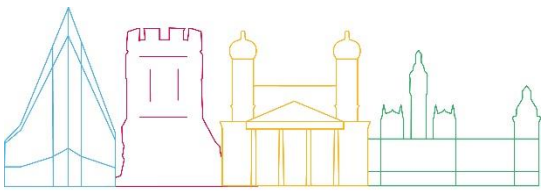
D3.3 ARCH city baseline report - Hamburg

17 December 2021



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1. City profile

This section profiles the Free and Hanseatic City of Hamburg in general terms, and introduces the local areas where the ARCH focus sites are located. Information is provided at a city-wide level, in terms of land use, population demographics and economy, followed by a closer look at the area(s) in the immediate vicinity of the focus sites.

The *Free and Hanseatic City of Hamburg*, one of the 16 states of the German federation, is the second largest city in Germany with 1.8 million inhabitants. In terms of formal governance, it is both a municipality and a city-state within the Federal Republic of Germany. There is no distinction between these administrative levels, meaning that the city-wide government of Hamburg is organised at the state-level. Furthermore, the city consists of seven districts with their own local parliaments who make decisions in matters of local importance (see Figure 1 below).

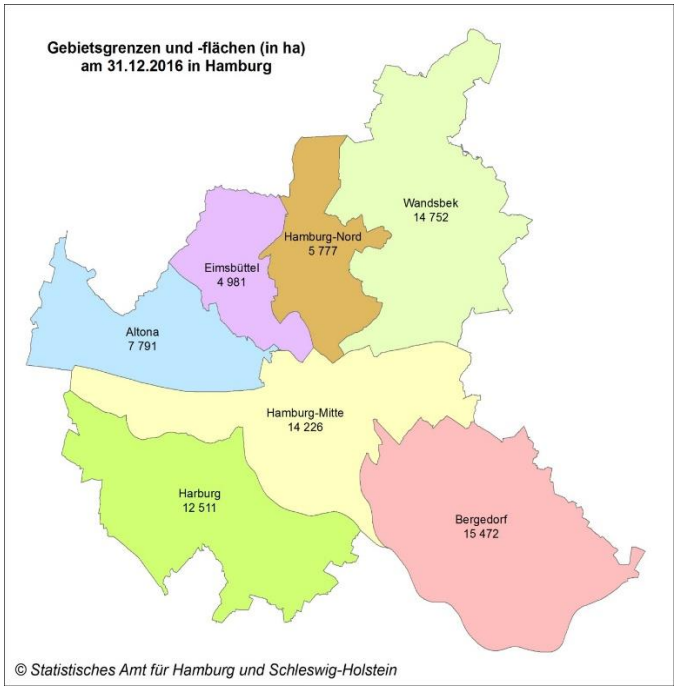

Figure 1. The seven districts of Hamburg (above map indicates size in hectares). Source: Bodenflächen in Hamburg am 31.12.2018 nach Art der tatsächlichen Nutzung; Published Oct. 2019; Statistisches Amt für Hamburg und Schleswig Holstein (https://www.statistik-nord.de/fil)

1.1. Land use

In total, Hamburg covers a surface area of 755.09 km². The size of the city is continuously growing.

In 2018, 46.4% of Hamburg's land area consisted of settlement areas, of which the largest part, 22.2%, is used for housing. Industrial and commercial areas account for 8.9% in Hamburg, while recreational areas in the city as a whole account for 6.6% and sports and leisure areas for 1.8%. Cemeteries account for 1.1% of Hamburg's total land area, the largest being the Ohlsdorf Park Cemetery. The remaining vegetation covers a total area of 24,833

hectares and accounts for 32.9% of the total area. These are primarily agricultural areas, which represent 23%, while forests make up 5.3% and woody plants 2.6%.

At a total of 9447 hectares, transportation routes in Hamburg account for 12.5% of the total land area. General roads account for 8.8% and other transport routes for a further 0.8%, while public squares account for 0.22%. Rail lines take up 1.41% of the space, airports 1.26%, and shipping infrastructure outside the waterways 0.01%.

A significant proportion of Hamburg is made up of water bodies, with 6157 hectares of the total area, a total of 8.1%. Of this, 5.7% is all watercourses and just under 1% is the harbour basin. Standing water accounts for just under 1% and the share of the sea is just over 0.5%.[1]

1.2. Demographic features

1.2.1. Population growth

The population of Hamburg had fallen from 1.7 million in 1939 to about 1.0 million by the end of the Second World War, but climbed up to 1.5 million already again by the end of 1948. This rapid growth comprised of refugees from the East German territories, returning evacuees from the countryside and former prisoners of war.[2] By 1970, just under 1.8 million inhabitants were living in Hamburg again. In the years that followed until the mid-1980s, the population fell to around 1.6 million, and from then on grew steadily (including a significant increase in residents from other countries in 2016), reaching 1,841,179 in total in 2018.[3]

A further increase in population is forecasted for the future. The estimated growth of the population through 2040 depends on different calculation models: With low immigration models, it is estimated that 1.949 million people will be living in Hamburg by 2040; with moderate immigration up to 1.988 million; and with a high immigration rate 2.051 million. Beyond 2040 the future prospective growth rates are declining for all scenarios, due to a lower birth rate than cases of death.

