ADVANCES TO ENHANCE THE UTILITY OF TRADITIONAL WIND-DRIVEN RAIN STUDIES ALREADY AVAILABLE IN MULTIPLE REGIONS

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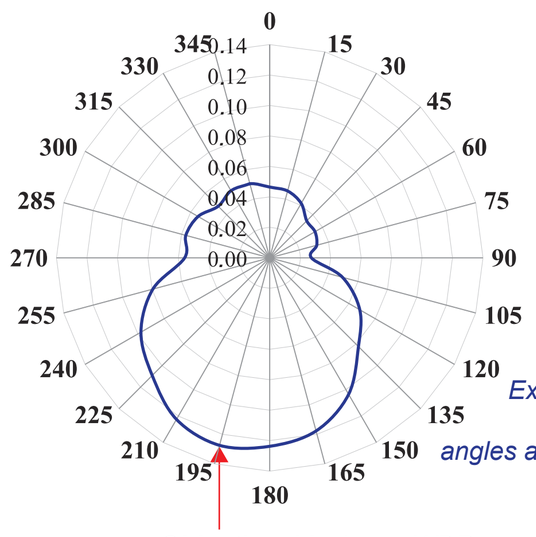
1. INTRODUCTION

► Wind-driven rain (WDR) studies are conditioned by the exhaustiveness of available rainfall and wind velocity records.

► Standard ISO 15927-3 requires long series of hourly records (often unavailable) for determining directional WDR exposures.

► Scalar exposures based on the annual Driving Rain Index (aDRI) have been determined for decades in different countries, thus providing aaDRI, maDRI and daDRI exposure maps based on annual, monthly and daily records, respectively.

► Since a similar configuration is often used for all building façades (regardless their orientation), only the most unfavourable directional exposure is relevant to support the practitioner's decisions concerning façade designs.

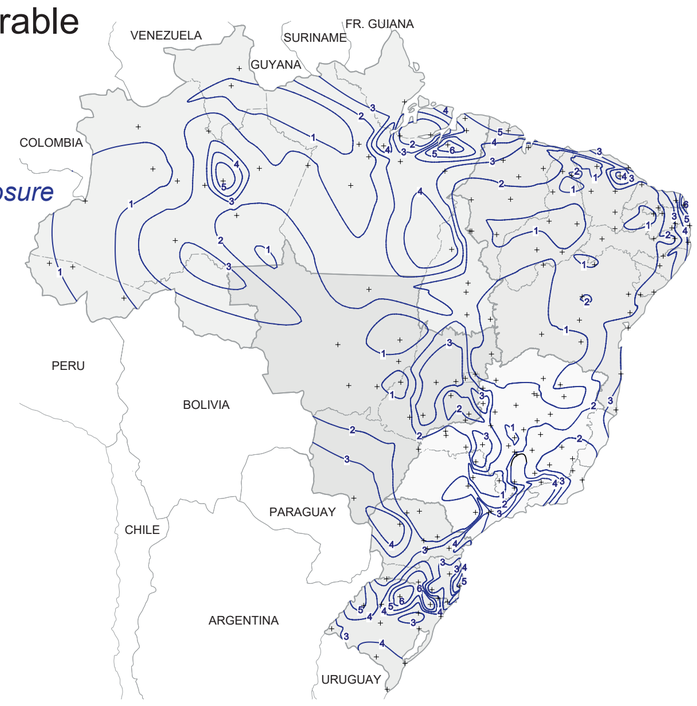


Objective: *Maximum WDR exposure to be considered*

Example of directional WDR exposure (daDRI values at Santiago, Chile; angles are measured in degrees from north)

Are both incompatible or unrelated approaches?

Example of scalar WDR exposure (daDRI values in Brazil)



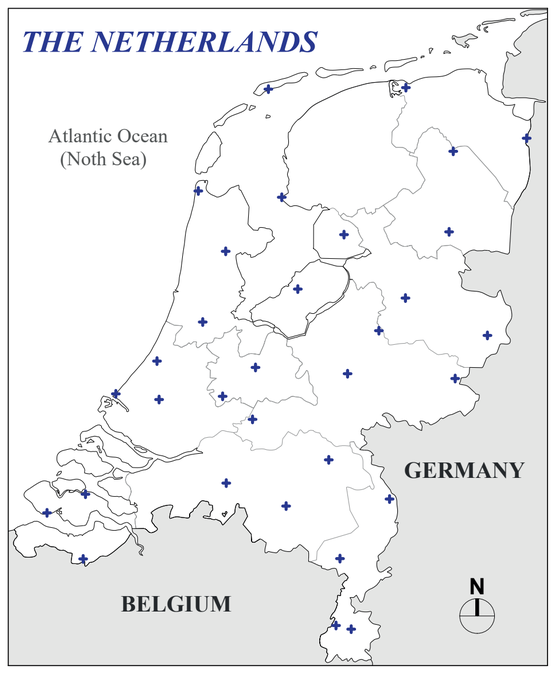
2. ANALYSIS CONDUCTED

► 10 years of daily and hourly climatic records have been analysed at 28 Dutch weather stations (2010-2019).

► Correlation between the scalar daDRI values and the maximum directional WDR exposures (max $daDRI_\theta$ values) is identified.

