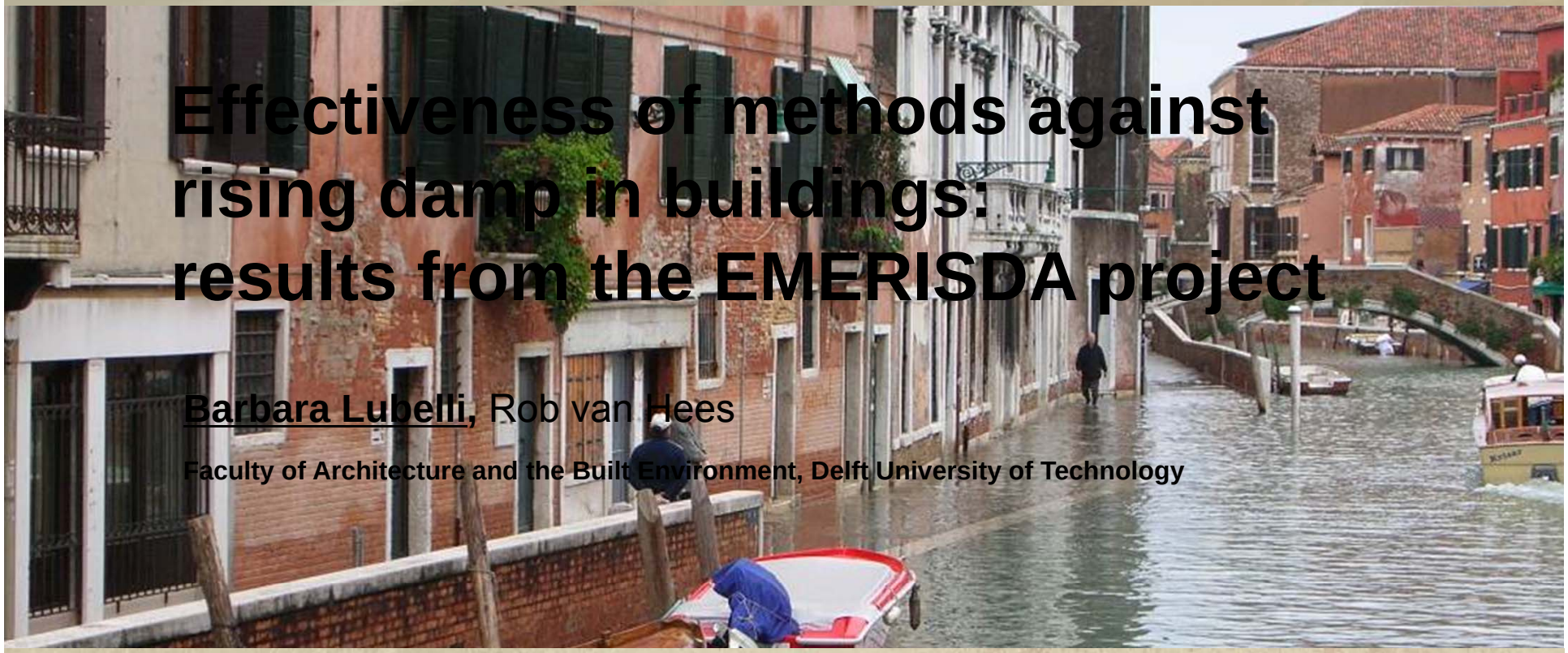
MOdihMA

MOisture detection in historic MAsonry



Effectiveness of methods against rising damp in buildings: results from the EMERISDA project

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PROBLEM

The rising damp problem

- Common problem in old buildings
- Many different solutions available
- No clarity about the effectiveness of solutions
  - Lack of scientific research
  - Difficulties in assessing effectiveness

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EMERISDA PROJECT

JPI Heritage Plus Pilot project (2014-2017)

"**E**ffectiveness of **me**thods against **ris**ing **da**mp in buildings: European practice and perspective".

Main aims of the project

- Evaluation of effectiveness of methods against rising damp
- Development of decision support tool for choosing suitable intervention

PARTNERS

Partners

- Belgian Building Research Institute – BE (coordinator)
- TU Delft, Fac. of Architecture and the Built Environment - NL
- Cultural Heritage Agency – NL
- CNR – ISAC – IT
- Ca' Foscari University, Venice – IT
- DIASEN – IT
- Restauri Speciali - IT

www.emerisda.eu

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RESEARCH APPROACH

Research approach

- Literature review & knowledge exchange on methods for
  - assessment of the presence of rising damp
  - evaluation of effectiveness of intervention

→ **Definition of procedure**

- Archive research and on-line questionnaire

→ **Overview of methods and their diffusion**
Survey of users' satisfaction

- Experimental research (scale models and case studies; chemical injection and "electrokinetic" methods)

→ **Assessment of effectiveness of methods**

↓

Decision support tool

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Experimental procedure

Criteria for choice of sampling locations

- at different depths and heights, along a vertical profile
- at places where rising damp is possibly present, but other sources are as much as possible excluded (e.g. interior wall with foundations)
- at damaged and undamaged locations

Measurements

$$\text{MC} = 100 \times \frac{(\text{initial weight} - \text{dry weight})}{\text{dry weight}}$$

$$\text{HMC}_{95\%RH} = 100 \times \frac{(\text{weight}_{95\%RH} - \text{dry weight})}{\text{dry weight}}$$

