Climate Change and its Impact on Flood (JNCID-INWEPF)

Flood caused by climate change was so huge and visibly destructive that there was no time to countermeasure. Moreover no body know where and when such a flood occurs again. Therefore infrastructure for flood mitigation should be properly constructed in advance for safety.

Professor of CNU in Korea
Vice president in ICID

Tai Cheol Kim

March 15, 2012 WWF-6
Marseille, France

Upgrading design criteria to cope with extreme flood and Reinforcing emergency spillway in irrigation dam

We had 870.5 mm/day of rainfall corresponding to Probable Maximum Precipitation (PMP) by typhoon Rusa on Aug. 31, 2002 at Sungju area. It seemed such heavy storm was caused by climate change. We've never experienced such huge storm and serious flood before. So far it has been emphasized to reduce flood damage by non-structural measures such as flood forecasting system, early release, catchment management, retention pond, and evacuation plan, etc.

Sung-ju dam, CA = 150km^2 , V = 38,240,000㎥

Gangreung dam, CA = 109km^2 V = 14,350,000㎥

Thousands of resident living in down stream of dams were evacuated.

People watching devastating moment of 50cm dam crest left and coming near overtopping and earth-fill dam breaking in a real time on nationwide TV so scared and realized non-structural approach was not that sufficient against such extreme flood. Some consensus was naturally formed on government's strategy to reinforce infrastructure. Normally it is very difficult to upgrade design criteria because of expensive cost.

123 irrigation dams destroyed by typhoon Rusa in 2002

Upgrading flood design criteria

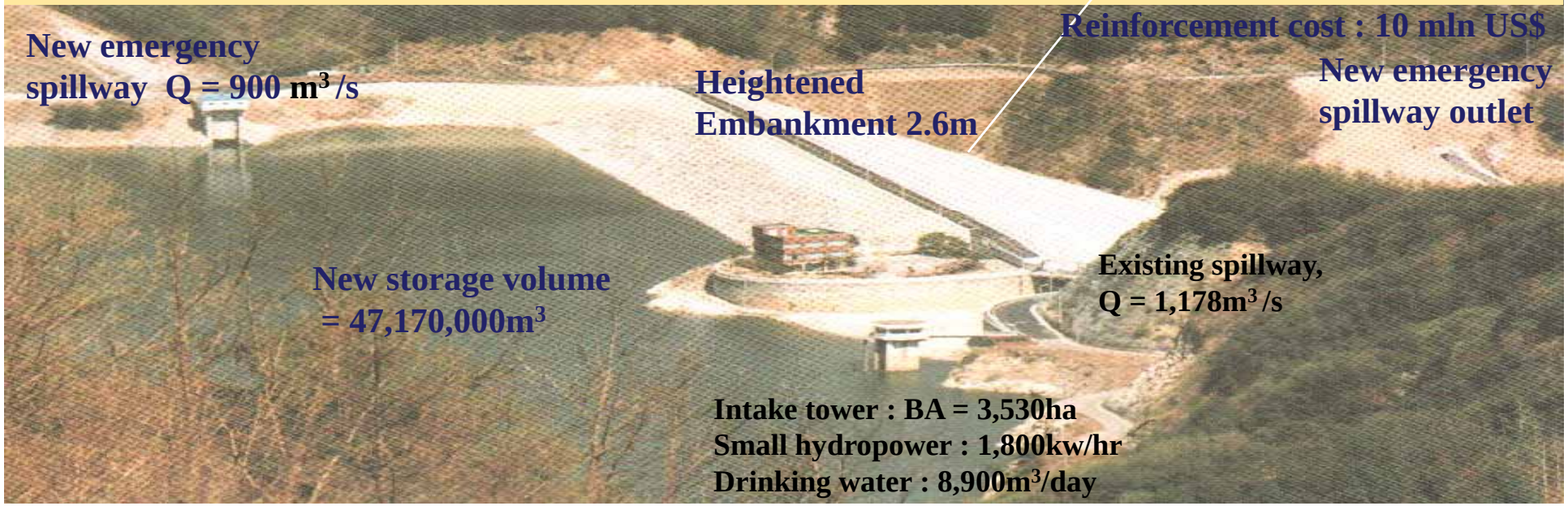
Due to such a consensus, Ministry of Agriculture concluded upgrading design criterion to cope with such extreme flood. *Probable Maximum Flood* (PMF) instead of existing 200 years frequency has been approved to irrigation dam with storage capacity over 5 mln m^3 and watershed area larger than 25km^2 by the technical committee.

