

Sustainability of the Aquarium Toward the "Green Aquarium"

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Abstract

Aquamarine Fukushima (here after AMF) suffered serious damage on March 11, 2011 when the earthquake and tsunami submerged part of institution. The accident at the Fukushima nuclear power plant seriously obstructed restoration activities and we had to completely stop aquarium activities for a while. In April 2011, we slowly started restoration work, encouraging our staff with the slogan, 'Revive! Our Oceans'. Miraculously the main building covered with glass experienced little damage and the seawater intake pipeline survived. Thanks to volunteers, many kinds of support, and encouragement from all over Japan and abroad we re-opened on 15 July 2011, our twelfth anniversary. We should like to express our deep and sincere appreciation to all our colleagues.

Sustainability Threatened

AMF open to the public on July 15, 2000 is located at the second wharf of the Onahama Port in Iwaki-City, Fukushima Prefecture, faced to the Pacific Ocean North East Japan. To commemorate the tenth anniversary, AMF held an international symposium in 2010, July 15 as same title of “Sustainability of the Aquarium”. Sustainability of the AMF was seriously threatened by the East Japan Great Tohoku Earthquake broke out and successive tsunami attacked the area on March 11, 2011.

Following is the sequential record of disasters.

- Magnitude 9 earthquake broke out 1446 on March 11, 2011 seismic center off shore Sanriku, Pacific coast of Tohoku District, Japan, following many after shocks.
- Iwaki City, intensity 6-, height of tsunami 5.4m at Fisheries Harbor, 2nd Pier AMF located 4.2m.
- Nuclear Power Plant No.1 broke out. Hydrogen explosion on March 12 and 14 .
- Died 14,981 persons, missing 9,853 persons, total 24,843 persons as of May11, 2011.
- In Fukushima, died 1,557 persons, missing 730 persons. In Iwaki City died 301persons, missing 82 persons as of May 12, 2011

AMF suffered the serious damages by the submergence of the part of institution by subsidence and the tsunami of the penumbra by the earthquake. The accident of the first Fukushima nuclear power plant remarkably obstructed the toration activities. Therefore, AMF had to stop the activity as the aquarium overall for a while. The following is the record of the chronological order of the day of March 11, 2012.

- 14:46: There remained 130 visitors and 80 staffs including volunteer.
- 15:10: Visitors left aquarium safely.
- 15:20: First tsunami approached.
- 19:30: Highest tsunami of 4.2m arrived. 80 staffs isolated in the aquarium. Ist floor submerged . Blackout , whole life line stopped.
- Secure lighting by home generator and portable generators.

The huge tuna tank and coral reef tanks maintained by the operation of the “water purification factory” were vulnerable to a blackout. Since the center of the aquarium is the facility of the water-purification equipment of the closed circuit-type, these all functions stopped by the blackout. It became fatal for coral reef fish and for the tropical freshwater fish to fall low water temperature in early March.

Damages of the facilities are as follow.

- Tempered paired glass damages 0,8% of totally 2600 windows.
- Acrylic panel of 60mm separated two big tank broken by the “Tsunami “ within tank.
- Water leaked in some tanks.
- Circulation system suffered Tsunami (heat exchangers, circulation pumps, air Conditioner, Electric plates, etc.
- Pump room of the water intake facility suffered Tsunami.
- Out door crack, subsidence, liquidation..
- Whole life lines, electricity , city water stopped.
- Vehicles trucks of live fish transport, Aquaraban, shuttle bus etc. washed away.
- Unonozoki , Kids Fisheries Museum, Conservation Center seriously damaged.
- Total cost of damages estimated 25 millions US\$, no human damages.

It was in late April 2011, that AMF started restoration activities, sharing key word "Revive! Our Oceans" with staff. It was miraculous that main building covered with glass, which imaged the fragile environment, had little damage. In addition, it favored for us that seawater intake pipeline for 2 km from

Misaki out of the Onahama Port was survived.