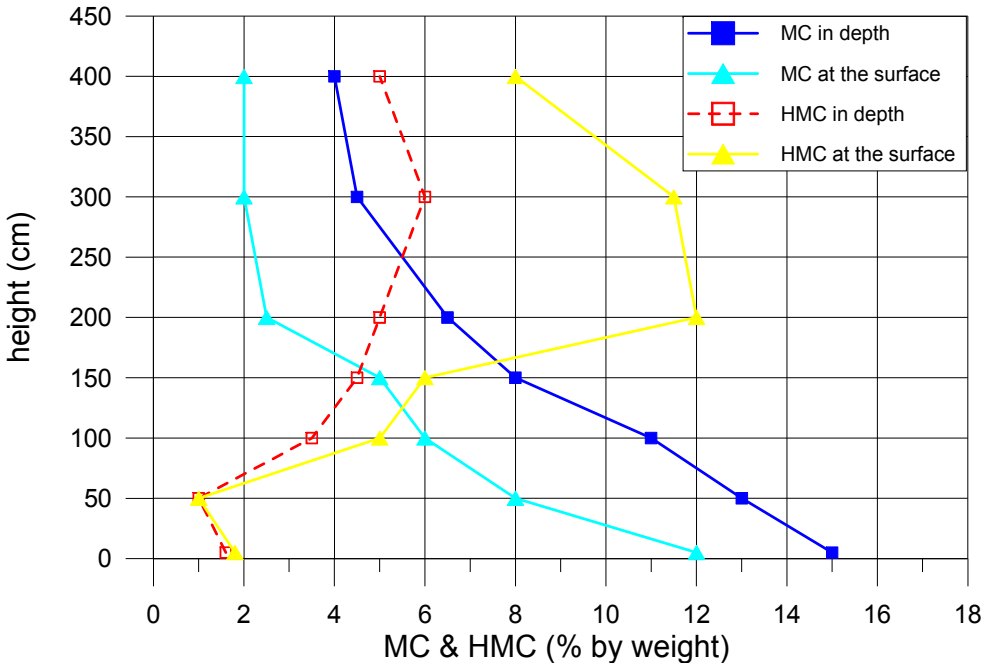
Material	Equilibrium MC (weight %) at 75 %RV	Equilibrium MC (weight %) at 93 %RV
Brick	0,25	0,5 – 0,7
Calcium silicate brick	0,5 - 2	3 - 6
Gypsum	< 0,1	3,5

HMC gives an indication of the presence of salts.

If HMC > equilibrium MC for that specific material, hygroscopic salts are present.

Interpretation of the results

MC > HMC → moisture source present (other than salt hygroscopicity)
HMC > MC → main moisture source is salt hygroscopicity in combination with air RH

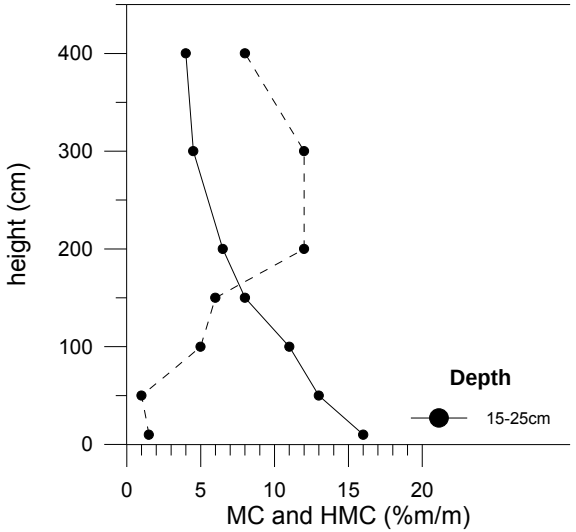


- MC decreases with height and increases with depth
- If salts are present, HMC line crosses MC line

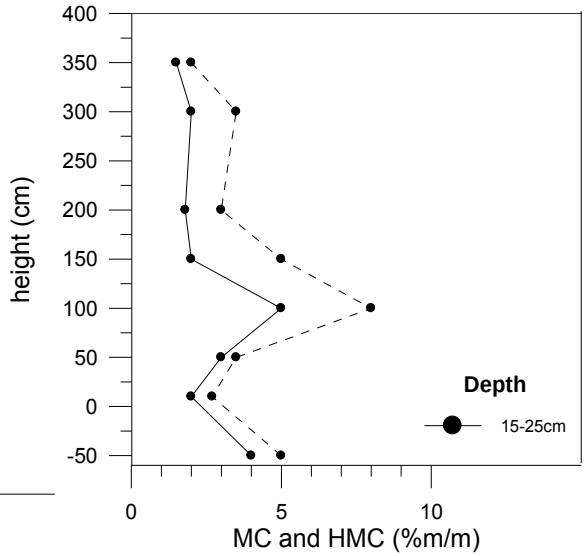
→ **Rising damp**

EXPERIMENTAL PROCEDURE

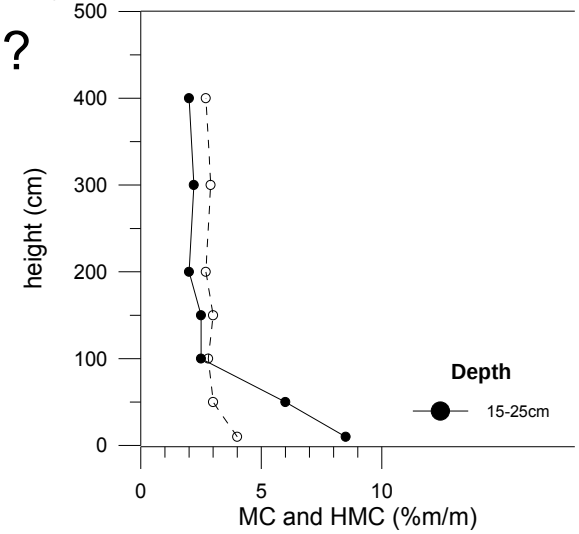
Interpretation of the results



Rising damp?
Salts?



Salts?
Rising damp?



Rising damp?
Salts?

