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Field observation on the spatial characteristic of wind-blown sand along the Hetian-Rouqiang Railway

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Background

Hetian-Ruoqiang Railway (HRR) is located in Xinjiang Province, China. The span of HRR passes through six cities and counties.The annual rainfall along HRR is very small and the wind speed is high, that leads to intense movement of wind-blown sand, forms the sand accumulation on the track bed of the new railway, and results in potential safety hazards of railway operation[1-3].

Although several sand-control methods are proposed, reasonable solution still need be formulated according to the local characteristics of sand transport. Especially for the project with large space span like HRR which includes various landforms and climate conditions, so the first-hand observation data about aeolian sand transport is essential important. Unfortunately, there are few long-period observation data of aeolian sand movement along HRR. Therefore our understanding of the spatial distribution of wind-blown sand along the HRR is very limited, which brings great restriction to the construction of the railway and the following prevention of sand disaster.

Expreiment

We select 10 monitoring points (from point 1to 10) in typical sand-disaster sections along HRR, as shown in Figure 1.

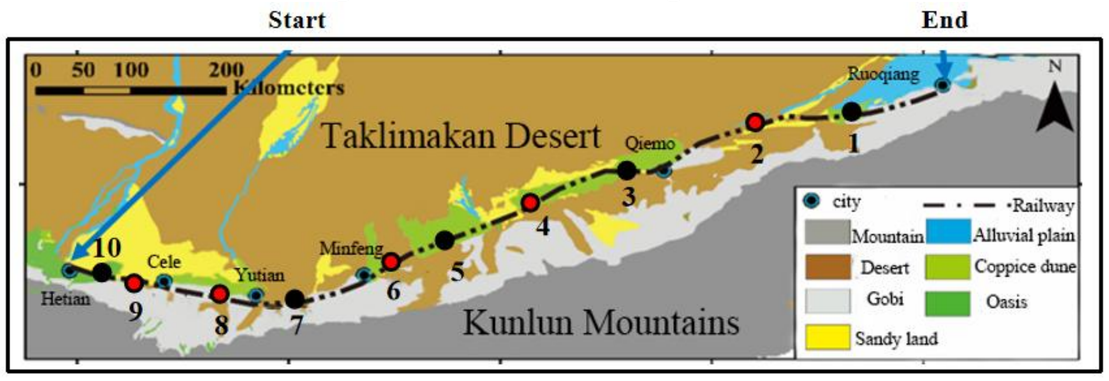

Figure 1. Observation positions along HRR.

