

WATER QUALITY Assessment

of The Rain Enhancement Program in Thailand

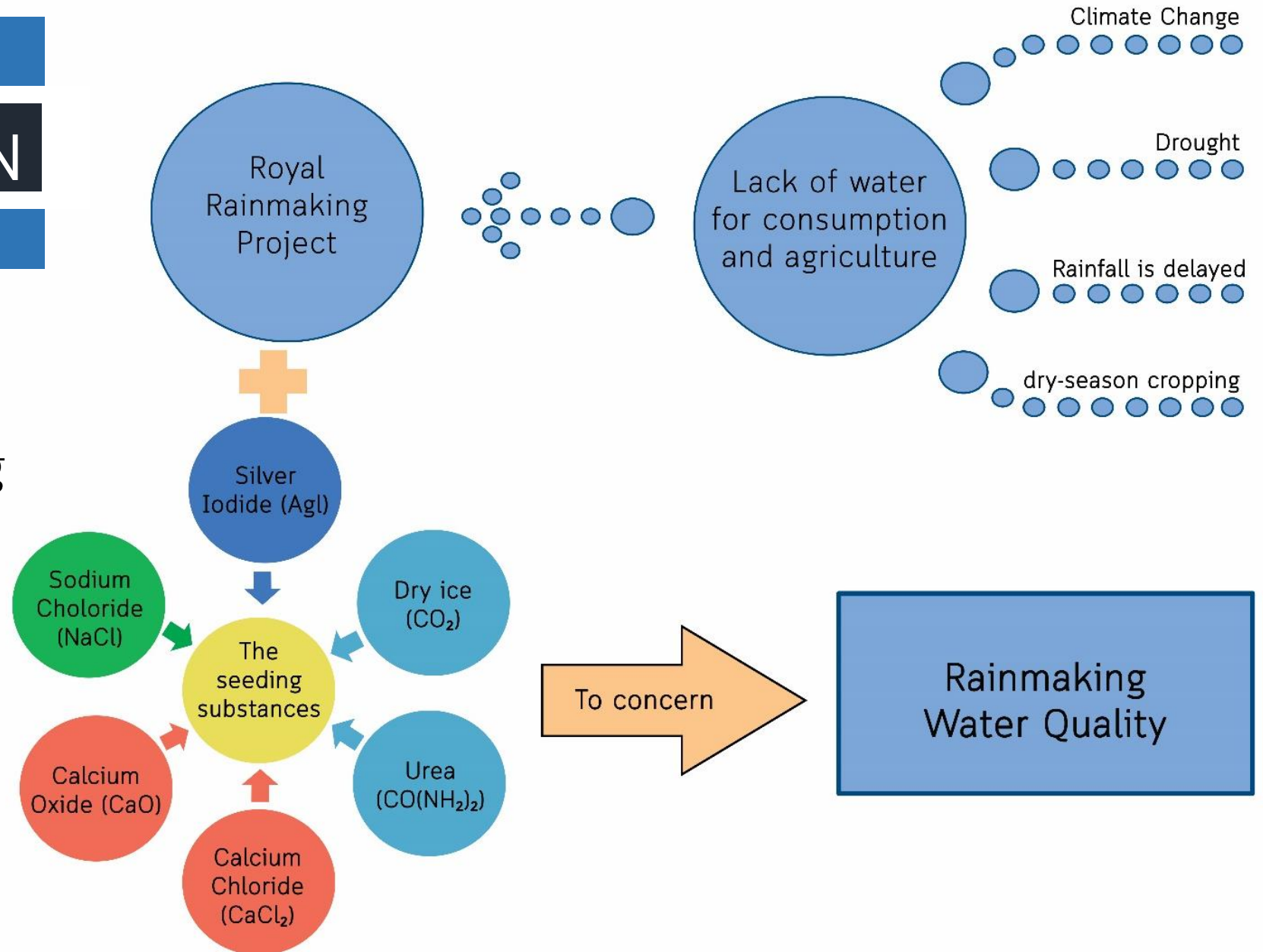


Supinya Boonchouy

Department of Royal Rainmaking and Agricultural Aviation,
Ministry of Agriculture and Cooperatives, Bangkok, 10900 Thailand

