HAZRUNOFF PROJECT

“Integration of sensing and modelling technologies for early detection and follow-up of hazmat and flood hazards in transitional and coastal waters”

Hazard Prioritisation Framework – Volume 2 Illustrative Case Study

Funded by
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participants	All Partners

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CONTENTS

INTRODUCTION

This report details a case study prepared by Public Health England (PHE) to illustrate the framework for prioritisation of chemical hazards associated with coastal and riverine industrial infrastructure under Task 4.1 of Work Package 4.

Work Package 4 aims to contribute actively to an efficient preparedness and response to floods and hazmat response in transitional waters, through the promotion of risk management tools to support effective contingency planning and decision-making.

Case Study Overview

The case study provides an illustration of the risk prioritisation process using a study area chosen from the Bristol Channel / Severn Estuary region. This region represents one of the four European areas selected for study as part of the Hazrunoff project.

It should be noted that the case study is intended to illustrate the process and should not be viewed as a comprehensive risk prioritisation for the area, which will be dependent upon other factors such as prioritisation aims and objectives as discussed in Step 1 of the methodology (see Volume 1).

The case study is presented as follows :

- Introduction / Description of the study area
- Scoping
- Hazard Identification
- Receptor Review
- Prioritisation
- Conclusions

The methodology is used in conjunction with the hazard prioritisation spreadsheet developed separately. This can be downloaded here

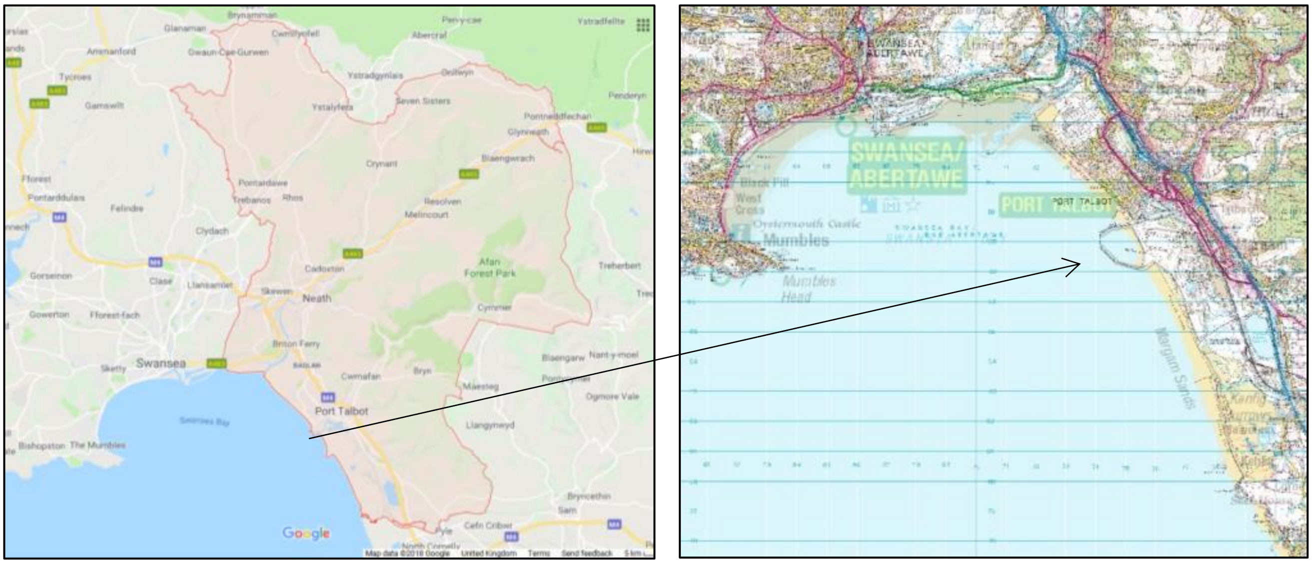
The Study Area

The case study area lies within the Welsh Borough of Neath Port Talbot situated at the western end of the Bristol Channel and centred at approximate Latitude / Longitude: 51.59,-3.80.

The area was chosen due to its current industrialised setting and its past industrial heritage, as well as its proximity to sensitive receptors both human and ecological.

Neath Port Talbot is the eighth most populous local authority area in Wales and the third most populous county borough. The majority of the population live in the coastal plain around Port Talbot and the land around the River Neath (See Figures 1 and 2).

The majority of land in the borough is upland or semi-upland in character. Most of the lower lying flat land is near the coast. An extensive dune system stretches along much of the coast, broken by river mouths and areas of development.



Figures 1 & 2 Map of Neath Port Talbot Borough & close-up of Port Talbot / Swansea (Google Maps)

Plate 1: Photograph of coastline looking south towards Port Talbot (Google Maps)

Step 1 : Scoping

A length of coastline containing a selection of features to illustrate the prioritisation process was selected for the study (as Figure 3 below). The selected coastline measures some 15 km in length from Kenfig Dunes to the Neath River (essentially the entire coastline of the borough). The towns of Port Talbot and Baglan occupy adjacent inland areas.

Figure 3 : Coastline selected for study

To scope the inland extent of the search area the 5m contour line was applied as an indicator of at risk shoreline (Figure 4 below). European data show that the area is not subject to erosion but is not classed as stable. Current shoreline management strategies are listed as '*holding the line*' and do not apply any specific shoreline defences. Reported coastal impacts are listed as accretion.