► Comparison with the correlation identified at 920 locations distributed throughout Mexico, Norway and Spain is performed.

► The maximum directional WDR based on ISO 15927-3 (annual average WDR_θ) is also determined and its correlation with the scalar daDRI values is analysed.



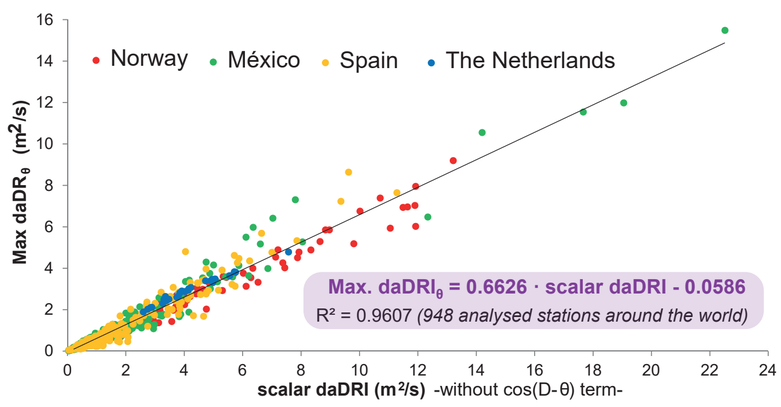
Weather stations analysed throughout the country

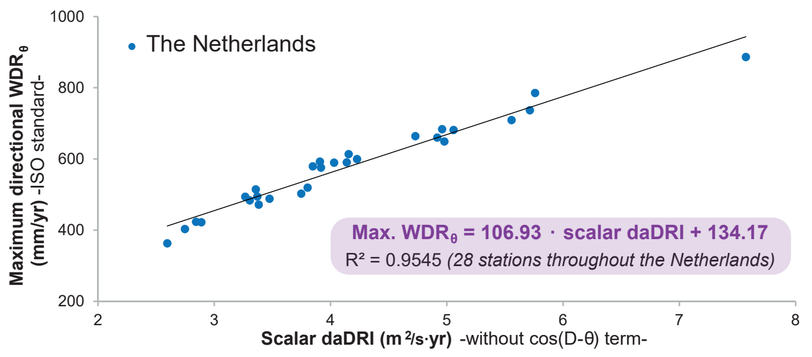
3. RESULTS AND DISCUSSION

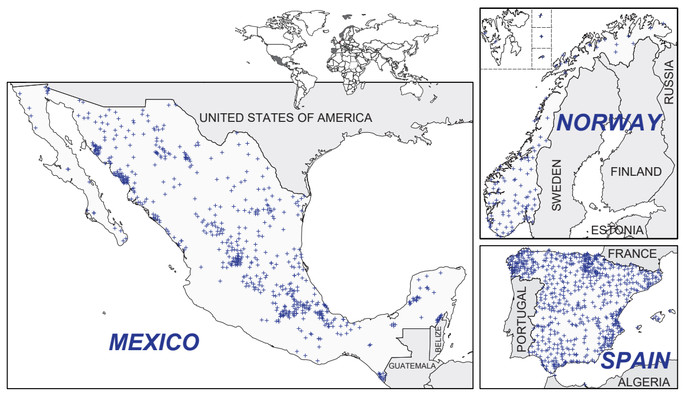
► The scalar daDRI - max $daDRI_\theta$ correlation identified in the Netherlands is similar to that already identified at 920 locations in Mexico, Norway and Spain. Thus, a rough global extrapolation may be proposed:

► The clear realtionship between the scalar daDRI values (based on daily records) and the maximum directional exposures from ISO standard (WDR_θ based on hourly data) demonstrates the accuracy of this approximation:

► Other proven correlations, such as maDRI-aaDRI, daDRI-maDRI, and daDRI-daDRI can also be used together with this approximation for identifying maximun directional WDR exposure.







Location of the 920 meteorological stations also compared

$$aDRI_\theta = \sum_{i=1}^{m} U_i \cdot (R_{h\,i}/1000) \cdot \cos(D_i - \theta) \Big/ N$$

Wind speed U (m/s); Rainfall R_h (mm); Wind Direction D (º); Façade orientation θ (º). m daily records (daDRI) gathered over N years for wich wind direction D blows against θ façade orientation.

$$WDR_\theta = (2/9) \cdot \sum_{i=1}^{m} U_i \cdot (R_{h\,i})^{8/9} \cdot \cos(D_i - \theta) \Big/ N$$

Wind speed U (m/s); Rainfall R_h (mm); Wind Direction D (º); Façade orientation θ (º). m hourly records gathered over N years for wich wind direction D blows against θ façade orientation.

► Thus, a functional and less-computational intensive approximation to the WDR exposure on the most unfavourable façade orientation is enabled from simple scalar aDRI results (in many cases already available).

References

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4. CONCLUSIONS

► New possibilities for the reinterpretation of traditional wind-driven rain studies are now available.

► Functional tool for the practitioner's design decisions were until now, only an inaccurate scalar exposure value was available.

► Obtaining an accurate directional characterisation of the WDR exposure (on the most unfavorable orientation), from less exhaustive climatic data (non hourly records).

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