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Estimation of Internal Exposure Doses of the Public Caused by Inhaled Radioactive Materials Released in Early Stage of Fukushima Nuclear Disaster

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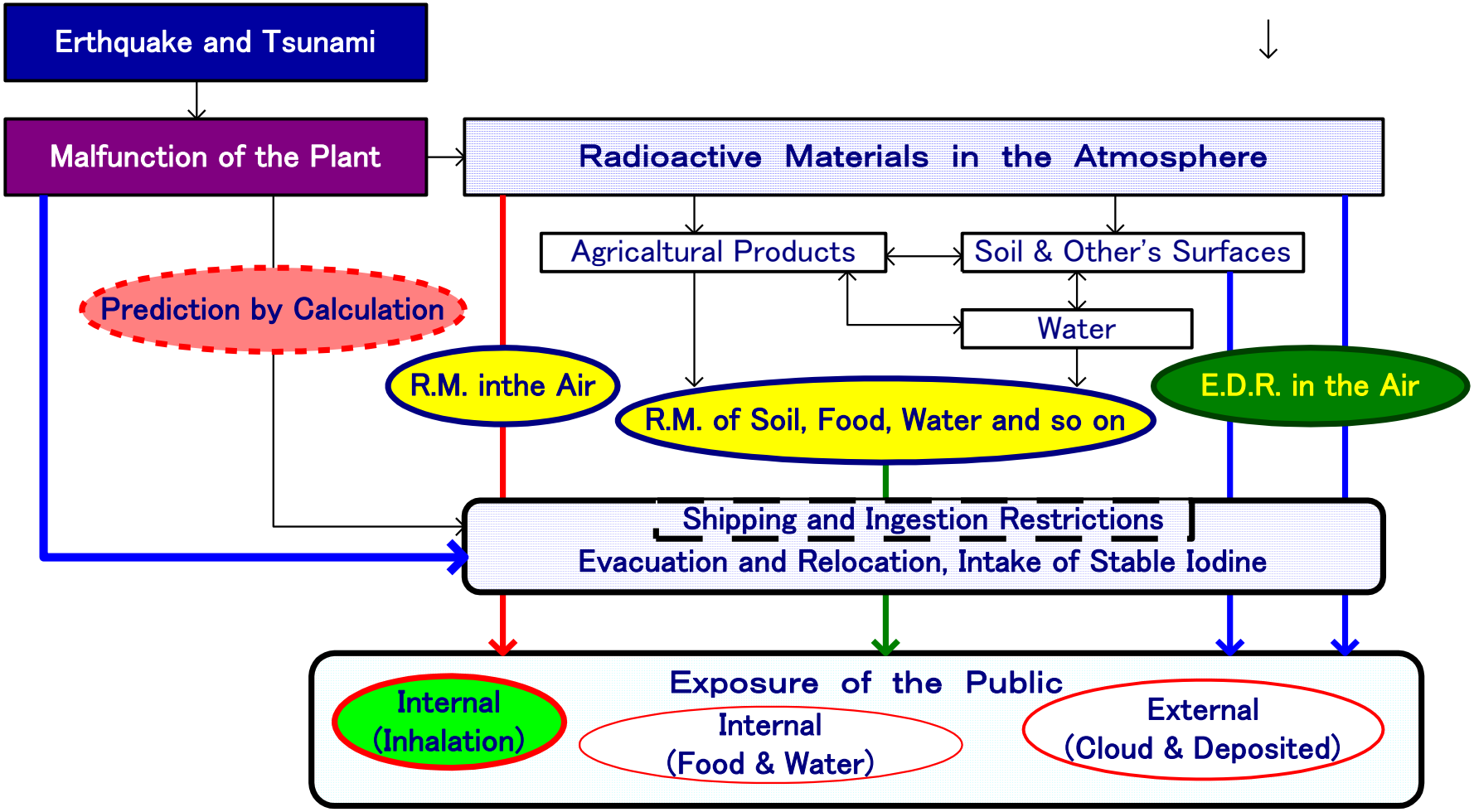
Nuclear Disaster was occurred on March 11, 2011 at Fukushima No1 N.P.P.

