

Probabilistic risk management for agricultural facilities under heavy snowfall: a Markov chain approach considering wet and dry snow conditions

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SUPPLEMENTARY MATERIAL

Supplementary Table S1. Markov transition matrix for farmer-advised 1-2W type greenhouse facility in Seoul, Gunsan, and Yeosu.

Seoul										
State	<i>j</i>									
<i>i</i>	1	2	3	4	5	6	7	8	9	10
1	0.8251	0.0852	0.0583	0.0179	0.0135	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.9107	0.0601	0.0120	0.0103	0.0052	0.0017	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.9178	0.0587	0.0209	0.0013	0.0013	0.0000	0.0000	0.0000
4	0.0000	0.0000	0.0000	0.9248	0.0643	0.0079	0.0030	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000	0.9233	0.0665	0.0101	0.0000	0.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000	0.9178	0.0783	0.0039	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.9345	0.0645	0.0010	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.9624	0.0376	0.0000
9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.9780	0.0220
10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000

Gunsan										
State	<i>j</i>									
<i>i</i>	1	2	3	4	5	6	7	8	9	10
1	0.8265	0.1173	0.0255	0.0153	0.0051	0.0102	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.7922	0.1247	0.0701	0.0104	0.0026	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.8326	0.1360	0.0230	0.0063	0.0021	0.0000	0.0000	0.0000
4	0.0000	0.0000	0.0000	0.8385	0.1292	0.0262	0.0062	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000	0.8890	0.1048	0.0049	0.0012	0.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000	0.8855	0.1094	0.0051	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.8835	0.1149	0.0016	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.9336	0.0664	0.0000
9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.9468	0.0532
10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000

Yeosu										
State	<i>j</i>									
<i>i</i>	1	2	3	4	5	6	7	8	9	10
1	0.9091	0.0000	0.0000	0.0000	0.0909	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.4000	0.0000	0.2000	0.0000	0.2000	0.0000	0.2000	0.0000	0.0000

Supplementary Table S3. Failure probability of farmer-advised 1-2W type greenhouse facility according to current snow load.

Seoul		Gunsan		Yeosu	
Current snow load (N/m ²)	P_f within 6 hours, P_f^6	Current snow load (N/m ²)	P_f within 6 hours, P_f^6	Current snow load (N/m ²)	P_f within 9 hours, P_f^9
0.1–1.7	0.0000	0.1–2.3	0.0000	0.1–0.9	0.0000
1.8–3.9	0.0000	2.4–5.4	0.0000	1.0–1.3	0.0000
4.0–7.8	0.0000	5.5–10.1	0.0000	1.4–1.9	0.0000
7.9–13.7	0.0000	10.2–17.7	0.0001	2.0–2.8	0.0000
13.8–22.4	0.0000	17.8–28.1	0.0003	2.9–4.6	0.0000
22.5–36.1	0.0002	28.2–42.8	0.0016	4.9–8.6	0.0000
36.2–57.7	0.0024	42.9–64.9	0.0147	8.8–14.4	0.0000
57.8–97.0	0.0270	65.0–106.4	0.1054	15.7–26.6	0.0000
97.1–189.4	0.3737	106.7–190.0	0.6827	28.7–82.9	0.0000
191.3–347.3	1.0000	190.2–340.0	1.0000	190.1–190.2	0.0000
Pohang		Sokcho		Daegwallyeong	
Current snow load (N/m ²)	P_f within 6 hours, P_f^6	Current snow load (N/m ²)	P_f within 6 hours, P_f^6	Current snow load (N/m ²)	P_f within 9 hours, P_f^9
0.1–2.9	0.0000	0.1–3.2	0.0005	0.7–2.2	0.0000
3.4–7.9	0.0000	3.4–7.7	0.0005	2.3–6.1	0.0000
8.2–14.1	0.0000	7.8–14.7	0.0015	6.2–12.7	0.0000
14.2–24.6	0.0003	14.8–24.9	0.0022	12.8–22.7	0.0003
25.0–42.8	0.0021	25.0–39.6	0.0141	22.8–37.0	0.0015
43.5–68.5	0.0198	39.7–60.9	0.0403	37.1–60.6	0.0079
68.9–96.1	0.1549	61.1–90.2	0.1986	60.7–94.8	0.0661
96.8–133.8	0.6695	90.5–130.6	0.6458	94.9–135.0	0.3366
135.6–188.7	0.9985	130.8–190.0	0.9667	135.1–190.0	0.8585
191.3–649.1	1.0000	190.4–1,466.3	1.0000	190.1–2,925.3	1.0000

Supplementary Table S4. Failure probability of various agricultural facility specifications in Seoul.

General-purpose A-type		Farmer-advised 1-2W type		Disaster-resistant 10-5 type	
Current snow load (N/m ²)	P_f within 6 hours, P_f^6	Current snow load (N/m ²)	P_f within 6 hours, P_f^6	Current snow load (N/m ²)	P_f within 9 hours, P_f^9
0.1–1.6	0.0002	0.1–1.7	0.0000	0.1–1.7	0.0000
1.7–3.4	0.0007	1.8–3.9	0.0000	1.8–3.9	0.0000
3.5–6.0	0.0002	4.0–7.8	0.0000	4.0–7.8	0.0000
6.1–9.7	0.0017	7.9–13.7	0.0000	7.9–13.7	0.0000
9.8–15.1	0.0008	13.8–22.4	0.0000	13.8–22.4	0.0000
15.2–23.3	0.0082	22.5–36.1	0.0002	22.5–36.2	0.0000
23.4–35.6	0.0299	36.2–57.7	0.0024	36.3–58.7	0.0002
35.7–52.6	0.2055	57.8–97.0	0.0270	58.8–103.0	0.0029
52.7–79.0	0.7832	97.1–189.4	0.3737	103.8–294.3	0.0574
79.2–347.3	1.0000	191.3–347.3	1.0000	300.2–347.3	1.0000