The physical protection of a 17th century VOC shipwreck in Sri Lanka

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Since 2002 a group of Maritime Archaeologists from Sri Lanka, The Netherlands and Australia are excavating a 17th century VOC shipwreck in the harbour of Galle in Sri Lanka. This excavation is part of a larger project that involves training local experts, research and the restoration of Dutch Heritage in Galle. This includes the Fort and the wreck of the Avondster.

The article deals specifically about the consolidation of the shipwreck. Due to changes in the environment, the wreck is now heavily degrading. First it will be physically protected against further deterioration and then systematically excavated in sections. The first year has already given us some interesting results, which we report in this paper.

THE *in situ* protection of archaeological objects becomes more and more an important part of underwater archaeological studies. The reason for this is partly because of the amount of interesting ancient shipwrecks and the high costs to excavate them. The other interest is to protect a representative part of our maritime heritage for future generations. The article 1 of the ICOMOS-charter of 1996 as well as the article 1 of the UNESCO-convention on the protection of Maritime Heritage of 2001 put emphasis on the fact that protection *in situ* should be the first option[1]. If protection of maritime heritage is going to be done rather routinely and quite extensively, it is important for us to understand the procedures. An assessment of factors that threaten our wrecks and their deterioration is an important aspect. It is also important to consider for how long our heritage such as a shipwreck can be protected. Equally important is to recognize the conditions in which preservation of archaeological remains is possible and whether the current procedures are appropriate for long-term management of these.

The Netherlands has a relatively long tradition of *in situ* preservation of maritime archaeological sites. It started with some shipwrecks found on the former Zuiderzee-bed in the Flevopolders[2] in the 1980s. Here, more than thirty wrecks are protected against the lowering of the groundwater table[3] (Figure 1). In 1988 the BZN 3 wreck, a ship of the Dutch East India Company (VOC) was the first wreck under water being physically protected as well as by the law[4]. The physical protection of the sites has always been led by common sense. After all these years our skill has increased on this subject but the scientific data are still inadequate to establish some of the techniques that we follow. The Dutch State (NISA/ROB) is currently involved in two European (EU) projects, MoSS and BACPOLES, focusing on the degradation and the protection of archaeological and historical heritage *in situ*[5]. Information about what is threatening our heritage is collected in a systematic way, our protection methods are being evaluated and new solutions are evolving out of these exercises. The protection of a Dutch shipwreck in Sri Lanka against fast ongoing deterioration with the help of information gained in these two European projects[6], may be cited as an example.

The EU-projects MoSS and BACPOLES

In 2001, various groups from Finland, Mecklenburg-Vorpommern (Germany), Sweden, United Kingdom, Denmark and the Netherlands have started an EU-project within the Culture 2000-program: 'Monitoring, safeguarding and visualizing North-European shipwreck sites (Moss): Common European Underwater Cultural Heritage – Challenges for Culture Resource Managements'[7]. This 4-year pilot project aims to get an insight into the processes that are responsible for the degradation of shipwrecks in an underwater environment and how severe the consequences are. A higher goal is to develop tools for different EU-countries to protect their maritime heritage effectively and to create public awareness by introducing several techniques to make shipwrecks underwater 'visible' for a wider public. The approach, in brief is to monitor, safeguard and make the images available for public viewing; all of which may involve introduction of newer and improved techniques from time to time.

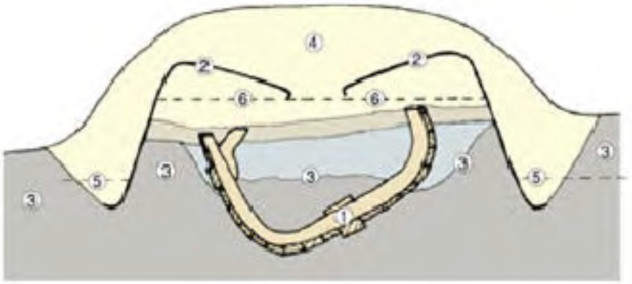

Figure 1. Method of *in situ* preservation of shipwrecks on the former Zuiderzee-bed in the Netherlands (drawing M. Manders).

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The EU-project 'Preserving cultural heritage by preventing bacterial decay of wood in foundation piles and archaeological sites' (BACPOLES) is a project that is focusing on bacterial wood degradation on land as well as underwater[8]. Not long ago it was thought that wood was protected against decay of bacteria in an underwater environment because of low oxygen. However, the oxygen level in groundwater and free flowing water can vary. Besides that, it is also known now that some bacteria can operate in extremely low concentrations of oxygen and possibly even in anaerobic environments. It has not been possible to identify and isolate these specific bacteria yet. This project tries to achieve this with a new combination of isolated techniques and DNA-technology and also tries to find ways to stop or slow down these processes.

