



THE FLIPFLOPI DHOW



How can design help develop
new tools and techniques to open
up new opportunities within the
global circular economy?

Type of output:
Physical Artefact
by

Simon
Scott-Harden

Cover:
The Flipflop at Diani.
Photo Credit: The Flipflop Project

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SUMMARY & INTRODUCTION

Annually, thousands of tonnes of plastic products are discarded and end up in the Indian Ocean. Plastic waste is washed up on the beaches of Kenya in East Africa. This impacts detrimentally on both the marine ecosystem and the economy of the country where the locals rely on coastal fishing, trade and tourism for their livelihoods.

Simon Scott-Harden worked with shoreline communities, master dhow builders, team members of the The Flipflop Project and researchers and technicians at Northumbria University, to help develop a processing method capable of giving waste plastic a valuable second life.

As a demonstration of the potential of this new recycled material, the shoreline communities constructed a traditional dhow sailing boat entirely from plastic trash collected from Kenya's beaches and towns.

During its 500 kilometre maiden voyage from Lamu in Kenya to Zanzibar in Tanzania, the researchers stopped at communities along the way to change mindsets about plastic waste.

This project practically demonstrates how an environmentally and economically damaging waste problem can be re-envisaged as a valuable resource that supports the local and regional economy and unblocks the circular economy in the shoreline communities of East Africa.

In November 2016, 35 tonnes of plastic was collected from a 10km beach in Lamu in Northern Kenya.

In one 3 hour beach clean-up that was organised locally by the community, 5.8 tonnes of plastic was cleaned up.

Right:
Marine trash washed up
onto the coast in Kenya.
Photo Credit: The Flipflop Project

Below:
The *Flipflop* made from 9 tonnes of recycled
marine trash... and 10,000 flipflops.
Photo Credit: The Flipflop Project



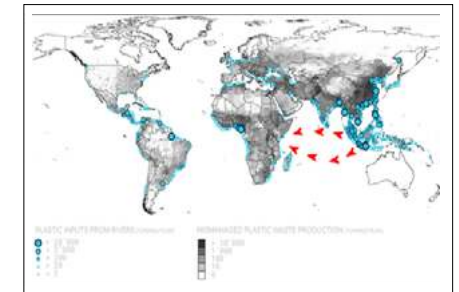
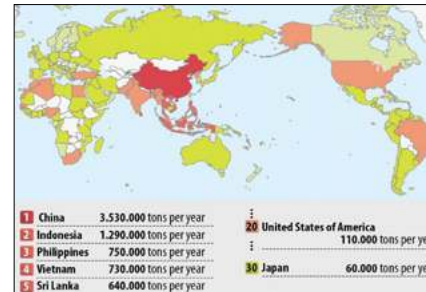
TIMELINE

2017	2018	2019	2020
<p>MARCH Low grade sample of recycled plastic produced by The Flipflopi Project is sent to Northumbria University for analysis.</p> <p>MAY Completion of the 1st reseach project on the sample recycled plastic material. Recommendations for improved production processes outlined and presented to the Flipflopi Project.</p> <p>AUGUST Production of the high quality recycled plastic at the manufacturing partners of the Flipflopi Project in Kenya utilising the optimised manufacturing process begins.</p> <p>DECEMBER The Flipflopi Project release “The Flipflopi Dhow” film. https://youtu.be/8mT2dQ8Og18</p>	<p>JANUARY The 2nd round of materials testing at Northmbira University, analysing and certifying the process for the manufacture of high grade recycled components for the manufacture of the The Flipflopi Dhow is completed.</p> <p>SEPTEMBER The Flipflopi Dhow is launched in Lamu in North East Kenya and undergoes her first sea trials.</p> <p>The Flipflopi Project release “Plastic; A Second Life”, a production by Borderland for The Flipflopi Project. The film is shortlisted by National Geographic as one of their Short Film Showcase films. https://vimeo.com/289669555</p> <p>DECEMBER The Flipflopi Project becomes an official partner of UNEP - UN Environment Programme.</p>	<p>JANUARY The Flipflopi Dhow sails 500km from Lamu, Kenya south to Zanzibar, Tanzania on its inaugural expedition where it is welcomed by Siim Valmar Kiisler, (Minister of the Environment, Estonia) President of the 4th United Nations Environment Assembly.</p> <p>MARCH The Flipflopi Dhow is the central attraction at 2019 UNEA-4, honoured to have on board the President of Kenya, H.E. Uhuru Kenyatta, Deputy Secretary-General of the United Nations Amina Mohammed, UN Environment Goodwill Ambassador and Chinese superstar Karry Wang, and Kenya Ambassador Prof. Judi Wakhungu.</p> <p>MAY Inspiring the next generation of environmentalists, The Flipflopi Dhow is exhibited at the Aga Khan Pavilion in Nairobi, Kenya.</p> <p>SEPTEMBER Paper presented at the International Association of Societies of Design Research Conference 2019, Manchester, United Kingdom, 2019. <i>Unblocking the Circular Economy</i>. Scott-Harden, S., English, S., Skanda, A., Schurg, L., Elleke, K. & Morison, B.</p>	<p>MARCH The Flipflopi Project and KPPC (Kwale Plastic Plus Collectors) start the construction of the first purpose built community lead recycling centre in South East Kenya using the recommendations for improved recycled plastic production developed during the production of the The Flipflopi Dhow.</p> <p>OCTOBER The Flipflopi Project realease the animation “The Wonderful Story of Flipflopi” It is nominated for Best Animation in the 2020 Kalasha Film Awards, Kenya. https://youtu.be/r97dCMm0M4A</p> <p>NOVEMBER Awarded grant from the FCDO (The British Foreign and Commonwealth Development Office) Soft Power Fund; “Charting a course towards a green recovery: Promoting the circular economy around Lake Victoria”.</p> <p>NOVEMBER The Flipflopi Project announce the Lake Victoria expedition that will take place in the spring of 2021.</p>