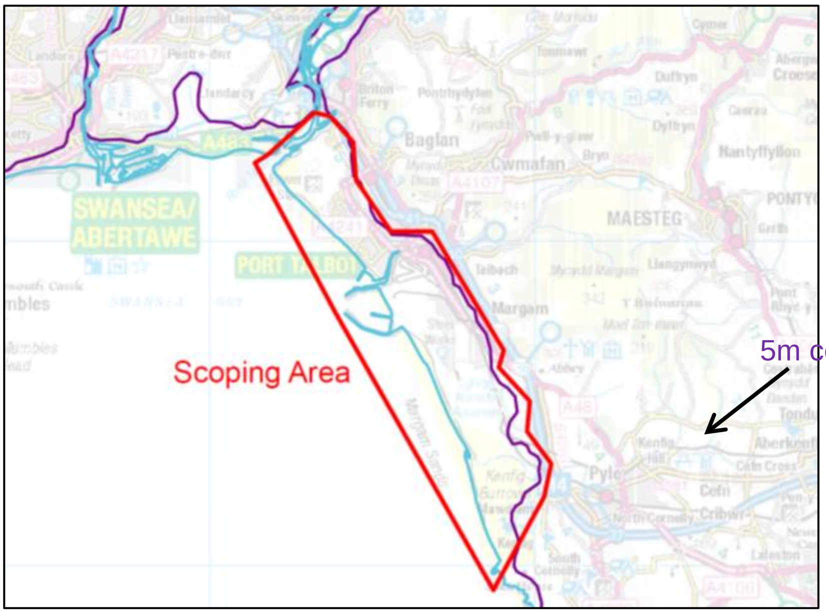


Figure 4 : Study area when applying 5m contour line

Mapping produced by Natural Resources Wales further identifies the study area as being at risk from coastal and riverine flooding (as Figure 5 below).

Zone C2 is a category used by Welsh Government and defined as an area with a greater than 1 in 1000 chance of flooding in any single year and without flood defences. This classification limits developments to low sensitivity uses and requires detailed flood assessment.

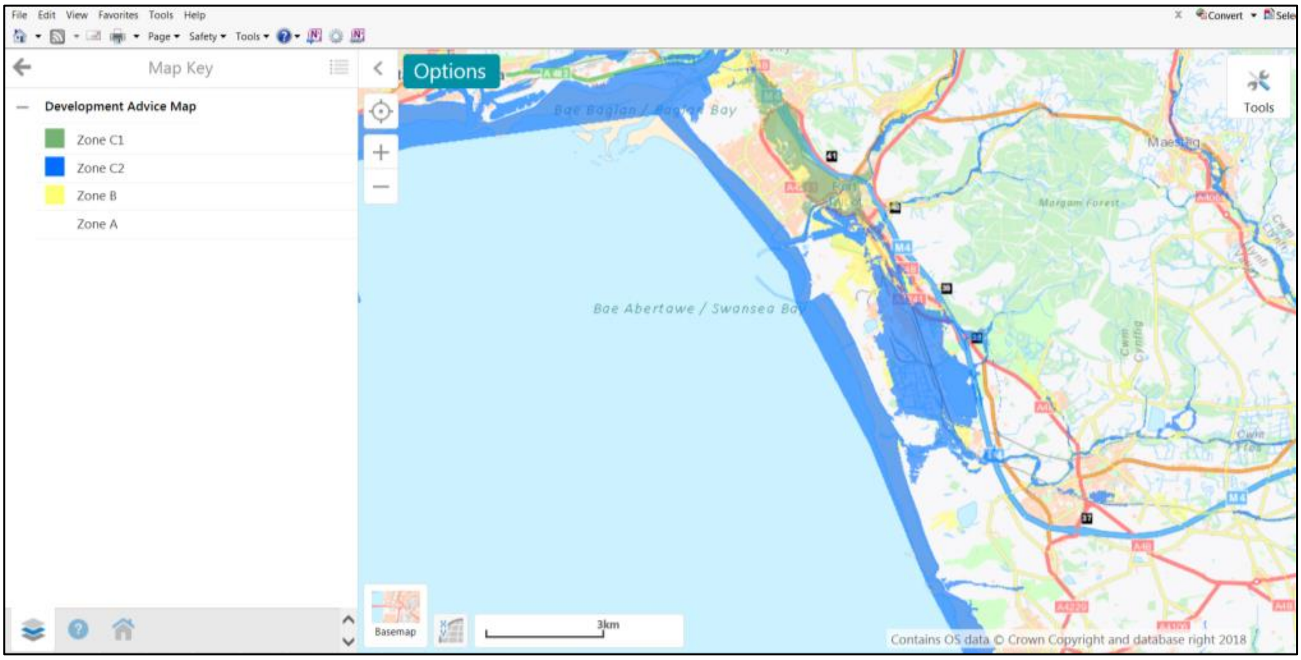


Figure 5 : Flooding affected areas (Natural Resources Wales Crown Copyright)

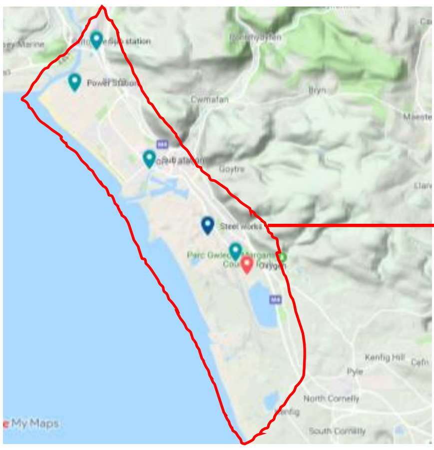
Regarding temporal scoping, a review of on-line historical mapping available from the National Library of Scotland provided editions for the area published from 1883 (surveyed 1870's). Thus scoping ranged from 1883 to current (see Table 1).

OS Map Series	**Sheets**	**Editions**				
6 inch	Glamorgan XXIV, XXV, XXXIII, XXXIX	1883	1900	1921	1948	1951
25 inch	Glamorgan XXIV, XXV, XXXIII, XXXIX	1899		1918	1947	
1 inch	Sheets 247 & 153	1883			1947	1960
1 :25000	SS78 & SS61				1956	1961
1 :10000	SS78					1980

Table 1 : Summary of Historical Mapping

Step 2 : Hazard Identification

A review of current mapping identified several industrial installations within the study area including a major steel works at Port Talbot, dominating the central section of the study area, an oxygen production plant serving the steelworks, a biomass (wood burning) power station at Baglan, a solar farm and several electricity substation.