INTRODUCTION

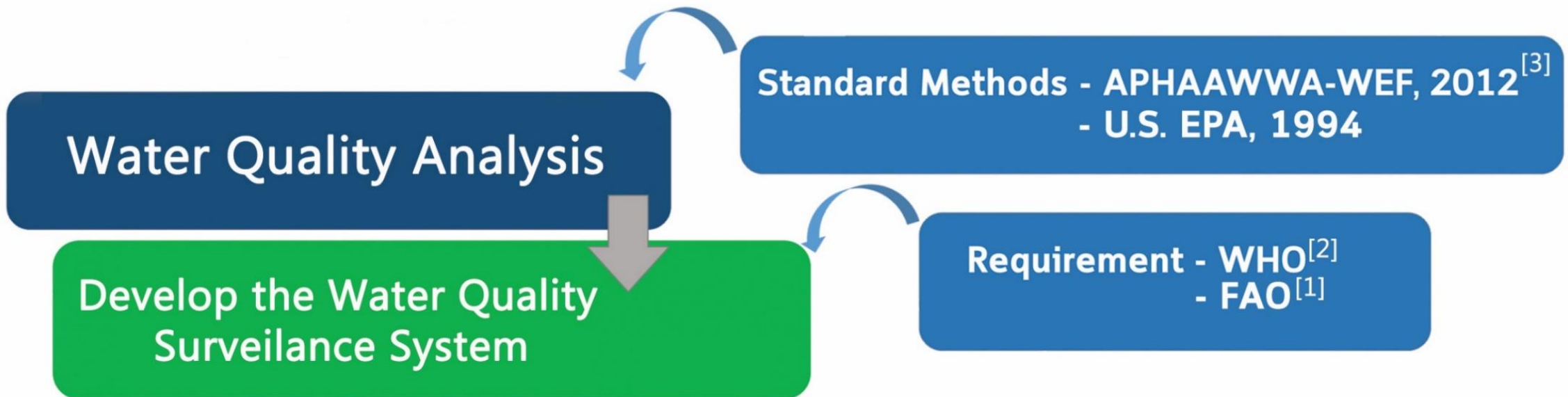
Accordingly, the usage of seeding substances raises *the concerns about water quality.*



METHODOLOGY



The samples of rainwater from 7 stations, 21 stations and 30 stations covering the whole country were collected in 2015, 2016 and 2017 respectively.



METHODOLOGY

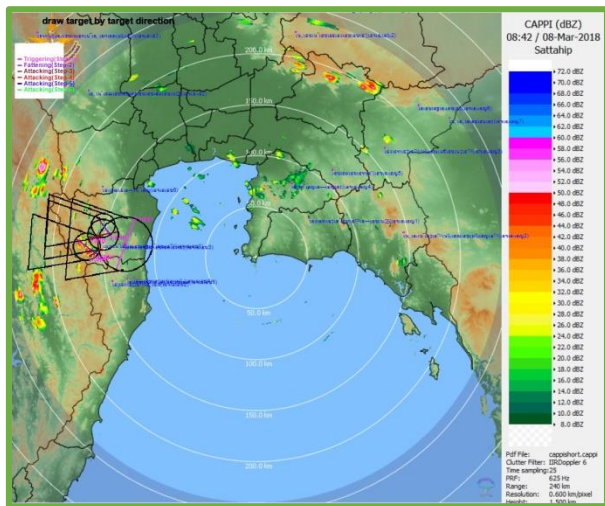
Criteria
of determining
rainwater
collection
stations

Located
in benefit
area

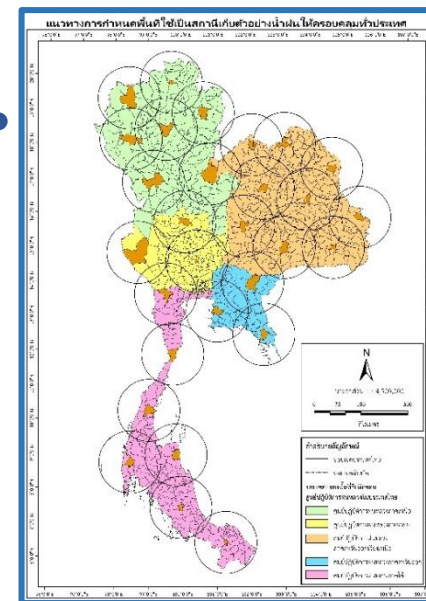
Monitored
by person
in charge

Covering
the whole
country

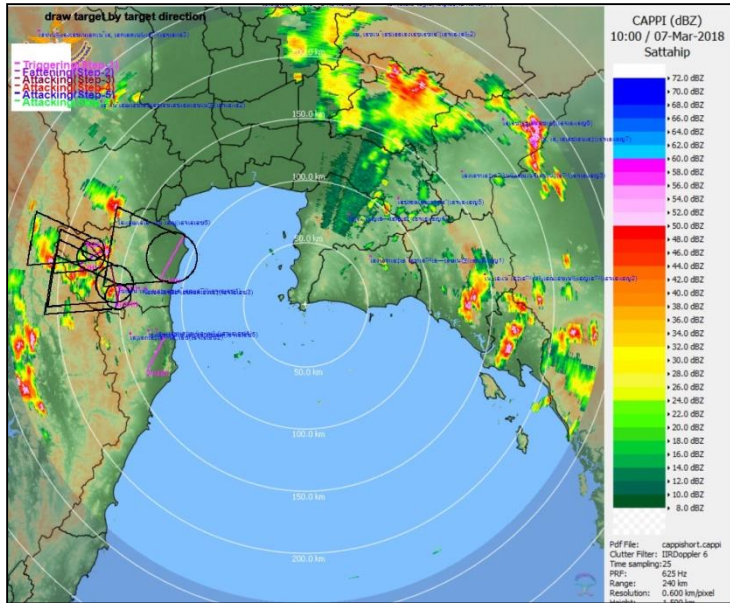
- Agricultural area
- Reservoir Basin



- Royal Rainmaking Volunteer
- Farmer
- Government official



METHODOLOGY



Operation map (Date 2018-03-07)