Difficulties in Getting Radiological Information

- Difficulty of management of the offsite countermeasure center prepared in advance.
- Malfunction of radiation monitoring system and failure of utilization of calculating prediction system.
- Difficulties to access to the disaster area including telecommunication system.

Radiation information needed for planning countermeasures



Purposes of the present work

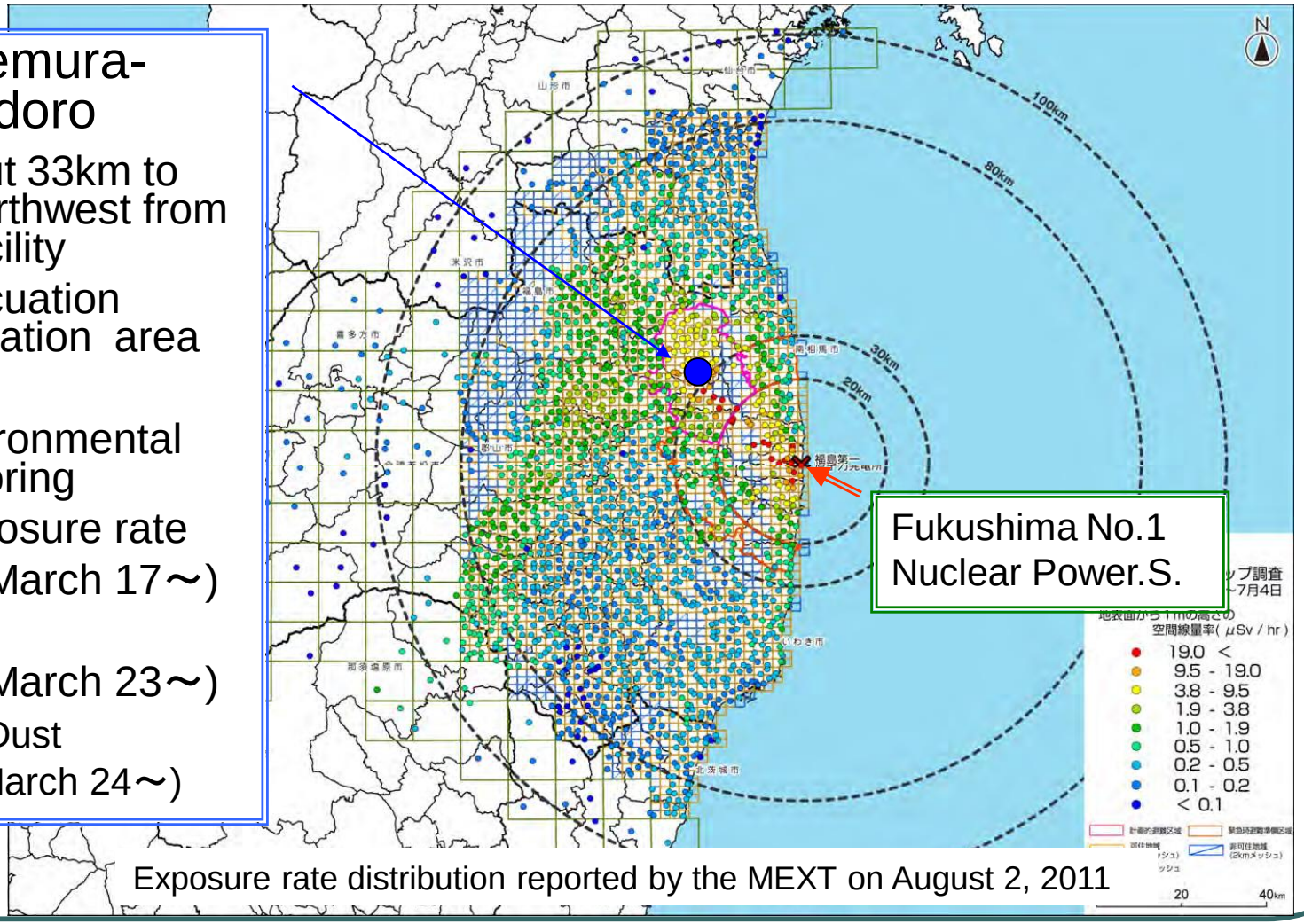
- Estimation of radioactivities in the air in early stage of the Fukushima nuclear accident on the basis of the soil radioactivities monitored at about 33km to the northwest from the facilities in the evacuation preparation area.
- Estimation of Internal doses by inhaling I-131, Cs-134 and Cs-137 on the basis of the radioactivies in the air on the assumption that the people were living indoors and outdoors during passing through the plume.