These projects have generated much information about the physical, chemical and biological deterioration of shipwrecks. The information we gather ranges from the effect the fishing industry has on the condition of the wreck to know how severe bacteriological attack on wood can be. Research on shipwrecks is typically of a long-term nature and clearly it is essential to have a follow-up programme to continue data collection. Results from other sites also provide many useful tips; for example, the protection of the Avondster wreck in Sri Lanka may be used as an effective model.

Background history of the *Avondster* wreck

On 2 July 1659, during a calm night, the VOC-ship the *Avondster* ran ashore in Galle harbour in the South of Sri Lanka and wrecked (Figure 2). The ship had been loading a cargo for India[9]. The *Avondster* was an English ship by origin of about 250–260 tons and 30–40 m long and was captured by the Dutch in 1653 during the first Anglo-Dutch war. The VOC official reported the loss of the *Avondster* as that of an 'old yacht'[10]. Probably the stern of ship might have hit sandy seabed and run ashore. Due to the constant pressure of the waves the sternpost broke off from the rest of the ship. The waves were also responsible for the breaking of the portside just under the bilge and the starboard side just above the first deck. Fine fluvial sediment of the river, that deposited its water and waste into the bay, must have covered the entire wreck. Whether the ship also sank into the soft soil of the seabed or it was only covered with fine silt is yet to be determined. The fact is that it must have been covered very soon after wreckage and stayed in an anaerobic condition for many centuries. The conditions were good enough to protect a large part of its wooden structure (Figure 3).

Immediately after its discovery in 1993 it became clear that the wreck site was eroding and exposing rapidly[11]. This process continued throughout the following years. In the warm water of the bay of Galle (about 30°C), strong solid wood can be completely eaten away by woodborers within a few months. This may lead to the destruction of the wreck and loss of vital archaeological information (Figure 4).

Construction of a new road only 50 m away from the site, a few decades ago, is almost certainly an important factor leading to the heavy erosion. The new road has been built on the former beach and near a river outlet. Waves coming from the ocean are abruptly stopped against a rocky wall instead of breaking on a gradually sloping sandy coast. This wall creates a strong current around the wreck site that is underscouring the construction and taking away the protective layer of fine silt and sand. Because of this stone barrier the river cannot deposit its fine sediment on the site anymore. In 2003 fresh work was

Figure 2. Location of the *Avondster* wreck site.

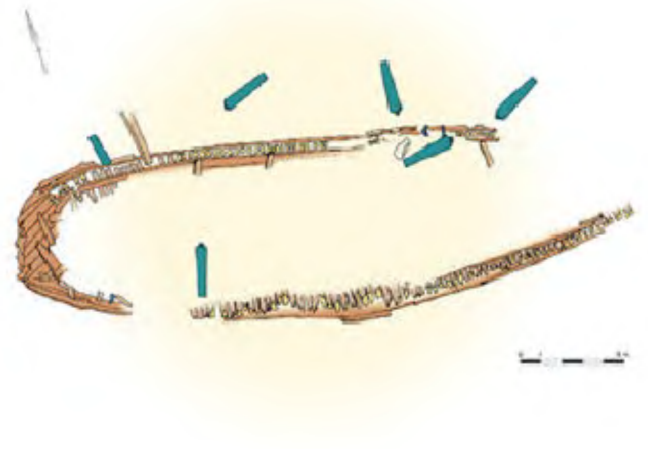

Figure 3. Site plan of the *Avondster* wreck (drawing diving team MAU).

executed on the stone barrier close to the wreck and some jetties were constructed near the barrier. In response to this construction, the currents took another course and now more sediment is removed from the site at places that were relatively stable before.

Preservation *in situ*

The *Avondster* wreck has been preserved for many centuries in a relatively stable environment. Now, due to the construction work near the site, this environment has suddenly become very unstable. The decision has been made to safeguard the valuable archaeological artifacts of the wreck by excavation. Many objects will be preserved *ex situ*, but the idea is to leave the wreck *in situ*[12]. Throughout the years we have seen its wooden construction being destroyed by wood-eating organisms and erosion. Not only the ship, but also objects that belong to the inventory, cargo and the persons on board are deteriorating and moved all over the wreck site by currents and waves. This means loss of archaeological information.