Mission /Steps	Seeding Time	Substance	Seeding Altitude : ft	Coordinates
1/1	11:10 – 11:33	NaCl (4/2)	6500/6000 ft.	N 12 51 E 99 53,- N 13 09 E 100 03 ,,
2/1	10:58 – 11:16	NaCl (4/2)	6,500 ft.	N 12 11 E 99 47,- N 12 26 E 99 55 ,,
3/2	13:57 – 14:21	CaO	8,500 ft.	N 12 57 E 99 17,- N 13 03 E 99 27 ,,
4/3	14:19 – 14:39	NaCl (4/2), Urea, Dry Ice	8000/6500 ft.	N 13 07 E 99 20,- N 13 00 E 99 26 ,,
5/2	15:35 – 15:52	CaO	8,500 ft.	N 12 48 E 99 35,- N 12 38 E 99 33 ,,
6/3	15:42 – 16:00	NaCl (4/2), Urea, Dry Ice	8000/6500 ft.	N 12 41 E 99 34,- N 12 56 E 99 31 ,,

Weather Radar Data

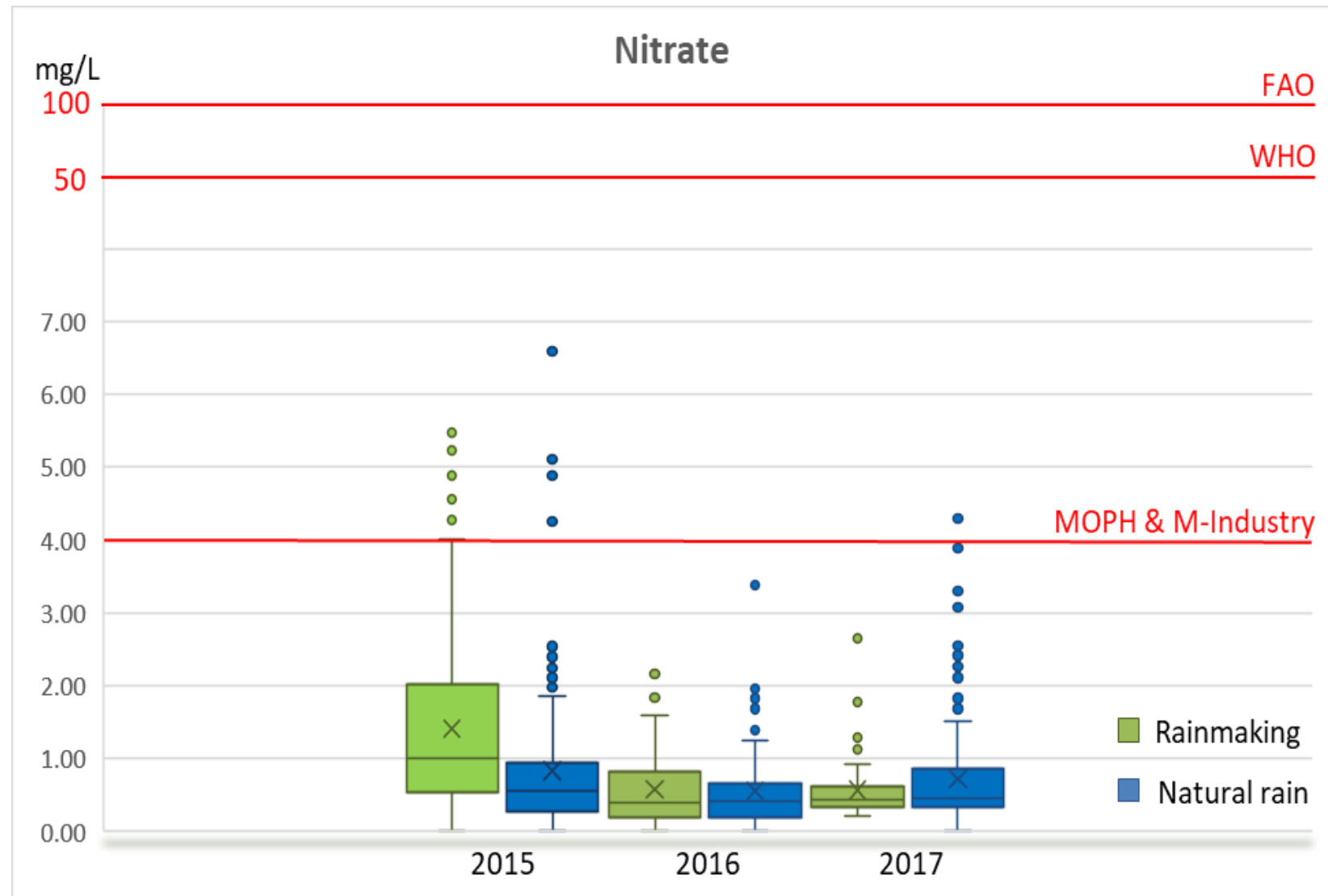
The Royal Rainmaking Operation Report System