Volunteers rushed from each place in Japan and abroad. We have received various supports and encouraging messages from the inside and outside the country. Thereby, speed of the revival accelerated. At last on the day of the twelfth anniversary on 15, July 2011, AMF achieved the re-opening.

Another Disasters

The accident of the Nuclear Power Plant No.1 caused the hydrogen explosion on March 12 and 14 was the another disaster. AMF established environmental laboratory soon to investigate the radiation pollution of shore waters and Abukuma Mountains area. The radiation in Iwaki City is now in safe level. Both the seawater intake and the river water are equal to or less than an official approval limit. However, for AMF making much of the function of the natural experience for children, it is necessary for information to send the state of the radiation in the building inside and outside precisely. Therefore, AMF has established the organization named AMF Environmental Laboratory and decided to send radiation information in the level originally. Since there is a limit for aquarium original research, AMF has established cooperative relation with universities of each place,

and wrestles with this problem. In the following, collaborative investigation organizations are listed and studies are summarized below.

- Kanazawa University Round Japan Sea Region Environment Research Center, measuring with AMF the radioactive material charges of a river flowing through the Fukushima within the prefecture regularly. They have a low-level radioactivity experiment institution in the center and can measure a very small amount of radioactive material. Aquamarine Environmental Laboratory sends the sample, river water collected regularly.
- The Tokyo University Marine Science and Technology: making survey on the radioactive material of the sea life continuously to elucidate the radiological diffusion process of the coast area of the sea of Iwaki. The information about the fish species except the fishery species offers the information of Aquamarine Environmental Laboratory.
- Iwaki Meisei University, Science Engineering Dept, Faculty of Life Environment. To cooperate with the local university, AMF does an action of long-term research and collaborates about sampling and measurement.

Records of radiation by fish species, and the radiation survey

data such as main coastal fishes, are tabulated below including the findings such as the original investigation of AMF Environmental Laboratory, Universities, and Fisheries Experiment Station of the Prefecture.

For the AMF as the environmental aquarium located in 55km from the Fukushima Nuclear Power Plant in the north, AMF decided to send a de-nuclear power plant message originally as one of the members of the Japanese Association of Zoos and Aquariums, the declaration is attached the last page.

Protection Measures against the Disasters

The prologue of the exhibition of the AMF is “The Evolution of Life in the Oceans”. The CG of a few minutes traced from the earth Creation 4,600 million years ago and life birth 3,800 million years ago to the **Proterozoic Era** by 600 million years ago. Most ancestors of the modern creatures evolved explosively in a short term since 600 million years ago, so-called the Cambria explosion. Tanks of the living fossils are arranged with show windows of fossils. Audiences can trace the living fossils along the phylogenetic tree. It was quite impressive that most of the such "living fossils" as sturgeon, Amia, gar pike, ratfish, lungfish etc. were survived in a violent changes of low temperature,

short of oxygen and dark environment. They were survived by the time in late March through beginning of April finally rescued by the Niigata Aquarium, Tokyo Sea Life Park and other facilities.

Followings are measures how to strengthen against the future disasters.

- To prepare against Tsunami for the aquarium located at the Water Front .
- To build traditional Suka Forest around aquarium to protect against future Tsunami.
- To equip sustainable power generator with reserve tank of enough oil.
- To make water tight for whole building , and every doors open outside.
- To move electric equipment to the higher level.
- To make the training for emergency more practical .
- To prepare diversification of source of energy .
- To equip freshwater reservoir
- To strengthen sea water intake pipe line.
- To realize Nuclear Power Plant free world

Active coastal fish such as sardine, mackerel, and tuna were weak in short of oxygen and sudden temperature change. In

addition, local fresh water creatures of Abukuma Mountain stream and pond at the top floor and goldfish were also survived against violent environmental change, too. The creatures also survived in the shallow touch pool in the 2nd floor with the vegetation of algae in the rocky tide pool under the glass roof. This will be called the greenhouse effect that the photosynthesis of plant and algae enabled to keep environment proper for them. Under these occasions, the Lorenz aquarium in the Ring of Solomon by Austrian ethnologist, Konrad Lorenz is remembered (1987) in my mind. He placed a small aquarium with a water plant in by the window, and Lorenz finally reproduced exhibit of the bottom of Lake Lemman in the tank. The aquarium has neither circulation pump nor the air pump. They need only the appropriate amount of light and the water plant for breeding the creatures. It was an art of breeding to keep the delicate balance. Such an aquarium is called balanced aquarium, or harmony aquarium, we know..