CONTEXT (GLOBAL)

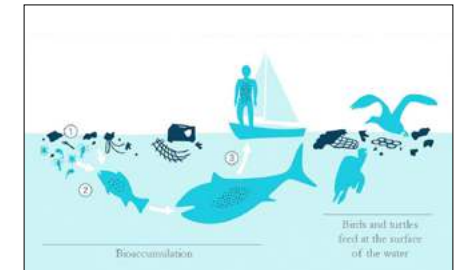
The Indian Ocean is surrounded by some of the most prolific contributors to marine pollution on the planet and the currents in action in the Indian Ocean deliver waste onto the shores of East Africa. It is estimated that 5 countries; China, Indonesia, the Philippines, Thailand, and Vietnam dump more than half of all ocean plastic waste that originates from the land (Ocean Conservancy, 2015).

It is estimated that over 12.7 million metric tonnes of plastic (Jambeck, 2015) enter the oceans each year, this originates mainly inland but then flows into the rivers and then out to sea. Between 88% and 95% of this waste emanates from ten rivers, eight can be found in Asia and two in Africa (Schmidt, 2017).



Top row:
The main contributors to marine pollution, hotspots of river based waste and red arrows depicting the Indian Ocean currents that drive waste into East Africa.

Photo Credits: Japan Forward, Nature



Bottom row:
Bioaccumulation.

Photo Credits: Shutterstock, The Ocean Cleanup

It has been estimated that there is almost 60,000 tons of plastic floating in the Indian Ocean alone (Eriksen, 2014). Plastic waste is a major problem for marine life, it can be ingested and larger animals can become entangled in it. Larger pieces are broken down into smaller particles that can then leach toxic chemicals into the sea.

In 2010 a massive marine plastic waste patch was discovered in the Indian Ocean (Parker, 2014) measuring roughly 2 million miles² (about 5 million km²). This is continuing to grow.

The plastic contamination of the sea and marine life within marine ecosystem (bioaccumulation) has a direct effect on the people who live in these coastal communities. The number of people who depend on the oceans as their primary source of protein is increasing, fish represents almost 20% of the average intake of protein (per capita) for about 3.2 billion people worldwide as reported by the Food and Agriculture Organization of the United Nations (FAO, 2018).



Right:
Larger pieces broken down into smaller
particles resulting in Micro Plastic and Micro Fibres.
Photo Credits: The Flipflop Project and Goje Case