Parameters	Unit	2015		2016		2017		Guideline of Quality Water			
		Royal	Natural	Royal	Natural	Royal	Natural	FAO	WHO	MOPH	M-Industry
		Rainmaking	Rain	Rainmaking	Rain	Rainmaking	Rain				
1. Color	Platinum-cobalt	0.56	0.36	0.23	0.34	0.34	0.43	-	15	20	5
2. pH - Value	-	6.24	6.03	5.81	5.80	5.83	5.92	6.5 – 8.4	-	6.5 – 8.5	6.5 – 8.5
3. Conductivity	µS/cm	8.86	4.95	6.14	6.07	10.49	10.50	700	-	-	-
4. Total Dissolve Solid	mg/L	4.10	2.47	2.91	2.91	4.85	4.86	450	1,000	500	500
5. Hardness	mg/L (as CaCO ₃)	ND	ND	ND	ND	8.36	9.40	-	-	100	100
6. Acidity	mg/L (as CaCO ₃)	1.09	1.11	1.00	1.00	-	-	-	-	-	-
7. Alkalinity	mg/L (as CaCO ₃)	4.92	175	4.00	4.00	-	-	-	-	-	-
8. Chloride	mg/L	1.66	1.44	0.72	0.88	0.31	0.30	105	250	250	250
9. Nitrate	mg/L	0.93	0.55	0.43	0.42	0.43	0.45	100	50	4.0	4.0
10. Nitrite	mg/L	ND	ND	ND	ND	ND	ND	10	3	4.0	4.0
11. Sulfate	mg/L	0.90	0.70	0.32	0.39	0.34	0.39	-	250	250	200
12. Ammonium	mg/L	0.90	0.57	0.42	0.36	0.26	0.29	-	-	-	-
13. Sodium	mg/L	-	-	-	-	0.10	0.11	69	-	-	-
14. Magnesium	mg/L	ND	ND	0.06	0.08	0.06	0.06	-	-	-	-
15. Calcium	mg/L	1.08	0.50	0.33	0.31	0.31	0.44	-	-	-	-
16. Boron	µg/L	-	-	-	-	1.50	1.61	700	2,400	-	-
17. Chromium	µg/L	0.10	1.35	ND	0.07	ND	ND	0.1	50	50	50
18. Iron	µg/L	1.50	1.51	ND	ND	0.54	1.33	5	0.3	300	300
19. Copper	µg/L	0.79	1.09	2.00	0.50	0.87	1.60	200	2,000	100	100
20. Silver	µg/L	0.33	0.23	ND	0.10	ND	0.8	-	-	50	-
21. Lead	µg/L	0.32	0.24	ND	0.60	ND	ND	5	10	50	50
22. Mercury	µg/L	0.15	0.18	ND	ND	0.67	1.00	10	6	1	1

RESULTS

Nitrate (mg/L)	2015		2016		2017	
	R	N	R	N	R	N
Min	0.17	0.12	0.02	0.01	0.21	0.06
Max	5.48	6.60	2.17	3.38	2.64	4.34
Mean	1.59	1.05	0.63	0.58	0.57	0.75
Med	1.18	0.67	0.43	0.4	0.43	0.46
SD	1.30	1.05	0.58	0.55	0.41	0.72
FAO			100			
WHO			50			
MOPH			4			
M-Insustry			4			