The excavation of the *Avondster* wreck started in 2001 but will go on for many more years to come[13]. Action was needed not to lose much information prior to excavation. A method of physical protection had to be designed that would protect the wreck and its contents against: (i) Natural erosion and scouring caused by sea and weather; (ii) Wood-eating organism; (iii) Looting; (iv) Fishing activities.

The method also had to be less expensive, easy to execute by ourselves and easy to remove in parts so we could continue the excavation in trenches. It was decided to do a test to protect the site with nets[14]. This method has been extensively used in the Netherlands. The environment in the Wadden Sea is however somewhat different from that in Galle Harbour[15]. In the aft of the *Avondster* wreck an area of approximately 4 × 4 m was covered with a black-shading net (100% polypropylene and 60% density)[16]. Within two weeks a layer of 15 cm fine sand and silt settled on the wreck site. After that not much more came in and the holes in the net closed due to organic growth (Figure 5). Unfortunately during the storms of May 2003 this net was destroyed. The results were however promising. Even a layer of 15 cm can turn an aerobic environment into an anaerobic environment[17].

In November 2003 a beginning was made to cover the whole site with a new kind of net (100% polypropylene and 40–50% density) with a more open and stronger structure[18]. At this moment the whole bow section is covered and sand is being deposited rapidly. Finally the whole wreck will be protected with 14 nets, 4 m wide and 25 m long. They are lying squared on the wreck side covering the hull and the area where parts of the broken-off starboard side are possibly still lying under the sand. The strips of the netting are weighted down both ends with sandbags, which are rolled in the net (Figure 6). The different strips are overlapping and connected to each other with ty-raps. The results are even more promising than the test with the black net. Within one week after installation the whole bow site was covered again with sand. It is however, important to maintain the netting and monitor its effect.

The Bay of Galle has tidal influences but most of the sediment is moved over the seabed by high swell and the currents caused by the stone barrier near the site. Before starting the physical protection with the net this had (as is stated above) a negative effect on the site. Much of the old protecting sediment layer was eroded by the current. The net is promoting the opposite effect. Sand transported over the wreck site drops down the holes of the net and settles there because there is hardly any water movement under the net. If this process continues, a thick layer of sand will be protecting the site and creates an anaerobic environment comparable to the conditions in which the wreck has been protected for a few centuries.

At the end, the whole construction has to be covered with sand again. If everything works out well, the wreck

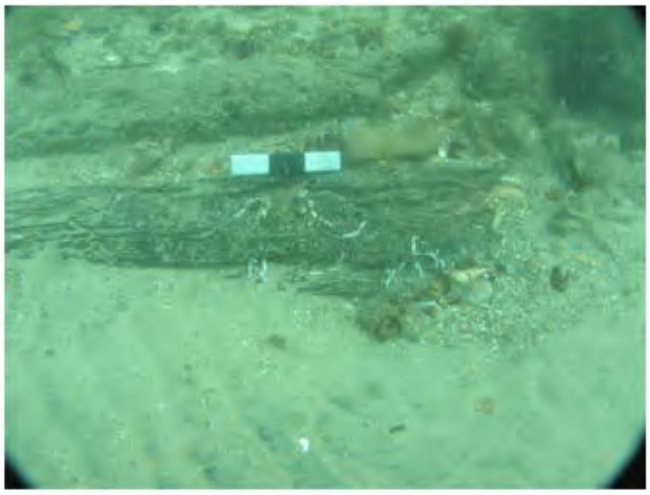

Figure 4. Oak wood in the bow section of the *Avondster* attacked by woodborers (photo P. Baker).

Figure 5. The test area in the aft of the wreck covered with black-shading net. A 15 cm thick layer of fine silt has settled on the wreck site.

site will be a slopping mount of sand and nets within a few months. Within a few years it will be an artificial reef that may be very difficult for looters to enter without the proper equipment. A positive side effect is that fishing nets will not get caught on the wreck parts. The conditions under the net will be favourable to keep the wreck site in good condition (Figure 7). In the case of the *Avondster* wreck there are a few difficulties that have to be taken into consideration:

1. There is no gradual sedimentation. Most sand is moved by the swell and within a few seconds it is moved from one side to other and back. This could have slowed down the process. The results of the first two weeks of observation however indicate that the trapping of sediments occurs quite rapidly.
2. The wreck is lying in high-energy zone ranges between water depths of 3.5 to 5.5 m. This makes the condition rough, especially during monsoon periods. This could rip the protection nets like it had happened with the black-shading net.