Reinforcing irrigation dam spillway

Flood damage we have experienced was so visibly devastating. Therefore constructive infrastructure adapted to climate change and flood has not only strategically been planned, but also practically been executed. Such upgrading design criteria and reinforcing emergency spillway was not intentionally made, but eventually it was made to adapt to climate change.

Sung-ju irrigation dam reinforced by PMF in 2003

PMF has almost double/triple bigger discharge than 200yrs. freq. and so it should be applied carefully even under upgraded criteria. Such structure is safe but expensive.



Managed by KRC	Design rainfall (mm)		Watershed	Design flood(m3/s)		Reservoir WL(El.m)		Designed WL(El.m)		Hydrological check for stability				measure	Unit FD(㎥/s/㎢)	
	200yr.	PMP	area(km2)	200yr.	PMF	Dam crest	HWL	200yr.	PMF	200yr. (HWL)	200yr. (Free board)	PMF (HWL)	PMF (Free board)		200yr.	PMF
Heungduk	269.2	931	44	455.8	1,314	15.20	12.43	12.22	14.43	safe	safe	unsafe 2.0m	unsafe 1.23m	proposed	10.3	29.8
Gosam	369.1	807	71	691.0	1,166	55.60	53.70	53.29	54.52	safe	unsafe 0.85m	unsafe 0.82m	unsafe 1.67m	done	9.7	16.4
Geumkwang	316.4	948	48	782.6	1,708	69.80	67.70	65.38	68.77	safe	unsafe 0.25m	unsafe 1.07m	unsafe 1.32m	on-going	16.2	35.4
Giheung	369.1	848	53	738.7	1,798	49.00	47.30	46.00	49.07	safe	unsafe 1.05m	unsafe 1.77m	overflow 2.82m	on-going	13.9	33.9
Idong	369.1	796	93	832.7	2,018	49.50	46.10	45.00	48.07	safe	safe	unsafe 1.97m	unsafe 0.79m	discussing	9.0	21.7
Bakgok	322.7	756	85	825.8	2,133	103.20	100.10	98.59	102.26	safe	safe	unsafe 2.16m	unsafe 1.31m	planning	9.7	25.2
Gopung	313.7	881	26	280.1	974	89.20	85.30	85.07	90.49	safe	safe	unsafe 5.19m	overflow3.29m	done	10.8	37.6
Yedang	383.1	657	374	2809.4	4,656	25.50	22.50	22.93	24.72	unsafe 0.43m	safe	unsafe 2.2m	unsafe 1.68m	proposed	7.5	12.5
Tapjung	297.5	635	219	1193.9	3,038	32.10	30.40	27.39	30.17	safe	unsafe 0.47m	safe	unsafe 0.47m	planning	5.5	13.9
Kyungchun	308.7	732	68	603.7	1,412	87.30	85.60	85.20	86.26	safe	unsafe 0.3m	unsafe 0.66m	unsafe 0.96m	on-going	8.8	20.6
Dongsang	308.7	816	80	874.0	1,901	138.00	141.00	139.80	141.11	safe	unsafe 3.0m	unsafe 0.11m	overflow 3.11m	safe	10.9	23.6
Dae-a	308.7	705	108	974.7	2,317	123.00	120.00	118.27	122.73	safe	safe	unsafe 2.73m	unsafe 1.82m	proposed	9.1	21.5
Gu-i	308.7	765	62	565.7	1,377	64.30	63.20	62.95	64.19	safe	unsafe 0.9m	unsafe 0.99m	unsafe 1.89m	on-going	9.1	22.2
Naju dam	311.7	867	85	824.7	2,403	67.50	63.90	62.89	64.21	safe	safe	unsafe 0.31m	safe	safe	9.7	28.4
Chongchun	410.3	766	70	881.9	2,076	42.50	40.20	40.16	42.49	safe	safe	unsafe 2.29m	unsafe 2.16m	on-going	12.6	29.6
Dongbu	377.6	914	28	636.9	1,026	18.40	17.00	17.18	18.09	unsafe 0.18m	unsafe 0.78m	unsafe 1.09m	unsafe 1.69m	on-going	22.7	36.5
Jangsung	311.7	748	123	1196.3	2,734	90.50	86.50	85.49	87.80	safe	safe	unsafe 1.3m	unsafe 0.68m	planning	9.7	22.3
Damyang	311.7	839	47	648.7	1,683	124.00	121.10	120.90	122.29	safe	safe	unsafe 1.19m	unsafe 0.31m	on-going	13.7	35.7
Naesung	329.6	638	92	790.5	1,751	231.50	229.00	228.99	234.21	safe	safe	unsafe 5.21m	overflow 4.93m	on-going	8.6	19.1
Seobu	377.6	798	30	643.6	1,166	25.10	22.80	23.16	23.95	unsafe 0.36m	unsafe 0.08m	unsafe 1.15m	unsafe 0.87m	on-going	21.1	38.4
O-bong	535.7	860	109	1542.9	2,735	121.30	115.80	119.86	122.38	unsafe 4.06m	unsafe 0.97m	unsafe 6.58m	overflow 3.49m	on-going	14.2	25.1
Dalchang	247.3	837	56	435.6	1,554	71.00	68.60	68.27	71.32	safe	safe	unsafe 2.72m	overflow 2.59m	on-going	7.7	27.6

