TOWARDS A MORE RELIABLE CHARACTERISATION OF WIND-DRIVEN RAIN SPELLS: ANALYSIS OF ACTUAL DRYING INTERVALS IN THE REGION OF MURCIA (SPAIN)

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1. INTRODUCTION

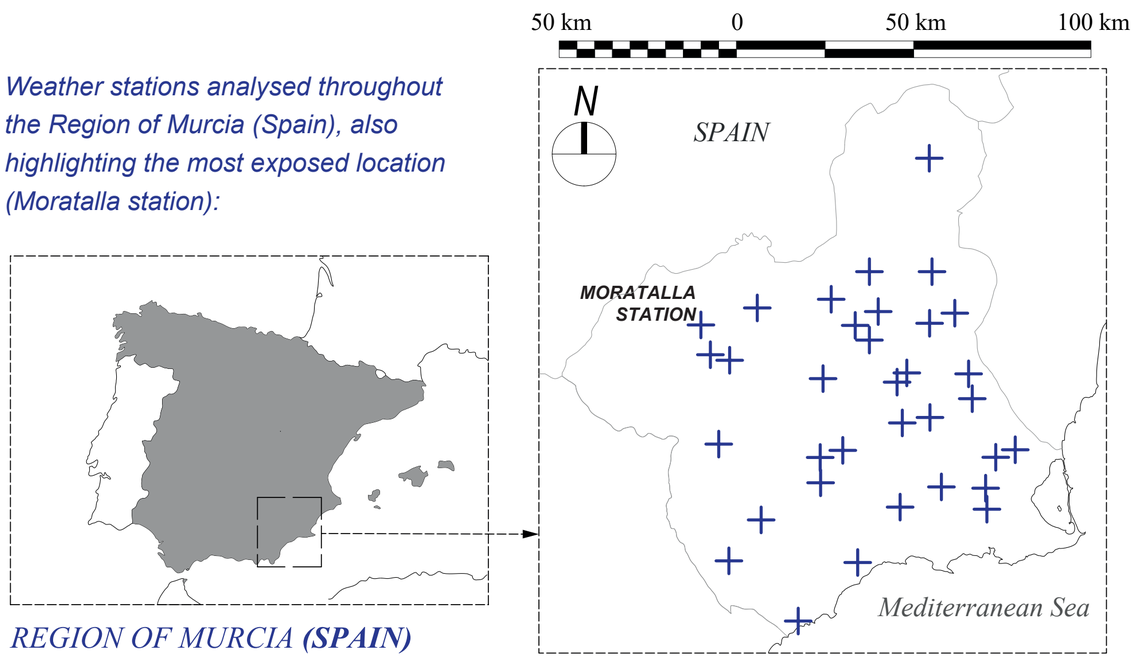
► ISO standard 15927-3 assesses temporary exposure to wind-driven rain (WDR) by characterising the worst spell likely to occur in any three-year period on the façade orientation.

► These spells are defined as continued wetting periods during which there are no more than consecutive 96 h without WDR on the façade.

► The generic 96-hour interval, supposedly required before evaporative losses exceed the prior water ingress due to WDR, does not consider multiple local factors such as orientation, solar radiation, wind speed, air temperature, façade thermal transmitance, etc.

► Thus, current spells indexes do not relialbly characterise the temporary WDR exposure, which can lead to unsuitable façade designs.

Weather stations analysed throughout the Region of Murcia (Spain), also highlighting the most exposed location (Moratalla station):