Figures 6, 7, 8 illustrating the existing industrial installations and the scale of the steel works at Port Talbot

(Google maps)

Mapping available from Natural Resources Wales (NRW) identified 8 licensed waste recycling sites currently active in the study area and essentially all operating within the boundaries of former industrial sites. No operational waste disposal sites were identified. One historic landfill disposal site was identified as illustrated below, operating between 1992 and 2000 and receiving inert wastes only (see Figure 9).

Figure 9 : Location of former landfill site (Lle, Crown Copyright)

The UK Health and Safety Executive database shows 2 current COMAH (Seveso) sites, one covering activities within the current Port Talbot steelworks and the second relating to the oxygen plant serving the steelworks.

Review of historical mapping and discussions with the local authority identified many more past industrial processes within the study area, showing the region to have been heavily involved in the production of iron and steel since the 1800s, and associated metal working including tin plating, galvanising (zinc) and copper plating. This also identified a range of other industries, including power generation, coke manufacture, oil storage, coal mining, waste-water treatment, timber treatment, and docks. Later maps show the development of other industries including a large petro-chemical works producing isopropanol. The following table and figures (prepared from search data) illustrate past industrial activity during the study period (See Table 2 and Figures 10 and 11).

Industry Category	Specific Activity	Map	Edition	Last Appeared
Aggregates	Brick Works	XXV	1921	1920s
Power	Coking Works	XXIV	1884	1940s
Mining	Colliery	XXIV	1884	1940s
Metal Work	Copper Works	XXIII	1883	1960s
Metal Work	Copper Works	XXIII	1921	1920s
Metal Work	Galvanising	XXIV	1921	1940s
Power	Gas Works	XXIII	1883	1940s
Power	Gas Works	XXIV	1921	1940s
Power	Gas works	XXV	1952	1940s
Power	Gasometer	XXV	1900	1940s
Iron and Steel	Iron Works	XXIV	1884	1940s
Chemical	Organic	1:10000	1980	Closed 2004
Power	Power station	XXXIII	1921	1940s
Military	Rifle Range	XXIV	1884	1940s
Military	Rifle Range	247	1897	1900s
Timber	Sawmill	XXV	1900	1900s
Timber	Sawmill	XXV	1900	1900s
Water	Sewage Works	XXIII	1921	1920s
Water	Sewage Works	153	1947	1940s
Iron and Steel	Steel works	XXIV	1900	1940s
Iron and Steel	Steel works	XXV	1921	1920s
Iron and Steel	Steel works	XXV	1952	1950s
Iron and Steel	Steel Works	SS78	1956	1960s
Power	Sub station	SS78	1956	1980s
Metal Work	Tin Plate	XXV	1900	1940s
Metal Work	Tin Plate	XXV	1900	1900s
Metal Work	Tin Plate	XXV	1900	1900s
Metal Work	Tin Plate	XXV	1900	1900s
Metal Work	Tin Plate	XXV	1900	1900s
Timber	Creosoting Plant	XXV	1952	1950s
Chemical	Inorganic	153	1960	1980s
Oil	Tank Farm	XXV	1952	1950s

Table 2 summary of historical industries in study area

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Approximate locations of past industrial activities (Google Maps)

Figure 10 & Plate 2: Baglan / River Neath Area (Aerial Photograph shows dock c1930's)

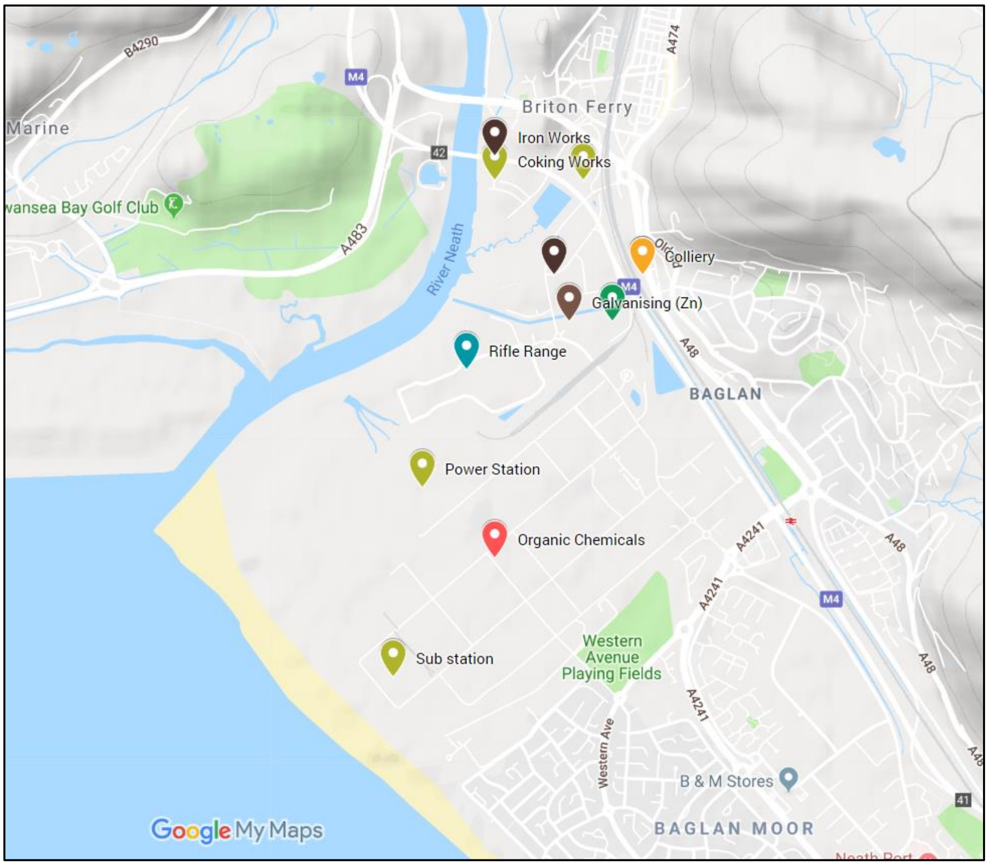
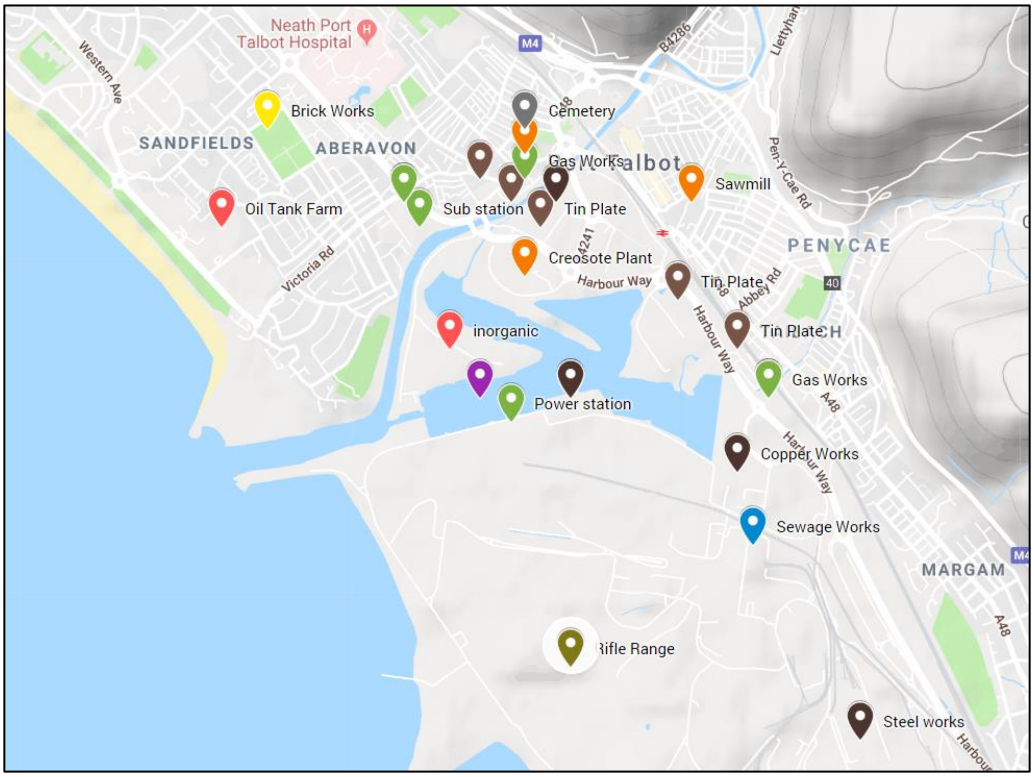


