In-situ preservation In Tropical Seas: Case Study on the Avondster Shipwreck

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Abstract

The VOC ship *Avondster* sunk on 2nd July 1659 when anchoring near the beach in Galle Bay, geographically located in the southern part of Sri Lanka. She was re-discovered in 1993 and subjected to a series of research projects including excavation in the bow, stern and mid-ship areas. Due to construction work in Galle Harbour it was important to protect the shipwreck *in situ.* The environment in the Galle Bay badly affected the wreck site and it was a big challenge to overcome all the harmful factors that were likely to damage the remains of *Avondster*.

In order to preserve *Avondster* a plastic net was introduced as a protective layer over the wreck site. This was monitored constantly throughout and after the research period. The protective layer was used over the fragile timbers for nearly 8 years before a violent tsunami hit Galle Bay in December 2004. Despite the serious damage caused on the land by the tsunami, it had less effect on the site and the covering-plastic net was still intact. From that time on monitoring has continued every two months.

This paper discusses in detail the present condition of the i*n situ* protection and its validity as a preservation technique in the conditions found in tropical seas.

Introduction

The requirements to preserve the underwater cultural heritage (UCH) are now emphasized in the maritime archaeological field more now than previously. Due to new technology and well developed equipment diver numbers have increased. Some divers are engaged in various tasks and functions that can be harmful to the UCH in many ways. Submerged archaeological remains are regularly found all over the world day-by-day due to increased diving activities. The idea of preserving *in-situ* as seen in parts of the European continent and other economically developed countries prior to the year 2000. This trend is seen in the Asian region after the year 2000. For example, in Sri Lanka there were more than 30 maritime archaeological sites reported in the Southern coastal belt, of which 26 are in Galle Bay harbour. Despite the scarcity in human and technological resources, funds and minimal political involvement; the Maritime Archaeology Unit (MAU) team was able to record and do research on most of these sites during the last decade.

In a developing country, such as Sri Lanka, the new trend to conduct *in-situ* preservation and analysis is a better option than to excavate. It is an efficient way to scientifically identify the deterioration threats on recorded UCH sites which are being continuously discovered, and to rebury them and/or utilize other protection methods. Excavation costs huge amounts of money. In both the International Council on Monuments and Sites (ICOMOS) 1996 Charter and Article 01 of the United Nations Educational, Scientific and Cultural Organization (UNESCO) 2*001 Convention on the Protection of Underwater Cultural Heritage* (2001 Convention) emphasis is placed on, “*in-situ* protection should be the first option” (Prott 2003:xxiii).

One of the pioneer countries to have undertaken *in-situ* conservation methods on UCH is the Netherlands. Since the early 1980s they have identified the needs of *in-situ* preservation and practiced it with their projects. One of these was a project to conserve more than 30 sites *in-situ* in Zuiderzee - bed in the flevopolders area. Further in 1988 the BZN3 shipwreck site, which was owned by Dutch East India company (VOC), was protected physically and by the law (Manders, *et al.* 2004:1251-1252). In the same manner several shipwrecks were preserved *in-situ* in Europe, Australia and Canada: the wooden shipwreck in Red Bay, Canada (Manders, *et al.* 2008:179-194); the German 14th century merchant vessel *Darssar Cog* (Manders, *et al.* 2008:189); the 4th century Roman quay in the Netherlands (Manders, *et al.* 2008:190); and in Australia, the *William Salthouse (*1841) in Victoria and the James Matthews wreck (1841) in Fremantle (Manders, *et al.* 2008:192).

Different methods were followed to preserve these sites considering the following facts: location, deterioration threats, environment, utility to the public and the technological improvements during that period. For example, sacrificial anode (see Godfrey, Richards and Cha this volume) treatment was used to preserve the metal parts of the *James Matthews* wreck in Fremantle, Western Australia (see Carpenter and Richards this volume). Thus far, Sri Lanka has only one example regarding *in-situ* conservation, the *Avondster* shipwreck situated in Galle Bay harbour. The purpose of this paper is to discuss the process of *in-situ* protection implemented on the *Avondster* shipwreck and its necessity, success or failure.