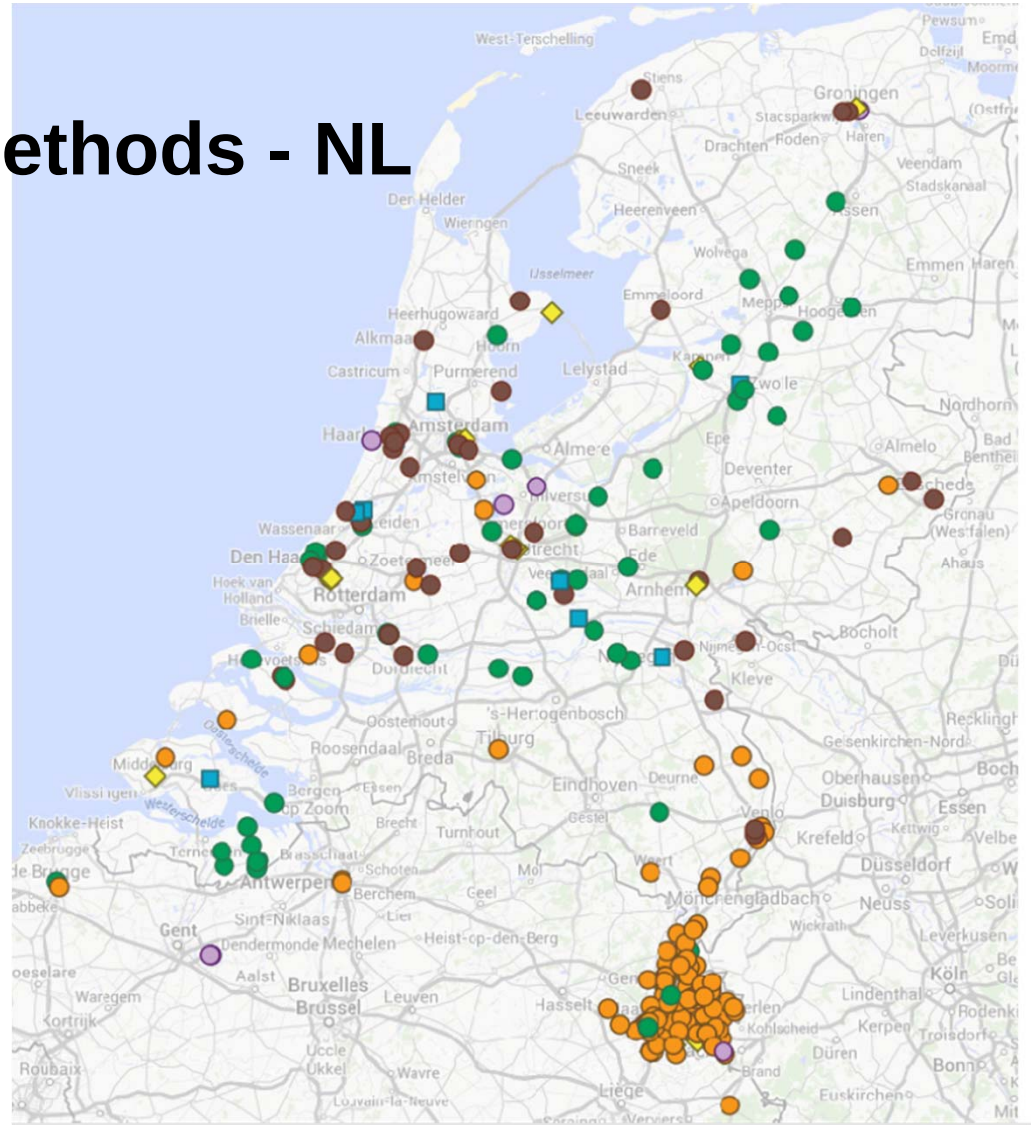
OVERVIEW OF METHODS

Overview of methods - NL

Chemical interruption

Drying stones

Different electro-kinetic methods



- Information often provided by producer/sellers of methods → bias
- Archive information not exhaustive (only present for some monumental buildings)
- Large diffusion of different electro-kinetic methods, also in monumental buildings

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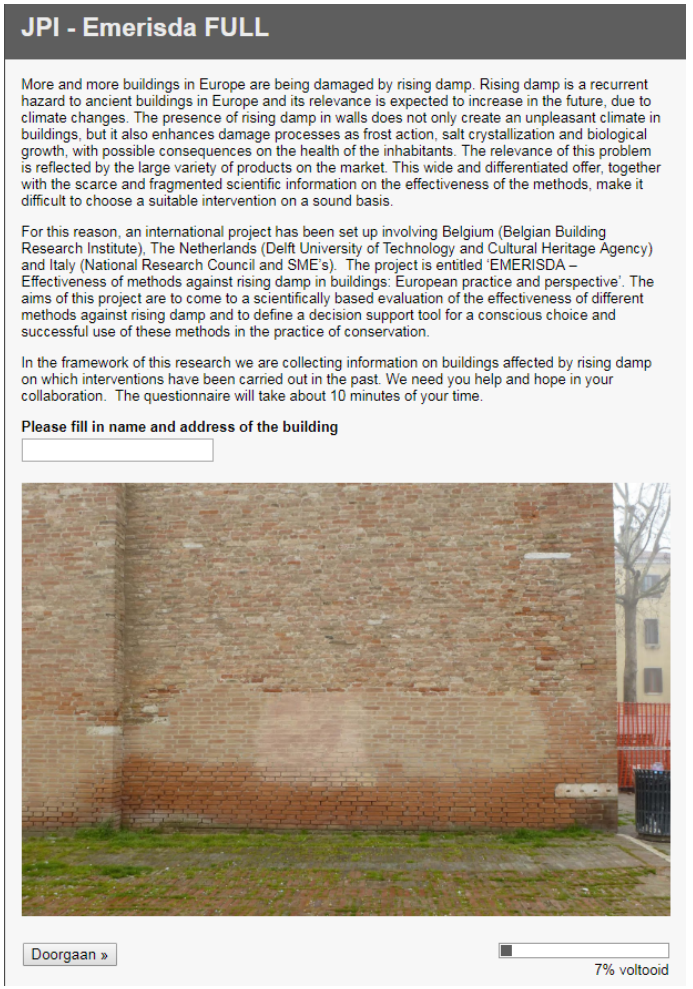
ON-LINE QUESTIONNAIRE

