Prioritising Chemical Pollution Hazards from Coastal Infrastructure. A Framework to Inform Planning and Preparedness

P. Harold, A. Kibble, E. Huckle, and P. Callow
Public Health England, CRCE Wales
paul.harold@phe.gov.uk

Abstract

This paper aims to describe a process to prioritise chemical hazards from past and present coastal industrial infrastructure following events such as flooding and coastal erosion. Industrial infrastructure is commonly associated with coastal and riverine locations, affording bulk transport of materials and products. Whilst current industrial activities are highly regulated to prevent pollution, this was not always so with many coastal and riverine areas representing a legacy of potential chemical hazards. Natural processes such as coastal erosion and flooding, further increase the potential for contaminants to impact health and the environment. As it is impossible to provide contingencies for every eventuality, a framework was developed to help prioritise chemical hazards, based upon past and present coastal infrastructure. The work undertaken for the Hazrunoff Project and funded by the European Union, aims to aid contingency planning and preparedness i.e. using existing knowledge to predict potential risks and subsequent steps to manage such risks.

The framework adopts a source-pathway-receptor (S-P-R) approach involving geographical and temporal scoping, together with hazard and receptor identification. An accompanying PC tool facilitates the prioritisation process incorporating toxicity and environmental behaviour of key industrial pollutants with user-defined weightings. A pilot study within the Bristol Channel region of the UK was able to prioritise chemical hazards from past and present infrastructure and identified areas of highest potential risk based upon potential contaminant distribution and location of receptors. The framework provides a relatively quick and simple approach to prioritise potential chemical hazards assisting planners to target resources and inform detailed assessment, monitoring and modelling programmes.

1. Introduction

Industrial infrastructure has always been associated with coastal and riverine locations, in view of the amenity of such locations to facilitate bulk transport of raw materials and products. Furthermore, the development of population centres in these areas would often mirror industrialisation and consequently result in the need for further infrastructure such as water treatment, power and waste disposal, to support large populations.

Whilst current industrial and waste disposal activities are highly regulated to prevent pollution of the environment and harm to human health, this was not always the case. EU studies indicate that soil contamination in 2011 was estimated at 2.5 million potentially contaminated sites in the EU Economic Area, of which about 45 % have been identified to date (European Environment Agency, 2014). Studies in the UK suggest in England alone, there are approximately 20,000 historic landfills constructed without any engineered waste management with circa 1200 of these facilities located in tidal flood zones (O'Shea *et al*, 2018).

As such many coastal and riverine areas represent a legacy of hazards, with potential for ongoing pollution of land, aqueous and marine environments. Natural processes such as coastal erosion and flooding, often enhanced by climate change, further increase risks of damage to current and historical infrastructure with the potential to pose hazards as illustrated

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in many media articles e.g. UK coastal landfills (Guardian, 2016) and metal mines flooding (BBC Wales, 2012).

Clearly it is impossible to plan for every eventuality when preparing contingency and response management protocols. Therefore, we have developed a framework to help prioritise hazards, based upon industrial infrastructure and their legacy within an area and the corresponding principal pollutant hazards. The process is intended to assist planning and inform management strategies.

The work was undertaken for the Hazrunoff Project and funded by the European Union (DGECHO, 2018). The project is principally intended to fill the knowledge and technology gaps around early warning and detection from flooding and hazmat pollution incidents in inland and transitional waters (http://www.hazrunoff.eu/), but has also considered tools and approaches to help to plan and prepare for such eventualities. The project commenced in January 2018, running for 2 years and includes a series of workstreams as illustrated in Figure 1 below.

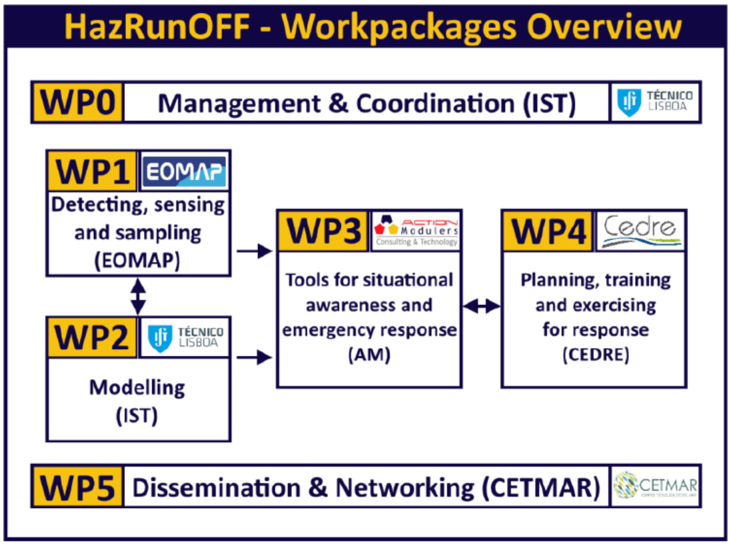


Figure 1: Illustration of Hazrunoff Project Work Packages (WPs) and lead partners

The project has five separate but related work packages (WP). WP1 (Detecting, sensing and sampling) focusses on aspects related with data acquisition and measurements related with flooding and potential water contamination. WP2 (Modelling) comprises development of flood modelling in transitional areas, as well as fate and transport of pollutants. WP3 establishes the interface between measured and modelled data with stakeholders (decision makers /emergency responders, and citizens), through development of tools for situational awareness e.g. real-time dashboards and social media interactions. WP4 focusses on planning and preparedness via training, exercising and contingency planning. The hazards prioritisation framework forms a deliverable in this package. WP5 relates to dissemination of deliverables, while WP0 covers management of the project.

The project comprises a consortium of 7 partners from the UK, France, Portugal and Spain and focusses on applying deliverables across 4 case study areas, one from each partner country. As such, to demonstrate the framework, a prioritisation was undertaken for an area within the UK case study area, namely the Bristol Channel / Severn Estuary.