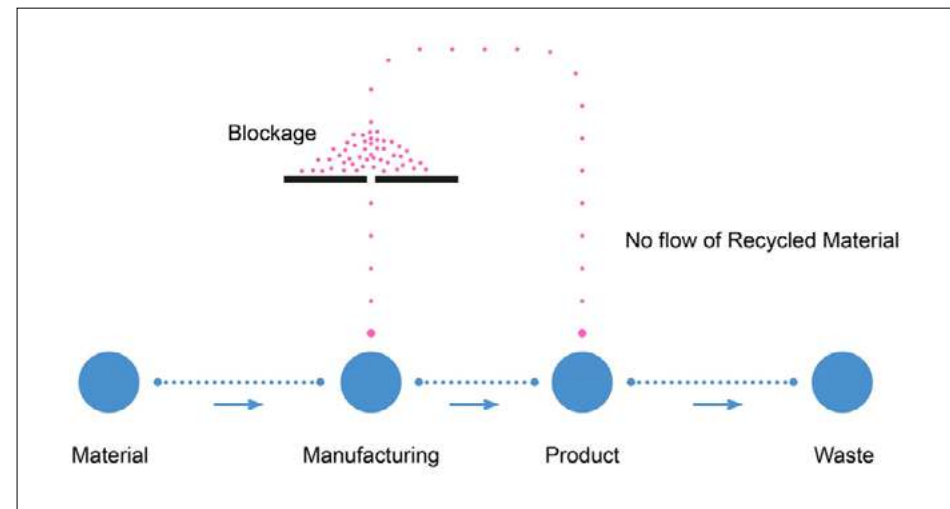
CONTEXT (REGIONAL)

The plastic that litters the shores of Kenya has reached the end of its life and has no direct use. This impacts detrimentally on both the local marine ecosystem and the economy of Kenya where the locals rely on coastal fishing, trade and tourism for their livelihoods.

- The plastic on the beaches is affecting the local communities reducing the amount of fish they can catch.
- One example highlights the way that pollution enters the food chain-bioaccumulation, tiny plastic particles are ingested by plankton that is then consumed by the fish that are eaten by the people who live on the coast. Larger pieces of plastic are eaten by larger marine animals and entanglement is also an issue.
- Casper van de Geer, a project manager with the Local Ocean Trust, a Watamu organization states that “in polluted beaches, turtles have to dig through the marine debris to lay eggs. Hatchlings get stuck in the debris when they hatch. Once they escape and swim into the middle of the ocean, [it’s] only to find heaps of mixed plastics, netting and other debris”. (Mbugua, 2018)
- Ali Skanda (The Flipflop Chief Boat Builder) reports that the local fishermen often catch more plastic in their fishing nets than actual fish.

Plastic waste comes ashore in many forms and is badly degraded by the elements such that when processed locally, the quality of the recycled material resembles the consistency of a Crunchy bar. This low-grade recycled material is not strong enough to meet most functional needs of the community.

Right:
Holes the sizes of Mangos!
When processed locally, the quality of the recycled plastic material is not good enough to be used to manufacture durable products that give the plastic a second life.
Photo Credit: Simon Scott-Harden



Above: Due to a blockage in the circular economy, tonnes of plastic waste is piling up.
Fig Credit: Simon Scott-Harden

RESEARCH CHALLENGE

The shoreline communities are keen to find solutions to the problems of plastic waste and are constantly looking for ways to turn it into something viably useful that can help their communities and local economy.

Currently, when processed locally, the quality of the recycled plastic material is not good enough to be used to manufacture durable products that give the plastic a second life. With the blockage in the circular economy and tons of plastic waste is piling up behind it, the aim of this research was to remove the block so that the recycled material can flow back into the system.

This research project focused on giving waste plastic a valuable second life. The project involved the construction of a traditional dhow from plastic trash collected along Kenya's coast that included flip flops after which the dhow was named. The dhow entailed a collaborative development with coastal communities informed by local heritage and sustainable low technology and low-cost models.

Scott Harden's research is centred around how design can help develop new tools and techniques to open up new opportunities within the global circular economy.

Through this project, he drew on his experience as an Industrial Design practitioner and his understanding of plastic materials and production processes. Working at a local and practical level he helped shape how communities can recycle plastic more effectively.



Right:
Shoreline communities are keen to find solutions to the problems of plastic waste.
Photo Credit: The Flipflop Project

