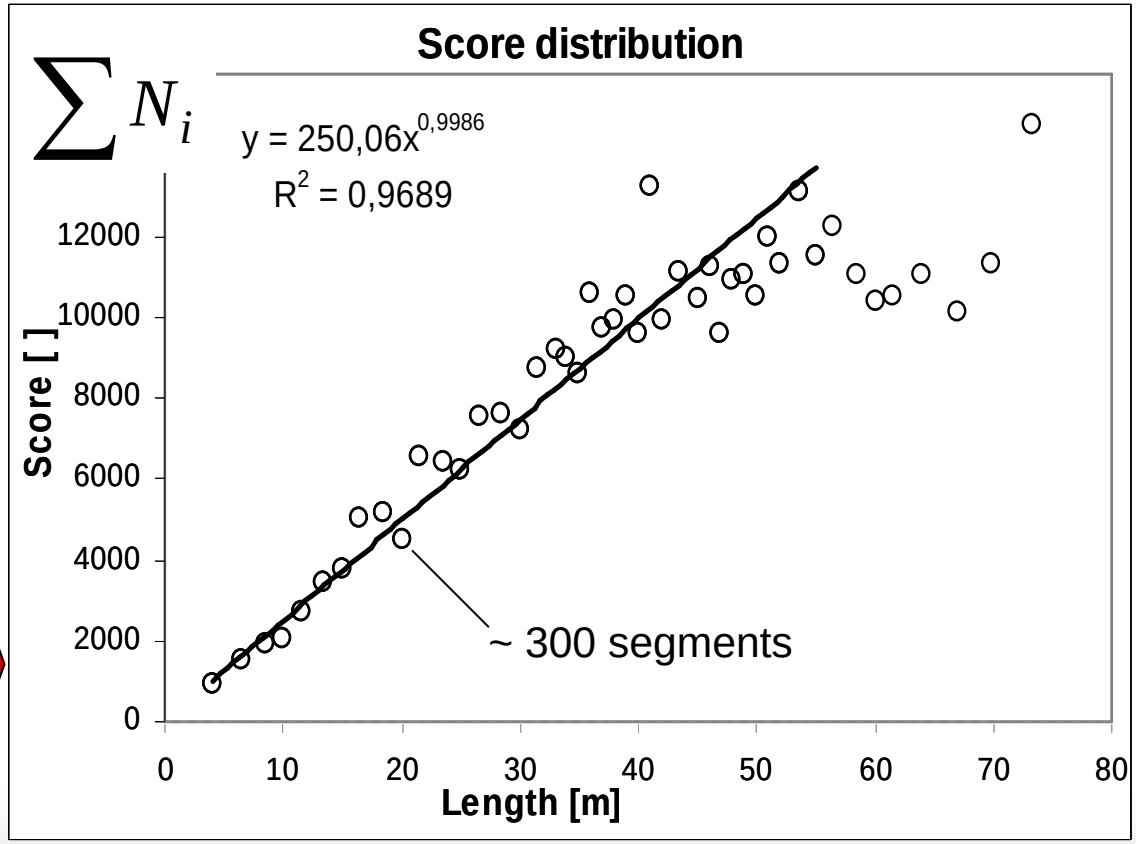


Single score: density of defects?

$$D = \sum N_i / LT$$ with LT: total length of the sewer segment [m]

Dysfunction: Infiltration (INF)

- Sewer networks of *Département du Bas-Rhin*
- Inventory of sewer networks carried out in 2003
- Analysis of CCTV results for ~ 15000 sewer segments