The rate of growth of the population is different depending on age groups, so the structure of ages among the population is expected to change in the future. While more young and elderly people are expected, the number of people who are able to work will decline in the scenarios for low and moderate immigration. [4]

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[1] Bodenflächen in Hamburg am 31.12.2018 nach Art der tatsächlichen Nutzung; Published Oct. 2019; Statistisches Amt für Hamburg und Schleswig Holstein *(https://www.statistik-nord.de/fileadmin/Dokumente/Statistische_Berichte/andere_statistiken/A_V_1_H_gebiet_flaeche/A_V_1_j18_HH.pdf)*

[2] Geschichtsbuch Hamburg; Nachkriegszeit und Fünfziger Jahre; https://geschichtsbuch.hamburg.de/epochen/nachkriegszeit/

[3] Handelskammer Hamburg: Entwicklung der Bevölkerung in Hamburg; https://www.hk24.de/produktmarken/beratung-service/konjunktur-statistik/hamburger-wirtschaft-zahlen/bevoelkerung-3676958

[4] Homepage Statistikamt NordSource: https://www.statistik-nord.de/fileadmin/Dokumente/Presseinformationen/SI19_089.pdf, last visited Jan. 15, 2020

1.2.2. Age and sex

Hamburg's growing population of roughly 1.8 million is made up of slightly more females than males (902,048 male and 939,131 females as of August 2019).

The map in figure 2 illustrates where people aged 65 and over were living in Hamburg in 2014. Most were located on the outskirts of Hamburg in the north and west parts of the city. The number of people aged 80 and over is predicted to grow between 2017 and 2040 from 99,000 (about 5.34% of the population) up to 135,000 people, i.e. roughly an increase of a third (corresponding to a slight proportional increase to make up 6.92% of the overall population, based on the conservative growth scenario outlined above), which can be partly attributed to expected increases in life expectancy (i.e. among newborn boys by 3.4 and among girls by 2.8 years).[5] The life expectancy of boys born in Hamburg increased since a previous calculation from 1986/1988 up to 5.8 years until 2011. It increased for girls who were born in Hamburg up to 4.1 years within the same period (1986/1988 – 2011). In 2011 (latest update in Hamburg) the life expectancy for newborn boys was 77.6 years and for newborn girls 82.7 years.[6]

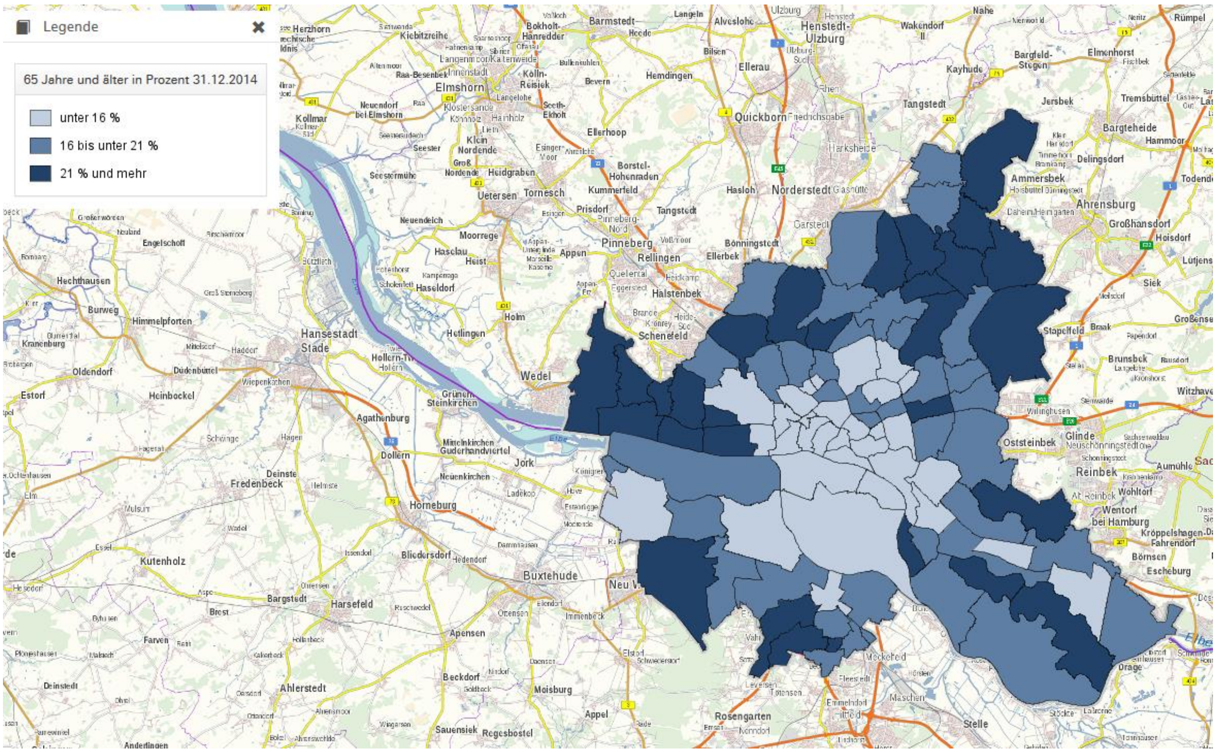

Figure 2 Population distribution of people 65 years old and over; Geoportal Hamburg https://geoportal-hamburg.de/Geoportal/geo-online/#)

[5] Homepage Statistikamt NordSource: https://www.statistik-nord.de/fileadmin/Dokumente/Presseinformationen/SI19_089.pdf, last visited Jan. 15, 2020