On-line questionnaire

Aim

- get insight in the way rising damp is tackled in every day's practice:

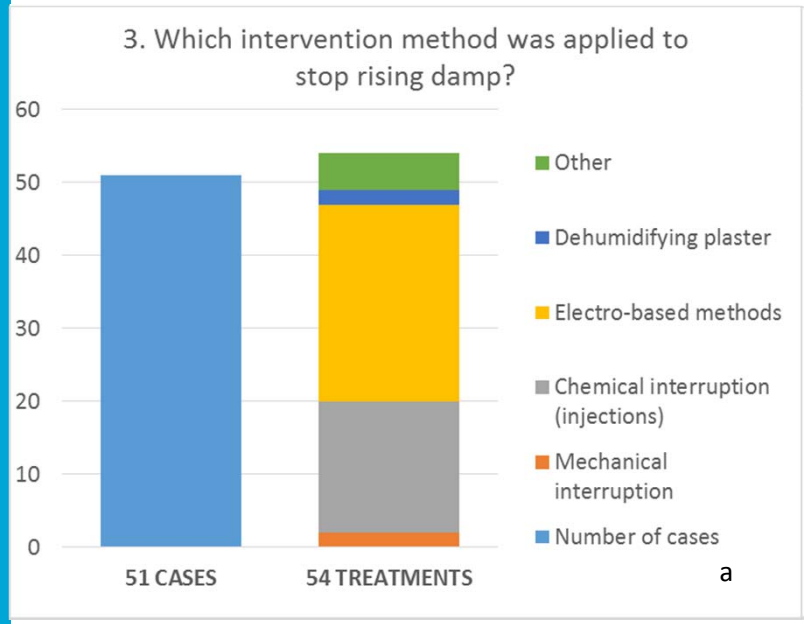
- *Is the presence of rising damp assessed before an intervention and how?*
- *What is the diffusion in the field of the different methods for tackling rising damp?*
- *What are the criteria for choosing an intervention method?*
- *Has the effectiveness of the intervention been determined afterward and how?*
- *What is the satisfaction degree of the users of the building for each of the methods?*



ON-LINE QUESTIONNAIRE

Results on-line questionnaire

Intervention method and criteria for its choice



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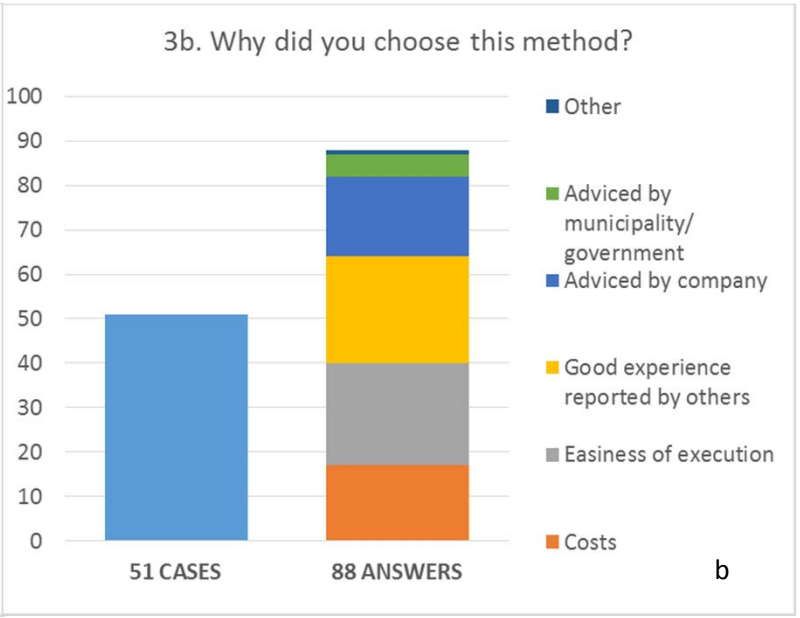

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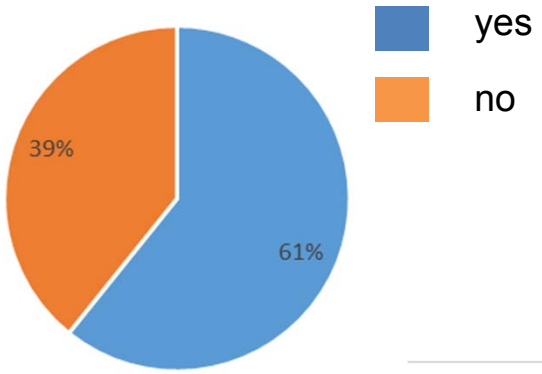
ON-LINE QUESTIONNAIRE

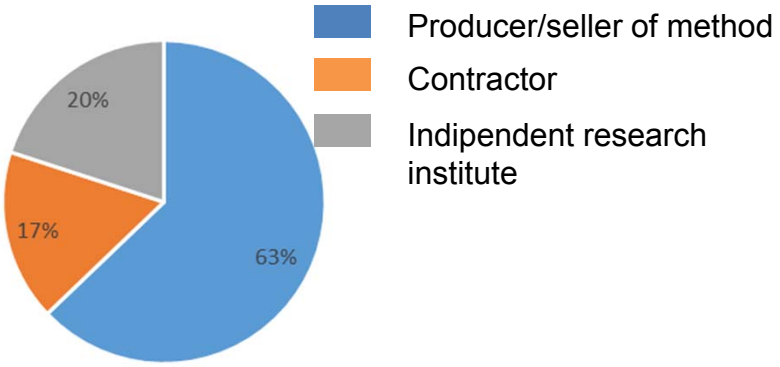
Results on-line questionnaire

Assessment of effectiveness of intervention

3g. Was the effectiveness of the intervention method determined by measurements?



