

SHIPPING'S BLACK CLOUD



Over summer **THE EDITOR** visited the beautiful Island of Gozo, meeting **PROF. RAY ELLUL** and his team based in Xewkija and the Giordan Lighthouse. Gozo is a tourist hotspot because of its beautiful landscapes, churches, and natural beauty. These same reasons attracted Ellul to obtain baseline readings of air pollutants; human effects should be minimal. Their equipment told them a different story



**Prof. Ray Ellul, Ing. Francelle Azzopardi
Alexander Smyth, Martin Saliba
Miriam Azzopardi**



They're very big, anything from 10,000 tonnes to 100,000 tonnes,' atmospheric physicist Prof. Ray Ellul is telling me about the 30,000 large ships his team observed passing between Malta and Sicily over a year. This shipping superhighway sees one third of the world's traffic pass by carrying goods from Asia to Europe and back.

The problem could be massive. 'A typical 50,000 tonner will have an engine equivalent to 85 MW,' Malta's two electricity plants churn out nearly 600 MW. You only need a few of these to rival the Islands' power stations.

Ellul continues, 'this is far far worse. We are right in the middle of it and with winds from the northwest we get the benefit of everything.' Northwest winds blow 70% of the time over Malta and Gozo, which means that around two thirds of the time the pollutants streaming out of these ships are travelling over Malta. Even in Gozo, where traffic is less

intense, air quality is being affected.

Malta is dependent on shipping. Malta's Flag has the largest registered tonnage of ships in Europe; shipping brings in millions for Malta. We cannot afford to divert 30,000 ships to another sea. Yet Malta is part of the EU and our politicians could 'go to Brussels with the data and say we need to ensure that shipping switches to cleaner fuels when passing through the Mediterranean.' Politicians would also need to go to the Arab League to strike a deal with North Africa. Ships currently use heavy fuel oil with 3.5% sulfur; this needs to go down to at least 0.5%. The problem is that it doubles the costs. Malta's battle at home and abroad won't be easy, but the Baltic Sea has already taken these measures.

German Dreams

The research station in Gozo is a full-fledged Global Atmospheric Watch station with a team of five behind it. Now it

can monitor a whole swathe of pollutants but its beginning was much more humble, built on the efforts of Ellul, who was drawn into studying the atmosphere in the 80s when he shifted his career from chemistry to physics.

In the early 90s the late rector, Rev. Prof. Peter Serracino Inglott, wanted the University to start building some form of research projects. 'At that time, we knew absolutely nothing about what was wrong with Maltese air and Mediterranean pollution,' explained Ellul. Building a fully fledged monitoring station seemed to be the key, so Ellul sent 'handwritten letters with postage stamps' to the Max Planck Institute in Mainz. Nobel prize winner Paul J. Crutzen wrote back inviting him to spend a year's sabbatical in Germany, but their help didn't stop there. 'He helped us set-up the first measuring station, [to analyse the pollutants] ozone, then sulphur dioxide, then carbon monoxide. That's the system we had in 1996 — [...] 2 or 3 instruments.'

They lived off German generosity until 2008 when Malta started tapping into EU money. After some ERDF money and an Italy-Malta project on Etna called VAMOS SEGURO (see Etna, **THINK** issue 06, pg. 40), Ellul now manages a team of five. In homage to his early German supporters he has structured the research team around a Max Planck model — ‘one of the best systems in the World for science.’

Paradise Lost?

Getting data about ships is not easy. ‘It is very sensitive information and there is a lot of secrecy behind it,’ explains Ing.

Francelle Azzopardi, a Ph.D. student in Ellul’s team. It is also very expensive. Lloyd’s is the World’s ship registry that tracks all ships, knowing their size, location, engine type, fuel used — basically

“Ships currently use heavy fuel oil with 3.5% sulfur; this needs to go down to at least 0.5%. The problem is that it doubles cost”

a researcher’s dream. However, they charge tens of thousands. Ellul took the decision that they gather all the data themselves.