Figure 6. Preparation of the new type of nets (Photo: R. Muthucumarana). The strips are weighted down on both sides with sandbags and are underwater attached to each other with ty-raps.

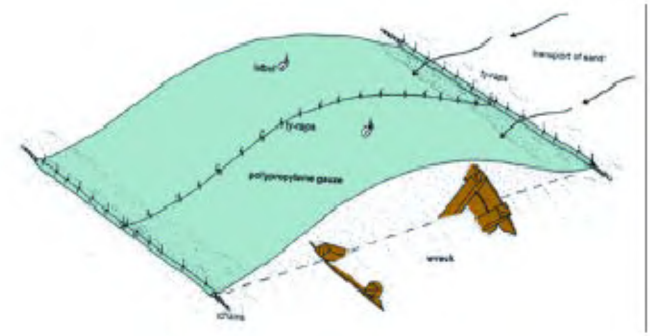

Figure 7. The method of physical protection with polypropylene net (mesh or gauze) as it is executed in the Netherlands for wreck sites under water (Drawing M. Manders/M. Kosian). A similar method is used on the *Avondster* wreck.

3. It would have been better if the site was protected immediately after its discovery. At present, parts of the construction are sticking far out of the seabed. This makes it more difficult to catch enough sand before the holes close due to organic growth. It also increases the possibility of ripping.
4. The galley is sticking out far to be protected with this netting method. It will not be covered with nets, but will be supported by sandbags (Figure 8).
5. The stern of the ship, that is standing upright about a few metres from the rest of the wreck, also cannot be protected for the same reasons as in the case of the galley. Lifting it to land for further investigations, conservation and display in the new maritime museum in Galle Fort, is another option.

To avoid a few above-mentioned problems, we may consider promoting deposition of the sand by using the water dredge, in case the deposition is not fast enough. Sand taken from outside the wreck and the excavation trench, can be pumped under the netting right next to the starboard and port side and other places in the wreck that need this support. The net will be inspected and cleaned in order to make it possible for the sand to penetrate longer through the holes. It is important to put all the nets in place a few weeks before the stormy periods start (usually by May). This way, we can provide sufficient time for the nets to trap enough sand.

It is however important to note that the degradation will go on. We can only slow down or stop a few processes that are responsible for the deterioration of different materials. If we manage to cover the whole wreck site

Figure 8. The galley midship is sticking too far out of the seabed to be covered again with sediment. It will be supported with sandbags (Photo: R. Muthucumarana).

with nets and sand again, it will stop the abrasion and the attack of woodborers. It probably will not stop the deterioration caused by the action of bacteria. This kind of deterioration is a much slower and continuous process[19]. The wreck should probably be completely excavated before this bacterial decay destroys the wreck.

Conclusions

Over the last two decades, the Netherlands has put emphasis on protection of maritime heritage *in situ*. Internationally, this has become common practice as well. Over the years much about this subject has been learned and there is practical knowledge available across the world. Within the two EU-projects, MoSS and BACPOLES, wood and environment of shipwreck sites are being investigated in a systematic way to find out more about the processes that are responsible for degrading wood and wrecks. The *Avondster* wreck is an example of a site that has been heavily deteriorating. The archaeological information of this site would have been lost forever if no action had been taken. The wreck has now been covered with shading nets to prevent the currents taking away the protective sediment. This method will even work as a trap to get more sediment on the site again. The first results are promising. With this method the *Avondster* wreck is being protected against the most degrading factors. The site will then be excavated, trench after trench leaving the rest of the ship protected under net and sand. In the coming years the site will also be monitored to see if this method is really effective in the long run since the purpose is also to preserve the wreck itself *in situ*.