3i. By whom was the effectiveness of the intervention determined?



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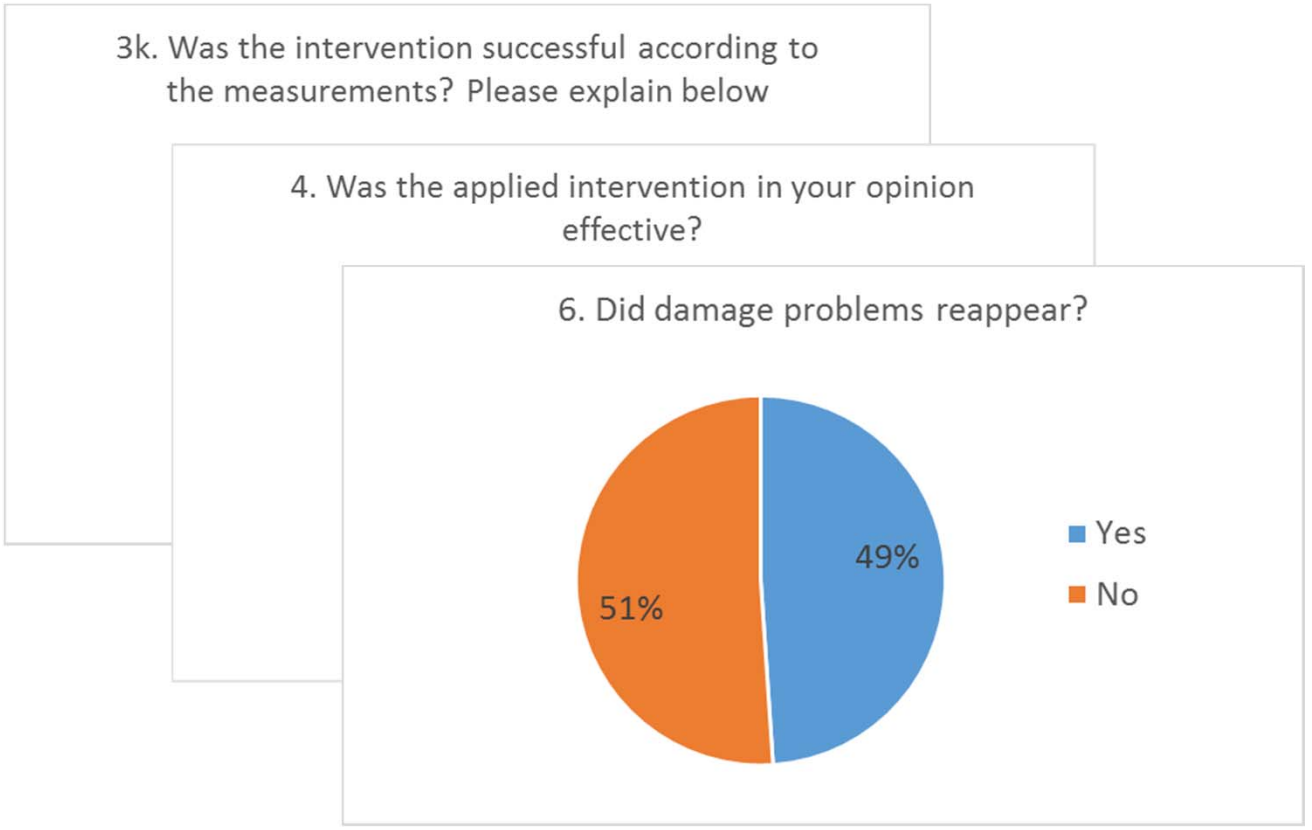
ON-LINE QUESTIONNAIRE

Results on-line questionnaire

Users' satisfaction



Degree of satisfaction does not always correspond with results of measurements and actual effectiveness.

DECISION SUPPORT TOOL

Decision support tool - prototype

For architects, contractors and owners of buildings

No advice, but help in the assessment of the presence of rising damp and in the choice of a suitable method.

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DECISION SUPPORT TOOL

Decision support tool

Digital decision support tool (excel file)

Different worksheets:

1. Is it likely to be rising damp?
2. Is the presence of rising damp confirmed?
3. Which interventions are suitable in this situation?
4. What are the risk of the different interventions?