Figure 11 & Plate 3: Port Talbot / Aberavon (Aerial Photograph shows Steelworks and docks c1930's)



Step 3 : Receptor Identification

Human Health

Receptors include the population centres at Baglan, Aberavon and Port Talbot identified from current mapping as illustrated below, with a combined population of around 38,000 and a high level of deprivation (see Figure 12). The area to the north of Port Talbot is designated as an Air Quality Management Area (AQMA) indicative of existing air pollution issues. No groundwater source protection zones are present within the area while a Principal Aquifer is present on the southern boundary of the study area (Kenfig) (see Figure 13). Principal aquifers have high groundwater flow and capacity and are major potable water sources. The remainder of the area is Secondary Aquifer, with a lower sensitivity in terms of usage. Several bathing water beaches lie directly south of the study area and to the north around Swansea.

Figure 12 : Population Centres (Google Maps)

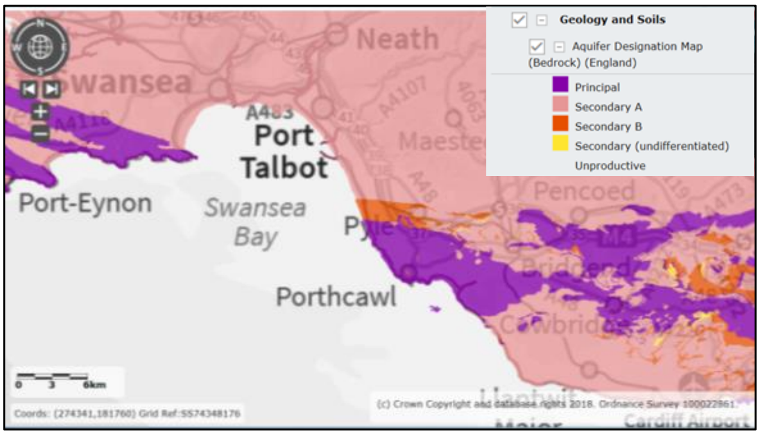
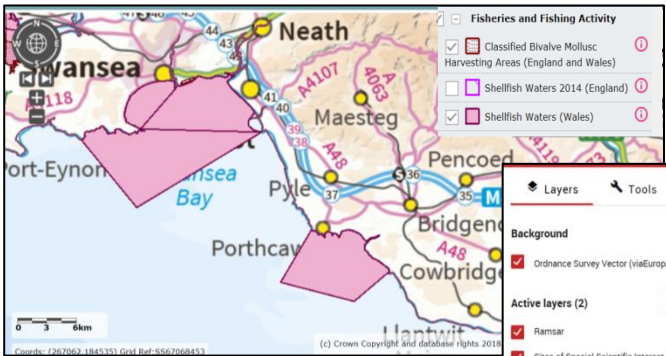


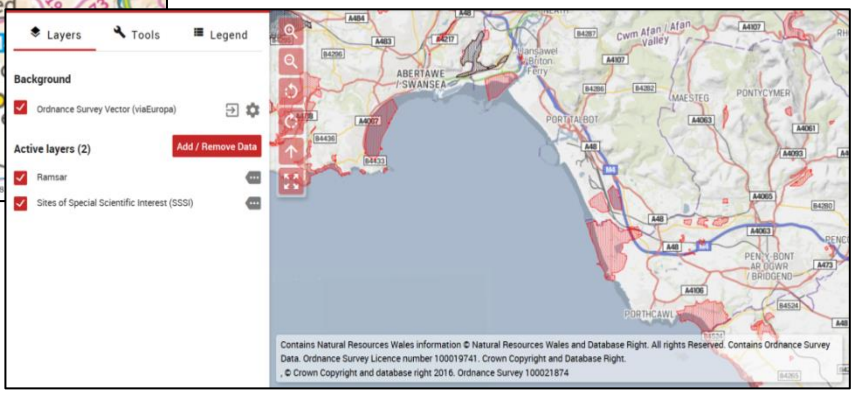
Figure 13 : Bedrock Aquifers (Magic, Crown Copyright)