History of Avondster Shipwreck

The *Avondster* was originally a British ship (30-40 meters in length), captured and modified by the Dutch (*http:cf.hum.uva.nl/galle/*). The vessel was constructed with two decks and the capacity was 250-260 tonnage. After a long life span of long distance trans-oceanic voyages it was assigned to short-haul coastal runs. It was wrecked on July 2nd 1659 while anchored in the Galle Bay harbour (Parthesius, *et al.* 2005:220). After the ship was discovered in 1993 the site was monitored; it became clear that the wreck was increasingly exposed through changes in the dynamics of the seabed, and it was considered important to implement a rescue archaeology project on the site to safeguard this important collection (Manders, *et al.* 2004:1253). The wreck lies close to the shore, in 6 metres of murky waters (Figure 1). From the year 2001 until the end of 2004 important sections of the ship have been excavated and conserved *in-situ*. Explorations revealed *in-situ* wooden parts of the hull, brick construction of the galley, six iron cannons and one of the ship’s anchor. At the time when the yacht sunk the rudder was separated from the stern section because it struck the sandy sea bed (*http:cf.hum.uva.nl/galle/*). The rudder now lies 18 meters away from the main shipwreck.

Figure 1. Location of the *Avondster*/Site L. (Photo – WA museum)

Reasons for Preservation in situ

Even before the official discovery of the *Avondster* shipwreck, looters collected artefacts from the surrounding zone. With the monsoon activities every year the sea bed become rough with high waves and exposed to erosion. It had become a common practice of the local divers to collect exposed artefacts and things moving on the sea bed after the monsoon season (Carpenter 1996:44-50) The marine drive, built by the Road Development Authority of Sri Lanka in the late 1960's, reduced the distance between the seashore and the wreck to 90 meters (previously it was about 150 meters); and in 2002, with the second stage of this development, reduced it to 70 meters. These developments and the construction of the stone barrier to stop sea erosion caused rapid changes to the coastal seabed. The natural sand and sediments which existed for hundreds of years shifted every year (Parthesius, *et al.* 2007:159). The high slope of the stone barrier directly impacted the seabed adjacent the beach, where the *Avondster* shipwreck lies. The waves from the open ocean struck the stone barrier with more force than the natural shore. This rolling wave pattern moved the sand from side by side causing erosion on the wooden wreck parts. The explorations made during the years 1997, 1998 and 1999 emphasized that the movable artefacts should be excavated and undergo sustainable conservation to prevent further erosion. This was included in the aims for the *Avondster* 2001 field season project (Parthesius, *et al.* 2005:221-222).

In both theory and practice *in-situ* conservation is an acceptable method for Sri Lanka. I will explain why, first, through the legalities. This country's legislature has the capacity to provide what is needed to protect the UCH. Under the Sri Lankan law conservation of both maritime heritage and UCH is included (*Antiquity Ordinance No.19 of 1940* and it's *Amendment No.24 of 1998*).

Avondster is one of the well preserved oldest wooden yachts found in Sri Lanka. As such there is a responsibility to keep it protected from damaging physical factors. At the time that three excavation trenches were initiated at the site there were neither maritime archaeologists armed with enough technological and scientific knowledge available in the country nor the infra-structural facilities needed with the MAU. The necessity of conserving this type of heritage for further scientific method study by future generations influenced the direction for its preservation.

Though the legal protection bans treasure hunters, looters and fishermen, it isn’t enough to protect against the natural physical, chemical and biological processes. *Avondster* is situated in a place facing direct impact from tidal movement and/or changes in water circulation and sediment erosion (Manders, *et al.* 2004:1253), these actions cause an aerobic environment within which more oxygen enters the exposed wreckage creating good conditions for wood-borers and many bacteria (Bonke, *et al.* 2007:133). Also the fresh water flowing from two networks of gutters coming from the city increased this situation and brought more bacteria. It was a common scene to see the waste and garbage coming from the city floating in the water over the *Avondster*. During the first archaeological excavation on *Avondster,* on its front bow section, we were able to identify and observe the quick deterioration on the wooden parts after they were exposed.