[6] Source: Statistikamt Nord 2015 based on Census 2011

Inhabitants in 2019			Age bracket									
Districts	Sex	In total	0 -3	3 - 6	6 - 12	12 - 18	18 - 20	20 – 30	30 – 45	45 – 60	60 – 65	65 - <
District	male	158 250	5 133	4 428	7 893	7 735	2 988	26 381	41 871	34 441	8 048	19 332
Hamburg-Mitte	female	143 296	4 785	4 305	7 313	7 138	2 705	24 570	35 002	26 893	7 085	23 500
	All	301 546	9 918	8 733	15 206	14 873	5 693	50 951	76 873	61 334	15 133	42 832
Percentage rate	%	15.9										
District	male	133 004	4 573	4 625	8 432	7 805	2 619	16 000	30 710	30 503	6 812	20 925
Altona	female	142 261	4 396	4 374	7 932	7 439	2 495	16 394	32 647	31 084	7 264	28 236
	All	275 265	8 969	8 999	16 364	15 244	5 114	32 394	63 357	61 587	14 076	49 161
Percentage rate	%	14.5										
District	male	127 671	4 338	4 065	6 780	6 043	2 169	16 925	31 168	28 170	6 425	21 588
Eimsbüttel	female	139 382	4 028	3 800	6 339	5 710	2 148	19 411	33 060	28 807	7 363	28 716
	all	267 053	8 366	7 865	13 119	11 753	4 317	36 336	64 228	56 977	13 788	50 304
Percentage rate	%	14.0										
District	male	151 279	5 237	4 279	6 811	6 020	2 240	23 723	41 783	32 851	7 215	21 120
Hamburg-Nord	female	163 316	4 968	4 150	6 561	5 623	2 134	27 836	42 237	32 248	7 975	29 584
	all	314 595	10 205	8 429	13 372	11 643	4 374	51 559	84 020	65 099	15 190	50 704
Percentage rate	%	16.5										
District	male	213 697	6 894	6 861	12 725	12 620	4 482	26 198	43 693	47 232	12 399	40 593
Wandsbek	female	227 318	6 563	6 685	12 309	11 655	4 319	25 180	45 082	47 770	13 310	54 445
	all	441 015	13 457	13 546	25 034	24 275	8 801	51 378	88 775	95 002	25 709	95 038
Percentage rate	%	23.2										
District	male	64 184	2 198	2 238	3 946	3 946	1 380	8 623	13 593	14 036	3 762	10 462
Bergedorf	female	66 076	2 030	2 072	3 743	3 728	1 371	7 712	13 435	14 081	4 025	13 879
	all	130 260	4 228	4 310	7 689	7 674	2 751	16 335	27 028	28 117	7 787	24 341
Percentage rate	%	6.8										
District	male	85 553	3 022	2 829	5 136	4 800	1 943	13 920	19 498	17 044	4 315	13 046
Harburg	female	83 873	2 886	2 793	4 736	4 653	1 722	11 917	17 297	16 221	4 525	17 123
	all	169 426	5 908	5 622	9 872	9 453	3 665	25 837	36 795	33 265	8 840	30 169
Percentage rate	%	8.9										
Hamburg	male	933 638	31 395	29 325	51 723	48 969	17 821	131 770	222 316	204 277	48 976	147 066
In total	female	965 522	29 656	28 179	48 933	45 946	16 894	133 020	218 760	197 104	51 547	195 483
	all	1 899 160	61 051	57 504	100 656	94 915	34 715	264 790	441 076	401 381	100 523	342 549
Percentage rate	%	100	3.2	3.0	5.3	5.0	1.8	13.9	23.2	21.1	5.3	18.0

Table 1 Population figures staggered by districts, age groups and sex in Hamburg (2019) (Source: Statistikamt Nord, Statistischer Bericht AI / S 1 – j 19 HH; S. 4ff.; (https://www.statistik-nord.de/fileadmin/Dokumente/Statistische_Berichte/bevoelkerung/A_I_S_1

1.2.3. Population density

Population density is distributed very differently among the seven districts and 105 quarters of the city of Hamburg. The district of Wandsbek in the north-west is the most densely populated, containing 23.2% of the total population (see Figure 3 below). In terms of land area, Wandsbek is the second largest of Hamburg's seven districts after Bergedorf. As Figure 3 shows, according to the colour gradation of grey, Wandsbek is much more densely populated than Bergedorf in the south-west, where only 6.8% of all Hamburg residents live and where most of the agricultural activity in the state is carried out. The map also shows the port area of Hamburg along the Elbe. There, correspondingly, large industrial areas along the waterways predominate, which is why only 8.9% of all Hamburg residents live in the large southern district of Harburg.[7]

Figure 3 Population density distribution in the 105 Hamburg city quarters (2019); Statistikamt Nord, Statistischer Bericht AI / S 1 – j 19 HH; S. 3; https://www.statistik-nord.de/fileadmin/Dokumente/Statistische_Berichte/bevoelkerung/A_I_S_1_j_H/A_I_S1_j19.pdf)

[7] Statistikamt Nord, Bevölkerungszahlen Hamburg vom 31.12.2019; https://www.statistik-nord.de/fileadmin/Dokumente/Statistische_Berichte/bevoelkerung/A_I_S_1_j_H/A_I_S1_j19.pdf