Ecology

Searches revealed several sites of special scientific interest bounding the study area, relating to dunes and wetlands. Two commercial shellfish areas lie off the coast, as illustrated below (Figures 14 & 15);



Left : Figure 14 : Shellfish waters (Magic, Crown Copyright)



Right : Figure 15 : RAMSAR and SSSI (Lle, Crown Copyright)

Step 4 : Prioritisation

Using the industry profile worksheet in the prioritisation tool and data from step 2, past and present industries in the study area were listed and principal pollutant groups highlighted as below (see Figures 16-18). This identified a broad range of potential contaminants including heavy metals, ammonia, cyanides, acids and bases as well as a range of organic chemicals.

Individual chemicals were then reviewed in the chemical data spreadsheet with reference to the information gleaned from the map searches e.g. for metal working the maps identified tin plating, copper works and galvanising thus tin copper and zinc were selected. A similar process was undertaken for the organic chemicals identified from the industry spreadsheet (see Figures 16-18).

Number identified	Industry	Key Chemical Pollutant Types Asbestos	Metals and Metalloids	Ammonia	Nitrates / Nitrites	Phosphates	cyanides	sulphates	sulphides	chlorides	silicates	Acids	Bases
1	Docks	(++)	(+)										
5	Gasworks, Coke Works Coal Carbonisation	(+)	(++)	(++)			(++)	(++)	(++)			(+)	(+)
1	Aggregates / Cement	(+)	(++)				(++)	(++)	(++)	(++)	(++)	(+)	(++)
6	Iron and steel making	(+)	(++)	(++)			(++)	(++)	(++)	(++)	(++)	(++)	(++)
2	Sewage Works		(+)	(++)	(++)	(++)		(++)	(++)	(++)		(++)	(++)
1	Mining		(++)					(++)	(++)	(++)	(++)	(+)	
2	Military Facilities	(++)	(++)										
2	Chemical Works (General)*	(+)		(+)	(+)	(+)	(+)	(+)	(+)	(+)		(++)	(++)
8	Metal works - Finishing	(+)	(+)	(+)			(+)	(+)	(+)	(+)	(+)	(++)	(++)
1	Electrical Substations												
2	Timber Treatment	(+)	(++)										

(++) Likely Presence (+) Potential Presence

* Additonal specific organic and inorganic contaminants depending upon process in question see https://www.claire.co.uk/useful-government-legislation-and-guidance-by-country/198-doe-i

Introduction | Industry Profile | Inorganic Pollutants | Organic Pollutants | Worksheet (Health)

Number identified	Industry	Coal tar PAH	PCB	Dioxins	BTEX	Oils	Phenols	Pesticides	Chlorinated Solvents	Alcohols	TBT / organo tin	Ethylene Glycols	ethyl lead	Methane	Faecal / Coliforms	UXO Ordnance
1	Docks	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(++)					(+)
5	Gasworks, Coke Works Coal Carbonisation	(++)			(++)		(++)									
1	Aggregates / Cement	(++)		(++)		(+)										(+)
6	Iron and steel making	(++)	(+)	(+)	(++)	(++)	(+)									
2	Sewage Works						(+)	(++)						(++)	(++)	
1	Mining													(++)		
2	Military Facilities		(++)		(++)	(++)		(+)				(++)	(++)			(++)
2	Chemical Works (General)*	(+)	(+)		(++)	(++)	(+)	(+)	(+)	(+)		(+)		(+)		
8	Metal works - Finishing		(+)		(++)	(++)			(++)	(+)						
1	Electrical Substations		(++)			(+)		(+)								
2	Timber Treatment	(++)	(+)		(+)	(+)	(++)	(++)								

				Indicative Hazard Ratings (GESAMP)							NFP Ratings		
			Human Health -			Ecological							
Chemical Name	CAS No	Physical State	Behaviour	Acute 0-4	Chronic 0 or 4	Health Score	Aquatic Toxicity 0-4	Bioconcentration 0-4	Persistence 0- 4	Eco Score	Flammability 0 - 3	Reactivity 0-3	Flammable / Reactive Hazard
Benzene	71-43-2	L	E	4	4	8	2	1	1	4	3	0	F
Toluene	108-88-3	L	E	2	0	2	2	1	1	4	3	0	F
Ethyl benzene	100-41-4	L	E	2	0	2	2	1	0	3	3	0	F
Xylenes	1330-20-7	L	E	2	0	2	2	1	1	4	3	1	F
Total PAH (Coal Tar)	NA	S	S	2	4	6	4	3	2	9	2	0	F
Naphthalene	91-20-3	S	D	2	0	2	4	3	0	7	2	0	F
Benzo(a)pyrene [B(a)P]	50-32-8	L	S	0	4	4	3	4	2	9	0	0	0
Petrol / Aliphatic TPH (as n-Hexane)	110-54-3	L	E	0	0	0	4	3	0	7	3	0	F
Kerosene Aliphatic TPH (as Cyclohexane)	110-82-7	L	E	1	0	1	3	3	0	6	3	0	F
Diesel /Aromatic TPH (see Napthalene)	91-20-3	S	S	2	0	2	4	3	0	7	2	0	F
Total PCB Congeners (as	1336-36-3	L	S	0	4	4	3	4	4	11	1	0	0

Figures 16, 17, 18 : Screenshots of prioritisation industry profiles and chemical data sheets

When selecting chemicals from the pollutant list it is necessary to choose those that best reflect the processes being undertaken. The types of processes are often indicated on historical mapping, while reference to industry profile documents can provide details on specific chemicals used or produced in a particular process. Where this is difficult it is advisable to select several chemicals as proxy indicators of the process. For example arsenic and lead were selected as proxy indicators for metals linked to burning of coal and coke, while copper, chromium, and arsenic were selected for timber treatment, as they are known to have been used in this process. In the case of metals, it is assumed that most historical wastes will be as oxides from combustion being insoluble in water and thus sinkers. Furthermore it is likely that metals will be associated with sediments again ultimately sinking in the water column. This however can be revised if evidence suggests otherwise, for example if acid leachates are suspected, where metals may be soluble and be in the dissolved phase.