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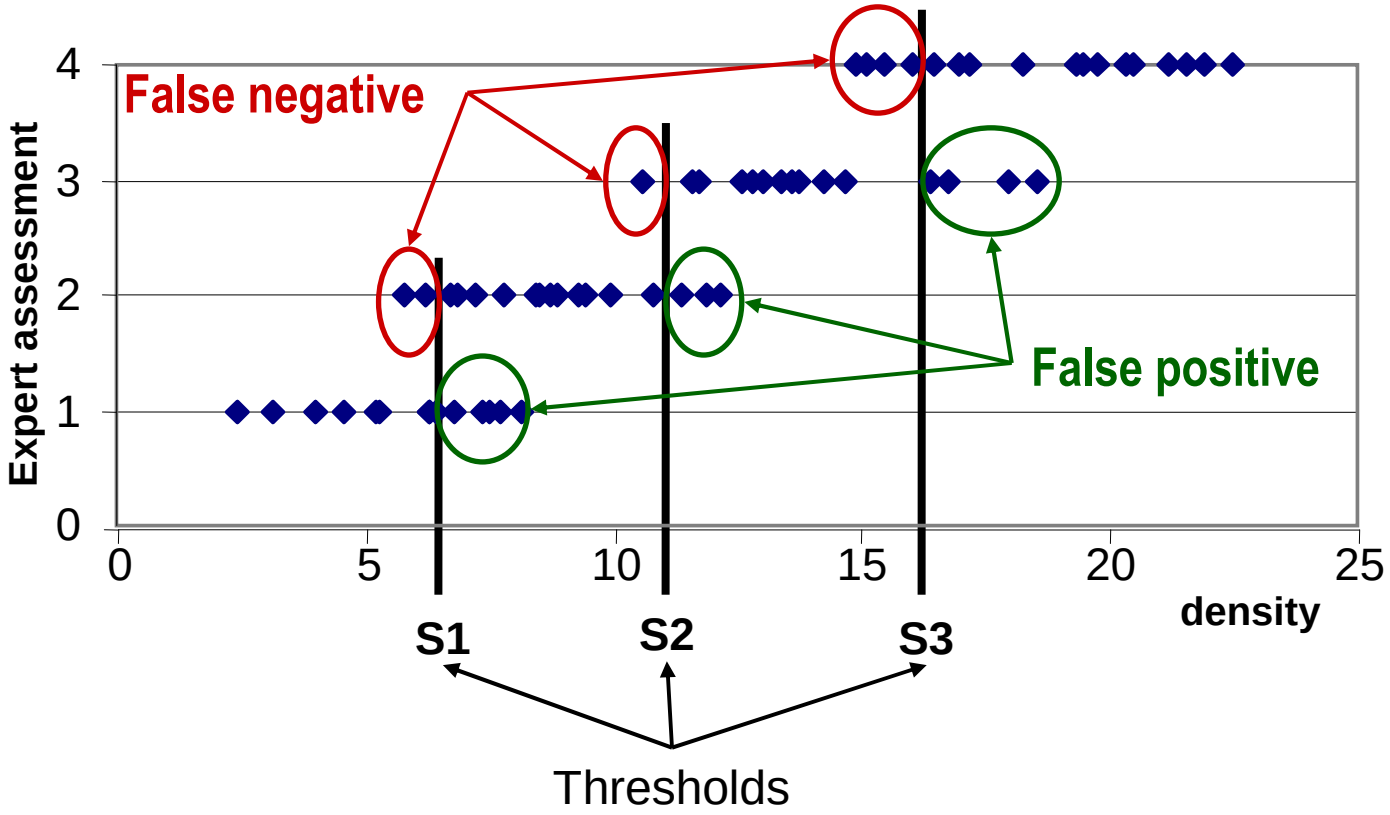
3 – Dysfunction quantification versus expert's opinion



- $D \leq S1$ ➔ *Grade 1*
- $S1 < D \leq S2$ ➔ *Grade 2*
- $S2 < D \leq S3$ ➔ *Grade 3*
- $D > S3$ ➔ *Grade 4*