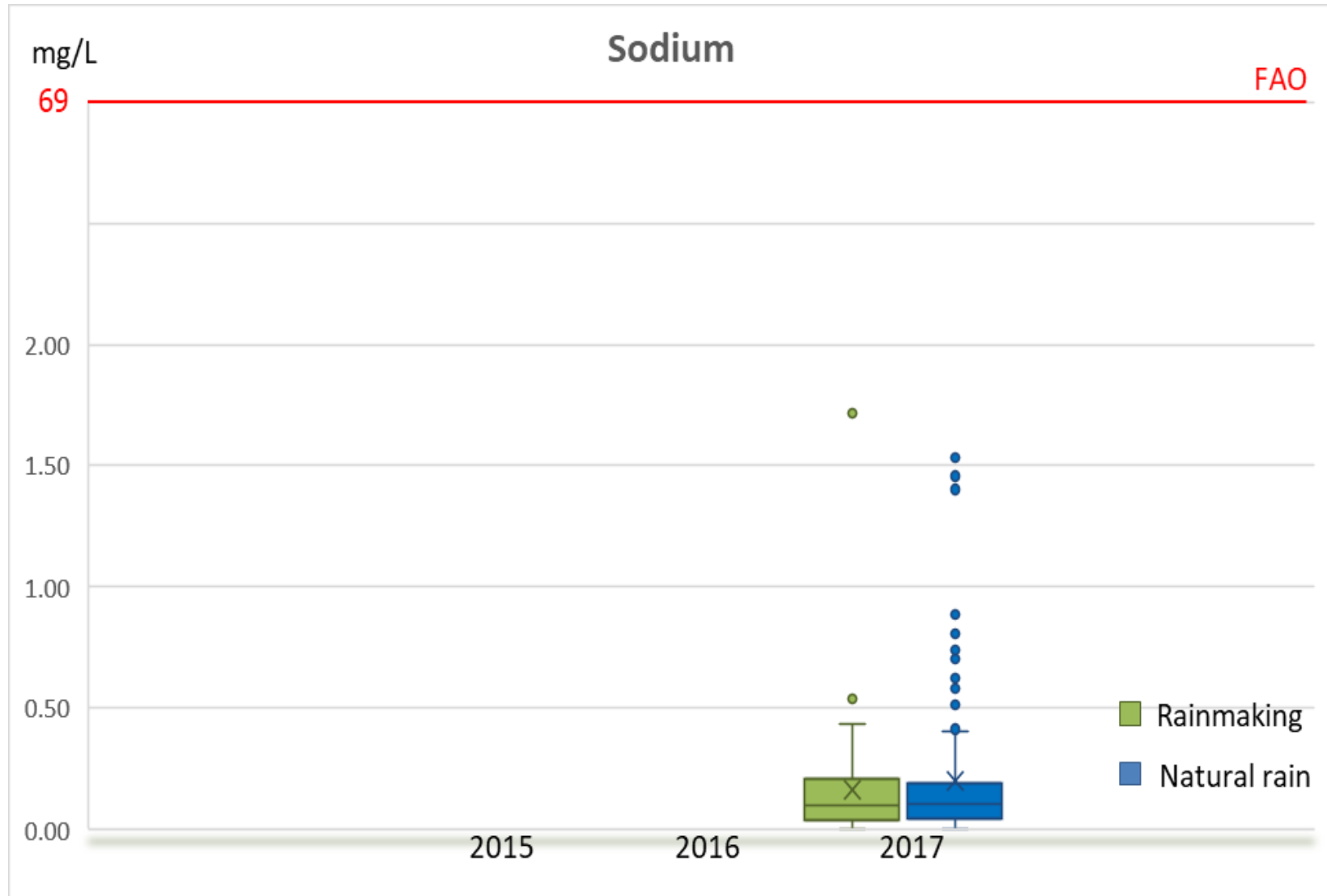
Note R = Royal rainmaking samples
N = Natural rainwater samples



RESULTS

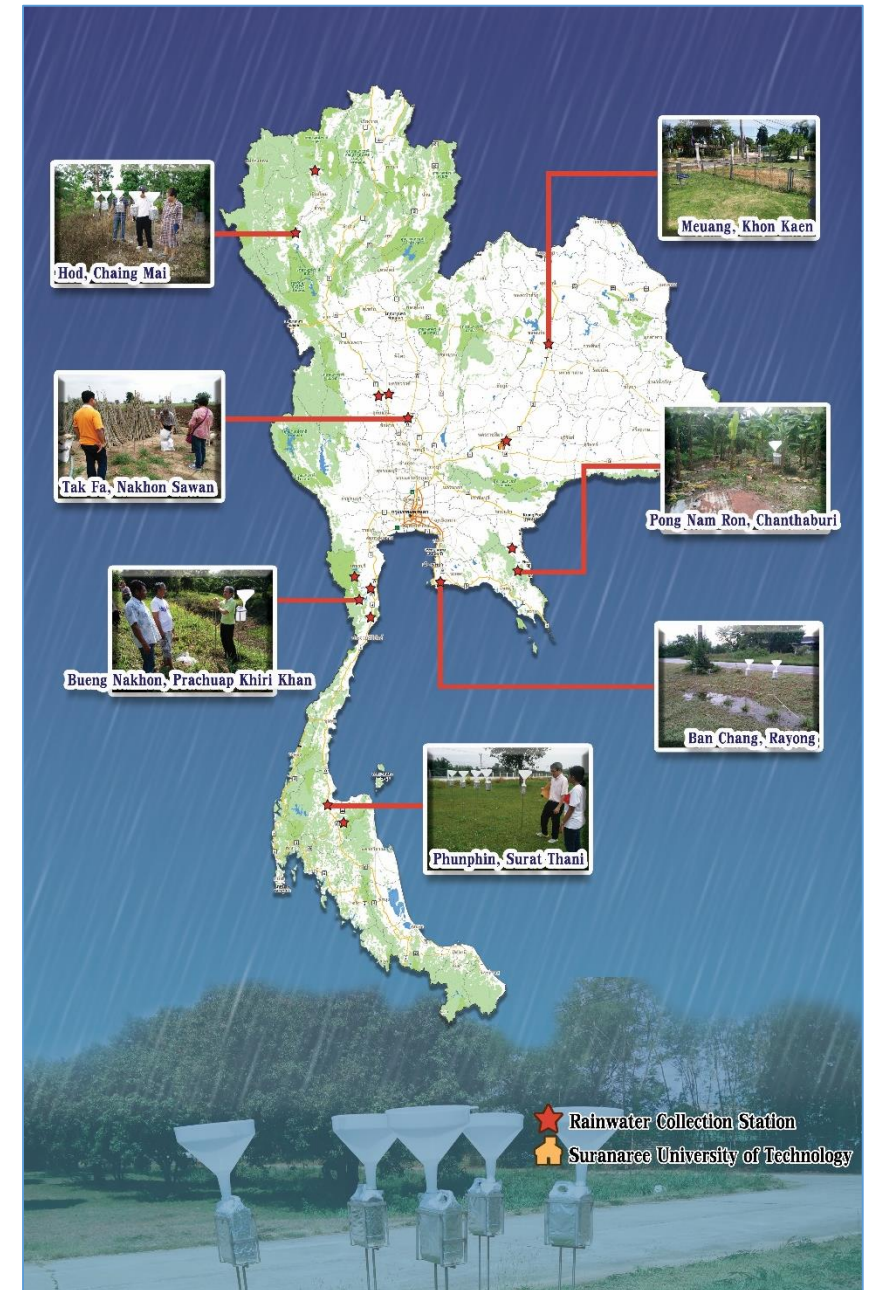
Sodium (mg/L)	2015		2016		2017	
	R	N	R	N	R	N
Min	-	-	-	-	0.01	0.00
Max	-	-	-	-	1.71	6.95
Mean	-	-	-	-	0.18	0.23
Med	-	-	-	-	0.10	0.12
SD	-	-	-	-	0.25	0.55
FAO			69			
WHO			-			
MOPH			-			
M-Insustry			-			