The place chosen for evaluation of the internal exposure

Iidaremura-nagadoro

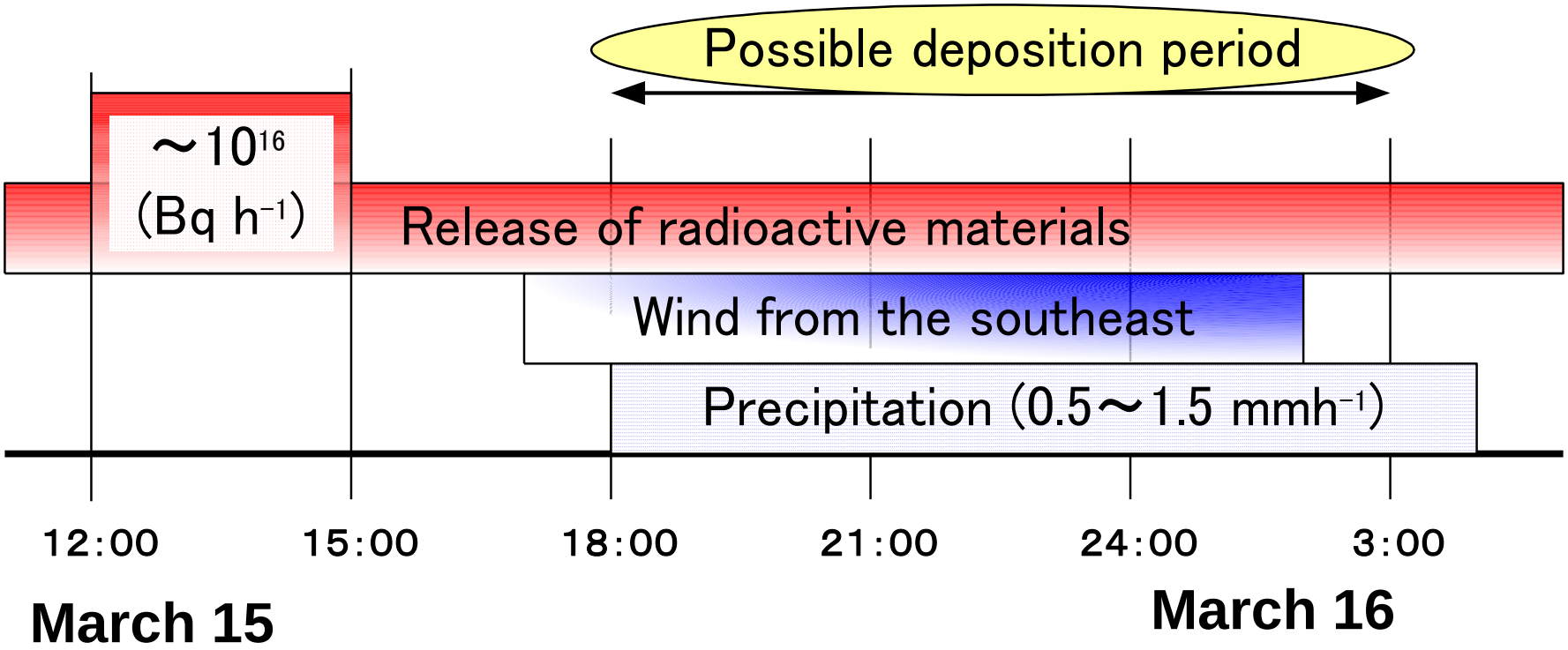
- about 33km to the northwest from the facility
- Evacuation preparation area