Several industrial facilities were omitted from the assessment based upon mapping data and the periods in which they had been developed. As such, the power station identified at Port Talbot docks was described as a hydraulic power station with low likelihood of having produced typical power station pollutants and thus posing limited hazard. Likewise the military land identified was described on maps as rifle ranges and thus unlikely to contain many of the pollutants listed for military facilities.

The biomass power station was also considered of limited hazard as were the modern substations due to the limited potential for polluting chemicals on site and their modern design and regulation which will minimise pollution.

Once pollutants were selected, their data were put into the worksheets for prioritisation (see Figure 19). This simply involved selecting pollutants from the dropdown lists, which automatically populates the relevant fields. This was done for both worksheets (health and ecological).

The worksheets have space for up to 20 pollutants. If more pollutants are to be considered then the prioritisation should be undertaken in batches and combined.

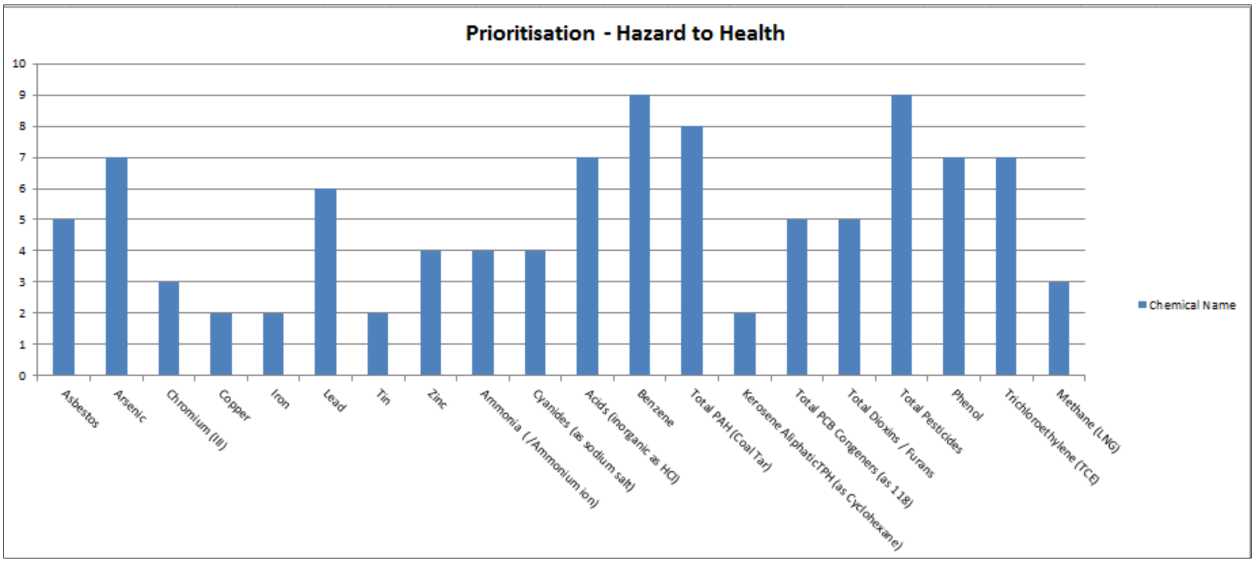
Entry	Chemical Name	CAS No	Physical State	Behaviour	Acute 0-4	Chronic 0 or 4	Health Score	ic Toxicity 0-4	Bioconcentration 0-4	Persistence 0- 4	Eco Score	Flammability 0 - 3	Reactivity 0-3	le / Reactive Hazard	Total Score (Eco)	Behaviour Score (1 - 4)	Reactivity Score (1 or 0)	Weighting (Optional)
1	Asbestos	1332-21-4	S	S	0	4	4	0	0	4	4	0	0	0	8	4	0	1
2	Arsenic	7440-38-2	S	S	2	4	6	2	0	4	6	0	0	0	10	4	0	1
3	Chromium (III)	7440-47-3	S	S	2	0	2	3	0	4	7	0	0	0	11	4	0	1
4	Copper	7440-50-8	S	S	1	0	1	3	0	4	7	0	0	0	11	4	0	1
5	Iron	7439-89-6	S	S	1	0	1	1	0	4	5	0	1	0	9	4	0	1
6	Lead	7439-92-1	S	S	1	4	5	3	0	4	7	0	0	0	11	4	0	1
7	Tin	7440-31-5	S	S	1	0	1	0	0	4	4	0	0	0	8	4	0	1
8	Zinc	7440-66-6	S	S	2	2	2	3	0	3	6	0	2	R	11	4	1	1
9	Ammonia (/Ammonium ion)	7664-41-7	L	E	4	0	4	2	0	1	3	1	0	0	3	0	0	1
10	Cyanides (as sodium salt	143-33-9	S	E	4	0	4	4	0	1	5	0	0	0	5	0	0	1
11	Acids (inorganic as HCl)	7647-01-0	L	D	4	0	4	4	0	0	4	0	3	R	8	3	1	1
12	Benzene	71-43-2	L	E	4	4	8	2	1	1	4	3	0	F	5	0	1	1
13	Total PAH (Coal Tar)	NA	S	S	2	4	6	4	3	2	9	2	0	F	14	4	1	1
14	Kerosene Aliphatic TPH (as Cyclohexane)	110-82-7	L	E	1	0	1	3	3	0	6	3	0	F	7	0	1	1
15	Total PCB Congeners (as 118)	1336-36-3	L	S	0	4	4	3	4	4	11	1	0	0	15	4	0	1
16	Total Dioxins / Furans	NA	S	S	0	4	4	4	4	4	12	0	0	0	16	4	0	1
17	Total Pesticides	NA	S/L	S	4	4	8	4	4	3	11	0	0	0	15	4	0	1
18	Phenol	108-95-2	S	D	4	0	4	3	1	0	4	2	0	F	8	3	1	1
19	Trichloroethylene (TCE)	79-01-6	L	S	2	4	6	2	2	1	5	1	0	0	9	4	0	1
20	Methane (LNG)	74-82-8	G	E	2	0	2	1	0	0	1	3	0	F	2	0	1	1