PMF is probable max. flood, but it is impossible flood event if looking at from an opposite side. P MF is extremely overestimated. Further study on PMP & PMF concept is needed.

Case Study Format (ARTF-CC)

Lessons from actual case

Focused on sustainable agriculture and irrigation & drainage

I. Outline of the activity

Group of Case Studies : (please check one)	■"Science& Technology" ☐"Peoples Recognition or Social Movement" ☐"Governance" ☐"Local Practices" ☐"Others"
Field of Case Studies : (please check one)	(If you check "Science& Technology" in the Group) ■"Strategy" ☐" Investigation" ■"Research" ☐"Analysis" (If you check "Peoples Recognition or Social Movement" in the Group) ☐"Symposium" ☐"Media" ☐"Campaign" (If you check "Governance" in the Group) ☐"Law & Regulation" ☐"Organization" ☐"Budget" ☐"Political Will" (If you check "Local Practices" in the Group) ☐"People participant" ☐"NGO activities" Based upon the above mentioned experience,
Country :	Korea

Title of Case Studies	**Design criteria for emergency spillway to cope with extreme flood in irrigation dam**
Implementing Organization	Ministry of Agriculture, Forestry, and Fishery (MAFF) The Korean Society of Agricultural Engineers (KSAE)
Operating members	Special research committee consisting of researchers, government officials and professors
Active term	From 2002 to 2003
Contact person	Dr. Tai-Cheol Kim (dawast@cnu.ac.kr)

Background :

Lots of dam and reservoir have been constructed to manage efficiently water resources in preparation for the reduction of flood and drought damage, because there are great changes in outflow by period. Analysis of inflow to dam found that dam inflow increased after the 1990s, but most of the inflow was concentrated during the August flooding period, which actually added to the difficulties of flood control.

As a result of assessments for water resources based on the IPCC SRES A2 Scenario, it was viewed that ET would increase with annual precipitation increasing and temperature increasing up to 4.5℃. Consequently, annual outflow would decrease, and the decrease in outflow at the southern areas would be relatively big in comparison with the northern area. It showed that there would be a general decrease in outflow during the spring and summer season, while the outflow in the autumn and winter season would increase due to the increase in precipitation.