After 2004, all international ships above 300 gross tons need to have a tracking device. Automatically, these ships are traced around the world and anyone can have a peek on www.marinetraffic.com (just check the traffic around Malta). Every half hour the team’s administrator Miriam Azzopardi saves the data then integrates it into the Gozitan database. This answers the questions: where was this ship? which ship was it? how big is it? Easy. »





If only! The problem is that the researchers also need to know fuel type, engine size, pollution reduction measures, and so on. Then they would know which ship is where, how many pollutants are being emitted, and how many are reaching Malta and Gozo. To get over this hurdle, they contacted Transport Malta (more than once) to ask for the information they needed. ‘About 50% of the ships passing there [by us or Suez are] Malta registered,’ explained Ellul. With this information in hand they could put two and two together. They could create a model for ship emissions close to the Islands and use the model to get the bigger picture.

Enter their final problem: how do you model it? Enter the Finns. Ing. Francelle Azzopardi travelled to the Finnish Meteorological Institute. They

had already modelled the Baltic Sea, now they wanted access to the Maltese data, in return the Maltese team wanted access to their model called STEAM.

STEAM is a very advanced model. It gathers all the ships’ properties like engine power, fuel type, and ship size. This is combined with its operating environment including speed, friction, wave action, and so on. STEAM then spits out where the team should be seeing the highest pollution indicators. Malta was surrounded.

Apart from the model, the team have seen a clear link between ships and pollution. At the Giordan lighthouse they can measure a whole host of pollutants sulphur dioxide, various nitrogen oxides, particulate matter, black and brown carbon levels, ozone, radioactivity levels, heavy metals, Persistent

Organic Pollutants (POPs) and more. When the wind blows from the North-west, they regularly show peaks of sulfur dioxide, nitrogen oxides, carbon dioxide, carbon monoxide, hydrocarbons which are all indicative of fossil fuel burning either from ships or Sicilian industry. They also picked up relatively high levels of heavy metals especially Vanadium, a heavy metal pollutant. Such metals are more common in heavy fuel oil used by ships.

Alexander Smyth is the team’s research officer who spends three months in Paris every year analysing filters that capture pollutants from the atmosphere. Two different filter types are placed in the Giordan Lighthouse. One filter for particles smaller than 2.5 micrometers and another filter for particles around 2 to 10 microns. ‘With the 2.5 filter we



can see anthropogenic emissions or ship emissions because they tend to be the smaller particles. The filters are exposed for three to four days, and then they need to be stored in the fridge. Afterwards, I take them to Paris and conduct an array of analyses,' continued Alexander. The most worrying pollutant he saw was Vanadium.

Vanadium is a toxic metal. When inhaled, 'it can penetrate to the alveoli of the lungs and cause cancer, a worst case scenario,' outlined Alexander. It can also cause respiratory and developmental problems — none are good news. The only good news is that 'they are in very small amounts.' Quantity is very important for toxicity, and they are seeing nanograms per cubic metre, a couple of orders of magnitude more are needed to cause serious problems. No huge alarm bells need to be raised, although Vanadium does stick around in bones and these effects still need more studies.

Vanadium seems to be coming from both Malta and shipping traffic. 'The highest peaks of vanadium are from the south [of Malta, but the largest number of times I detected came] from the northwest, [from ships],' said Smyth. 'There is a larger influence from ships compared to local pollution at the Giordan lighthouse.'

Vanadium is not the only pollutant that could be affecting the health of Maltese citizens. Smyth also saw lots of different Persistent Organic Pollutants (POPs). At low concentrations these compounds can affect immunity leading to more disease, at higher concentrations they can lead to cancer. The local researchers still need to figure out their effect on Malta's health. Francelle Azzopardi also saw peaks of sulfur dioxide and nitrogen oxides. No surprise here as shipping is thought to cause up to a third of the World's nitrogen oxides and a tenth of the sulfur dioxide pollution.

Inhaling high levels of sulfur dioxide leads to many problems. It is associ-

ated with respiratory disease, preterm births, and at very high levels, death. It can affect plants and other animals. Nitrogen oxides also cause respiratory disease, but can also cause headaches, reduce appetite, and worsen heart disease leading to death. These are pollutants that we want to keep as low as possible.

Ship emission expert James Corbett (University of Delaware) calculates that worldwide around 60,000 people die every year due to ship emissions. Most deaths come from the coastlines of Europe, East Asia, and South Asia. Shipping causes around 4% of climate change emissions. This is set to double by 2050. In major ports, shipping can be the main cause of air pollution on land.