The framework developed by Public Health England for WP4 adopts a source-pathway-receptor (S-P-R) approach commonly applied to risk assessment (EUGRIS, 2019). The basic concept of the S-P-R approach is to identify the potential receptors, contaminants and pathways and therefore enable the determination of whether there is a potential risk to human health or the environment. Without all three components being present i.e. contaminants (source), communities / sites being or to be-exposed (receptors) and a medium through which exposure can occur e.g. air, water, soil or food (pathway) there cannot be a risk.

Applying the framework comprises a series of simple steps involving (1) scoping of the study area / time-frame, (2) hazard identification, (3) receptor review and (4) pollutant prioritisation. Prioritisation uses an accompanying database, which has been developed with reference to previous prioritisation and assessment studies undertaken in past projects such as the Atlantic Area Coastal Pollution project (ARCOPOL, 2011).

The framework is designed to be applied to any coastal or riverine area, while a case study from the UK (Figure 2) has been used to illustrate the process.

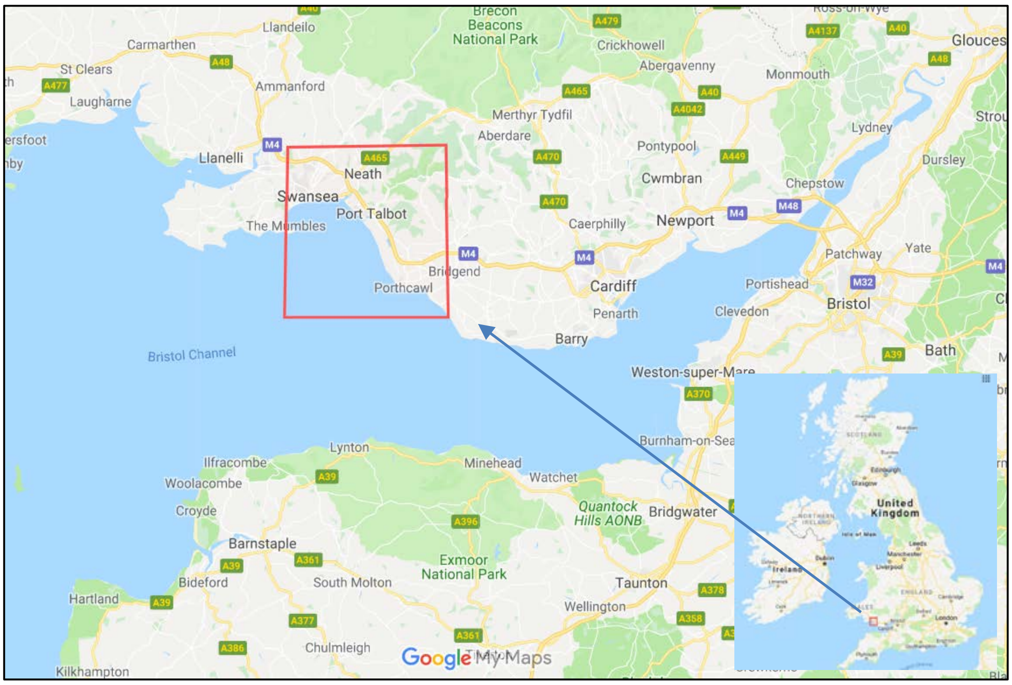


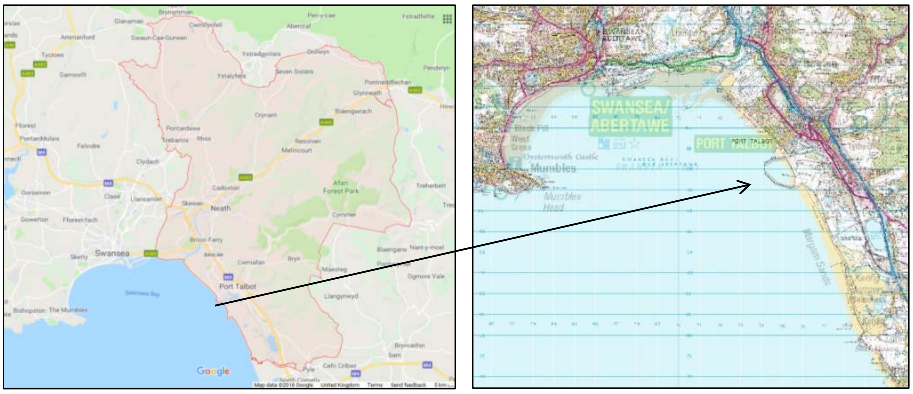
Figure 2 : Map showing Bristol Channel and location of study area (Google Maps)

2. Methods

The following sections detail each of the steps to complete a prioritisation and demonstrates their application to the case study area.

The study area was selected within the Welsh Borough of Neath Port Talbot situated at the far edge of the Bristol Channel and centred at Latitude / Longitude: 51.59, -3.80 approximately. 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. Most of the population live in the coastal plain around Port Talbot and the land around the River Neath (See Figures 3 and 4).



Figures 3 & 4 Map of Neath Port Talbot Borough & close-up of Port Talbot / Swansea (Google Maps)

Step 1 Scoping

Before commencing any study it is important to define its scope i.e. its extent. For the hazard prioritisation framework, scoping requires establishment of boundaries for the proposed area to be assessed and the time-frame for data searches.

There are no defined limits to where boundaries should be set. Instead these should be determined by the assessor and based upon the underlying objectives of the study i.e. why is the study being undertaken?

Studies may be undertaken as a general review of a region or they may be in response to, or in readiness for specific events or for a specific receptor. In all cases it is recommended to scope the study area to a manageable size for assessment and if necessary use multiple prioritisation assessments for large areas e.g. assessment of an entire region.

The methodology is specifically aimed for prioritising chemical hazards from coastal or riverine infrastructure and as such it is important to define the scope of the land beyond the tidal or riverine region to be studied. This area will typically be the land susceptible to coastal or riverine effects, such as erosion, flooding, storm surges and in the longer term climate change impacts. Again this is determined by the assessor, who may have existing knowledge of the study area. Alternatively it is possible to apply some general criteria for scoping. For example, many studies have been published (Eurosion, 2019), identifying areas at risk from coastal erosion (European Environment Agency, 2016), while the 5 metre contour line provides a useful scoping boundary for coastal land susceptible to sea level rise and flooding (European Environment Agency, 2016a).