1.2.4. Vulnerable groups

In Germany, the poverty rate in 2018 averaged 15.5% of the total population. If we look at Hamburg in the chart comparing the individual federal states (Table 2 below), the city with a rate of 15.3% is thus in the top third of those federal states with the lowest poverty rate. However, this positive picture conceals the fact that Hamburg, compared with the other federal states, has seen the third-highest increase in the poverty rate over the past ten years from 2008 to 2018 (after Hesse and North Rhine-Westphalia), at over 16%. According to the 2019 Poverty Report of the Paritätischer Gesamtverband, the following groups in society in general are particularly threatened by poverty in Germany:

"These are children and young adults under 25 years of age, women, single-person households, single parents, couple households with three or more children, unemployed persons, pensioners, persons with low qualification levels as well as persons without German citizenship and persons with migration background"[8]

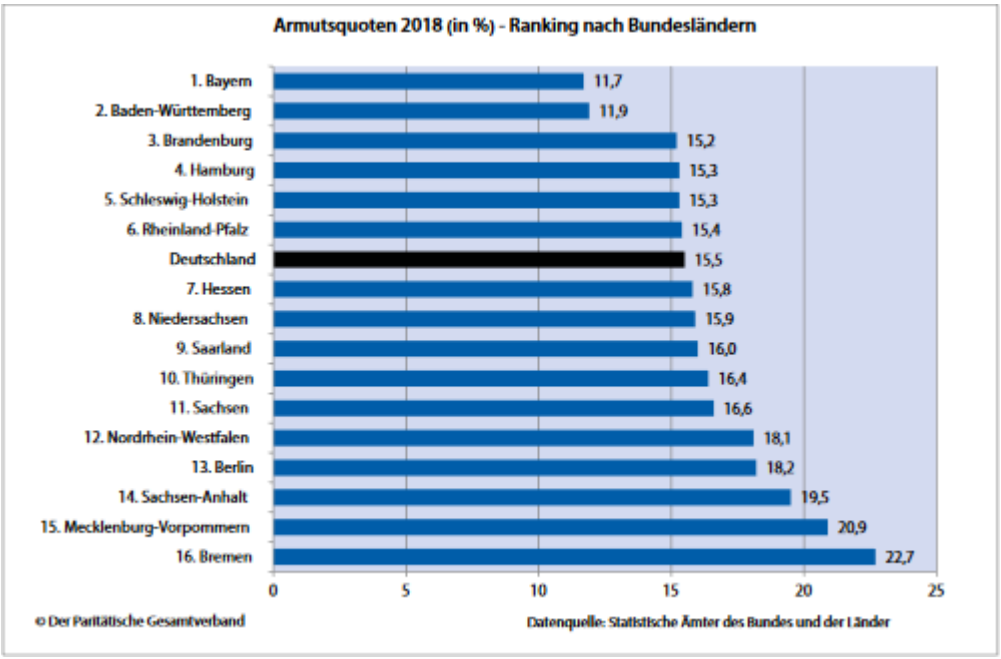

Table 2 Poverty Index Ranking of all federal states in Germany 2018: Der Paritätische Gesamtverband - Armutsbericht 2019, P. 9 http://www.der-paritaetische.de/armutsbericht/

By the end of 2019, 4% more senior citizens in Hamburg were also dependent on so-called "basic social security" than in the previous year. This basic provision is intended to enable senior citizens who have reached statutory retirement age to cope with the daily costs of living by means of additional state benefits if the individual old-age pension alone does not make this possible. At the end of 2019, this age was 65 years and 8 months. It will be increased by one month every year. According to the Northern Statistical Office, it was primarily women

[8] Pieper, Schneider, Schröder, Stilling: Der Paritätische Gesamtverband - Armutsbericht 2019, P. 34 http://www.der-paritaetische.de/armutsbericht/

(54%) who were dependent on a basic pension. More than half of the men and women in Hamburg who were dependent on basic social security were previously unemployed.[9]

According to the dissertation of Giedrion Kaveckis (Hamburg, 2017) vulnerable population groups from the perspective of climate impacts can be defined in many different ways. People in a community may be exposed to the risk of an environmental hazard (e.g. a landslide, or air pollution) or a climatic hazard (e.g. flooding or extreme heat). However, not everyone is vulnerable to the same extent. A range of factors affect a person's vulnerability, including access to support networks (e.g. friends, family, social services), income (especially risk of poverty), age, ability, health and gender – some of which may in turn determine where someone lives, as restrictions on financial freedom or mobility are likely to limit options. Where one lives, and the particular characteristics of that area (e.g. the degree to which it is protected from extreme weather such as flooding or heat), can in turn be a key determinant of vulnerability, even if a person spends the day at other locations for work or other reasons.[10]

In the case of the ARCH focus areas in Hamburg, which are its Speicherstadt and the Kontorhausviertel, housing is not permitted at all, and only a low number of households are located in close proximity, suggesting that the climatic and environmental risks of relevance to this area, as well as any measures planned to address these, are unlikely to impact directly upon resident vulnerable groups. Nonetheless, both areas are in regular use by people working in commercial buildings, as well as visitors to public spaces who access and use these spaces in different ways, and their needs warrant consideration. In addition, impacts and associated risk mitigation measures within this area may have significant indirect consequences for other parts of the city, e.g. redirection of stormwater to prevent flooding in Speicherstadt may cause flooding elsewhere. Taking a broader view of these sites in the context of the wider city itself, made up of a number of inter-linked systems, can help to ensure the recognition of these connections and aim for more holistic and integrated planning.