2. ANALYSIS CONDUCTED

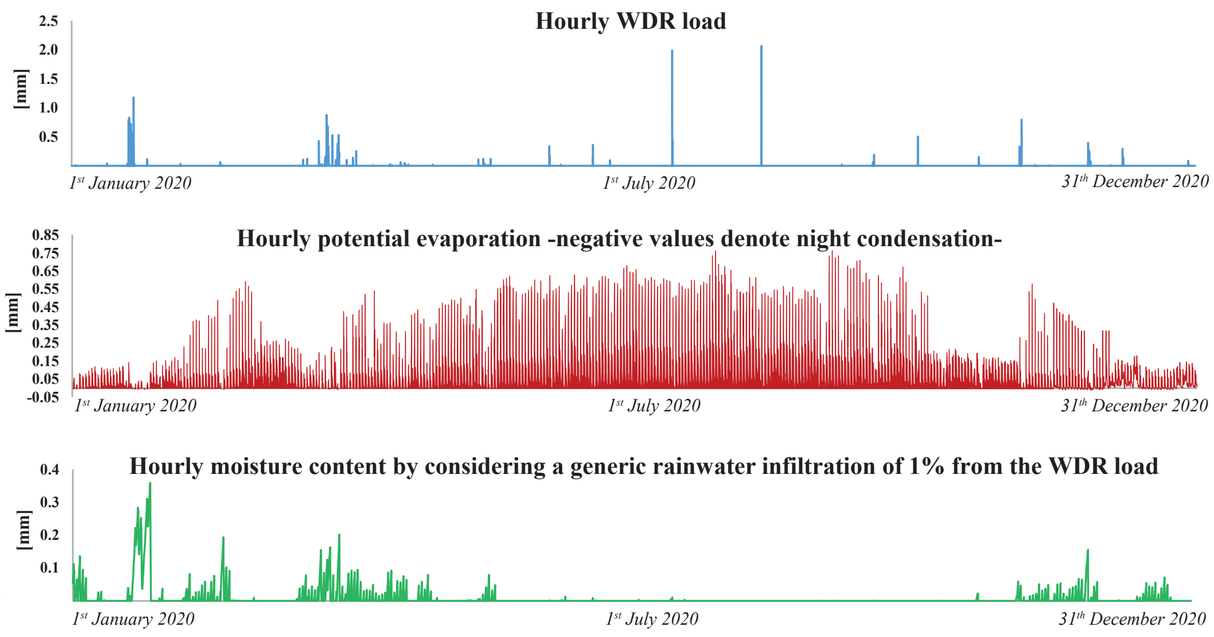
► Ten years of hourly climatic records have been analysed at 34 weather stations in the Region of Murcia -Spain- (2011-2020).

► Common formulae used in evapotranspiration applications have been adapted to estimate potential evaporation losses in tilted surfaces.

► Specific assumptions have been proposed to fast analyse short- and longwave radiation exchange of façades with varied orientations as well as their heat flux and surface temperature.

► Representative values of albedo (0.200), façade emissivity (0.910), and ground emissivity (0.974) has been fixed to develop a functional and analytical calculation, whose results are comparable everywhere.

► A 1% of the WDR load is considered as a generic and representative value of rainwater infiltration (other values can be equally used).



Example of the analysis performed (Moratalla station; 0º -North facing façade-). For succinctness, only year 2020 is shown.