- Environmental monitoring
  - Exposure rate (March 17～)
  - Soil (March 23～)
  - Air Dust (March 24～)

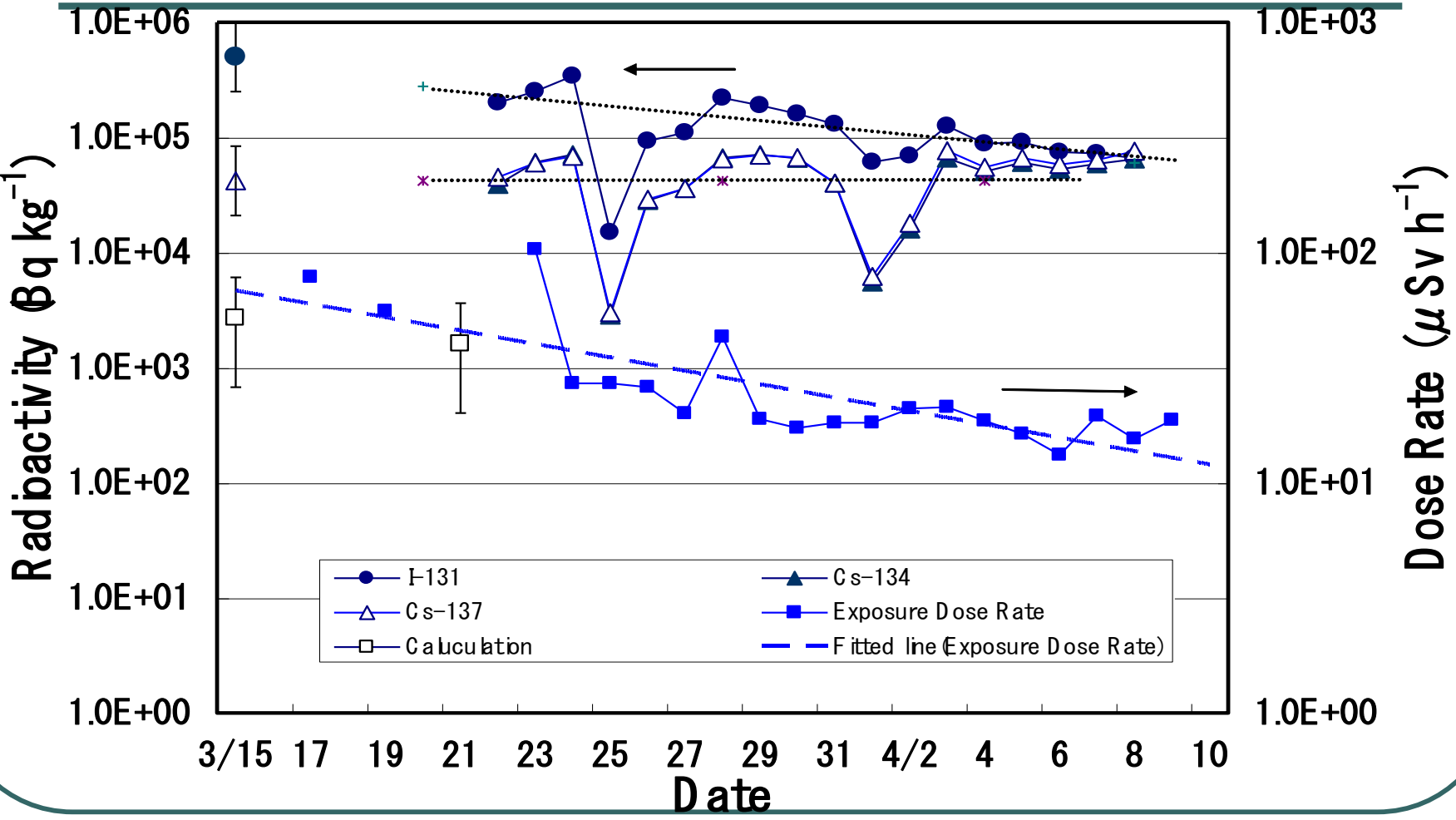