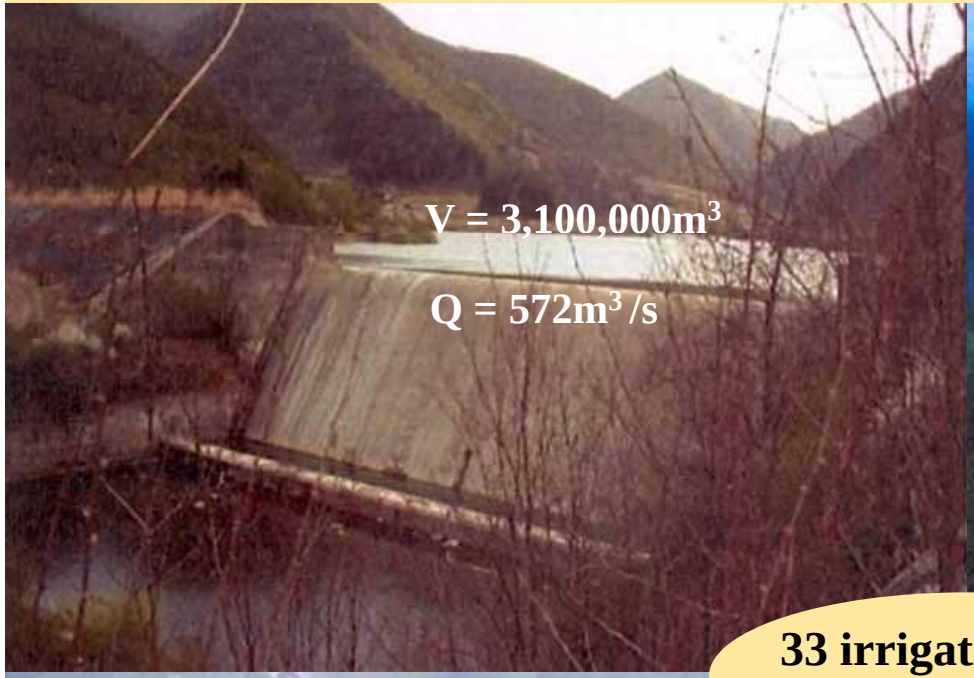
However this rainfall pattern is often disturbed by heavy storms mainly caused by typhoon. Actually, we experienced such a heavy storms caused by the typhoon Rusa from Aug.4 to Sep.1 and serious flood damage like collapse of embankment and spillway occurred on earth-fill dams in 2002. On the 31st August, **the amount of 24 hours rainfall reached 870.5mm(and 100.5mm/hr) which is corresponding to the level of Probable Maximum Precipitation(PMP) in Gang-reung area.**

This amount of 24 hours rainfall is 2.24 bigger than the present design criterion of 200 years frequency rainfall 388.4mm. Such heavy storms and floods were considered as phenomena of climate change.

Many people watching the drastic moment of 0.5m freeboard of embankment left on the TV in real time on Aug. 31, 2002 in the Sung-ju dam was so shocked and scared that social consensus on the government's strategy was

I'm personally afraid we are constructing an emergency spillway by PMF with expensive cost to be safer against an impossible flood.