Note R = Royal rainmaking
N = Natural rain



RESULTS

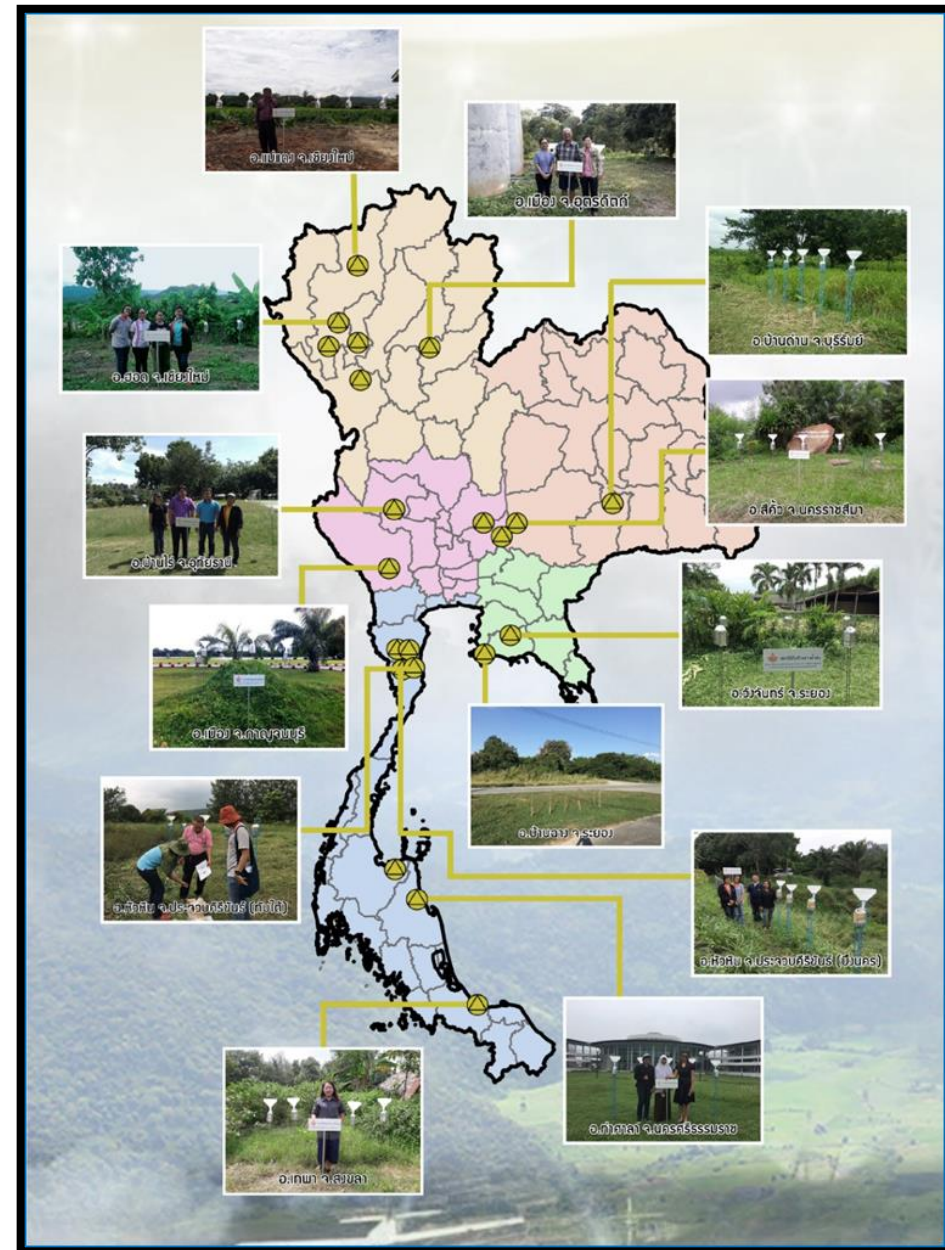
Year	No. of Stations	No. of Samples		
		Royal Rainmaking	Natural Rain	Total
2015 (Mar - Sep 2015)	7	47	73	120
Requirement	WHO	Pass	Pass	Pass
	FAO	Pass	Pass	Pass
	MOPH	Pass	Pass	Pass
	M-Industry	Pass	Pass	Pass