Exposure rate distribution reported by the MEXT on August 2, 2011

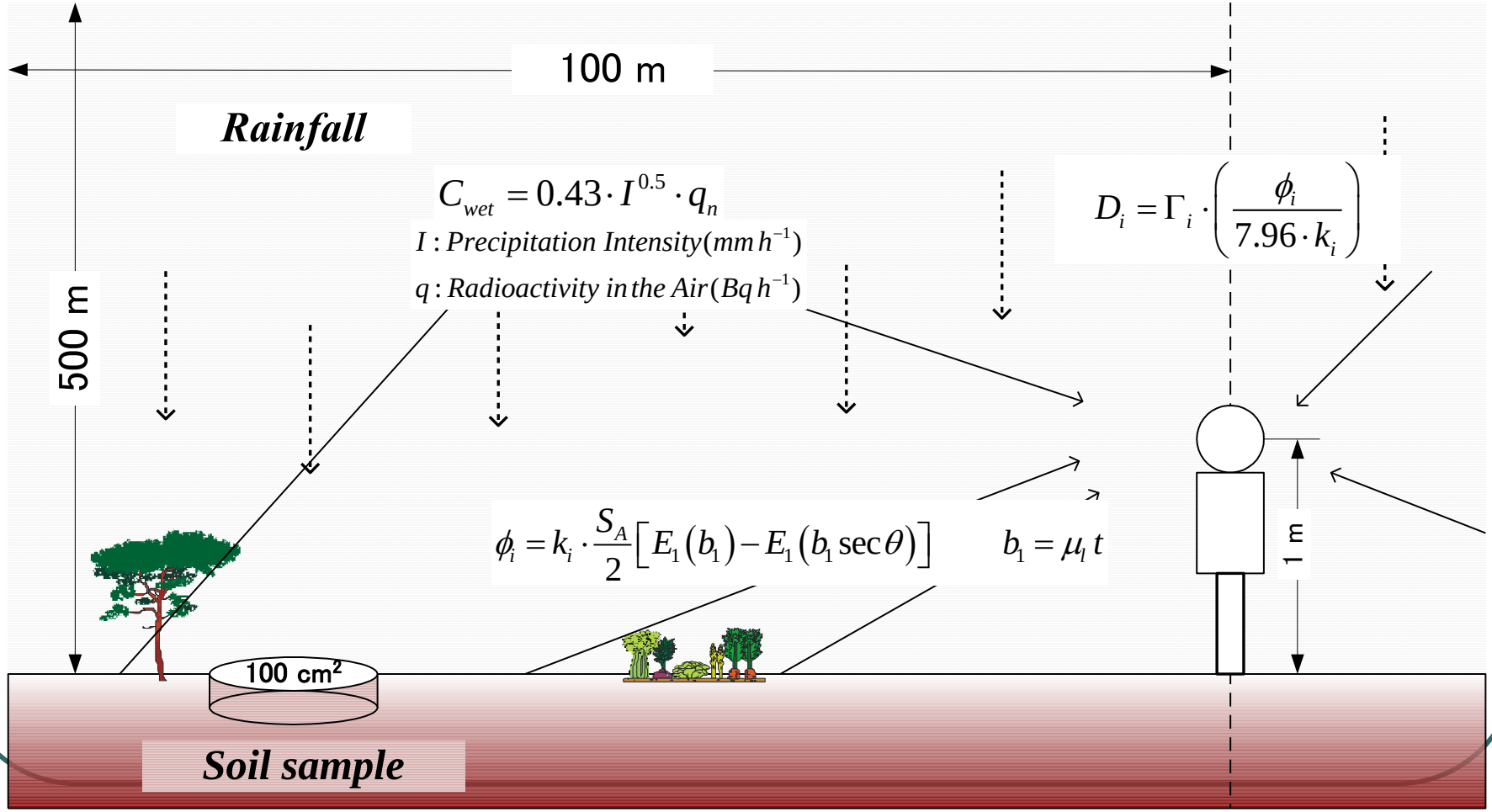
Time chart to show the possible period of the main contamination