before Sung-duck reconstructed irrigation dam after



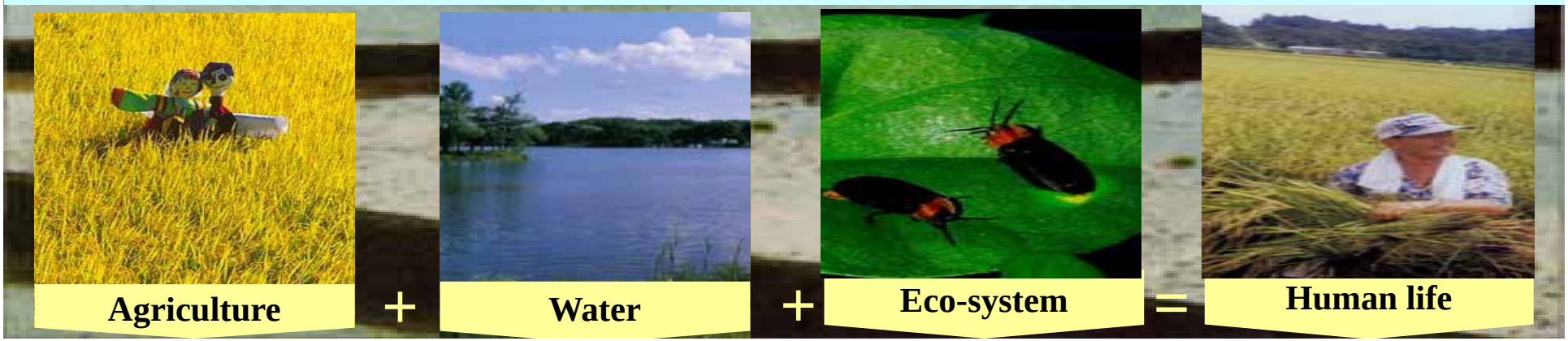
33 irrigation dam spillway reinforced

Go-pung (additional spillway) dam

Decision makers sometimes are in favor of development project than conservation. up

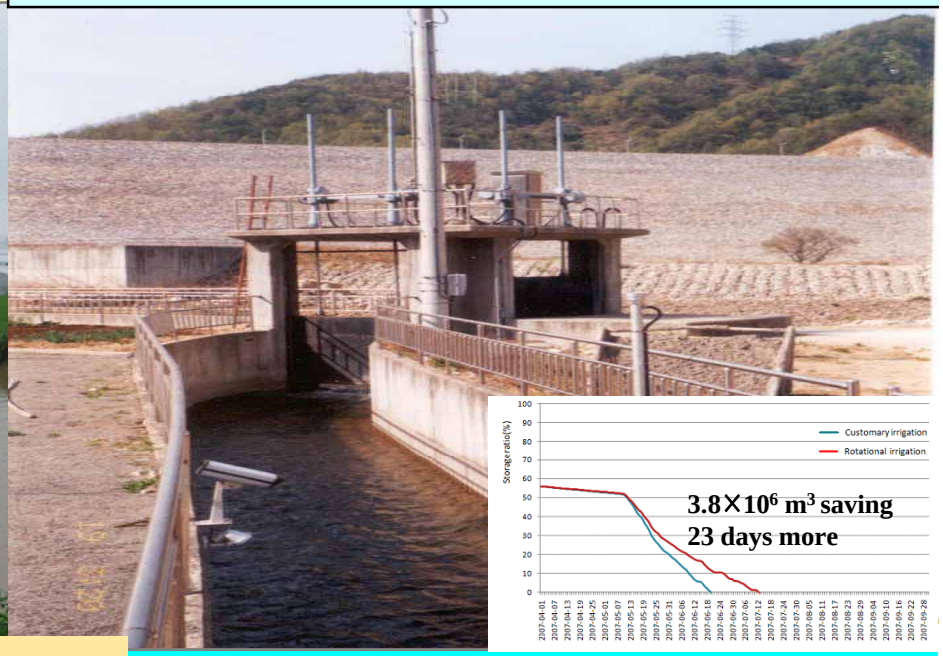
Lessons from actual case and experience

1. P*robable Maximum Flood(PMF)* has been upgraded and applied and infrastructure reinforced in 33 existing irrigation dams in Korea.
2. Emergency spillway reinforced by PMF is safe but expensive. PMF should be harmonically applied with non-structural measures.
3. It is necessary to evaluate project feasibility carefully beyond B/C, IRR, and AHP, especially considering climate change and applying PMF. Because existing dams were constructed and still safe under such conventional evaluation.
4. There is no over-emphasis in disaster prevention, but study should be continued to find out optimal solution between dam safety and construction cost.



2. Infrastructure for drainage in pumping facility

3. Infrastructure for drought & irrigation system



Other projects for climate change

4. Project for the four river restoration

5.Emergency spillway in multipurpose dam

Thank you for your attention.

dawast@cnu.ac.kr