For rivers, a useful general criteria would be to identify areas most at risk from flooding. Flood maps are generally available from national environment agencies or regional authorities, while partners within the Hazrunoff project have also developed detailed flood models for a number of EU regions.

Temporal scoping is similarly user defined and dependent upon the aims of the assessment, but will also be determined by available historical mapping and records for the study area (This is discussed further in Step 2).

Step 2 Hazard Identification (Source)

This step involves the identification of past and current industrial facilities for the study area scoped in Step 1. As industrial processes can range considerably in scale it is recommended that searches focus on those facilities meeting criteria for regulatory management. Such regulation does not apply to all facilities, for example small combustion units, motor vehicle repair shops are exempt in the UK.

Current industrial facilities can be determined with reference to existing maps for the area and to records available from regulatory bodies. For example, in Wales the environmental regulator, Natural Resources Wales provides web based interactive mapping identifying licensed waste facilities (NRW, 2019a). Similarly, the UK Health and Safety Executive who regulate Seveso sites (covered under the Control of Major Accident Hazards (COMAH) Regulations in the UK) provide a database of sites searchable by postcode (HSE, 2019).

Past industrial activity can be identified using historical maps. Paper maps can typically be accessed from local libraries or can be purchased from national mapping agencies. Historical maps may also be available on line via national archives, such as that provided by the National Library of Scotland (NLS 2019), which offers an interactive map finder for the entire UK but may not hold all editions for an area.

In addition to publicly available maps and records, data may also be available via local and regional authorities. For example, in the UK local authorities are required to undertake searches of their boroughs under contaminated land regulations (DEFRA, 2012) and will produce maps detailing potential past polluting activities. Aerial photography also offers a useful record of past and current land usage. Again, this can often be acquired from local libraries or from commercial services.

Some commercial companies also offer search services, which are commonly used for planning and development purposes and will collate the current and historical data described above as well as receptor data outlined in Step 3. Such searches however are typically performed around a single location with a defined buffer of 1 to 2 km and incur financial charge.

The results section illustrates how data sources are applied to the case study area.

Step 3 Identifying Areas at Risk (Receptors)

This step is used to identify the key human health and ecological receptors for the study area. This step can also inform the prioritisation process by identifying the most relevant pollutants from identified sources. For example, if it is known that the main receptors are the aqueous environment and associated commercial shell fish beds then pollutants that sink or dissolve and with high aqueous toxicity will be most significant. In contrast if the main receptors are nearby population centres then ongoing releases of toxic gases or vapours, such as from landfill facilities are likely to be of most concern. Key receptors to consider will include

- Human Health - population centres including vulnerable populations (hospitals, care homes, schools etc), amenities (bathing waters and outdoor recreational facilities e.g. boating, angling)
- Socio-economic – transport infrastructure, industry, agriculture / aquaculture, housing
- Environmental – surface water bodies, abstractions, aquifers, source protection zones
- Ecological - sensitive habitats / species, protected sites and sites of scientific interest (Special Areas of Conservation SACs, Sites of Special Scientific Interest SSSIs,)

Human and environmental receptors can be identified through a review of current maps and regulatory sources. Local, regional and national regulatory and protection bodies will often make data freely available on line for example the Welsh Government provide a geo-portal (Lle, 2019) providing environmental mapping data for Wales, while a similar site (Magic, 2019) operates for England. Hydrogeological maps showing key aquifers are also often available on line via government or regional agencies. In the UK the British Geological Survey (BGS, 2019) have on line mapping data for drift and solid geology, while Magic has data for aquifers.

Step 4 Prioritisation (S-P-R)

Once source and receptor data had been collated it was possible to prioritise the potential pollutants present using the prioritisation tool. The tool contains an industry profile database, which lists key pollutants for a range of major industrial processes based upon UK Industry Profiles (UK Department of Environment, 1995*)* (Figure 5).

B	O	P	Q	R	S	T	U	V
Industry								
	Coal tar PAH	**PCB**	**Dioxins**	**BTEX**	**Oils**	**Phenols**	**Pesticides**	**Chlorinated Solvents**
Docks	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)
Gasworks, Coke Works Coal Carbonisation	(++)			(++)		(++)		
Aggregates / Cement	(++)		(++)		(+)			
Iron and steel making	(++)	(++)	(++)	(++)	(++)	(+)		
Sewage Works						(+)	(++)	
Mining								
Military Facilities		(++)		(++)	(++)		(+)	
Chemical Works (General)*	(+)	(+)		(++)	(++)	(+)	(+)	(+)
Metal works - Finishing		(+)		(++)	(++)			(++)
Electrical Substations		(++)			(+)		(+)	
Timber Treatment	(++)	(+)		(+)	(+)	(++)	(++)	

Figure 5: Image of industry profile Database

Those pollutants marked ++ represent chemicals directly linked to the industrial processes and thus most likely to be present. Those marked + represent pollutants that may have been used for ancillary purposes such as site maintenance with potential to be present.

Once the principal pollutants have been identified for an industrial process, the chemical pollutant sheets can be consulted to access hazard information (Figure 6).