Radioactivities on the ground surface and external dose rates



Relation between external dose rates and radioactivities in the air

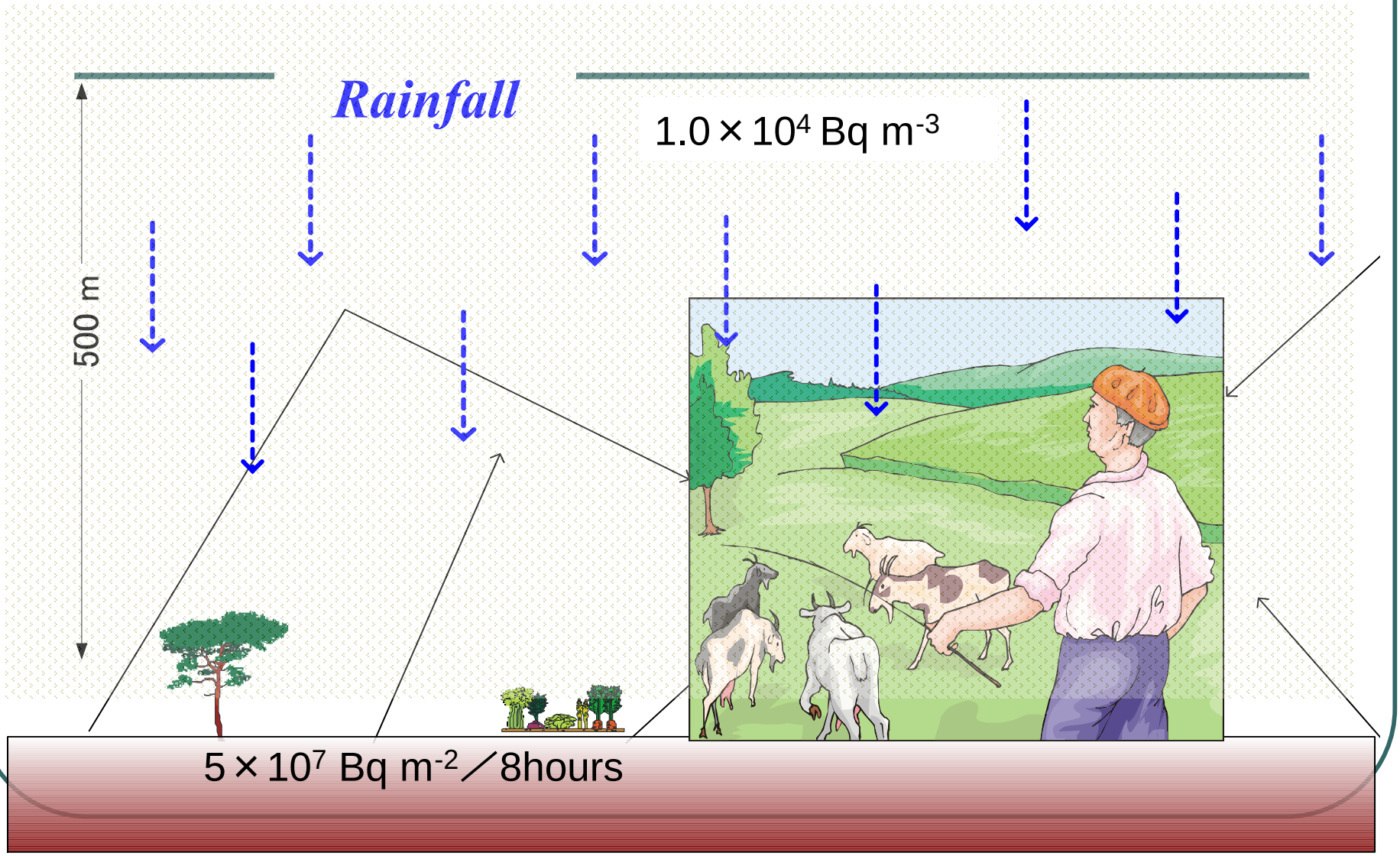


Radioactivity in the Air
(without precipitation washout)