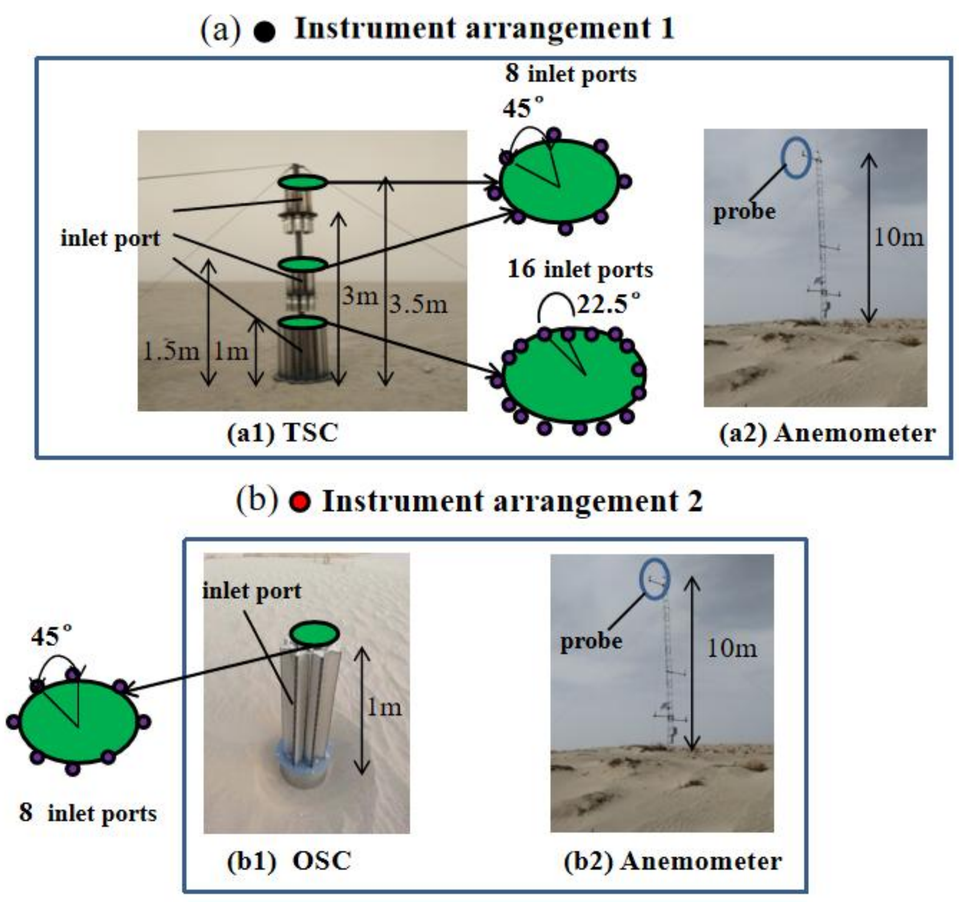

Figure 2. Instruments and arrangement, (a) instrument arrangement 1, and (b) instrument arrangement 2.

There are two instrument layout modes for monitoring points, as shown in Figure 2. The first one is arranged at monitoring position 1, 3, 5, 7 and 10, and the second one is placed at monitoring position 2, 4, 6, 8 and 9, with the monitoring seen in Figure 1.

The first instrument layout mode includes the three-layer sand container (TSC) and anemometer, as shown in Figure 2 a.

As shown in Figure 2 b, the second instrument layout mode includes the One-layer sand container (OSC) and anemometer.

Results

As shown in Figure 3, the northwest wind mainly exists in the west section (Yutian to Hetian section: positions 9-10). The northeast wind mainly exists in the east section (Ruoqiang to Minfeng section, positions 1-4). The two main wind currents roughly converge in the middle section (Minfeng to Yutian, positions 5-8). The convergence center is near monitoring point 7, which makes the surface airflow in the central section convergence scattered and wind direction variable.

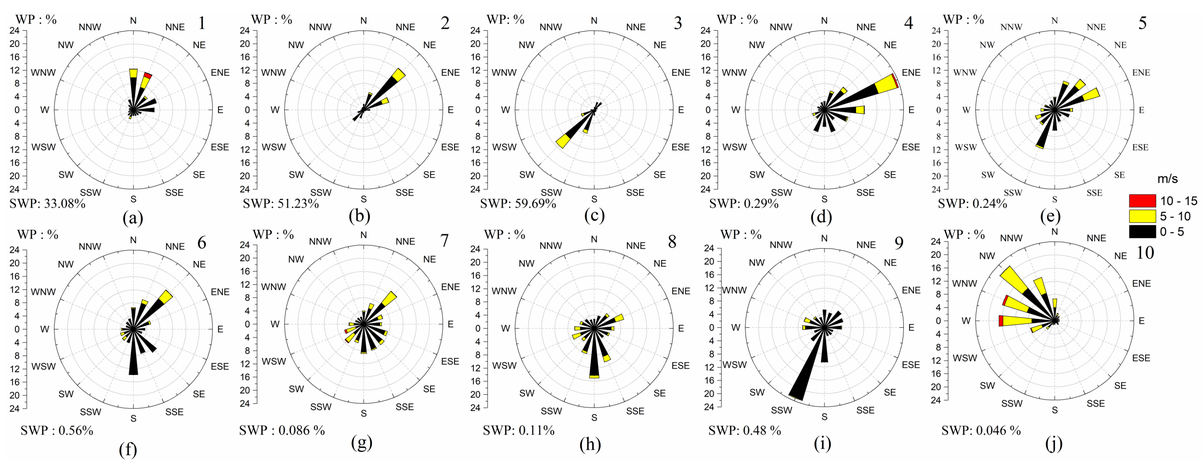

Figure 3. Wind speed rose diagram in different locations, (a) at position 1, (b) at position 2, (c) at position 3, (d) at position 4, (e) at position 5, (f) at position 6, (g) at position 7, (h) at position 8, (i) at position 9,and (j) at position 10.