METHODS & PROCESSES

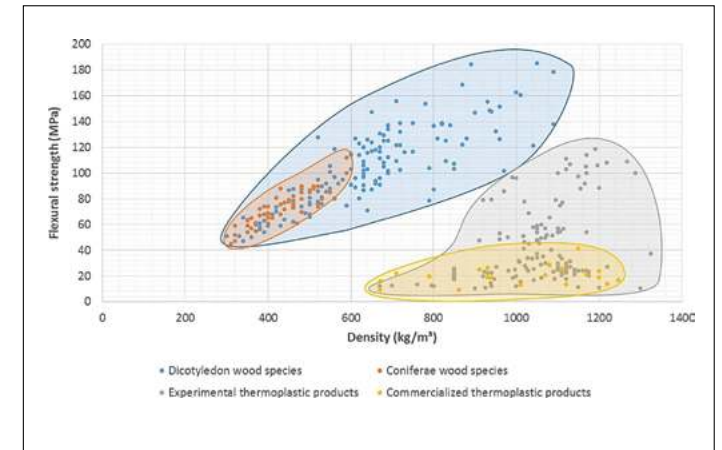
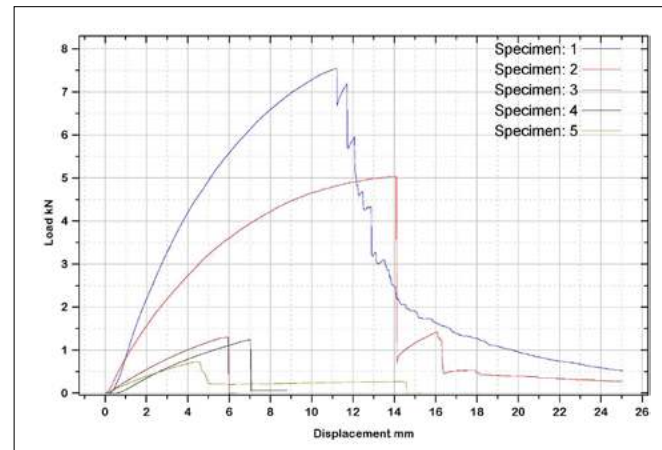
An initial objective was to find out whether it would be possible to produce high enough quality material from the waste plastic found on Kenyan beaches and make it fit for the purpose of building a dhow. The first challenge was to eliminate the presence of large bubbles in the recycled material, this needed to be addressed to create high quality parts using low-tech machinery.

Samples of the low-quality material were tested using a simple three-point bending configuration; this allowed the Flexural Strength of sample materials to be tested by measuring the applied force against deflection.



Right:
The samples of recycled material were analysed against well known timber materials to benchmark required material properties which provided data that allowed the necessary recommendations for an improved manufacturing process to be made.

Photo Credit: Simon Scott-Harden



The original recycled material that was being produced and tested was significantly below the Flexural Strength required for boat construction.

The main reason as identified prior to the testing was the presence of the air pockets within the recycled material. The failures always originated from the holes that allowed cracks to permeate through the material. It was therefore important to reduce the overall number of holes, but also to eliminate holes with sharp corners which caused stress concentration, ultimately leading to failure in the material (this is the same characteristic that leads aircraft to have rounded windows).



Right:

The samples of recycled material were analysed against well known timber materials to benchmark required material properties provided data that allowed the necessary recommendations for an improved manufacturing process to be made.

Photo Credit: Simon Scott-Harden

The local community of boatbuilders uses the high quality recycled plastic to build The Fliflopi Dhow in 2018 in Lamu, Kenya.

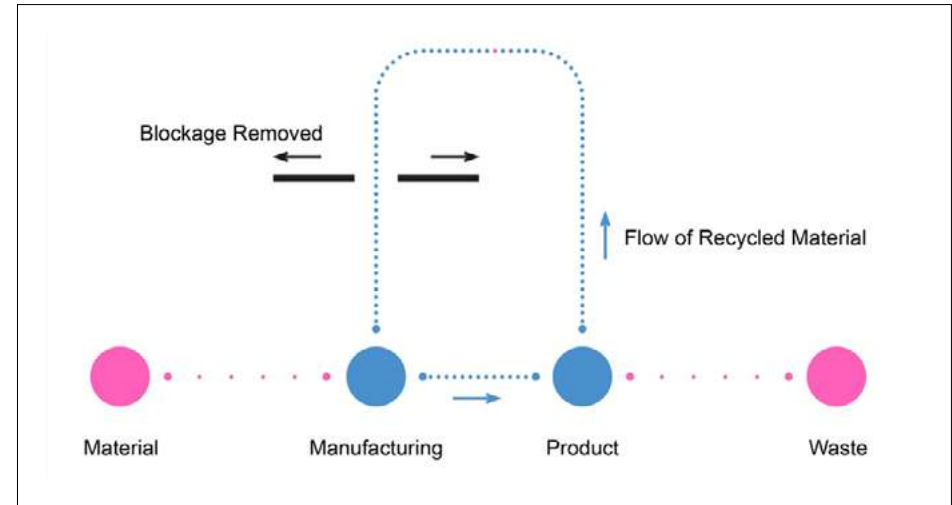
Photo Credit: The Fliflopi Project



A refined process of recycling the waste was developed. Observation and testing revealed that three aspects of the recycling process needed to be addressed to reduce the shape, frequency and size of the air bubbles and increase the quality of the material.