	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
Acids (inorganic as HCl)	7647-01-0	L	D	4	0	4	4	0	0	4
Bases (inorganic as NaOH)	1310-73-2	S	D	3	0	3	2	0	0	2
Benzene	71-43-2	L	E	4	4	8	2	1	1	4
Toluene	108-88-3	L	E	2	0	2	2	1	1	4
Ethyl benzene	100-41-4	L	E	2	0	2	2	1	0	3
Xylenes	1330-20-7	L	E	2	0	2	2	1	1	4
Total PAH (Coal Tar)	NA	L	S	2	4	6	4	3	2	9
Naphthalene	91-20-3	S	D	2	0	2	4	3	0	7
Benzo(a)pyrene [B(a)P]	50-32-8	S	S	0	4	4	3	4	2	9
Petrol / AliphaticTPH (as n-Hexane)	110-54-3	L	E	0	0	0	4	3	0	7
Kerosene AliphaticTPH (as Cyclohexane)	110-82-7	L	E	1	0	1	3	3	0	6
Diesel /Aromatic TPH (as Napthalene)	91-20-3	S	D	2	0	2	4	3	0	7
Total PCB Congeners (as 118)	1336-36-3	L	S	0	4	4	3	4	4	11
Arochlors as 1254	11097-69-1	L	S	0	4	4	3	4	4	11
Total Dioxins / Furans	NA	S	S	0	4	4	4	4	4	12
Total Pesticides	NA	S/L	S	4	4	8	4	4	3	11
Aldrin	309-00-2	S	S	4	4	8	4	4	3	11
Parathion	56-38-2	L	S	4	4	8	4	3	2	9
Glyphosate	1071-83-6	S	S	3	4	7	2	1	2	5
Phenol	108-95-2	S	D	4	0	4	3	1	0	4
Methyl phenols (as Cresols)	1319-77-3	L	S	3	0	3	2	1	0	3
Nonylphenol	84852-15-3	L	F	1	0	1	4	2	2	8
Chlorophenols (as 2,4,6 TCP)	88-06-2	S/L	S	1	0	1	2	1	1	4
Pentachlorophenol	87-86-5	L	S	1	4	5	2	1	1	4

Introduction | Industry Profile | Worksheet (Health) | Worksheet (Ecological) | Chemical data | References

Figure 6: Image of Pollutant Database

The database provides the common name for each chemical entry, its Chemical Abstracts Service (CAS) identifier and its physical state (USEPA, 2019). Each chemical entry is assigned defined hazard scores, based upon literature-based toxicity ratings developed by GESAMP (Group of Expert Scientists for the Assessment of Marine Pollution) (Wells et al, 1999) as well as reference to current health and environmental standards, such as Acute Exposure Guideline Levels (USEPA, 2019), European drinking water standards (DWi, 2016) and European ecological standards (WFD, 2000). The behaviour characteristics of each chemical entry are also assigned scores (Table 1) based upon the standard European behaviour classifications (SEBC). These are recognised descriptors for hazardous chemicals relating to their behaviour when released into the marine environment and based upon their density, vapour pressure and aqueous solubility (Bonn Agreement, 1991).

Behaviour	Human Health	Ecological
Gas / Evaporator	4	1
Floater	3	2
Dissolver	2	3
Sinker	1	4

Table 1: Assigned Behaviour Scores based upon SEBC classifications

When relevant pollutants and receptors have been identified they can be prioritised using the prioritisation worksheets. There are two worksheets (health and ecological).

Worksheets automatically calculate relative hazard, based upon the scoring criteria and plot the results to provide a rapid visual assessment of those most hazardous for each receptor type, as illustrated in results section.

An option is also available for users to include a weighting to scores to "fine tune" the prioritisation. A default score of 1 must be included in the weighting column.

Outputs from the worksheets are presented for the case study area in the following section.

3. Results

For the case study, a length of coastline containing a variety of features to illustrate the prioritisation process was chosen. The selected coastline measures some 15 km in length with the towns of Port Talbot and Baglan occupying adjacent inland areas.

To scope the inland extent of the study area the 5m contour line was applied as an indicator of at risk shoreline (Figure 7). European data (European Environment Agency, 2016b) showed the area is not subject to erosion but is not classed as stable. Reported coastal impacts are listed as accretion.

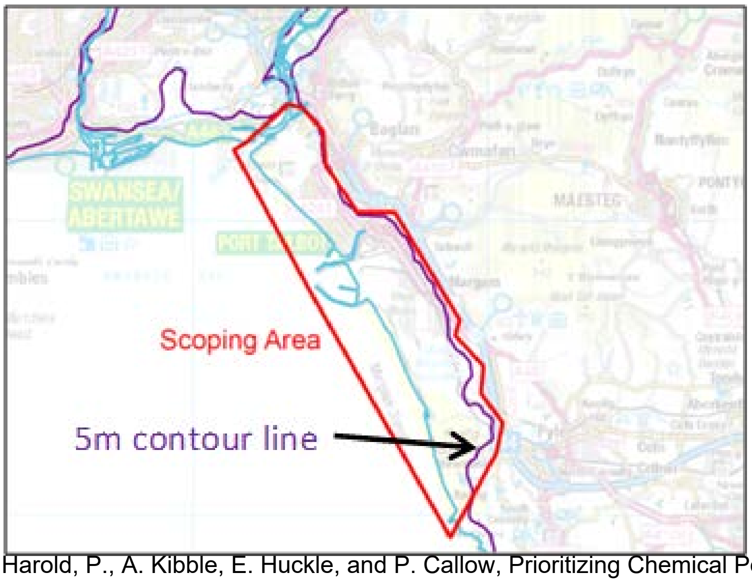


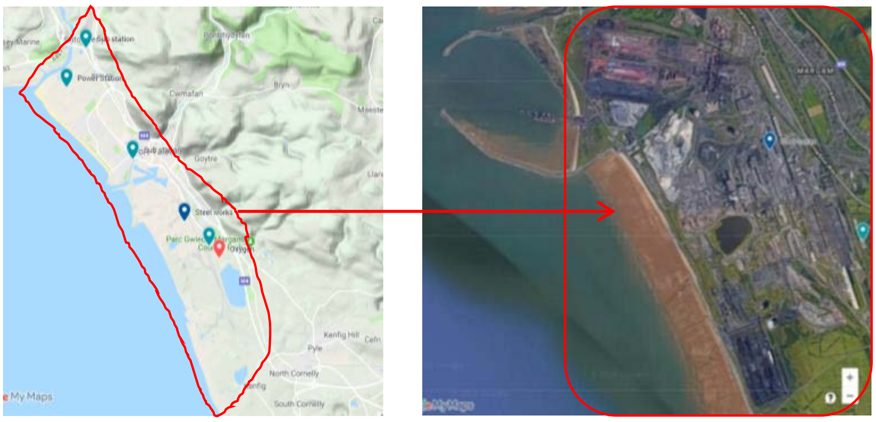
Figure 7: Study area with 5m contour line

Regarding temporal scoping for the pilot study, a review of on-line historical mapping provided editions for the area published from 1883 (surveyed 1870's). Thus, scoping ranged from 1870's to present day (Table 2).

