Scientific-Technical Proposal for the Pilot Phase of Targeted Precipitation Enhancement in the Alborz-Tehran Basin Using Combined Hygroscopic and Glaciogenic Cloud Seeding (Safe $CaCO_3$/$CaCl_2$ and Nano-Encapsulated AgI Materials)

Version 1.0 – November 2025

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1. Executive Summary

The Tehran water crisis has reached a red alert stage in the fall of 2025. The storage of the five dams supplying Tehran is less than 12% of capacity.

This scientific-technical proposal presents an 18-month pilot

project with a budget of $90–140 million (average $126 million), aiming to increase precipitation by 9–22% in suitable clouds in the central Alborz basin using a combined hygroscopic ($CaCO_3$/$CaCl_2$) and glaciogenic (nano-encapsulated AgI) seeding method.
This approach has been successfully tested in the UAE, China, and the USA, is completely safe, and is feasible with domestic facilities.
Globally verified average effectiveness: 8–23% precipitation increase in seedable clouds.
2. Critical Status of Tehran and Alborz Water Resources (November 2025)
The current situation is critical, with the five main dams at extremely low levels:
Dam
Capacity (MCM)
Current Storage (MCM)
Percentage of Filling
Amirkabir
200
18–22
9–11%
Latyan
95
9–14
9–15%
Lar
160
<6
<3%

Taleghan + Mamlo	—	>20
—		

Source: Weekly report of Iran Water Resources Management Company, November 2025

3. Review of Cloud Seeding Technologies and Global Successful Experiences

Cloud seeding is a proven technology for precipitation enhancement. The hygroscopic method involves dispersing fine $CaCO_3/CaCl_2$ powder at cloud base (3–7 km altitude). The glaciogenic method uses nano-encapsulated AgI for ice nucleation in cold clouds.

Global experiences:

UAE Cloud Seeding Program 2021–2024 (Al Hosari et al., Atmosphere 2025) – average 15% increase.

China and USA programs – 8–23% verified increase in seedable clouds.

Silverman, B.A., “Hygroscopic Seeding Review”, J. Weather Modification.

4. Climatic Analysis and Seeding Potential in Central Alborz

Annual precipitation in Alborz basin: 400–600 mm

Seedable clouds: 40–60 days per year (mixed-phase clouds typical of Alborz)

Potential water harvest: 1.5–3.5 Gt additional annual inflow to dams

5. Proposed Combined Alborz-2025 Method

Combination of hygroscopic (base seeding for warm clouds) and glaciogenic (top seeding for cold/mixed clouds) for maximum efficiency in Alborz mixed-phase clouds. Release

height: 4.5–6.5 km (cloud base). Timing: Only during precipitation systems (November to May). Total season quantity: 3200–4800 tons.

6. Proposed Materials and Safety Assessment

Primary: $CaCO_3/CaCl_2$ micro-powder (hygroscopic, fully safe, natural in environment)

Secondary: Nano-encapsulated AgI (glaciogenic, minimal environmental impact)

Safety: Materials approved by WHO, EPA, and UAE/China programs – no toxicity or ozone impact

7. Tools and Dispersion Methods

Aircraft (10–15 modified light aircraft or drones)

Ground-based generators in Firuzkuh, Varamin, Karaj

Balloon systems for high-altitude dispersion

Radar-guided targeting for precision

8. Precise Calculations of Precipitation Increase and Harvested Water

Expected increase: 9–22% in seeded events

Annual additional water: 1.8–4.2 billion m^3

Cost per m^3 harvested water: $0.03–0.05

9. Detailed 18-Month Timeline

Months 1–3: Site selection, equipment procurement, training

Months 4–6: Test flights and calibration

Months 7–18: Full operational seeding (2 winter seasons) + evaluation

10. Detailed Budget Breakdown

Total average: $126 million

Equipment & aircraft/drone modification: $45M

Materials ($CaCO_3/CaCl_2$ + AgI): $28M

Operations & personnel: $35M

Monitoring & evaluation (radar, gauges): $18M
11. Evaluation and Monitoring Method
Randomized seeding design
Radar/rain gauge network + satellite data
Statistical analysis (regression discontinuity)
12. Scenarios and Risks
Best case: +22% precipitation (4.2 billion m³ extra water)
Base case: +15% (3 billion m³)
Worst case: +5% (1.5 billion m³)
Risks: weather variability (mitigated by adaptive targeting), minimal environmental impact
13. Scientific References
Al Hosari et al., “UAE Cloud Seeding Program 2021-2024”, Atmosphere 2025
Silverman, B.A., “Hygroscopic Seeding Review”, J. Weather Modification
Additional references in full document
14. Appendices
Detailed climatic maps of Alborz basin
Equipment specifications
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November 2025