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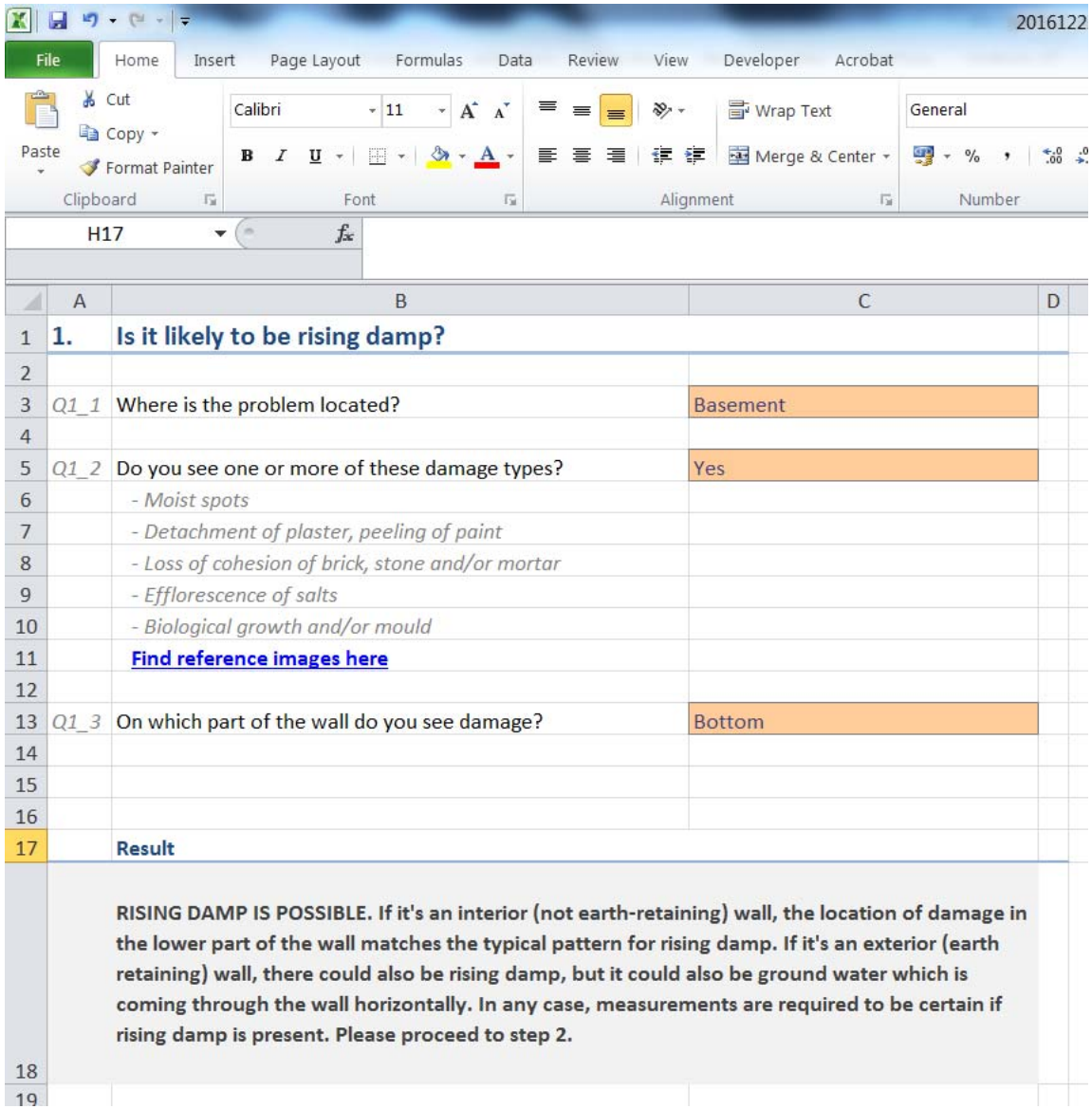
DECISION SUPPORT TOOL

1. Is it likely to be rising damp?



	A	B	C	D
1	1.	Is it likely to be rising damp?		
2				
3	Q1_1	Where is the problem located?	Basement	
4				
5	Q1_2	Do you see one or more of these damage types?	Yes	
6		- Moist spots		
7		- Detachment of plaster, peeling of paint		
8		- Loss of cohesion of brick, stone and/or mortar		
9		- Efflorescence of salts		
10		- Biological growth and/or mould		
11		Find reference images here		
12				
13	Q1_3	On which part of the wall do you see damage?	Bottom	
14				
15				
16				
17		Result		
18		RISING DAMP IS POSSIBLE. If it's an interior (not earth-retaining) wall, the location of damage in the lower part of the wall matches the typical pattern for rising damp. If it's an exterior (earth retaining) wall, there could also be rising damp, but it could also be ground water which is coming through the wall horizontally. In any case, measurements are required to be certain if rising damp is present. Please proceed to step 2.		
19				

DECISION SUPPORT TOOL

2. Is the presence of rising damp confirmed?

1	2.	**Can rising damp be confirmed?**	
2			
3		Please collect powder samples according to the provided guidelines. If possible, collect samples from an internal wall WITH FOUNDATION. Otherwise, collect samples from an external wall WITH FOUNDATION. In any case, be sure to collect multiple samples at several heights along a vertical profile, and at several depths. Determine MC and HMC for all samples.	
4			
5	Q2_1	Did you take samples in an internal or an external wall?	Internal wall
6			
7	Q2_2	Is the MC in depth, in the lower part of the wall, (much) higher than the HMC?	Yes
8			
9	Q2_3	Is the MC, in depth, decreasing with height?	Yes
10			
11		**Result**	
12		COULD VERY WELL BE RISING DAMP. The moisture distribution in the wall suggests that moisture is indeed transported from below and that there must be an active moisture source other than hygroscopicity of the salts possibly present in the wall.	
13		Because you have sampled from an INTERNAL wall, it is not necessary to fill out the following questions. Please proceed to sheet 3.	
14			
15		**Please fill out these questions if you have sampled in an external wall**	
16			
17	Q2_4	Is there a good drainage of rain water?	Yes
18			
19	Q2_5	Are the foundations below ground water level?	I don't know
20			
21		**Result**	
22		The following information could be relevant for you:	
23		- Rain water is properly drained, so this should not be a problem.	
24		- If the foundations are in the ground water, they are permanently saturated and there will be moisture transport upwards through the wall. However, even if the foundations are not in the ground water, capillary transport through the soil might still cause rising damp.	