We unblocked the circular economy- allowing material to flow back into the system. Our production process involved:

- **Sorting:** Sorting of different plastics so that similar polymers are used together.
- **Cleaning/Drying:** Cleaning and drying of the plastic prior to melting to remove any impurities that cause the sharp air bubbles to appear.
- **Casting:** Application of heat and pressure to create small regular air bubbles.



Above:
The blockage is removed allowing material to flow back into the system.
Fig Credit: Simon Scott-Harden

Below:
Low quality recycled plastic with air bubbles.
Photo Credit: Simon Scott-Harden



Below:
By simple, but significant, modification of processing methods, the researchers found that significantly higher quality material could be consistently produced.
Photo Credit: The Flipflopi Project



OUTCOMES & DISSEMINATION

Through this research project a new high grade, locally produced recycled plastic is able to provide a sustainable alternative to the traditional materials used in dhow building. This high-grade recycled plastic is a good substitute for the wood of the Mangrove tree, it brings with it many additional properties and offers a valuable second (and longer) life for waste plastic that would otherwise litter the shores of East Africa. The direct impact of building the dhow using 100% recycled plastic allowed the research project to generate the following impact during its first expedition and subsequent year:

- The dhow was launched in late 2018 in Lamu and the Project partnered with UN Environment's Clean Seas campaign, which engages governments, the public and the private sector in the fight against marine plastic pollution.
- The partnership of the Flipflopi Project with the UN Environment was key to enabling to engage international decision makers on the environment to activate real change beyond the expedition.
- The expedition team travelled 500km in two weeks from Lamu (Kenya) to Zanzibar (Tanzania) at the end of January 2019. They stopped at 12 different coastal communities en route and communicated their message to over 10,000 people who met them on the beaches, including over 3,000 schoolchildren and 50 local conservation and ecotourism organisations.
- Following the completion of the Clean Seas expedition, the Flipflopi boat was the centre piece exhibit at the UN Environment Assembly (UNEA-4) in Nairobi Kenya (11th to 15th March 2019), a forum that brought together more than 150 ministers of environment. Guests onboard the Flipflopi included: President of Kenya, H.E. Uhuru Kenyatta, Deputy Secretary-General of the United Nations Amina Mohammed, UN Environment Goodwill Ambassador, Karry Wang and Kenya Ambassador Prof. Judi Wakhungu.



The project was joined by the President of the United Nations Environment Assembly, Mr Siim Kiisler commented that:

“The Clean Seas - Flipflopi Expedition inspires citizens from Africa and around the world to become more aware of one of the most urgent environmental issues that we face”



Mbarrak Bayaka Salim who is a Fundu (Kiswahili / Boatbuilder) from Lamu uses traditional tools to create the structure of The Flipflop which is covered in over 10,000 flipflops creating a watertight hull.