As shown in Figure 4 a-b and e, the cumulated aeolian transport mass flux F_{cm} at the east section and the sand-transport spokes in the middle section of HRR are relatively large, i.e. position 1, 2 and 6, while the F_{cm} of the remaining locations (positions 4-5 and positions 7-8 shown in Figure 4 c-d and Figure 4 f-g) are relatively small.

As shown in Figure 4 h, the total F_{cm} (the Fcm for each layer of the TSC in all directions) at the position1 and pisition7 (Some data from position 5 are ineffective) is in line with the negative exponential variation in height.

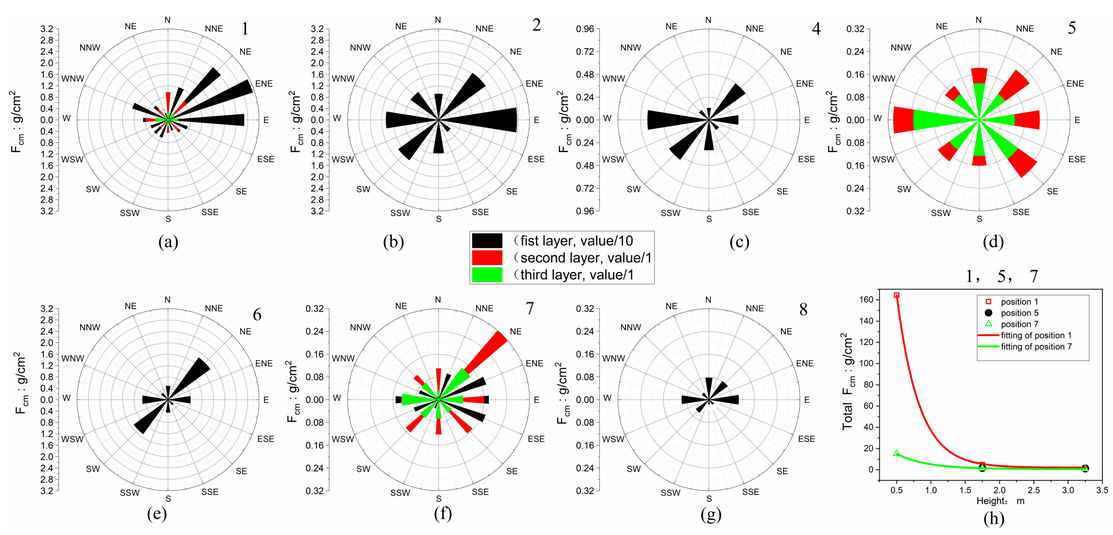

Figure 4. The cumulated aeolian transport mass flux F_{cm} in different directions along HRR, (a) at position 1, (b) at position 2, (c) at position 4, (d) at position 5, (e) at position 6, (f) at position 7, (g) at position 8, and (h) the total F_{cm} at position 1, position5 and positin7 in different heights.

Conclusion

1.Spatially, there are two main wind directions in the area, northeast-east, and northwest-west, and the two wind systems roughly converge around Yutian-Minfeng, forming turbulent air currents.

2.The aeolian sand transport in the section from Ruoqiang to Qiemo is larger. Whereas the aeolian sand transport in the section from Qiemo to Minfeng is smaller, mainly because small wind speed and complex terrain. The position 6 on the right flank of Minfeng has many flowing sand dunes and flat terrain.

References

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