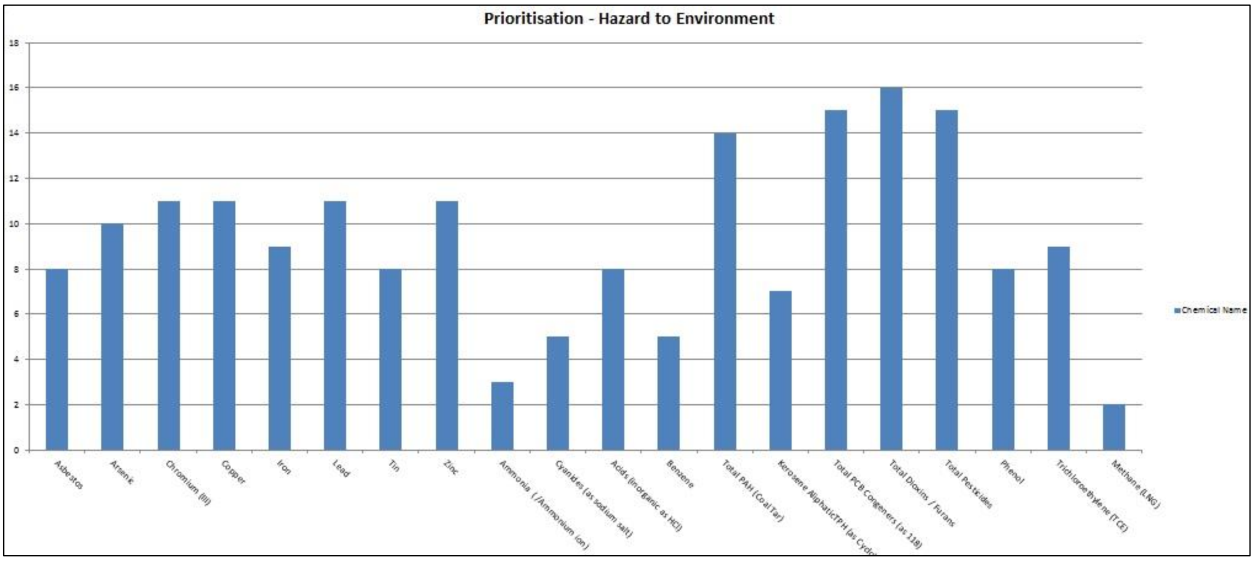
Prioritisation - Hazard to Environment

Inorganic Pollutants | Organic Pollutants | Worksheet (Health) | Worksheet (Ecological) | R

Figures 19 : Screenshot of prioritisation worksheet

When populated, the worksheets automatically calculate the hazard rating for each selected chemical, by summing the health or environmental toxicity score with the corresponding reactivity and behaviour scores. The worksheet then displays the results graphically as below (see Figure 20 & 21).





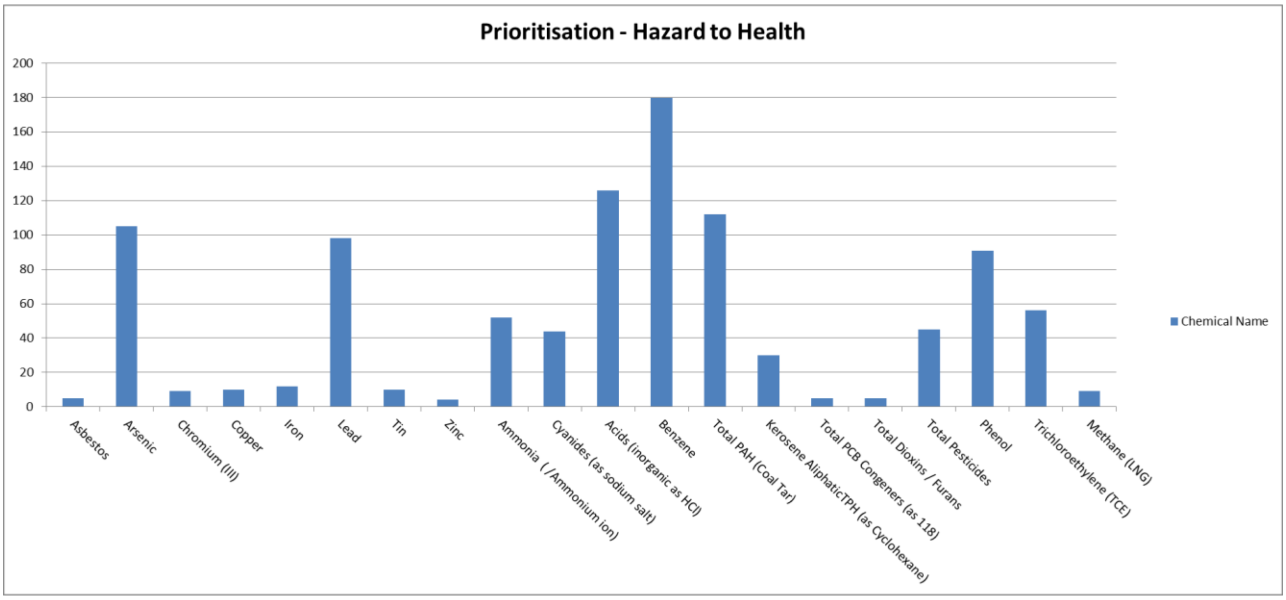
Figures 20 and 21: Unweighted prioritisation results as presented graphically by the tool.