Due to above circumstances we had to cover the *Avondster* site. In February 2003 we decided to do a test project. A 4 x 4 meter area on the Avondster bow section was selected for the purpose. The highest parts of the hull's timber were coming out from the sea bed up to one and a half feet. A black plastic net (100% polypropylene and 60% density) was used for this purpose (Parthesius, *et al.* 2007:162). In order to prevent the net moving with the swell old iron chains were placed on it using plastic zip-ties/ty-raps (small plastic straps use to tie things).

After covering it was monitored twice a week for one month. During the first month success was observed. At the end of the first month tears were seen in a number of points on the net. A sand deposit 10-15 cm thick was found under the net. As the marine growth has covered the small holes of the net any further deposit of sand could not be identified. The marine growth on the net helps to gather sand on the net and keep it stable (Weerasinghe and Manders 2003:10).

Although it was believed for some period that the test programme would be a success and that we can use this system for the rest of the wreck, when we checked the situation a few month later (the diving was stopped for nearly four months due to the monsoon rain) the whole plastic covering was destroyed by the high waves. It was not strong enough to resist it. This helped us to understand the situation in this area and to select a more suitable net of greater strength and to better secure it.

Covering the shipwreck

In implementing the main *in-situ* project after the failure of the first test our challenge was to select a more suitable and stronger net. We had to check many samples for the strength and for the density (strength by checking the material and try to tear it and density by checking the size of the holes of the net). Finally the 100% polypropylene and 40% - 50% density manufactured in Israel was selected as the most suitable net. The area needed for coverage on the *Avondster* shipwreck was estimated to 400 square meters. Fourteen pieces of 25 x 4 meter size nets were purchased. The specialty of this net was that it is stronger and wider than the previous one. With less density the holes in the net will help sand to permeate and deposit under it.

The covering was placed in November 2003 from the bow section. Before taking the strip of net to the sea it was rolled from both sides to the middle. After placing it on the wreck the rolled strip was unrolled to the each side covering the wreck. In order to prevent the net from swinging some bags of sand were placed on both ends. The second net was placed overlapping the first one and the ends tied with plastic threads (zip-ties/ty-raps). In total four strips of net covered the ship from bow to mid-ship. Sand bags were put on some sharp wooden edges to prevent the damage caused to the net by swells (Weerasighe and Manders 2003:9). On some points we covered the wreck with some sand by using a water dredge in reverse, especially on the excavated areas.

Monitoring and stabilization

We placed sand bags on the net to prevent movement and damage but it did not stop it completely. The movement of the net helps sand and silt go though the net. Fine sand and silt deposits are quite suitable for the creation of a stable anaerobic environment (Richards 2007: 119-120). As such, the swinging motion of the net is similar to a filter (sieve) used for removal of gravel and pebbles from the sand used in construction (Author's personal experience). In the preliminary monitoring and maintenance programme the team of divers always paid attention in the prevention of damages to the net and measured the sediment deposition. Monitoring by way of visual observation, was made four times within one week after the process of conservation. Thereafter monitoring was made in the aforesaid manner once every two weeks. Monitoring revealed within the first week that sand deposits under the net ranged from 5-15cm. Our MAU *Avondster in-situ* Data Sheets from fieldseasons 2005-2009 recorded minimum deposition was observed on the starboard side and the maximum was deposited towards the port side.

We did not expect to see sand deposits on every part equally. We noticed the port side gained more sand than the starboard. Minimum deposition was observed towards the west corner of the bow section. The mid-ship area was not covered because there was an ongoing excavation on that area. In April 2004 two strips of nets were used to cover the 4 meter space towards the stern section from the galley. After placing the net it was covered with sand immediately because the monsoon season was beginning and there was no time to let the net fill naturally. We did not try to cover the galley because it stands nearly 5 feet above the sea bed. After the excavation of the mid-ship area, the decision was made to cover the trench through the same system. After the excavation the trench was filled with sand using the water dredge in reverse, and again after the net was laid. Also two strips of net were placed on the trench.

During the diving in May to September we noticed the nets were damaged in several places due to the high waves. The nets were loosened and moving from side to side. The nets on the excavation trench were in bad shape. The hull was exposed in this area and the net was torn badly in some places. Especially the places near the wooden parts of the hull. But we were not able to do anything about these issues due to the rough sea conditions. Our MAU Dive Report for October 2004 recorded that this work resumed and the tears were covered with sand bags. The sand is resting on the nets again and the net at the stern area is in good shape.