	I-131 ($T_{\frac{1}{2}} = 8.04d$)	Cs-134 ($T_{\frac{1}{2}} = 2.06y$)	Cs-137 ($T_{\frac{1}{2}} = 30.2y$)
soil(Bq kg^{-1})	$5(3\sim10)\times10^{5}$	$4(2\sim8)\times10^{4}$	
ground surface(Bq m^{-2})	$5(2\sim15)\times10^{7}$	$4(2\sim12)\times10^{6}$	
exposure dose rate(μSv h^{-1})	$2(1\sim6)\times10^{1}$	$2(1\sim7)\times10^{1}$	$9(3\sim27)\times10^{0}$
WSPEEDI calc. G.S. (Bq m^{-2})*	$9(3\sim27)\times10^{7}$	-	
radioactivity in the air(Bq m^{-3})	$2(1\sim6)\times10^{4}$	$2(1\sim6)\times 10^{3}$	

*Assuming 3×10^{16} Bq of I-131 was released during 8 hours.

Radioactivities in the air during rainfall



Intake rates and Internal dose rates caused by inhalation of I-131, Cs134 and Cs137

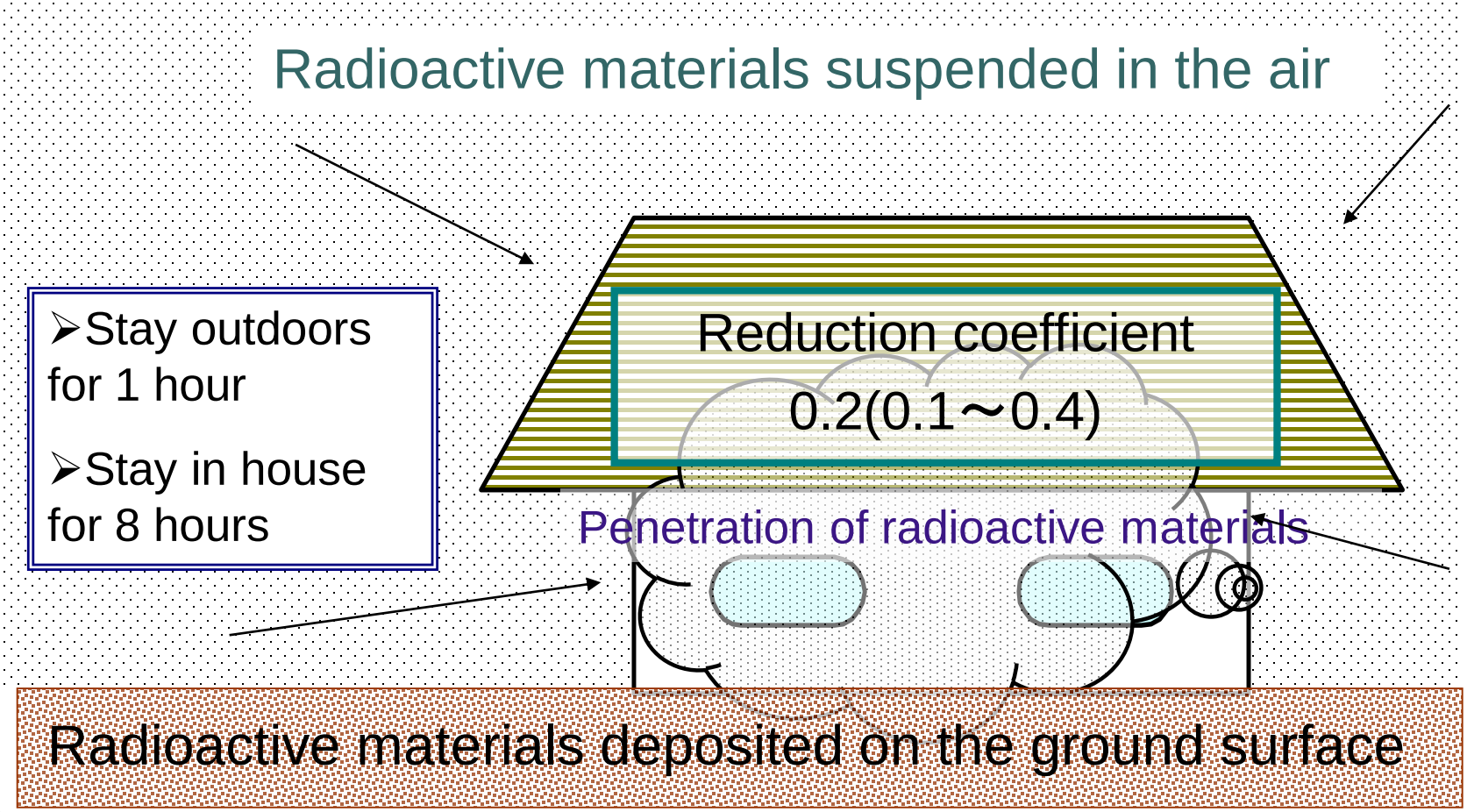
(from 18:00 pm on March 15 to 3:00 am on March 16)