Manual | 1. Likeliness | **2. Confirm** | 3. Techniques | 4. Risks | A. Att

DECISION SUPPORT TOOL

3. Which interventions are suitable in this situation?

Solutions → Situation↓	Based on reduction of water flux in ingress	Based on stopping/reducing water transport higher up in the wall		Based on evaporation increase			Based on electrokinetic phenomena			Additional/alternative methods, treat symptoms					
	Sub-soil drains	Mechanical interruption	Chemical damp-proofing	Knapen Siphons & similar	Wall base ventilation	Thermal methods	Active electro-osmosis	Passive electro-osmosis	'Electro-kybernetic' and similar methods	Take no action	Veneer walls, tiles and impermeable layers	Salt blocking plasters	Salt accumulating plasters	Salt transporting plasters	Air Conditioning and/or dehumidification of air
Owner requirements															
Heritage issues															
Wall characterics															
Moisture and salt content/damage															

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DECISION SUPPORT TOOL

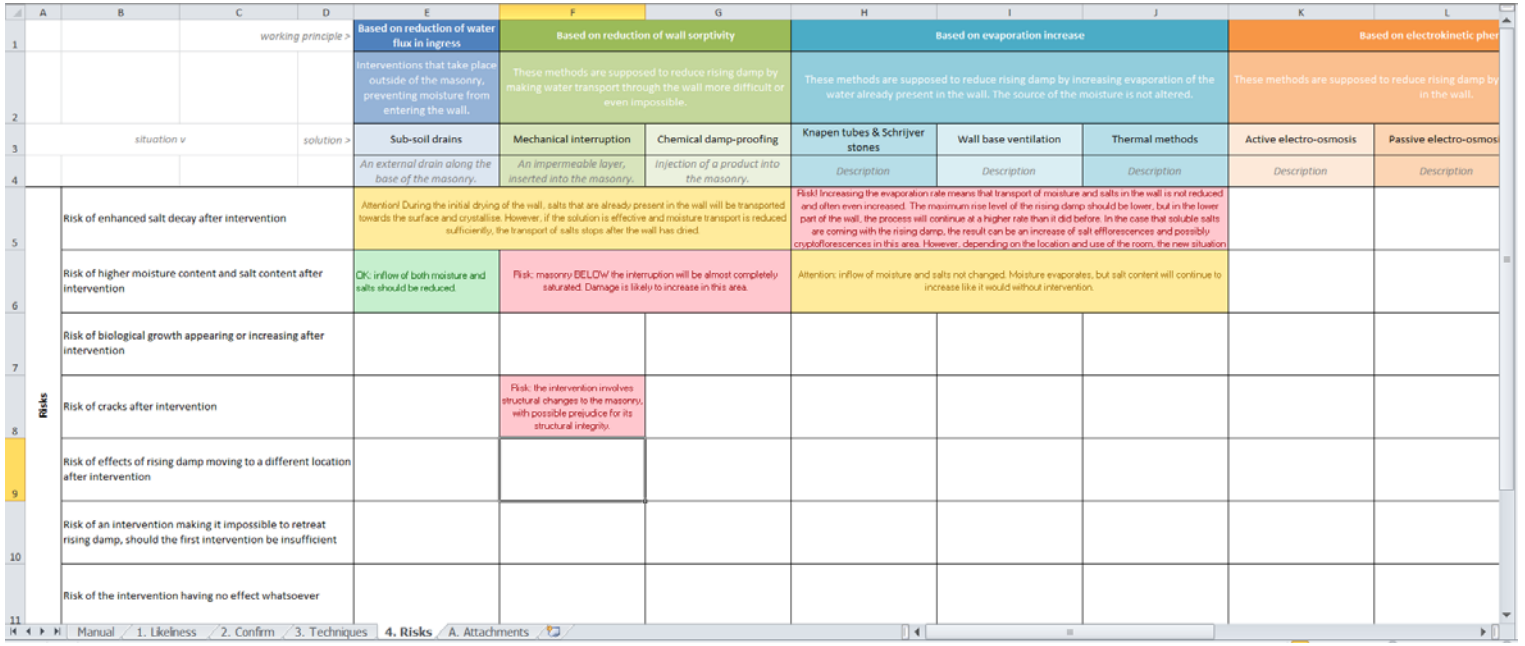
3. Which interventions are suitable in this situation?