Up to December 23rd 2004 these visual monitoring activities were conducted, together with the excavation, on the end of the stern section. During a period of three months, from October to December, we noted a sedimentation pattern had formed that was conducive to an anaerobic environment.

Three days after the end of the *Avondster* project on December 26th 2004 a strong tsunami wave hit Sri Lanka destroying many coastal areas. The city of Galle was also badly affected and the MAU laboratory and the diving unit were completely destroyed. Luckily no one was hurt because it was a Sunday and the unit was closed. It took more than three months to get-back on to our feet and start work. The MAU building was partly reconstructed and most of the artefacts and equipment that were left were brought to a new building inside the Galle fort. In March 2006 we did our first dive on the *Avondster* to find out its situation. We were expecting to see more damage on the galley, which was in an unstable situation even before the tsunami and to examine the damage to the nets. The site was completely covered with sand. We were not able to see any wooden parts at the bow section. It was covered with a thick layer of sand, including the edges of the nets. The upper part of the galley was located and the brick structure was well intact. Two cannons and some wooden hull parts were detected at the stern section. The condition of the galley gave us hope for the rest of the wreck. The whole seabed was destroyed with waste and debris that came with the tsunami. A lot of fibreglass (from boats) hung all over the *Avondster* site. We also noticed few large tree logs on the site that we worried were harmful to the galley.

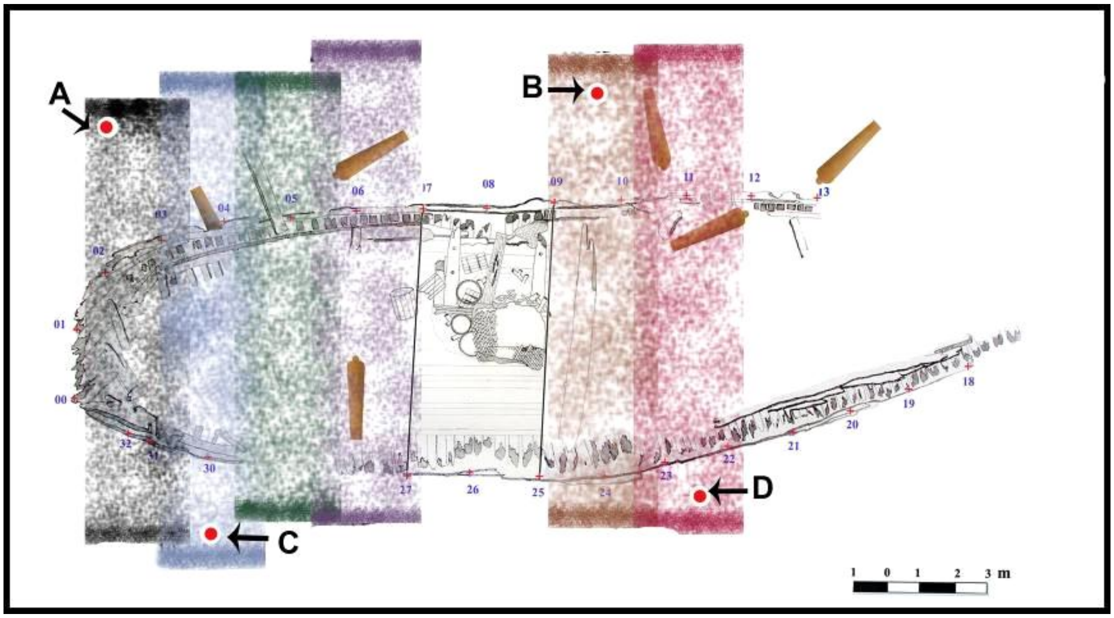


Figure 2. Location of the covering nets and the control points for monitoring
(Drawn by R. Muthucumarana).

The day we had our fist dive we had very bad visibility. During the following months we did more diving on *Avondster* and found out the wreck survived without further damage. The sand layers deposited under and on the net withheld against the tsunami wave firmly and protected the wreck.