	I-131		Cs-134 or Cs-137		Res. Rate ($m^3\ h^{-1}$)
	Radioactivity* (Bqm^{-3})	Intake (Bqh^{-1})	Radioactivity* (Bqm^{-3})	Intake (Bqh^{-1})	
adults	1.0×10^4	9.2×10^3	8.5×10^2	7.9×10^3	9.3×10^{-1}
children (1)		3.6×10^3		3.1×10^2	3.6×10^{-1}

*Washing ratio was assumed to be 0.53 h^{-1}.

	I-131		Cs-134	Cs-137
	Equivalent dose ($mSv\ h^{-1}$)	Effective dose ($mSv\ h^{-1}$)	Effective dose ($mSv\ h^{-1}$)	
adults	2.6×10^0	1.4×10^{-1}	1.6×10^{-2}	3.1×10^{-2}
children (1)	5.0×10^0	2.5×10^{-1}	2.0×10^{-2}	3.1×10^{-2}

Inhalation of radioactive materials during staying indoors and outdoors
(from 18:00 pm on March 5 to 3:00 am on March16)



Total Internal exposure doses caused by inhalation of I-131, Cs-134, Cs-137
(from 18:00 pm on March 15 to 3:00 am on March 16)

	I-131		Cs-134	Cs-137
	Equivalent dose (mSv)	Effective Dose (mSv)	Effective dose (mSv)	
adults	$7(3\sim22)\times10^{0}$	$4(2\sim12)\times10^{-1}$	$1.2(0.6\sim4)\times10^{-1}$	
children (1)	$1.3(0.6\sim4)\times10^{1}$	$7(3\sim21)\times10^{-1}$	$1.3(0.6\sim4)\times10^{-1}$	

Conclusions

- The radioactivities of I-131, Cs-134 and Cs-137 in the air, from 18:00 pm on March 15 to 3:00 am on March 16, were obtained as 1×10^4 Bqm^{-3} for I-131 and 8.5×10^2 Bqm^{-3} for Cs-134 and Cs-137 within an error of factors 2 or 3.
- Adults and children would receive thyroid equivalent doses of 3～22 mSv and 6～40 mSv, respectively. And effective doses by I-131 were about 0. 2～1.2 mSv for adults and 3～21 mSv for children, and those by both Cs-134 and Cs-137 were 0.6～4 mSv for adults and children.
- It was become clear that the protective actions to deduce thyroids equivalent doses for children was the most important in the early stage of the Fukushima nuclear accident.

Thank you for your time you attentioned !