Kaveckis defined the vulnerable areas of the city of Hamburg according to a range of indicators, including population characteristics and access to healthcare facilities: "In most of the cases, the eastern areas of Hamburg City would experience the highest relative vulnerability, mainly due to higher concentration of older population and welfare recipients. Along the outskirts of Greater Hamburg, the eastern and southern areas would also be vulnerable, because of higher monthly average minimum, maximum temperatures and the long distance to the closest healthcare facility. The sensitivity analysis has shown that climate data from other global climate models would cause 225% higher average vulnerability, meanwhile the increase of older population by 0,5 of standard deviation would cause higher average vulnerability by only 18%."[11]

[9] Statistikamt Nord: https://www.statistik-nord.de/fileadmin/Dokumente/Presseinformationen/SI20_109.pdf

[10] Kaveckis, G.: Modelling future population's vulnerability to heat waves in Greater Hamburg; (2017), pg. 7; http://ediss.sub.uni-hamburg.de/volltexte/2017/8738/

[11] Kaveckis, G.: (2017), pg. iii of the abstract; http://ediss.sub.uni-hamburg.de/volltexte/2017/8738/

Aside from scientific studies such as Kaveckis's dissertation above, and a vulnerability study concerning storm surges, inland flooding and heavy rains by the Hamburg Institute of International Economics (HWWI) in 2015 (http://hdl.handle.net/10419/119458), no official information or spatial mapping concerning specific vulnerable population groups in relation to climate change hazards or effects on the city of Hamburg was identified for this study. But especially concerning any kind of flooding events Hamburg provides a huge range of information.

1.2.5. Income structure in Hamburg

In Hamburg there is a much greater gap in the distribution of income among the population than in other major German cities. This is reflected less clearly in a calculated poverty quotient than in the morphology of the different city districts / quarters. According to the Statistics Office North, there was an annual taxable income discrepancy between the city districts "from 13 777 euros to 120 716 euros per taxable person"[12] in 2013 (a married couple assessed jointly for tax purposes is deemed to be one taxable person). "As the map shows, the five city districts with the highest values each have an average income of at least 93 310 euros per taxpayer. These are the three Elbe suburbs Nienstedten (120,716 euros), Blankenese (117,139 euros) and Othmarschen (108,258 euros) as well as Harvestehude (111,088 euros) and Wohldorf-Ohlstedt (94,234 euros)".[13] The city districts with the apparently lowest incomes are located in the city centre and belong to the major districts of Hamburg-Mitte and Harburg. Some of them are directly adjacent to our study area, which for the most part belongs to the HafenCity district.[14] However, the city districts of Kleiner Grasbrook, Steinwerder and Veddel also have either very few residents or none at all due to their industrial character.

[12] Statistikamt Nord; https://www.statistik-nord.de/fileadmin/Dokumente/Statistik_informiert_SPEZIAL/SI_SPEZIAL_VIII_2017.pdf
[13] Statistikamt Nord; https://www.statistik-nord.de/fileadmin/Dokumente/Statistik_informiert_SPEZIAL/SI_SPEZIAL_VIII_2017.pdf
[14] Statistikamt Nord; https://www.statistik-nord.de/fileadmin/Dokumente/Statistik_informiert_SPEZIAL/SI_SPEZIAL_VIII_2017.pdf