Forming a system for monitoring

As there was no sufficient equipment to do the biological and chemical analysis of the shipwreck we decided to monitor the sediments on the wreck. The sedimentation level was measured manually. In November 2005 four aluminum poles were hammered and fixed vertically around the wreck near the net. Each was 3.5 meters long and had a 2 inch diameter. They were secured at 1.5 meters depth and each pole stood 2 meters above the seabed. Two were fixed near the bow section and two near the stern. Rods were not placed in the center of the shipwreck because it was thought that it would damage the artifacts attached to the vessel. The poles were marked using plastic tape and zip-ties/ty-raps. Zip-ties/Ty-raps were used to mark 5cm intervals. In order to find the poles more easily during occasions of low visibility, the rods were inter-connected with nylon rope. A diving data sheet was prepared to record the measurements. The monitoring work was begun in November 2005 and is planned to continue through the coming years (once every two months). During the monsoon season this is expected to be difficult and also when the team going on the field work out of the Galle region.

Result Analysis

Generally inside the Galle bay there are no seasonable and noticeable deferences in pH level (see Godfrey, Richards and Cha this volume), salinity, water temperature and Oxygen percentage. Also we didn’t have the sophisticated and necessary equipments to measure these things regally. The only topic given attention is sedimentation or its fluctuations. Most of the time anaerobic biological situations are formed due to the thickness of the protective sand layer or direct impacts caused by this. It is generally accepted that an anaerobic biological situation is formed under a sand layer with a minimum of 15 cm coverage (Richards 2007: 116-117). However, this is based on the type of protective layer. For example, a protective layer made of core sand or pebbles, of somewhat large size, is not as stable as a protective layer made of silt or fine sand. The spaces among the large particles circulate oxygen creating a welcoming environment for organisms. As such, not only the thickness of the protective layer but the composition and the steadiness were also considered.

Table 1.Sedimentation levels taken from the measuring poles from 2005- 2009
(MAU Avondster *In-situ* Data Sheets 2005/2009)

Date	Pole A	Pole B	Pole C	Pole D
2005/12/04	9cm	13cm	15cm	23cm
2006/04/26	17cm	22cm	28cm	34cm
2006/10/27	11cm	16cm	24cm	32cm
2007/03/30	15cm	23cm	33cm	41cm
2007/11/04	13cm	19cm	36cm	48cm
2008/04/30	18cm	28cm	46cm	56cm
2008/12/16	4cm	14cm	42cm	44cm
2009/04/08	20cm	24cm	55cm	71cm
2009/10/12	26cm	32cm	63cm	92cm

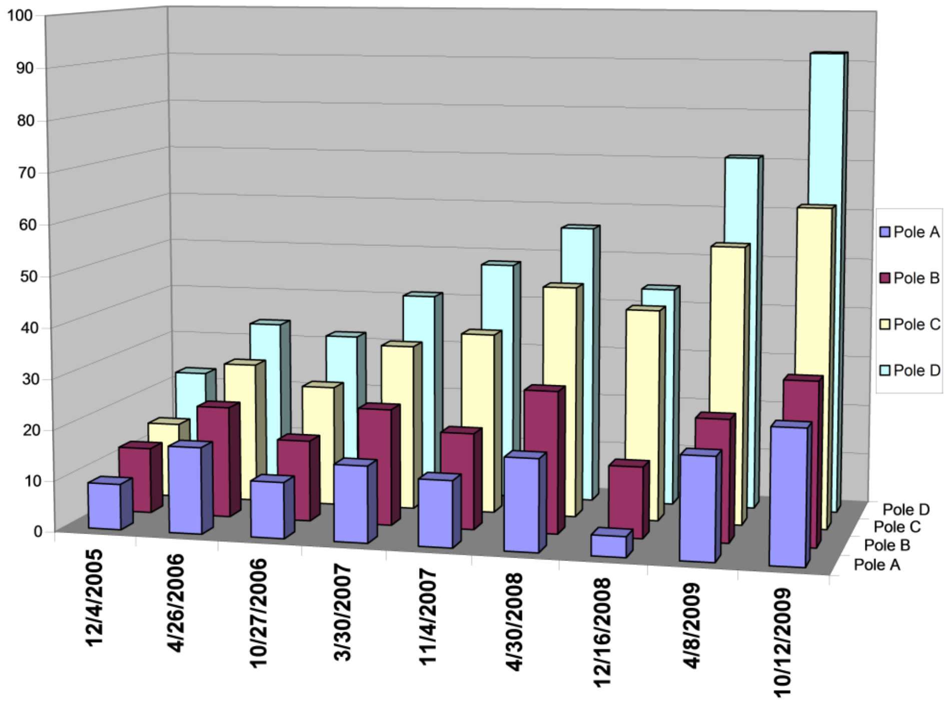
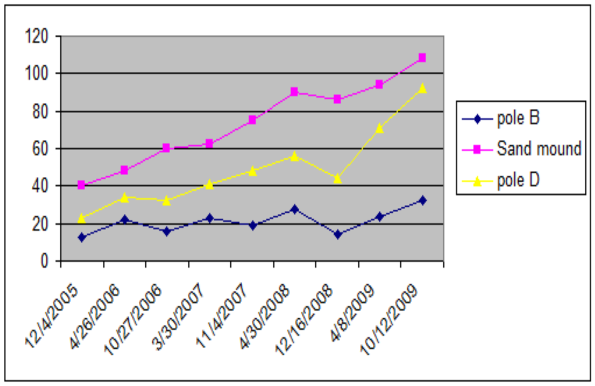