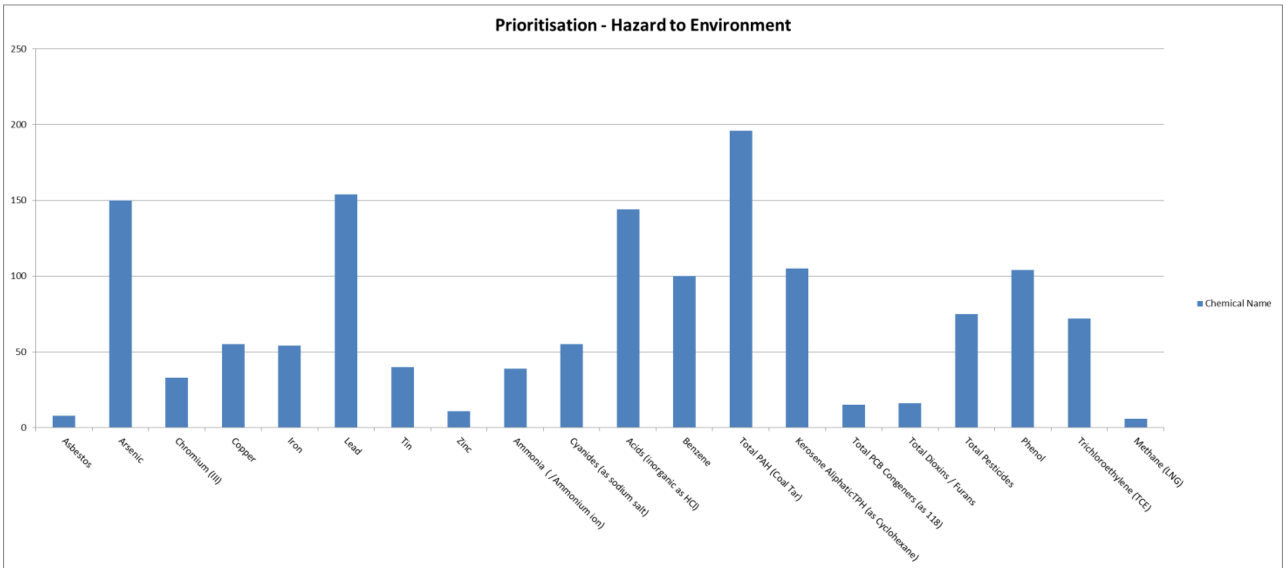
Results indicated that priority pollutants in respect of human health comprised arsenic, lead, acids, benzene, PAHs, pesticides, phenols and trichloroethylene (TCE). In contrast chrome, copper, zinc, PCBs and dioxins were identified as priority pollutants in relation to environmental hazards, while benzene, acids and phenols were of less significance in terms of environmental hazard.

This initial prioritisation looked solely at the pollutants in terms of their individual hazard scores (toxicity and behaviour scores). However, it was felt that the prioritisation could be further refined by introducing weightings to help differentiate initial priority pollutants. While weightings are arbitrary and user defined they should always be based upon justifiable parameters.

For the case study it was considered to weight scores to reflect the likely prevalence of pollutants across the study area in addition to their toxicity and behaviour. Thus hazard scores were multiplied by the number of facilities where the contaminants were indicated to be present by industry profiles. For example, the score for copper was multiplied by a weighting of 5 to reflect that 2 copper works and 3 timber treatment sites where copper may have been used, were identified in the study area. PAHs / were given a weighting of 14 to reflect the 14 industrial facilities where these are likely to have been produced from coal combustion and carbonisation and from timber treatment.

Weighted results confirmed that arsenic, lead, acids, benzene, phenols and PAHs remained as priority hazards in terms of human health, while TCE and pesticides were found to be of lower priority in view of their lower prevalence (Figures 22 & 23). Likewise, arsenic, lead, acids and PAHs were confirmed as priority environmental hazards, while chromium, copper, zinc, PCBs, dioxins and pesticides no longer scored highly reflecting the lower prevalence of facilitates where these pollutants may be present.





Figures 22 and 23: Prioritisation results after applying weightings based upon prevalence.

Conclusion

A case study was undertaken within the Bristol Channel region to illustrate application of the hazard prioritisation framework developed to for the Hazrunoff Project.

The study identified several priority chemical hazards across the study area based upon past and present industrial activities, and potential impact to human health or the environment. Priority chemicals were identified reflecting past and present metal working and coal carbonisation.

Mapping information collated during the process was also able to identify specific areas of potential concern. The current landscape of the study area would suggest obvious hazards from the steelworks. However historical mapping shows additional potential hazards around Baglan and the River Neath and around the Sandfields area. Such information can be helpful to inform the need for area specific assessments. For example the information for Baglan would be helpful when considering risks to the adjacent shell fish area and SAC and could help inform plans for management and monitoring of these receptors.

A key aim of the framework is to provide a rapid hazard screening methodology requiring limited user input. In this respect the entire process can be completed in a matter of days depending upon data availability. In most cases data are readily available on line but where data need to be sourced from libraries or local archives this may require additional time.

Whilst the methodology aims to be as prescriptive as possible there is requirement for a degree of subjective judgement by the user, to ensure sites are typical of their corresponding industry profiles and to select the most relevant proxy pollutants from a process, as illustrated in previous sections. The use of weightings to reflect factors such as potential prevalence of contaminants can also help to improve the sensitivity of the prioritisation. Additional information such as whether sites have previously been remediated may also inform judgements and discussions with local or regional authorities and planning agencies can be very useful in this respect.

Regards the selection of specific process chemicals, additional information is often present in the industry profile documents. Where information is not readily available it is suggested to default to those chemicals with the highest toxicity ratings or with regulatory standards. Furthermore as the prioritisation step can be completed in a short time it is relatively easy to run sensitivity anaylses to assess potential proxy chemicals and the influence of factors such as weightings.

In conclusion, the case study has illustrated use of the prioritisation framework and shown how this process can identify potential chemical hazards helping planners to prioritise resources. The process can further help inform detailed assessments enabling preparation of chemical specific datasheets, aiding modelling of potential release scenarios and assisting development of appropriate monitoring strategies on an area specific basis.