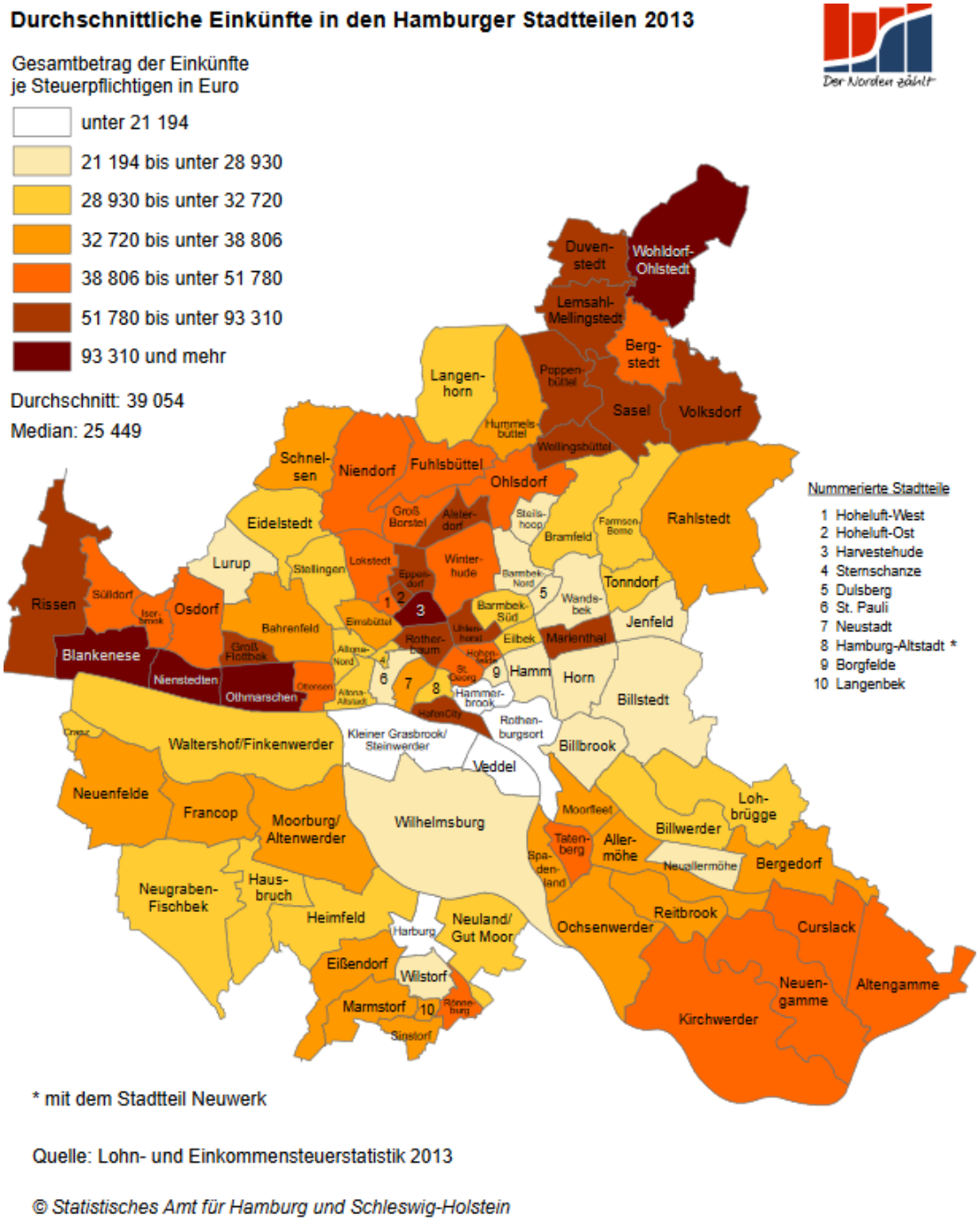

Figure 4 Average income in the Hamburg city districts; Statistikamt Nord 2013; https://www.statistik-nord.de/fileadmin/Dokumente/Statistik_informiert_SPEZIAL/SI_SPEZIAL_VIII_2017.pdf

1.2.6. Economic features

The gross domestic product of Hamburg in 2018 was around 118.91 billion euros.[15] The average annual economic growth rate in Hamburg was rounded to 2.8%, based on calculations of the Ministry of Economy, Transport and Innovation.[16] Gross value added at market prices for the year 2018 was composed of the following economic sectors:

o Trade, transport, hospitality, information and communication

o Financial and business services, real estate

o Public and other services, education and health care system

o Manufacturing industry, excluding construction.[17]

Services in Hamburg make by far the largest contribution to gross value added (as of 2018) with 12.2%. Overall, the share of services in the total gross value added in current prices in Hamburg amounts to 73.6%.[18]

Employed persons in 2018 in Hamburg (per 1000 persons)

Employed persons in total:	1260.1	100%
Self-employed persons:	117.4	9.32%
Employees:	1142.6	90.68%
Whereof marginal employed persons:	109.7	8.71%
Agriculture and Forestry, Fisheries:	1.7	0.13%
Production industry without construction industry:	119.7	9.50%
Whereof manufacturing industries:	105.4	8.36%
Construction Industry:	40.0	3.17%
Trade, transport, hospitality industry, information and communication:	408.7	32.34%
Financial and corporate service providers, real estate sector:	319.4	25.35%
Public and other service providers, education, health:	370.6[19]	29.41%

[15] Homepage Statista: https://de.statista.com/statistik/daten/studie/5014/umfrage/entwicklung-des-bruttoinlandsprodukts-von-hamburg-seit-1970/

[16] Homepage Statistische Ämter des Bundes und der Länder: https://www.statistik-bw.de/VGRdL/tbls/tab.jsp?rev=RV2019&tbl=tab01&lang=de-DE#tab02

[17] https://www.statistik-nord.de/fileadmin/Dokumente/Statistische_Berichte/wirtschaft_und_finanzen/P_I_1_j_H/P_I_1__2__j18_HH.pdf page 6

[18] Arbeitskreis "Volkswirtschaftliche Gesamtrechnungen der Länder" im Auftrag der Statistischen Ämter der 16 Bundesländer, des Statistischen Bundesamtes, Statistik und Wahlen: Bruttoinlandsprodukt, Bruttowertschöpfung in den Ländern der Bundesrepublik Deutschland 1991 bis 2019, Reihe 1, Länderergebnisse Band 1, Frankfurt a.M., März 2020; from data sheet 2.4 onwards. https://www.statistik-bw.de/VGRdL/tbls/RV2019/R1B1.zip

[19] Source: https://www.statistik-nord.de/fileadmin/Dokumente/Statistische_Berichte/wirtschaft_und_finanzen/P_I_1_j_H/P_I_1__2__j18_HH.pdf

In 2019 the city of Hamburg had in total an unemployment rate of 6.1%.[20] In the specific area of the World Heritage Site, which belongs partly to the so called HafenCity, the rate was less than 4.11% in 2014.