7 Stations in 2015

RESULTS

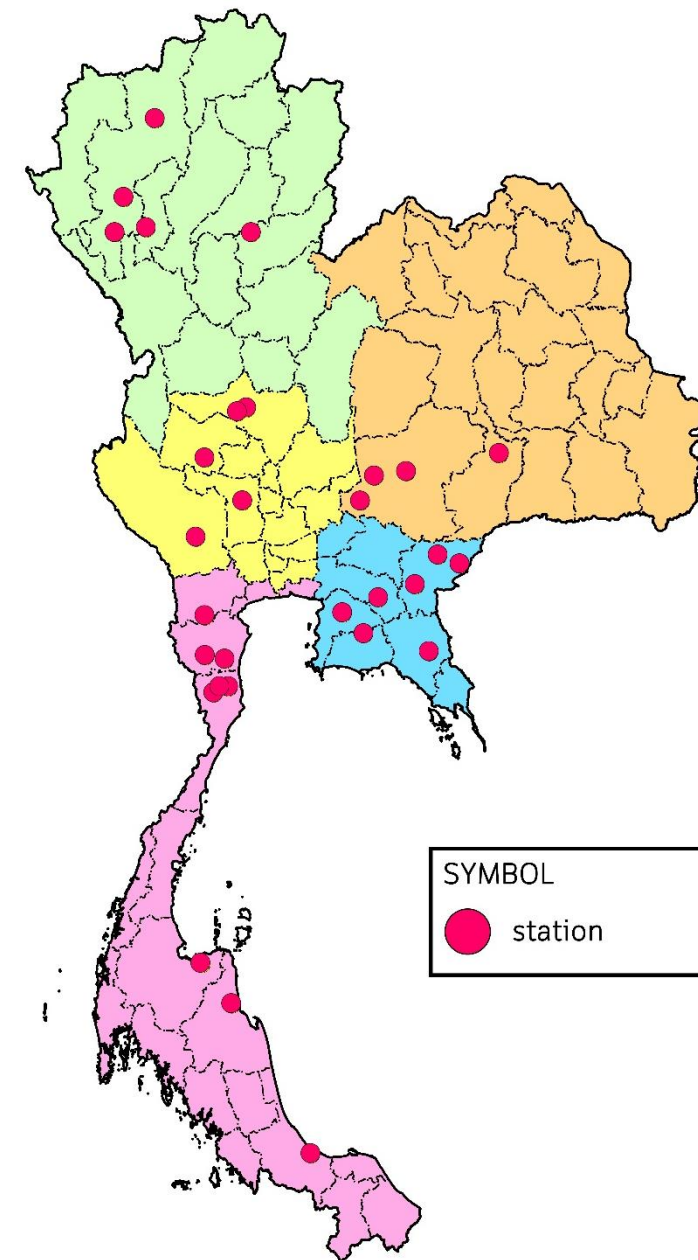
Year	No. of Stations	No. of Samples		
		Royal Rainmaking	Natural Rain	Total
2016 (Aug - Nov 2016)	21	30	104	134
Requirement	WHO	Pass	Pass	Pass
	FAO	Pass	Pass	Pass
	MOPH	Pass	Pass	Pass
	M-Industry	Pass	Pass	Pass



21 Stations in 2016

RESULTS

Year	No. of Stations	No. of Samples		
		Royal Rainmaking	Natural Rain	Total
2017 (Jul 2017 - Mar 2018)	30	58	216	274
Requirement	WHO	Pass	Pass	Pass
	FAO	Pass	Pass	Pass
	MOPH	Pass	Pass	Pass
	M-Industry	Pass	Pass	Pass



30 Stations in 2017

RESULTS

Outstandingly, the overall water quality of the Royal Rainmaking and natural rain samples were in accordance with the standard of the recommended figures.

International Standards

- WHO ; Guidelines for Drinking-water Quality
- FAO ; Water Quality for Agriculture, Irrigation and Drainage Paper 29

Thai Standards

- MOPH ; No.135 - Drinking Water in Sealed Container
- M-Industry ; Thai Industry Standard - Drinking Water.