Chart 1Sedimentation levels taken from the measuring poles from 2005- 2009 (MAU Avondster *In-situ* Data Sheets 2005/2009).

At the time when the monitoring system was established in November 2005; a considerable level of erosion had occurred towards the starboard side of the shipwreck. At the time, we start the monitoring a 40-50 cm sand mound was observed on the net along the port side hull. This sand mound was recorded as established up to December 2009 when monitoring work ceased.

Data extracted from the aforementioned diving data sheets are given below. The sediment level on the net or on the middle of the wreck was taken between A-C and B-D poles with a bubble-level which was attached to a string. Table 1 summarizes the data collected.



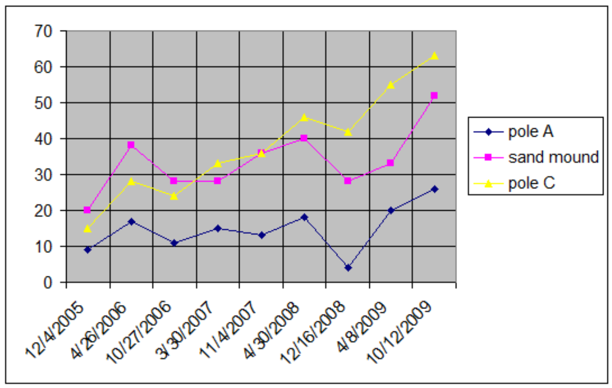


Chart 2a and b. Measurements taken from the poles and from the sand mound near the port side hull 2005- 2009 (Dive reports from 2005/2009)

Conclusion

Preserving organic wreckage in tropical and shallow seas with high oxygen concentration and temperature is a challenge. In these conditions the wrecks can vanish without any trace (Manders, *et al.* 2004:1253). There is no 100% reliability with regard to the success of the *in-situ* preservation even after 8 years of process. The wreck is still open to the risk of natural, biological and human factors. To some extent the wreck is protected from looters and fishermen.

Before covering the wreck, after the monsoon activities, there were a lot of loose artefacts moving on the seabed around the wreck. Now that situation is fully controlled.

Deep in the mid-ship area within an excavation trench we found a thick layer of steady protective silt with well protected wooden/organic remains. The trench is now fully filled with sand and may have a stable anaerobic environment.

The effectiveness of the polypropylene net covering was quite successful. The edges that can be found in some places are still in good strength, so we recommended this type of net we used in other tropical regions attempting *in-situ* preservation projects.

By using the 2 meter wide stripes to cover the wreck the advantage is ease of access to excavate or re-open the wreck site, or a part of a site. We can easily remove the sand by a water dredge and uncover the exact area we seek by removing the associated strip. There is no need to cut or remove the whole net.

Overall we can report that the port site of the wreck's hull is relatively safe and some parts of the starboard side is exposed, especially during the monsoon season.

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