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 2: List of available historical mapping (National Library of Scotland)

For this study, current mapping (Google Maps) 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 substations (Figures 8 and 9).

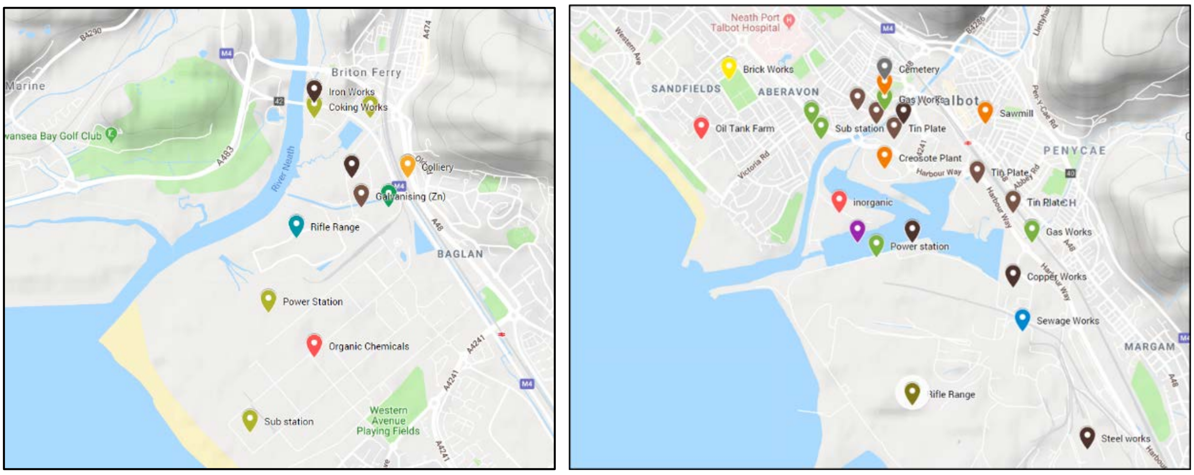


Figures 8 and 9 illustrating the existing industrial installations and the scale of the steel works at Port Talbot

(Google maps)

NRW mapping identified 8 licensed waste recycling sites currently active in the study area but no operational waste disposal sites. One historic landfill was identified, operating between 1992 and 2000 and receiving inert wastes only and thus of limited risk. The HSE database identified 2 current COMAH (Seveso) sites, both relating to gas storage associated with the steelworks. As such the current industrial hazards were principally related to the current steelworks occupying land in the southern / central region of the study area.

In contrast, review of historical mapping identified many more past industrial processes across the entire study area, showing the region to have been heavily involved in the production of iron and steel and associated metal working since the 1800s. Other activities, including power generation, coke manufacture, oil storage, mining, water treatment and timber treatment, supported these industries and associated populations. Later maps showed the development of a large petrochemical works producing isopropanol. (Figures 10 and11). These past activities may have resulted in pollution that could still present a risk to coastal areas.



Figures 10 & 11: Past industries in study area (1870's -1980's)

Historical aerial photographic records of the area helped to corroborate mapping data (Figures 14 & 15)

Figures 14 & 15: Illustrative Aerial Photographs of study area circa 1930's (Copyright britainfromabove.org.uk)

Within the case study area, human health receptors included 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 socio-economic deprivation. The area to the north of Port Talbot is designated as an Air Quality Management Area indicative of existing air pollution issues.

Several bathing water beaches lie directly south of the study area and to the north around Swansea. No groundwater source protection zones were present within the area while a Principal aquifer is present on the southern boundary of the study area (Kenfig). 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. (Figure 16).

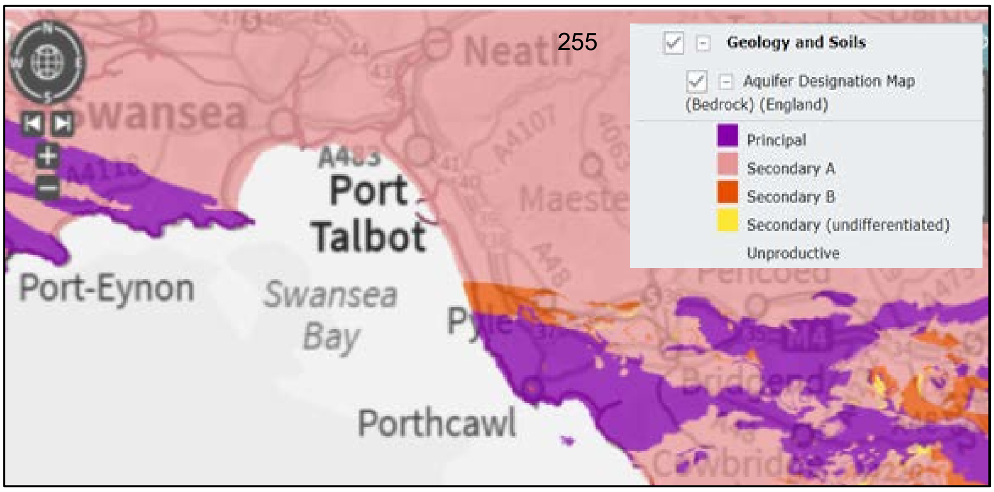


Figure 16 Local Aquifers (Crown Copyright)

Regarding ecological receptors, 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 (Figures 17)

