Impacts of Coral Reefs in Amphibious Operations（Manuscript: Draft）

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These are contents of my presentation.

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In World War Ⅱ, coral reefs had serious impact in amphibious operations in the Pacific theater. Especially, in the battle of Tarawa and Peleliu, the beautiful tropic coral reefs were bloody battle zone.

In cold war era, assumed battle fields of amphibious operations shifted to the subarctic zone, Norway and the northern part of Japan. Coral reefs did not exist there.

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However, we have to consider coral reefs again because the possible fields of amphibious operations returned to the tropic zone. Now, there are risk of regional conflicts, terrorism, and organized crimes in the South & East China Sea, the Persian Gulf, the Red Sea, and the Indian Ocean.

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In addition, tropic zone is the most disaster prone region on the earth. Recently, we saw serious damage caused by tsunami, typhoon, and cyclone. The global warming may cause more meteorological disasters in future. The amphibious operation is one of the most effective ways for humanitarian assistance and disaster relief in littorals.

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Then, let me mention the impacts of coral reefs. This slide shows the graphic of typical coral reef zones. The reef crest is the highest point of the reef, and it is exposed over the surface of the sea at low tide. Therefore, all ships are forced to stop at the fore reef zone. Amphibious vehicles may be able to run onto the reef crest but they may get stuck in the undulation of the

reef. At high tide, waves break over the reef crest but the depth of water is not enough for ships to sail over. Therefore, the first impact of coral reefs is difficulties to run onto and sail over in all tide condition.

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This slide shows the map of Miyako Island. This island is in southern Ryukyu Islands in Japan and the typical coral reef island. Coral reefs of Miyako Island, shown by orange lines, surround most of the coastline. Therefore, landing crafts are enforced to use ports for unloading. However, most of ports in coral reef islands are small and shallow because it is difficult to build big and deep ports in coral reefs. For example, big ports in Miyako island, shown by green dots have depth more than 4 meters but all other ports, shown by red dots, have just about 2.5 meters depth. Accordingly, landing crafts have to consider unloading in small ports. That is the second impact of coral reefs.

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The capability of AAV-7s and BvS10s (Vikings) to run onto and sail over coral reefs are not enough. Therefore, new vehicles more adaptable to the changing feature of coral reefs will be necessary. The US Marine Corps' Expeditionary Fighting Vehicle (EFV) program has already canceled but the EFV tried to equip with a power transfer module to sustain movement in the transition between water and land drive[1]. Now, a new amphibious vehicle is under development in Japan[2]. The detail of that vehicle is unknown but high adaptability is expected.

In addition, the US Marine Corps is now testing Ultra Heavy-Lift Amphibious Connector (UHAC). A full-sized UHAC, 84 feet long and 34 feet high, will be huge enough to overcome coral reefs[3].

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1 Expeditionary Fighting Vehicle (EFV), United States of America, army technology.com, http://www.army-technology.com/projects/efv/

2 NIKKEI, 30 November, 2014, http://www.nikkei.com/article/DGXLASFS05H1E_Z21C14A1MM8000/

3 Marines Test Heavy Duty Landing Craft Prototype at RIMPAC, USNI News, July 16, 2014 http://news.usni.org/2014/07/16/marines-test-heavy-duty-landing-craft-prototype-rimpac

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Another way to overcome the impact of coral reefs is to bridge on them. Pontoon bridge is one of solutions. However, pontoon bridges over coral reefs need great adjustability to the changing feature.

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In Japan, Shibata Industrial Co., Ltd., Mitsui Zosen Steel Structures Engineering Co., Ltd., and Akishima Laboratories (Mitsui Zosen) Incorporated have an idea for an innovative pontoon bridge which can fit the undulation of reef crest at any tide conditions. As this slide, their pontoon bridge will fit the undulation by air pressure adjustment of bladders under causeways. Their target is to provide stable platform for traveling of a main battle tank under Sea State 3.

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In order to minimize the impact of coral reef, landing crafts which can unload in small ports will be necessary. Existing LCACs are difficult to enter into small ports because of their limited maneuverability. LCMs and LCUs can use small ports but their speed is too slow for the over-the-horizon operations. Recently, French Navy developed Landing Catamaran (L-CAT) as high speed landing crafts[4]. The Caimen 90 Fast Landing Craft designed by BMT Defense Service may be smaller and faster than L-CAT while having same payload[5].

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In order to minimize the impact of coral reefs, the situation awareness is indispensable. However, existing survey measures by boats, divers, or unmanned underwater vehicles need much time.

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Airborne Laser Bathymetry (ALB) may be a ways to know the

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[4] L-CAT Landing Catamaran / Landing Craft / EDA-R http://www.navyrecognition.com/index.php/world-naval-industry/europe/993-l-cat-landing-catamaran-fast-landing-craft-amphibious-warfare-reduced-draft-dock-roro-roll-onroll-off-lpd-lhd-bpc-ssc-sea-to-shore-connector-for-main-battle-tank-mbt-eda-r-marine-nationale-french-navy-cnim-datasheet-pictures-photos-video-specifications.html

[5] Caimen 90 Datasheet, http://www.bmtdsl.co.uk/media/5119403/AMPD002_0214_Caimen90.pdf

geographical feature of coral reefs in short time. ALB uses two types of lasers from the mother aircraft. One is the infra-red laser and its reflected pulse indicates the height of the aircraft above the surface. Another laser is the green laser. It reflected pulse indicates the height of the aircraft from the ocean floor. The difference between the two heights shows the water's depth and the geographical feature of ocean floor[6].

In Japan, PASCO Cooperation and Leica Geosystems have an idea to utilize ALB for amphibious operations. As this 3D map of Kerama islands in Ryukyu Islands shows, situation awareness by ALB will be helpful to identify the detailed configuration of coral reefs in short time.

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These days, tropic littorals may be fields of regional conflicts, terrorism, and organized crimes. Therefore, amphibious operations in coral reefs should be prepared and minimizing impact of coral reefs is one of the most significant challenges. Improvement of amphibious vehicle, pontoon bridge, landing craft, and situation awareness means should be more focused.

6 Australian Department of Defense, *LADS II (LASER AIRBORNE DEPTH SOUNDER)*, http://www.hydro.gov.au/aboutus/lads.htm