It is said the most primitive circulation system to circulate water of breeding tank through the big reservoir without filtration was innovated by a British named Rhynd (1860). Even in the closed circulation system, it covers only the first half of the nitrogen cycle. It may be technology to maintain stability of the harmony

aquarium more.

Design of the Green Aquarium

We could have aquarium tank stronger against the disaster, and more economical if the cycle of natural environments is adopted to the artificial environments. AMF have learnt many things through the present disasters, the biggest gain is origin recurrence of Lorenz aquarium. AMF have to improve the facilities to revive the facilities resisting against disaster, protecting machine room from the tsunami, moving the electric equipments to the higher level, reinforcing the lifeline and water intake plumbing, and such and such. This will be related with the change of the exhibition policy along, in the future.

Restoration means to repair the destroyed, however, the restoration is not true revival if it is not followed by the creation. The re-opening of the AMF is becoming the driving force for the local revival. AMF have learned most from the disasters.

The zoos walked with the exhibition policy to arrange animals according to the order of systematic or zoogeography. The aquarium developed as the institution, which took charge of aquatic creatures in the zoo. The underwater world to look at through glass or the acrylic panel which upsized-impressed

people because of the non-everydayness. The aquarium developed before long as an institution independent from the zoo. The shows of the dynamic dolphin and sea lion have won the popularity. However, because of having separated from the zoo, the aquarium has lost insects, reptiles and birds, land mammals to breathe air same as human.

The New England Aquarium in Boston opened in 1967, which designed by the Cambridge Seven Associates. Present author supposed their tiny triangle greenhouse must be symbolized the zoo. In the modern aquarium, fish tank becomes gigantic, and space of non-daily life is emphasized. As much as emphasized non-daily life space by the huge acrylic panel, the difference from land nature will be enlarged. .

AMF has established under the water front developing project at the 2nd wharf of the Onahama Port. In addition, lines of flow in the four levels of the building take in an advantage of the Cambridge Seven Associates. The people are led to the local mountain stream at the top floor with an escalator at a stretch from the geological age. Furthermore, the greenhouse of the triangle roof, which was a symbol of the Cambridge Seven, becomes the real greenhouse covering up the whole 4 stories building.

However, present author has recognized the AMF to be an unbalanced institution from the viewpoint of the environmental education function. Therefore, AMF made a tiny biotope in the basin, which was a glassy surface of water to project a building. Successively AMF increased the large shore waters of 4,600m² at the tip of the wharf. Balance with the building exhibition and outdoor exhibition may have become better. More or less same length of line of flow in the building as the outside of the building line of flow was prepared.

Present author has not satisfied yet for the AMF exhibit. AMF is going to develop a land for "Satoyama Village" of 2ha within a few years, symbolizing recovering the circulation of Ocean-River-Mountain in the space of approach to a main building.

New aquarium design for the sustainability will be summarized as follow.

- Keep in mind the merit of Greenhouse Aquarium
- Keep in mind to keep good balance with outdoor exhibits
- Adjust the project to the Port OASIS program
- To revive Satoyama well balanced environment in the past in outdoor
- Satoyama habitat should be surrounded by the safety

SUKA forest bank against tsunami

This project is believed well much with "Port Oasis" plan that Japanese Government pushes forward, which is the supplying materials plan from the sea route at the time of the severe disaster in the future. Black pine tree forest named traditionally SUKA to prevent tsunami will be constructed around the wharf surrounded the aquarium. AMF is going to build "Port Oasis", ideal nature or microcosm within the mound of the SUKA. Outdoor area of AMF is changing into the place literally of the Port Oasis for the recreation and relaxation for people.