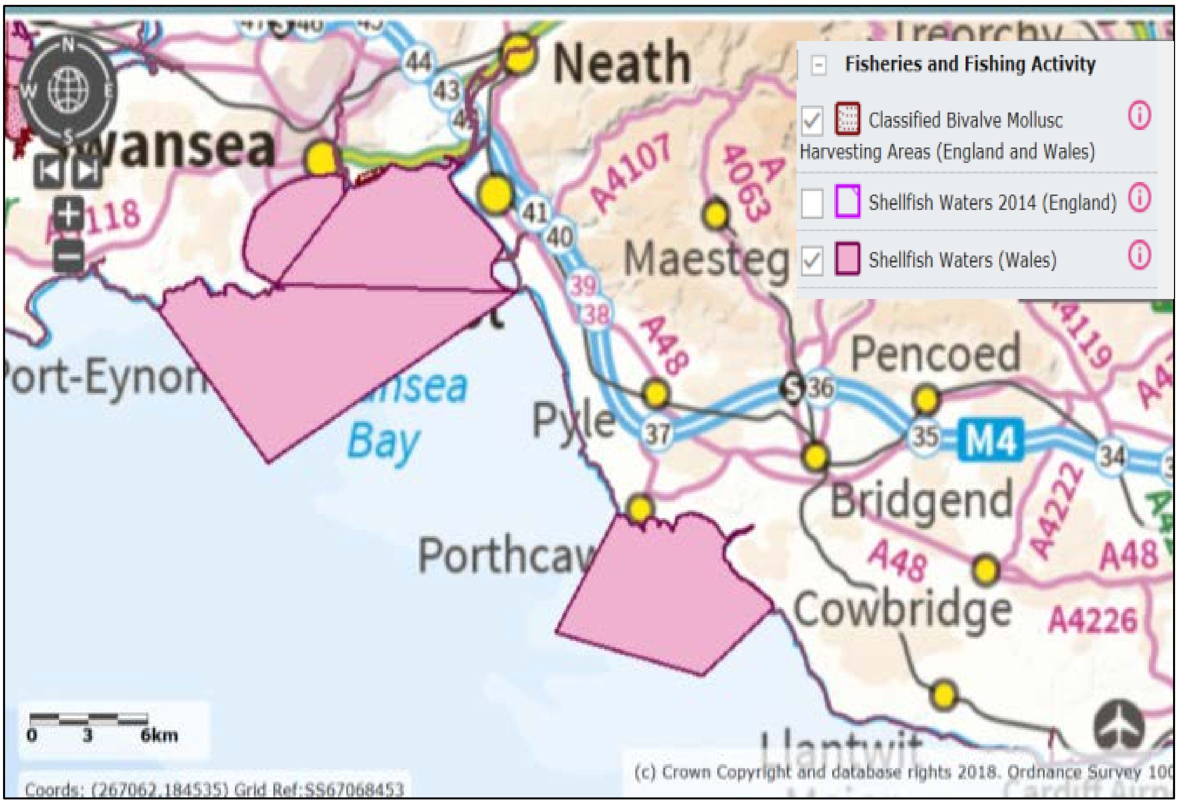


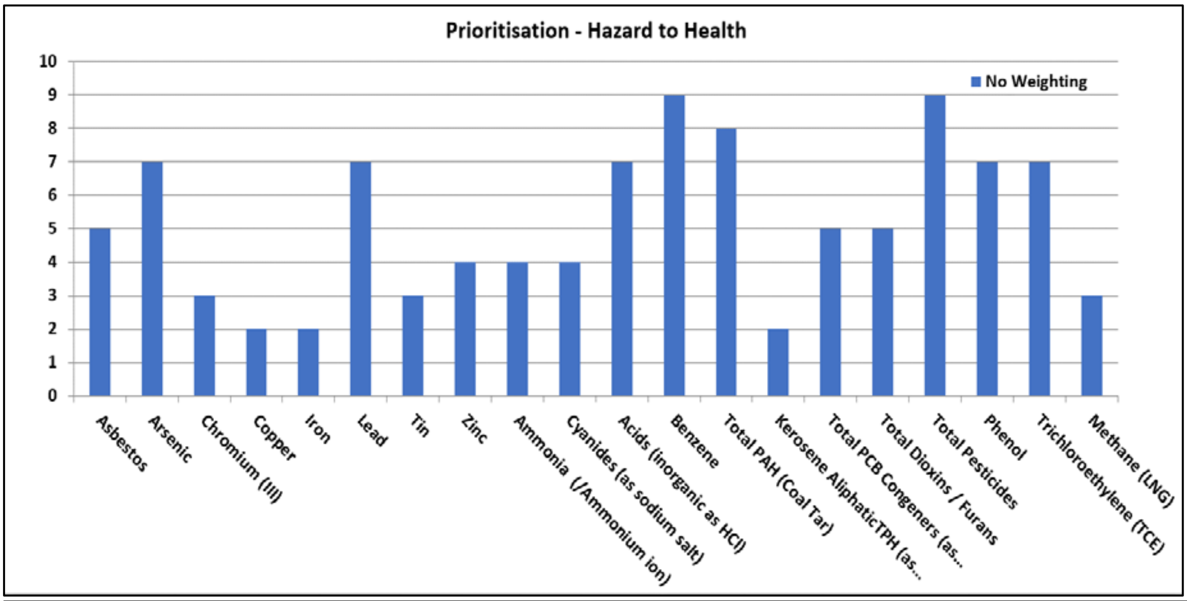
Figure 17 Local Fisheries (Crown Copyright)