		working principle >	Based on reduction of water flux in ingress	Based on stopping/reducing water transport higher up in the wall		Based on evaporation increase			
			Interventions that take place outside of the masonry, preventing moisture from entering the wall.	These methods are supposed to reduce rising damp by making water transport through the wall more difficult or even impossible.		These methods are supposed to reduce rising damp by increasing evaporation of the water already present in the wall. The source of the moisture is not altered.			These methods are s
	situation v	solution >	Sub-soil drains	Mechanical interruption	Chemical damp-proofing	Knapen Siphons & Schrijver stones	Wall base ventilation	Thermal methods	Active electro-osm
Owner requirements	Is it acceptable to have to do maintenance to keep the method working?	Yes	OK; be aware that, depending on the execution, the drains might need to be cleaned.	OK; no maintenance is required.	OK; no maintenance is required.	OK. Expect to have to clean the openings evey so often, so the airflow is not blocked.	OK. In case of active ventilation, the devices might need maintenance.	OK; depending on heating method, device might need maintenance.	OK. Be aware that the effe of the method might de when the water level de
	Do I need to stop rising damp completely?	Yes	Attention: the method can work but there is little experience in practice.	OK; rising damp is completely stopped above the level of the interruption.	Attention: the effectiveness of this method depends on several factors. It is advised to check the effectiveness 6-12 months after the intervention.	Risk: this method is not meant to stop rising damp completely but to reduce the MC in the wall. The effectiveness of this method is low.	Risk: this method is not meant to stop rising damp completely but to reduce the MC in the wall. The effectiveness of this method is low.	Risk: this method is not meant to stop rising damp completely but to reduce the MC in the wall. The effectiveness of this method is low.	Attention: the principle is but there are several lir there is only very little exp practice.
	Do you have a large budget available for this intervention (initial costs + operation + maintenance)?	No	Attention; relatively high initial costs but no running costs or maintenance.	Risk; very high initial costs but no running costs or maintenance.	OK; moderate initial costs but no running costs or maintenance.	OK; moderate initial costs and no running costs or maintenance.	Attention; apart from initial costs, take into account the running costs for the mechanical ventilation devices.	Risk; apart from high initial costs, expect high running costs as well.	Attention; apart from init expect limited running (electric power) as w
	Is it acceptable if you cannot use the room for some time while/after the intervention is carried out?	Yes	OK; the intervention is on the outside and the wall is not affected.	OK; keep in mind that the intervention is quite rigorous.	OK; be aware that, depending on the product/solvent, you may not be able to use the room for a few weeks.	OK; the intervention does not take long to carry out.	OK; the intervention is on the outside and the wall is not affected.	OK; depends on the chosen method.	OK; during the intervention not use the room
	Is aesthetic damage (e.g. efflorescence, moist spots, biological growth) acceptable?	No	Attention: as rising damp is not stopped completely, it might be necessary to combine the methodb with a special plaster to prevent visible damage.	Attention: during drying of the wall, in the case salts are present, salt efflorescence or damage might occur above the level of the mechanical interruption, due to	Attention: during drying of the wall, in the case salts are present, salt efflorescence or damage might occur above the level of the chemical interruption, due to drying	Risk; if salts are present, the evaporation increase might lead to an increase of efflorescences and/or salt damage.	Risk; if salts are present, the evaporation increase might lead to an increase of efflorescences and/or salt damage.	Risk; if salts are present, the evaporation increase might lead to an increase of efflorescences and/or salt damage.	Attention: as rising dam stopped completely, the needs to be combined with layer to prevent visible d
	Is a change of appearance of the wall acceptable due to the intervention?	No	OK; the wall is not changed. Depending on execution, there might be a zone with gravel or metal grid adjacent to the wall.	Attention: wall finishings (plasters etc) will have to be repaired. On a bare brick wall, a horizontal line will remain visible.	Attention: holes are drilled in the wall. The holes will be filled, but will remain visible on a bare wall. If a plaster layer is present, this needs to be repaired.	Risk: the siphons are in sight, changing the appearance of the wall.	OK; the wall itself is not changed. Depending on execution, mechanical ventilation devices might be visible.	Attention: depends on method.	Attention: electrodes are i plaster layer can be applie them.

Manual | 1. Likeliness | 2. Confirm | 3. Techniques | 4. Risks | A. Attachments

DECISION SUPPORT TOOL

4. What are the risks of the different interventions?



	working principle >	Based on reduction of water flux in ingress	Based on reduction of wall sorptivity		Based on evaporation increase			Based on electrokinetic phen	
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	situation v / solution >	Sub-soil drains	Mechanical interruption	Chemical damp-proofing	Knapen tubes & Schrijver stones	Wall base ventilation	Thermal methods	Active electro-osmosis	Passive electro-osmosi
		An external drain along the base of the masonry.	An impermeable layer, inserted into the masonry.	Injection of a product into the masonry.	Description	Description	Description	Description	Description
Risks	Risk of enhanced salt decay after intervention	Attention! During the initial drying of the wall, salts that are already present in the wall will be transported towards the surface and crystallise. However, if the solution is effective and moisture transport is reduced sufficiently, the transport of salts stops after the wall has dried.			Risk! Increasing the evaporation rate means that transport of moisture and salts in the wall is not reduced and often even increased. The maximum rise level of the rising damp should be lower, but in the lower part of the wall, the process will continue at a higher rate than it did before. In the case that soluble salts are coming with the rising damp, the result can be an increase of salt efflorescences and possibly cryptoflorescences in this area. However, depending on the location and use of the room, the new situation				
Risks	Risk of higher moisture content and salt content after intervention	OK: inflow of both moisture and salts should be reduced.	Risk: masonry BELOW the interruption will be almost completely saturated. Damage is likely to increase in this area.		Attention: inflow of moisture and salts not changed. Moisture evaporates, but salt content will continue to increase like it would without intervention.				
Risks	Risk of biological growth appearing or increasing after intervention								
Risks	Risk of cracks after intervention		Risk: the intervention involves structural changes to the masonry, with possible prejudice for its structural integrity.						
Risks	Risk of effects of rising damp moving to a different location after intervention								
Risks	Risk of an intervention making it impossible to retreat rising damp, should the first intervention be insufficient								
Risks	Risk of the intervention having no effect whatsoever								

Manual | 1. Likeliness | 2. Confirm | 3. Techniques | 4. Risks | A. Attachments

DECISION SUPPORT TOOL

Development and availability of the tool

Prototype to be updated, refined and further tested.

For the future:

- Allow the user to attribute a relative importance to each aspect
- Make the tool available on-line

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CONCLUSIONS

Experimental procedure

It allows to assess in a simple and reliable way the presence of rising damp and the effectiveness of an intervention (after 1y from application).

On-line questionnaire

Assessment effectiveness of interventions only rarely performed, seldom by independent party.

High degree of users' satisfaction does not always mean that the problem has been solved.

Decision support tool

It facilitates comparison between interventions → it helps to select suitable method.

It considers different aspects in decision process → it helps clarifying the relevance of each aspect to involved parties.

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MOdihMA

MOisture detection in historic MAsonry

Thank you for your attention

Grazie per l'attenzione

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