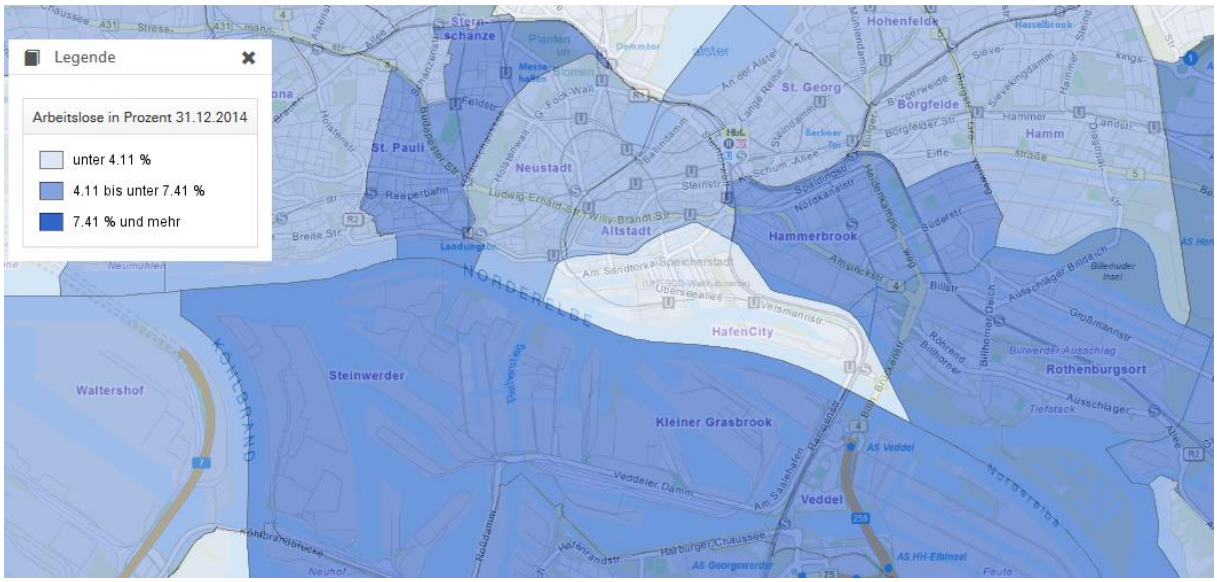

Figure 5 Rate of unemployment is less than 4.11% in the HafenCity quarter (centre of the figure) and comparably low to its surroundings. Map: https://geoportal-hamburg.de/Geoportal/geo-online/#

In June 2020 the youth unemployment rate of young people from 15 to under 25 years old was 8.7% in Hamburg. It is unclear whether this rate is already influenced by the Covid-19-pandemic impacts on the economy of the city.[21]

1.3. Around the focus sites: Speicherstadt and Kontorhausviertel

The historic areas in focus for the ARCH project are UNESCO World Heritage Sites: the Speicherstadt and the Kontorhausviertel. The Speicherstadt, which borders the Hamburg city centre, is a former warehouse complex of the port of Hamburg, and has been part of the newly developed HafenCity district since 2008. Overall, this area is characterised by retail and offices, gastronomy and cultural facilities, and it is one of the most important areas in the entire city, particularly in terms of tourism.

The public space is mainly characterised by the water of the port of Hamburg and the numerous canals that run through the city and this area. Green areas exist only in very small numbers in this urban environment. Park-like zones do not exist in this district.

[20] Homepage Statista https://de.statista.com/statistik/daten/studie/762326/umfrage/arbeitslosenquote-in-hamburg/

[21] Agentur für Arbeit, Monthly report, June 2020, page 14 https://www.arbeitsagentur.de/datei/arbeitsmarktbericht-juni-2020-_ba146561.pdf

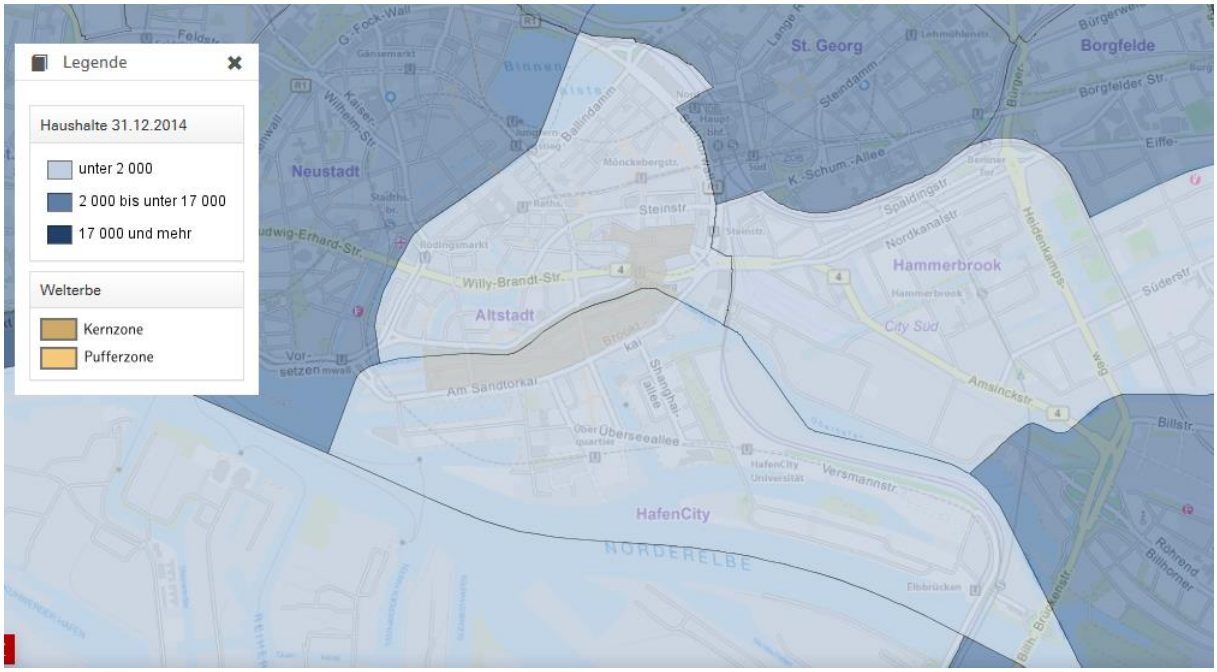

Figure 6 The number of households surrounding our research area are less than 2000. The inscribed World Heritage Site (Kontorhausviertel and Speicherstadt) are in the centre of the figure marked as a light brown coloured layer. Map: https://geoportal-hamburg.de/

In neighbouring HafenCity, there were a total of 2121 households with 4592 inhabitants as of December 31, 2018. Of these, 47.6% of residents were female and 52.4% male. According to estimates, 45.8% have a migration background, while the number of residents with dual citizenship was 1,326 in 2018.