Photo Credit: The Flipflop Project

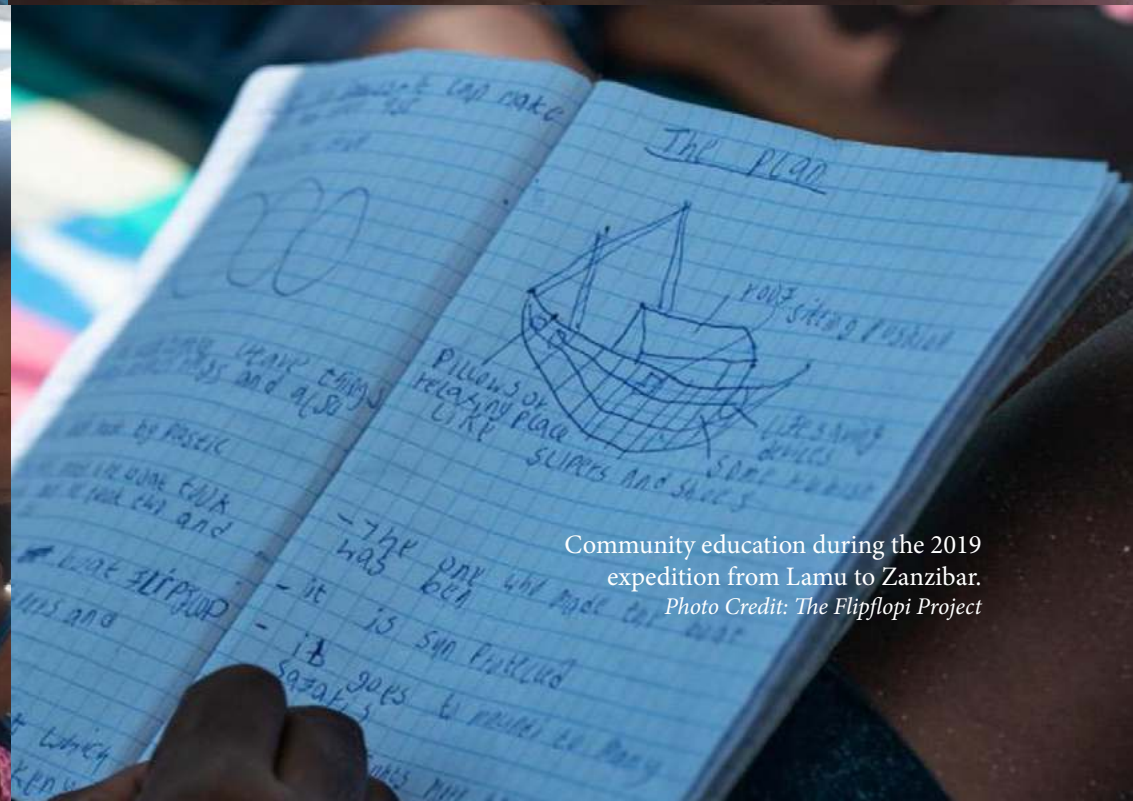
During the two-week voyage, a worldwide audience of over 890 million was reached via media coverage and appeared in over 200 media articles and features in over 30 languages across the world.

- Described as creating Africa's 'Blue Planet Moment' *The Times*.
- Featured in high profile publications, including Al Jazeera, CNN, *BBC Le Monde*, *AFP Thomson*, *Reuters The Economist*, *The Guardian*, *Der Spiegel*, *Xinhua*, *Sky News* & many 100's more.
- The Flipflop film was shortlisted in National Geographic short film showcase.
- United Nations plays Flipflop film on its website homepage and chooses The Flipflop in top 5 innovative projects in the world.
- 600k viewings of feature film and more than 1.2 million social media hits (... from Africa to Europe/Asia/South America).

Engagement with individuals, businesses and policy makers at national and regional level reaching 12 different communities along the East African coastline; directly engaging over 5000 people.

- The expedition team ran 7 community events, together with over 50 local conservation and ecotourism partners.
- More than 3000 schoolchildren came on the boat to learn about plastic pollution and hosted 50 recycling workshops showcasing how to make valuable things from wasted plastic with low-tech tools. Directly engaged 250 people from the Kenyan tourism fraternity including county and national government members.
- The Kenyan PET industry body PETCO pledged to find new solutions to plastic pollution and government ministers and environmental governing bodies made commitments for long-term solutions.
- 39 businesses, including 37 hotels in Kenya, committed to banning the use of plastic bottles and straws, replacing them with sustainable alternatives during the journey.
- The Mombasa county government committed to close down biggest dumpsite and install environmentally friendly waste management systems in its place.





Community education during the 2019 expedition from Lamu to Zanzibar.
Photo Credit: The Flipflop Project

Below: Conference paper
“Unblocking the Circular Economy”
at IASDR 2019.

Photo Credit: IASDR



Below: The Guardian: “Can a boat made of flipflops stop us using so much plastic?” <http://bit.ly/34kmILo>

Photo Credit: The Guardian



Below: Presenting at one of seven community events, this one is in Mombasa attracting over 1000 people.

Photo Credit: The Flipflopi Project



Below: President of Kenya, H.E. Uhuru Kenyatta onboard during (UNEA-4) 2019 UN Environment Assembly.

Photo Credit: The Flipflopi Project



Left: Mr Siim Kiisler personally welcomes Ali Skanda and Hassan Shafii onboard The Flipflop to Zanzibar, Tanzania after completing its inaugural 500km journey.

Photo Credit: UNEP - UN Environment Programme



Left: 12 different communities along the East African coastline were visited directly engaging over 3000 children.

Photo Credit: The Flipflop Project



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