ON GOING ACTIVITIES

- We have continually monitored the water quality monitoring system to ensure that people can get access to good water quality for consumption and agricultural use.
- The chemical laboratory has been set up to develop water quality monitoring system.



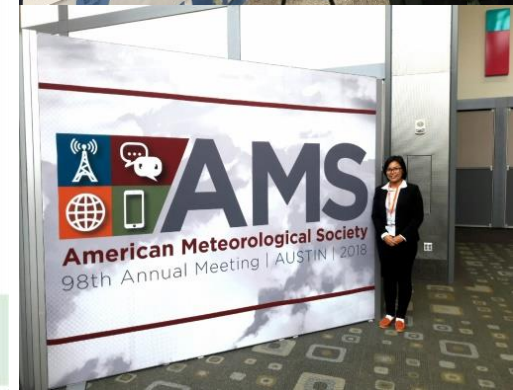
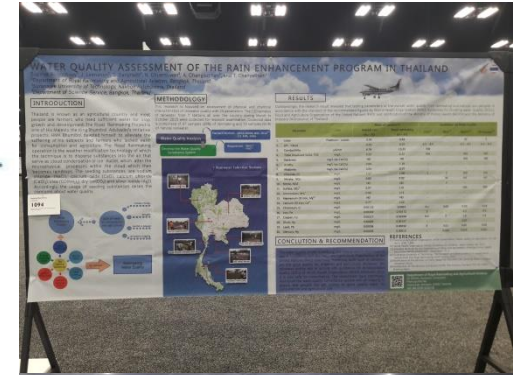


AMERICAN METEOROLOGICAL SOCIETY

45 BEACON STREET, BOSTON, MA 02108-3693 U.S.A.

TEL: 617-227-2425
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Poster Session P2: No. 1094, Wednesday, 10 January 2018

“Water Quality Assessment of The Rain Enhancement Program in Thailand”

WATER QUALITY ASSESSMENT OF THE RAIN ENHANCEMENT PROGRAM IN THAILAND
 Supinya Boonchouy¹, J. Leenanon¹, S. D. ...
¹Department of Royal Rainmaking and Agricultural Aviation, ...
²Suranaree University of Technology, Nakhon Ratchasima, Thailand
³Department of Science Service, Bangkok, Thailand

INTRODUCTION
 Thailand is known as an agricultural country and most people are farmers who need sufficient water for crop growth and development. The Royal Rainmaking Project is one of His Majesty the King Bhumibol Adulyadej's ...

METHODOLOGY
 This research is focused on assessing the characteristics of rainwater quality with recorded figures by World Health Organization (WHO) Guidelines for Drinking Water Quality (2011) ...

RESULTS

No.	Parameter	Unit	Mean of samples ¹⁾		Guidelines for Water Quality		
			Natural rain ²⁾ (n = 73)	Enhanced rain ³⁾ (n = 73)	FAO ⁴⁾	WHO ⁵⁾	M-Industry ⁶⁾
1.	Color	PCU	0.54	0.54	-	20	5
2.	pH- Value	-	6.01	6.19	6.5 - 8.4	-	6.5 - 8.5
3.	Conductivity	µS/cm	6.76	13.23	700	-	-
4.	Total Dissolved Solid, TDS	mg/L	5.22	6.32	450	500	500
5.	Hardness	mg/L (as CaCO ₃)	ND	ND	-	100	100
6.	Calcium, Ca	mg/L	1.18	1.18	-	-	250
7.	Magnesium, Mg	mg/L	0.82	0.82	-	50	4.0
8.	Nitrate, NO ₃	mg/L	0.01	0.01	-	3	4.0
9.	Nitrite, NO ₂	mg/L	0.01	0.01	-	250	200
10.	Ammonium, NH ₄	mg/L	0.82	1.11	-	-	-
11.	Magnesium Hardness ⁷⁾	mg/L	ND	ND	-	-	-
12.	Iron, Fe	mg/L	0.0001	1.62	0.1	0.05	0.05
13.	Copper, Cu	mg/L	0.00269	0.00172	5	-	0.3
14.	Silver, Ag	mg/L	0.00217	0.00106	0.2	2	1.0
15.	Lead, Pb	mg/L	0.00029	0.00167	-	-	0.05
16.	Chloride, Cl	mg/L	0.00038	0.0032	5	0.01	0.05
17.	Sulfate, SO ₄	mg/L	0.00015	0.0015	-	0.006	0.002
18.	Fluoride, F	mg/L	0.00015	0.0015	-	-	0.001

CONCLUSION & RECOMMENDATION
 The water quality of rainmaking and natural rain in this research ...

REFERENCES
 1. Department of Royal Rainmaking and Agricultural Aviation, ...
 2. WHO, Guidelines for Drinking Water Quality, 2011.
 3. ...
 4. ...
 5. ...
 6. ...
 7. ...

Department of Royal Rainmaking and Agricultural Aviation
 90 (Wilson) Road
 Chachoengsao 24
 Chachoengsao, Bangkok 10900 Thailand
 Tel: +66 2109 5100-18



THANK YOU