Another unexpected pollutant was ozone, normally formed when oxygen reacts with light. Yet the Giordan light-

"Ship emission expert James Corbett calculates that worldwide around 60,000 people die every year due to ship emissions"



house was not the first to start measuring this gas. It all started with the Jesuits, scholarly catholic monks.

Monks at work

A lot of time is needed to see changes in our atmosphere. Researchers need to gather data over years. To speed up the process, Ellul was hunting around Malta and Gozo for ancient meteorological data about the Islands' past atmosphere.

He was tipped off that there were still some records at a seminary in Gozo. 'We expected to find just meteorological data and instead we also found ozone data as well. It was a complete surprise and a stroke of very good luck. We were able to find out what happened to ozone levels in the Mediterranean over the last hundred years.'

Jesuit monks meticulously measured ozone levels from 1884 to 1900. They analysed them seeing that the concentration of ozone was a mere 8 to 12 parts per billion by volume, ppbv. Ellul compared these to a 10-year study he conducted from 1997 to 2006. 'We measure around 50ppb on average throughout the year,' which is nearly 5 times more over a mere 100 years.

The situation is quite bad for Malta. In the past, the minimum was in summer and the maximum in winter and spring. Now, this has reversed with spring and summer having the highest ozone levels because of the reactions between hydrocarbons and nitrogen oxides. These come from cars, industry, and ships.

Over the Eastern Mediterranean ozone levels have gradually decreased. Over Malta, in the Central Mediterranean, they remained the same. Ellul thinks this could be because of an anticyclone over the central Mediterranean bringing pollutants from Europe over Malta and Gozo. The levels of ozone in Malta and Gozo are the highest in Europe, and it could be mostly Europe's »



fault. Our excessive traffic doesn't help.

Ozone can be quite a mean pollutant. While stratospheric ozone blocks out harmful UV rays, low-level ozone can directly damage our health or react with other pollutants to create toxic smog. It's been known to start harming humans at levels greater than 50 ppbv. It inflames airways causing difficulty breathing, coughing and great discomfort. Some research has linked it to heart attacks — a pollutant not to be taken lightly.

Over those 10 years Ellul and his team saw 20 episodes in summer where ozone levels exceeded 90 ppbv. Some were during the night, unlikely to be of local origin but due to transport phenomena in the central Mediterranean and shipping. Ellul does nod towards the possibility of air recirculation from Malta. The atmosphere is a complicated creature.

Plants also suffer from ozone. Above 40 ppbv yield from fields decreases. Gozo is definitely being affected; we could be producing more.

The devil is in the details

Ellul and his team have found a potentially big contributor to the Islands' pollution. This would be over and above our obvious traffic problem. Yet Ellul admits that 'there is no particular trend, it's too short a time span. What it tells us is that what we think is a clean atmosphere is not really a clean atmosphere at all. The levels are significant.' Azzopardi honestly says 'I can [only] give you an idea of what is happening.'

The team needs to study the problem for longer. It needs some statistics. Clearly they see a link between ships passing by Malta and peaks in pollution levels, but the Islands need to know if shipping pollution levels beat industry, traffic, or Saharan dust. What is ships' contribution to Malta's health problems?

When the team knows the extent of pollution, they can see whether they go above European standards. Ozone already does, and likely to be due to pollution from the European continent. If they can extend it to a whole host of other pollutants that skyrocket above European standards due to ship traffic, then 'our politicians,' says Ellul, can go to Brussels to enforce new legislation. That could control Mediterranean shipping traffic to clean up our air. At least it would solve one significant problem that Malta cannot solve on its own.

The main problem is economic. A ship can be made greener by reducing its sulfur fuel content. Low sulfur fuels are double the price of the bunker fuel they currently use. New legislation would need enforcement, which is costly. Ships could also be upgraded, again at a price. Passing these laws is not going to be easy.

Ships have been a pollution black hole for a while. The fuels ships burn contains 3,000 times more sulfur than cars are allowed to burn. Quite unfair. Going back to Corbett's figures estimating European deaths at 27,000, the current rise in shipping pollution could end up killing hundreds of thousands if not millions before new legislation is enforced. Now that would be truly unfair. ●