Sewer networks of the *Département du Bas-Rhin*

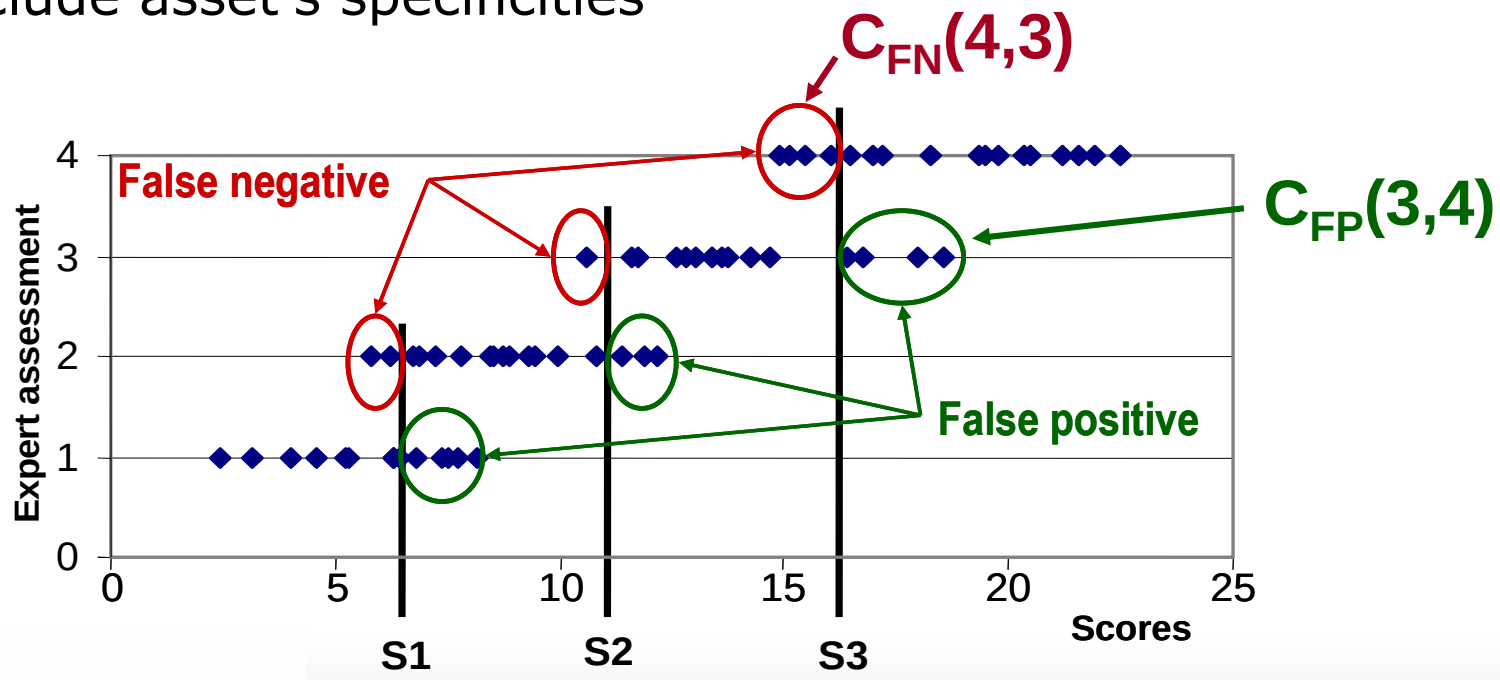
- Confrontation of grade classification based on expert's opinion and on calculations
- 6 indicators calculated for 13 sewer segments

$\alpha = 3$

Expert's opinion	Dysfunction quantified				
	1	2	3	4	Total
1	**26**	3	1	0	30
2	3	**3**	3	2	11
3	3	1	**4**	11	19
4	4	0	1	**13**	18
Total	36	7	9	26	78

4 – Fixing thresholds

- Objectives
  - Take into account both false positives and false negatives
  - Weight each type of error
  - Include asset's specificities



4 – Fixing thresholds: minimizing a cost function

$$C = \sum_{i=1}^{3}\left(\sum_{j=i+1}^{4} C_{FP}(i,j)P(C_j / E_i)P(E_i) \right) + \sum_{i=2}^{4}\left(\sum_{j=1}^{i-1} C_{FN}(i,j)P(C_j / E_i)P(E_i) \right)$$