AMF is reproducing a place of the well-balanced life of human and nature retroactively since "Jomon" period, 20000 years ago here in Japan. Named " Satoyama" village would be no more in the category of aquarium.

The aquarium looking at the water world over perpendicular glass will be called the ordinary aquarium. On the other hand, the aquarium with the Satoyama village can be called so to speak "Green Aquarium", where arranged the hill of shrine and small streams run down to the rice field and village.

There are people whom predicting that the fence of the zoo and the aquarium will become low. However, as for the low fence, it cannot be together again, because there is the history that

aquarium specialized from zoo and became independent from the zoo. Both the poultry and the domestic animal may coexist in the Green Aquarium. It will be an opportunity to return the zoo and aquarium to daily life. As for the fusion with the Green Aquarium and ordinary aquarium, it becomes a premise that creature exhibition will be based on the in-situ conservation of the district. Let us exhibit local nature generally, and experience it, which is, so to speak, an “Aquarium of Every Day”. The name of the conventional zoo and aquarium is not suitable for both. It is the “Green Aquarium” AMF have decided to strengthen the international network of the aquarium located at the waterfront to share the information on the disaster prevention and to continue sending a common message of the conservation of the oceans.

Acknowledgement

Finally, present author likes to add a message to the Monterey Bay Aquarium (MBA) located at the same latitude as N37 degree with the Amphi-Pacific or Horizontal friendship aquarium relation with AMF. Their theme is the Kelp Forest and never changes their philosophy to exhibit Monterey Bay habitat and biodiversity. Present author would like to name, Lorenz Aquarium for MBA, and is proud of to be sister relations with

MBA. In addition, the Tow Oceans Aquarium as the same name for their theme of sustainability must be added.

The Napoli, Stazione Zoologico as an oldest aquarium in the world, also will be remembered as the most sustainable aquarium with almost open circulation system to use seawater of the Mediterranean.

Finally, our goal of revival will be to hold 10th IAC in 2018, as the steering committee suggested, which could be joint with the Ocean Expo in the year under the theme of the Sustainability of the Oceans. This is still remained my dream.

The Message of the De-nuclear Power Plant, AMF

The radioactive pollution resulting from the Great East Japan Earthquake and successive accident of the Nuclear Power Plant No.1 caused the hydrogen explosion on March 12 and 14 has contaminated a vast area centering on the Abukuma Mountains and make its way into coastal sea beds. It is affecting not only human society, but also the animals and plants and marine life inhabiting the region. For more than one year, member of the Japanese Association of Zoos and Aquarium (JAZA) located in the disaster struck areas have put all

their efforts into disaster recovery.

During this time, including the rescue of the exhibition animals, the support activity of JAZA member in rescuing animal exhibits and providing support has not only given encourage to the struck facilities, but has also been highly commended socially.

We learned many things from this disaster, namely overwhelming danger and vulnerability of using nuclear power plants as an energy source on the Japanese Archipelagos, an area exposed to major earthquakes and tsunami associated with plate movement.

Zoos and aquariums are environmental education facilities that hold the conservation of biodiversity as an important philosophy. This is a time when these facilities should be sending out a message of de-nuclearization through the global network of zoos and aquariums to the public in response to the problem, of unparalleled environmental pollution.

Not a few fellow directors of facilities affiliated to JAZA concur with this message. Present author would like to take this opportunity to express my gratitude to them to make the communiqué here.

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Reference (Bibliography by the Aquarium Directors)

Newman, M. 1994. Life in a Fishbowl, Confessions of an Aquarium Director. I-ix, p.1-262pp, Douglas &McIntyre. Vancouver/Toronto.

Powel, D. 2001. A Fascination for Fish. P.1-400pp. University of California Press.

Yoshitaka Abe. 2011. How to Create Aquarium (in Japanese). Figs., 1-190pp. Seizando.

Garratt, P. 2012. Crazy! Adventures of Marine Biologist. P.1-387pp. New Voices Publishing, Cape Town, South Africa.