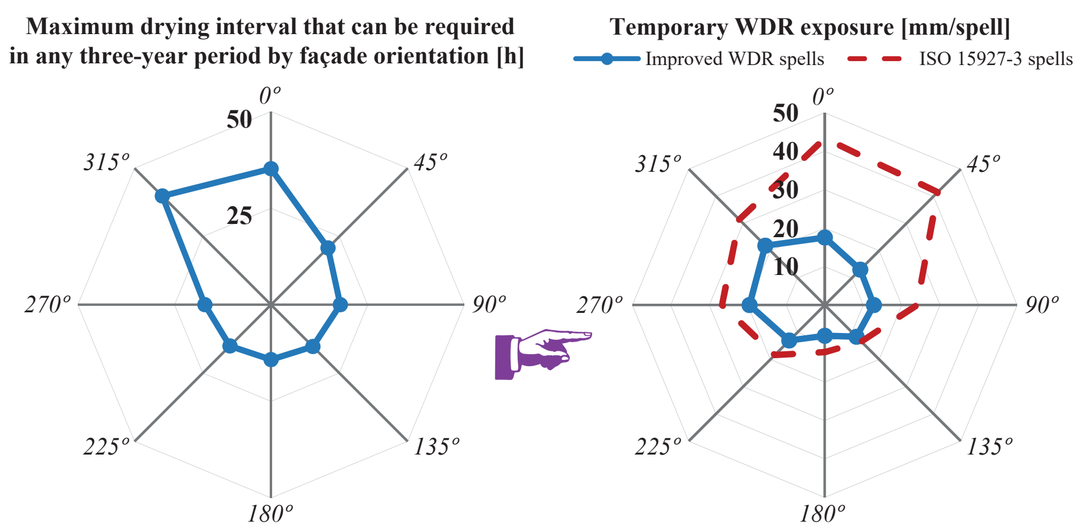
3. RESULTS AND DISCUSSION

► Hourly WDR exposure on façades with varied orientations (45º intervals) has been compared with estimates of their simultaneous potential evaporation, thus analysing the transitory moisture content of each façade as well as the drying intervals required to counteract prior WDR loads.

► These improved drying intervals allow to determine façade-specific spells, and to identify WDR spell indexes that integrate orientation and climate factors, in contrast than those obtained from the generic 96-hour interval.

►On the basis of the abovementioned assumptions (functional evaporation estimation, generic value of rainwater infiltration, etc.), the maximum drying intervals that could occur every 3 years range from 4 h to 40 h in this warm region of Spain (that is, much shorter than the 96 h of the ISO standard).

►Divergences regarding generic spell indexes of ISO standard vary according to façade orientation and are more significant the higher the WDR load. This improved calculation would reduce the temporary WDR exposure between 4.63% and 80.33% on average in the Region of Murcia, which would reduce the watertightness design requirements currentyconsidered.



Representative drying intervals to be considered and comparison of WDR spell indexes in the site.

Moratalla station -	*0º*	*45º*	*90º*	*135º*	*180º*	*225º*	*270º*	*315º*
Hours with WDR exposure (*h/yr*)	151.9	128.7	112.7	118.4	125.7	148.7	164.7	159.2
WDR load (*mm/yr*)	38.8	28.4	23.5	23.1	23.6	33.8	46.3	50.0
$R_{s\ direct}$ (*MJ/m²·yr*)	1032.9	6711.2	10178.9	12938.7	13477.7	9748.8	6365.0	2876.3
$R_{s\ diffuse}$ (*MJ/m²·yr*)	206.2	1367.8	2084.9	2726.6	2952.2	2238.1	1534.9	771.5
$R_{s\ 90º}$ (*MJ/m²·yr*)	312.0	1682.7	2499.2	7154.0	13028.0	8204.0	4784.8	1805.5
$R_{nlw\ 90º}$ (*MJ/m²·yr*)	-480.9	-480.9	-480.9	-480.9	-480.9	-480.9	-480.9	-480.9
$G_{façade}$ (*MJ/m²·yr*)	-20.3	-20.3	-20.3	-20.3	-20.3	-20.3	-20.3	-20.3
Potential evaporation E (*mm/yr*)	684.3	985.1	1160.7	2167.4	3385.3	2438.1	1721.5	1049.2
Moisture content (*mm/yr*)	24.5	15.5	12.3	10.6	10.3	13.4	16.2	27.6
Representative drying interval for a three-year occurrence *(h)*	35	21	18	15	14	15	17	40
I_s *(mm/spell);* from the proposed façade-specific drying intervals	17.6	13.0	12.7	11.7	8.0	13.0	19.6	21.9
I_s *(mm/spell);* from the current 96-hour ISO model	43.4	41.5	24.0	13.4	12.2	18.3	26.7	31.5
ISO model error (%)	**146.6**	**219.2**	**89.0**	**14.5**	**52.5**	**40.8**	**36.2**	**43.8**

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4. CONCLUSIONS

► Spell definition set by ISO standard 15927-3 should be reviewed in order to include the local factors that drive water evaporation phenomenon on building façades.

► The use of façade-specific drying intervals, such as those here calculated, will open new paths for the improvement of temporary WDR characterisation in different regions.

► Not only WDR exposure affects the drying intervals to be considered, but also the façade orientation and the climate of its location.

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