Cost of a false positive i → j

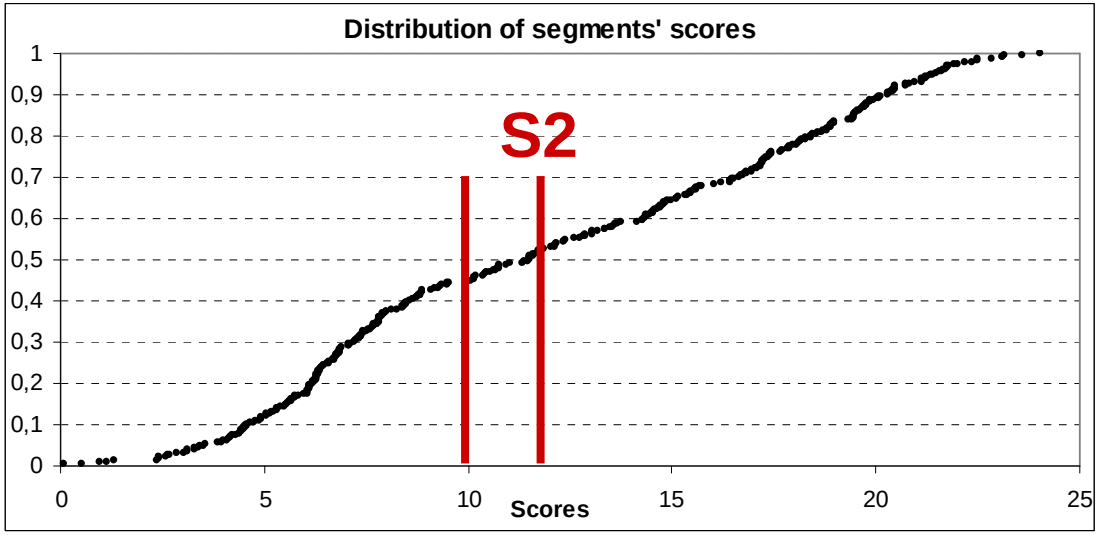
Cost of a false negative i → j

For a segment in state i (E_i): probability of being assigned to state j (C_j)

Probability that a segment is in state i (E_i)

(depending on the asset stock)

Illustration with 400 sewer segments



Expert's opinion	Dysfunction quantified					Dysfunction quantified					Dysfunction quantified			
	1	2	3	4		1	2	3	4		1	2	3	4
1	**0**	**1**	**1**	**1**		**0**	**1**	**1**	**1**		**0**	**1**	**1**	**1**
2	**1.5**	**0**	**1**	**1**		**3**	**0**	**1**	**1**		**5**	**0**	**1**	**1**
3	**1.5**	**1.5**	**0**	**1**		**3**	**3**	**0**	**1**		**5**	**5**	**0**	**1**
4	**1.5**	**1.5**	**1.5**	**0**		**3**	**3**	**3**	**0**		**5**	**5**	**5**	**0**
S1= 8.14 ; S2= 12.15										**S1 = 5.33 ; S2= 9.98**				

Discussion

- RERAU methodology successfully applied in Bas-Rhin (assessing dysfunction indicators from CCTV inspections)
- A calibration criterion: MC (Misclassification Cost) takes into account both "false negative" and "false positive" errors
- However…
  - Minimising errors at the scale of the whole asset stock
  - but important errors for some segments (→ a fuzzy approach on going)

The French INDIGAU Project (ANR – RGCU 2006)

INSA-Lyon LGCIE
G2C environment
LCPC – Env. & Water Div.
Cemagref-Engees GSP
Univ. Marne-la-Vallée

Caen-la-mer
Brest
Strasbourg
Bas-Rhin
Lyon
Lille
Nantes
Noisy-le-grand

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indicateurs de performance … for urban sewer asset management