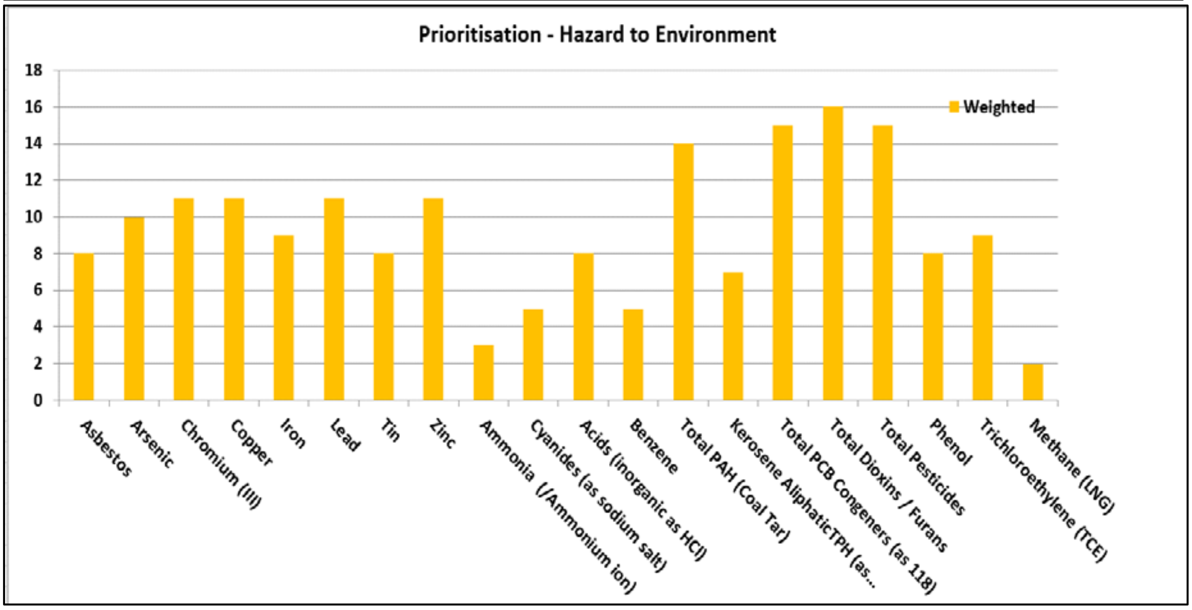
Using the industry profile database in the prioritisation tool a number of key pollutant groups were reviewed based on past and present industries identified including heavy metals, ammonia, cyanides, acids and bases as well as a range of organic chemicals.

The contaminants were reviewed in terms of their toxicity and behaviour using the chemical database sheets and with reference to any additional information gleaned from maps e.g. for metal working the maps identified tin plating, copper works and galvanising thus tin copper and zinc were selected as potential contaminants of concern. Once all pollutants were identified, they were used to populate both prioritisation worksheets.

Results indicated that priority pollutants in respect of human health comprised arsenic, lead, acids, benzene, PAHs, pesticides, phenols and trichloroethylene (TCE). In addition to PAHs and pesticides, chrome, copper, zinc, PCBs and dioxins were also identified as priority pollutants in relation to environmental hazards, while benzene, acids and phenols were of less significance for these receptors (Figures 18 and 19).

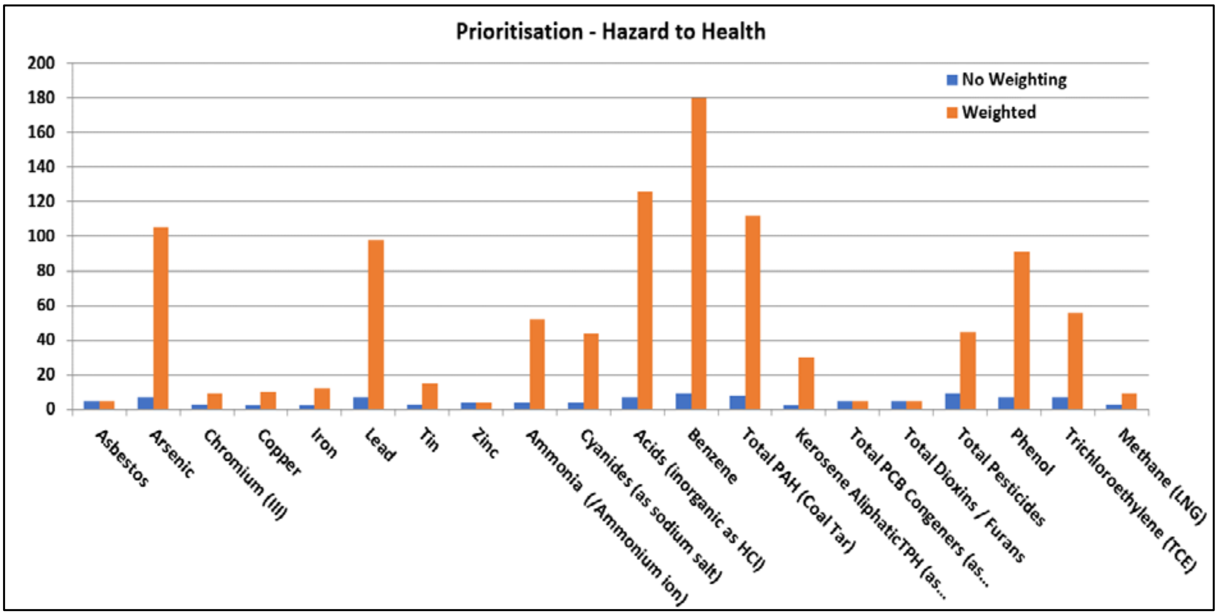
The initial prioritisation looked solely at the selected pollutants in terms of their individual hazard scores (toxicity and behaviour scores). However, it was felt that the prioritisation could be further refined by introducing weightings. While weightings are arbitrary, and user defined they should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