Notes and references

1. ICOMOS, Charter on the Protection and Management of Underwater Cultural Heritage, Sofia, 1996. The UNESCO convention concerning Underwater Cultural Heritage (2001) exists in two parts; 1. Set of rules that apply for the countries that have signed the convention. These countries have to implement these rules in their own law system 2. The Annex: a code of good practise in which is described how an archaeological research has to be executed. Article 1 relates to part 1.
2. Reclaimed land in the former Zuiderzee. The Noordoostpolder was reclaimed in 1942, Oostelijk Flevoland in 1957 and Zuidelijk Flevoland in 1967.
3. Oosting, R., *Monumenten*, 1990, **3/4**, 26–29.
4. Maarleveld, Th. J., *Bull. Aust. Inst. Maritime Archaeol.*, 1993, **17/2**, 31–36; also see De Verenigde Oostindische Companie (VOC, United (Dutch) East India Company).
5. Nederlands Instituut voor Scheeps – en onderwaterArcheologie/ Rijksdienst voor het Oudheidkundig Bodemonderzoek (NISA/ROB). For MoSS see text and note 7. For BACPOLES see text and note 8.
6. Test with this kind of physical protection has also been executed in Germany on the Darsser Cog and in Great Britain on the Colossus.
7. The partners in the project are: Finland (Maritime Museum of Finland), England (Mary Rose Archaeological Services Ltd.), Sweden (Södertörns Högskola), Denmark (National Museum of Denmark/ Centre for Maritime Archaeology in Roskilde), Germany (Department for the Conservation of Archaeological Sites and Monuments/ Archaeological Museum of the State Mecklenburg-Vorpommern) and The Netherlands (Nederlands Instituut voor Scheeps – en onderwaterArcheologie/Rijksdienst voor het Oudheidkundig Bodemonderzoek, NISA/ROB). See also: www.mossproject.com
8. The partners in the BACPOLES project are: SHR Foundation of Timber Research (Co-ordinator, The Netherlands), Fugro (The Netherlands), University of Portsmouth (United Kingdom), Netherlands Institute for Ship and Underwater Archaeology/National Service for Archaeological Heritage NISA/ROB (The Netherlands), RING Centre for Dendrochronology (The Netherlands), Ecopiano Engineering SRL (Italy), Swedish University of Agricultural Sciences, Department of Wood Science (Sweden), Phagen AB (Sweden), University Göttingen, Institute of Wood Biology and Technology (Germany), University Göttingen, Institute of Soil Science and Forest Nutrition (Germany). See also WWW.BACPOLES.nl
9. Of which a cargo of areca nuts (*Areca catechu*). These are the seeds of a palm tree and an ingredient of Sirih, a kind of chew.
10. It is thought that the ship derived its name from the fact that it was already old when the Dutch captured it, since 'Avondster' means 'Evening Star'. The historical information about the Avondster is taken from the Sri Lanka Maritime Archaeological Unit, Publication No. 1, 2003.
11. The wreck has been discovered during a survey of Galle Harbour. This Galle Harbour Project started in 1992 and lasted three years. It was a co-operation between the Department of Archaeology (Sri Lanka), the Central Cultural Fund (Sri Lanka), the Post Graduate Institute of Archaeology (Sri Lanka) and the Western Australian Maritime Museum (Australia).
12. The wreck itself will not be taken up because of the fact that the ship would be extremely expensive to lift, to conserve and to exhibit. The information about the ship construction will be gathered under water. The finds are being conserved in a laboratory near the site and created for the Avondster project.
13. In 2004 the involvement of the Netherlands and Australia will be reduced. The people from the Maritime Archaeological Unit (MAU) of Sri Lanka that have been educated within the Avondster Project will take over the excavation and conservation of the objects.
14. Manders, Martijn, *Bull. Aust. Inst. Maritime Archaeol.*, 2002, **26**, 99–104.
15. See MoSS (2003). The Wadden Sea is much colder (from approx. 0 to 22°C depending on the season) and has a strong tidal movement. It seems that it transports much more sand up and down the seabed than in Galle Harbour. This process seems to be also much more gradual. The Wadden Sea in some ways is comparable with the situation in Galle: It is also shallow and has a sandy seabed.
16. This net has been manufactured in Israel by Polly Sack Plastic Industries. The density can be compared with the shading capacity.
17. If a sandy environment is stable, oxygen only penetrates through a top layer of about a few millimetres to a few centimetres. The seabed around the *Avondster* site is not stable. This is why probably a thicker layer of sand is aerobic. The net however takes away the influences of the swell and currents. We have seen by the colour of the sand (black is usually anaerobic) that under the net the sand turns into a stable and anaerobic environment. We have done some tests outside the wreck with a handheld redox devise to measure the reduction of oxygen potential of the sediment. The results were however not satisfactory. It takes a few days on site for redox sensors to stabilize. In the future it would be good to do some research on the site with a data logger that can measure the redox-potential and that can stay on the site for a longer period and that can read data after every fixed time. These systems have been used in the MoSS project. See for more information the website of the MoSS-project.
18. This net is manufactured in Sri Lanka by Malba Ropes Ltd and is normally used in the shrimp fishing industry.
19. Björdahl, C. G., Daniel, G. and Nilsson, T., *Int. Biodeteriorat. Biodegradat.*, 2000, **45**, 15–26.