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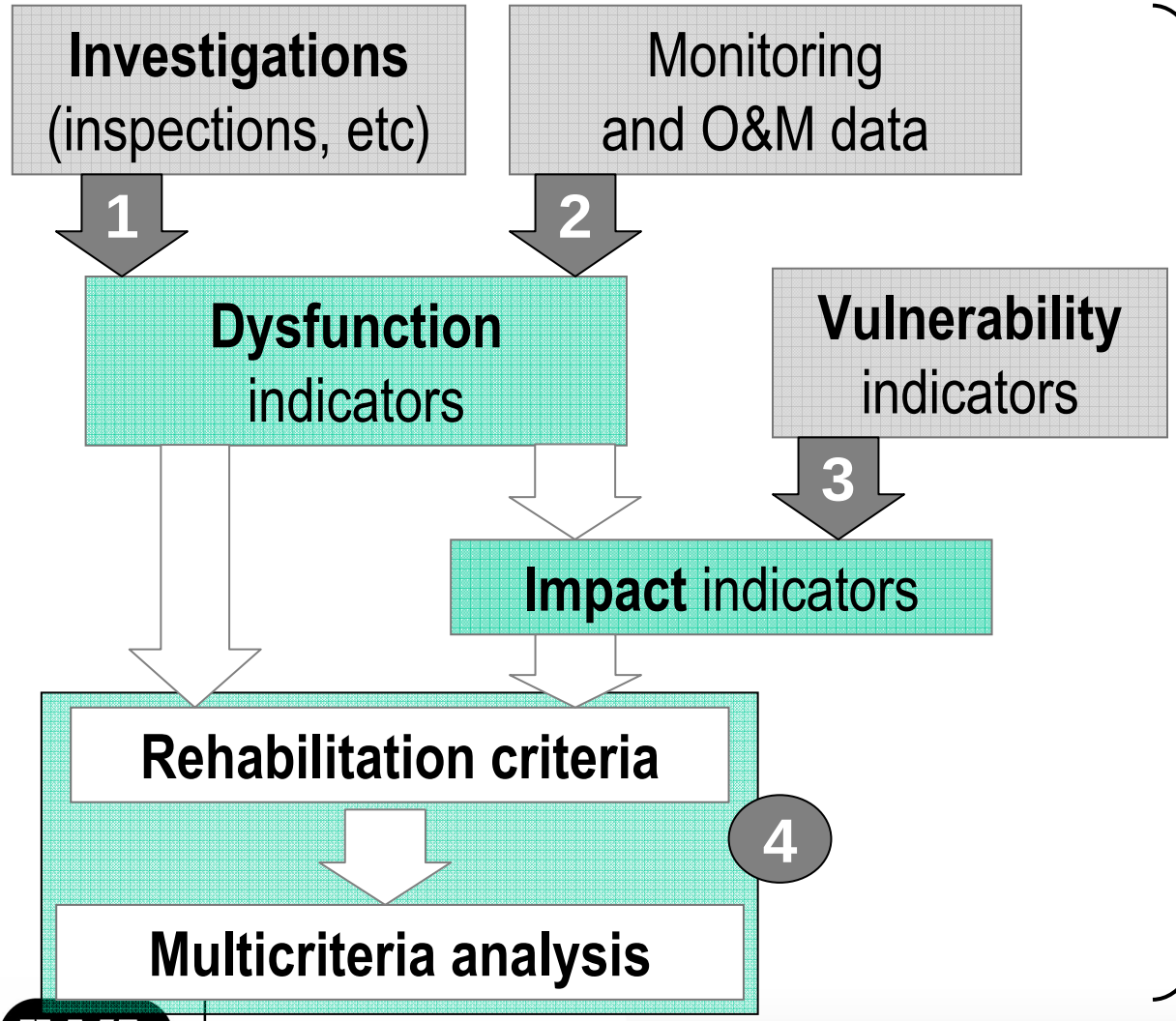
Thank you for your attention!

The INDIGAU Project Work Packages



5

Taking into account:
uncertain,
imprecise and/or
incomplete data

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