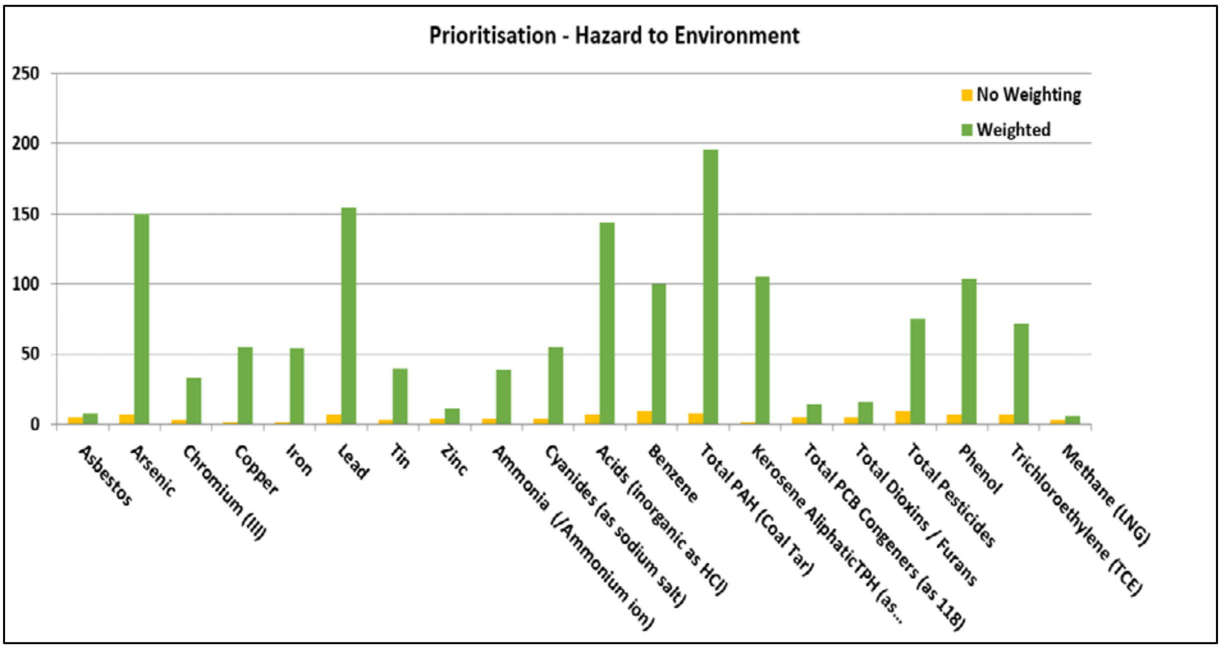




Figures 18 & 19: Initial Results of Prioritisation

For the case study it was decided 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 two copper works and three 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 number of industrial facilities where these are likely to have been produced from coal combustion and carbonisation and from timber treatment in the form of creosote.





Figures 20 & 21: results of prioritisation (with and without user defined weightings)

Weighted results confirmed arsenic, lead, acids, benzene, phenols and PAHs 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. 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 20 & 21).

4. Discussion

The risk prioritisation framework identified several priority chemical hazards across the study area based upon past and present industrial activities, and their potential impact to human health and the environment. Priority chemicals reflected 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 showed additional potential hazards around Baglan and the River Neath. 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 fisheries area and Special Area of Conservation (SAC) and could help inform plans for management and monitoring of these receptors.

A key aim of the framework is to provide a hazard screening methodology that can be completed in a relatively short time using readily available information sources (historical mapping and open-source government data). 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 pollutants from a process. While industry profiles can be helpful in selecting specific process chemicals, there may be gaps. Where information is not readily available it is suggested to default to those chemicals with the highest toxicity ratings or with regulatory standards.

In some cases, chemicals may need to be selected as proxy indicators for a process. For example, in this case study, 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 typically used in this process.

In the case of metals, it was further assumed that most historical wastes would be oxides from combustion being relatively insoluble in water and thus sinkers (NOAA, 2019). This however could be revised if evidence suggested otherwise, for example if acid leachates are suspected, where metals may be more soluble and thus be in the dissolved phase.

There is also a requirement for the user to make judgement on the applicability of industry profiles to the activities identified in map searches. In this case study, several industrial facilities were omitted from the assessment based upon mapping data and the periods in which they had been developed. For example, an historical 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, military land identified in searches was described on maps as rifle ranges and thus unlikely to contain many of the pollutants listed for military facilities in the industry profile database.

Additional information such as whether sites have previously been remediated may also inform judgements and subsequent discussions with local or regional authorities and planning agencies can be very useful in this respect.

The use of weightings to reflect uncertainties such as those above can help judgements. Furthermore, as the prioritisation step can be completed in a short time it is relatively easy to run sensitivity analyses to assess potential proxy chemicals, the influence of non-standard industrial processes and factors such as weightings.

5. Conclusions

The database provides a comprehensive list of contaminants associated with key industrial activities, all of which can pose potential hazards to health and / or the environment, although the extent of any risk will be dependent upon their potential to reach relevant receptors. The subsequent prioritisation aims to provide an indication of which contaminants are likely to pose the highest comparative hazard should this connection with receptors be realised, for example because of coastal erosion or flooding events.

Results can be used to help planners prioritise resources in preparedness for such events arising, helping to inform modelling of potential release scenarios and preparation of chemical specific datasheets. Results can also help to inform longer-term management of hazards by identifying areas of concern and assisting development of appropriate monitoring strategies for these areas.

The case study has illustrated how use of the prioritisation framework can identify potential chemical hazards, as illustrated by the results described in earlier sections.

Once priority pollutants have been identified these can be used to inform plans and prepare detailed risk assessments as necessary. Further information to supplement detailed assessments can be accessed and downloaded via a range of other web-based resources including; Hazardous and Noxious Substances (HNS) datasheets from European projects such as HNS-MS (DGECHO 2016), chemical profiles and incident response sheets published by Public Health England (PHE, 2017) and Toxicological Profiles published by US Agency for Toxic Substances and Disease Registry (ATSDR, 2018).

Finally, data can be used to help prevent incidents by aiding engagement with industry and regulatory bodies and helping to target further investigation and remedial works in respect of the prioritised chemical hazards identified.

6. Recommendations

Whilst the framework has been successfully demonstrated for a case study area in the UK, it is recommended that further prioritisations are undertaken across a range of coastal and riverine locations to assess its application. Further engagement with regulators and planners could also help in this process and assess potential benefits.

It is further recommended that the results of future case studies and feedback from users be collated to help prepare training materials to demonstrate the process and the application of results to management strategies, exercises and risk communications.

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HAZRUNOFF PROJECT

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