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Practical problems and solutions with separation technology in relation to plastic pollution.

Plastic pollution is a modern-day environmental issue due to its with widespread global effects on the environment and complex implications for socio-economic factors such as fishing and tourism.
A plastic pollution incident occurred off the West coast of Sri Lanka in 2021, resulting in the release of hundreds of tonnes of microplastic 'nurdles' into the marine and nearshore environments. 'Nurdles' are classified according to them being primary sources of microplastic and their size being less than 5mm. As a result, this type of microplastic pollution is highly mobile and polluted the coastline in an area which is heavily used for tourism and subsistence fishing.

Oil Spill Response Limited was one emergency response organisations mobilised to assist with the nurdle clean up. During the initial response a number of practical problems were encountered such as shoreline type, the size of the nurdles, resources in country, limitation of pre-established proven plastic recovery technologies, and effectiveness based on tide and weather conditions. Faced with these complex challenges several improvised separation technologies were adapted and developed.
This case study will feature the development from manual aids to mechanical equipment that were used during the plastic recovery along with their effectiveness, problems encountered and potential solutions. It will also consider where gaps remain for future development and how industry could bridge this gap.

Manual recovery
The same as any oiled shoreline response, a lot of the initial clean-up to remove the bulk contamination or whilst waiting for equipment the manual techniques are at the forefront of the response. This was the same for the Sri Lanka response with collecting knee deep nurdles with buckets and spades during the emergency phase. However, once this bulk was removed, there were issues that match shoreline response with increasing excess of the substrate being removed by non-trained personnel. This inefficiency led to the implementation of sieves.

The sieves we designed were a basic rectangular structure with a mesh that the nurdles would be caught on with the sand passing through. This enabled the efficiency of the substrate separation to be overcome however, there were limitations with this method. Unfortunately, nurdles come in a range of different sizes so the mesh did not stop some of the smaller pieces from passing through, this also included the burnt microplastics created as a result of the fire. It also became clear pretty quickly that there was an overarching background plastic issue with the beaches we were working on. Therefore, separating the nurdles from this different plastic source was another challenge that needed to be overcome. The solution; The Trevett table.

The Trevett table was a basic idea that by simply stacking two sieves together with a large mesh on top and a smaller mesh below would provide us a solution to remove the larger background plastic debris. This worked brilliantly and it allowed for an additional benefit to the clean up operations by collecting this plastic. However, with both sieve methods the limitation was that it is still labour intensive, the mesh still allowed the burnt microplastics to pass through and it did not work effectively

with wet sand. As a result of the limitations, the same way as an oiled shoreline would evolve, mechanical aids were looked into to accompany the manual techniques being used.

A final manual method was using flotation. Both the burnt and fresh nurdles float when submerged in water whereas the sand and other debris do not. By filling large basins with sea water and depositing shovels full of sand and nurdles, the nurdles were efficiently and easily separated and removed off the surface. This method allowed for good waste separation and when used alongside sieving was the preferred method of the local community.

Mechanical recovery

One of the first pieces of equipment trialled in country was the trommel that has been used previously in the construction industry. Similar to a Trevett Table but with a cylindrical structure the sand is fed into one end and as the trommel is rotated the sand progresses past different grades of mesh, separating the nurdles and smaller debris from the larger debris and sand. The trommel allows for an increased throughput of sand and an improvement of debris separation. The use of the trommel still requires an element of manual labour and it also requires a bit more training for those using the machine to understand the speed necessary for best efficiency. Again, it does not work effectively on wet sand and to get an even better separation of the debris, the flotation method was used in conjunction with the trommel.

Another mechanical drive device was the BeachTech Sweepy and BeachTech 2000's. These machines were already in use for cleaning and levelling out tourist beaches but could be modified to retrieve nurdles. However, these pieces of equipment needed to be brought into country and with the logistically constraints brought on by the pandemic there were increased lead times. When they arrived in country, it was quickly realised that the standard mesh was too large and allowed nurdles to pass through, therefore modifications were made to capture the nurdles but allow the sand to still pass through. They were much more efficient, and of course less labour intensive due to only requiring one person to use the machines. But again, there were constraints, it needs flat, dry sand in order to work efficiently and a small amount of training for the personnel to use the machines correctly.

Future development and next steps

During our ongoing involvement with the plastic clean up in Sri Lanka, our personnel are always trying to implement other initiatives to increase the efficiency in nurdle separation. Currently the team are looking into whether low-pressure high-volume flushing could be utilised and if the nurdles will behave in a way that this is possible. If this method proves effective it will allow larger cleaning areas to be tackled whilst being less labour intensive and overall being an efficient method of separation.

It was clear during this spill that there were no 'good practice guides' on how to respond to a nurdle spill or clean up and with only one previous large-scale spill situated in South Africa, it was a learning curve for OSRL as well as the other organisations involved. As a result of this spill, it is clear that there are a lot of improvements and gaps regarding the recovery methods that are still to be plugged. Moving forward, it would be beneficial for industry to join together and create an expertise group to begin to produce good practice guides, technology innovation or adaption for specific shoreline types and potential of stockpiling nurdle clean-up equipment for if/when a future spill occurs. When these spills occur, it enables us to learn and mitigate the same issues from reoccurring in the future, the same way as oil spills have helped the spill response industry to develop overtime.