The population structure of HafenCity is made up as follows: The group of people up to 17 years of age numbers 908 (19.8%), the 18-24 year olds make up 405 (8.8%) and the 25-29 year olds 468 (10.2%). Meanwhile, the population structure of HafenCity is dominated by the 30 - 49 year olds, who make up 1736 (37.8%), which means that the average age of the population in this part of town is 35.7 years. The 50 - 64 year olds make up 651 inhabitants (14.2%) and those over 65 years of age make up 424 inhabitants (9.2%).

This means that in 2018 the birth rate in this district, with 68 live births, was significantly higher than the death rate of 9 deceased people overall.[22]

Less than 10% of the residents of the HafenCity quarter are older than 65 years and about twenty percent of the households have children, up to 17 years of age.

[22] Homepage Regionaldaten für HafenCity: http://region.statistik-nord.de/detail/10000000000000/2/1715/227679/

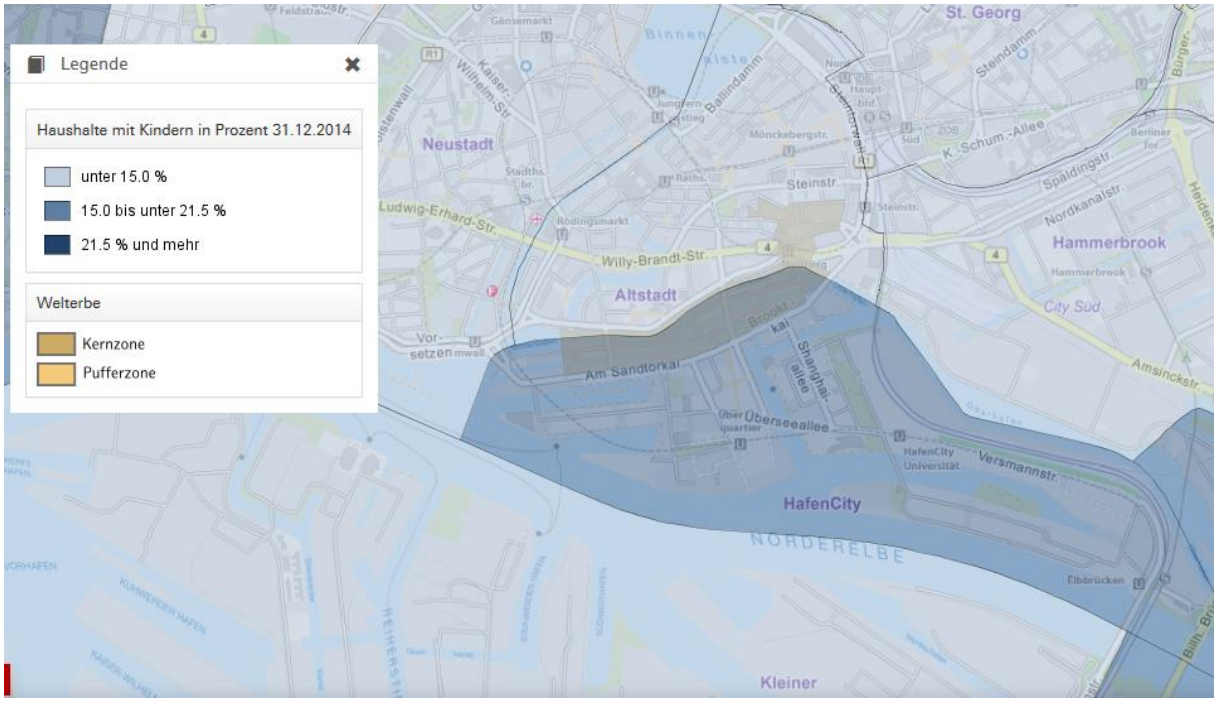

Figure 7 Households with children in the nearby surroundings of our focus area make up about 20% of all households. Map: https://geoportal-hamburg.de/Geoportal/geo-online/#

Besides the small number of residents living in the vicinity, these historic sites receive many visitors on a daily basis. Among them are also people of all ages, including seniors and children, but there are no numbers available. The whole area is open and free to enter for everybody. Regular daily visitors include employees working in the area.

1.4. Overview of existing local framework for disaster risk reduction, climate adaptation and cultural heritage management

The boxes ticked below provide a preliminary overview of the local policy framework in regard to disaster risk reduction, climate adaptation and cultural heritage management (specifically, which information has already been mapped), which will be expanded upon in Chapters 3, 4 and 5.

☒ *Emergency response procedures and responsibilities in the city*

☒ *Existing adaptation measures, strategies and key legislation in the city*

☒ *Existing cultural heritage protection measures, strategies and key legislation in the city*

☒ *Existing databases on climate risk information for the city*

☒ *Decision-making structures in the city regarding adaptation*

☒ *Decision-making structures in the city regarding cultural heritage protection*

☒ *Inventory of heritage assets and their condition*

2. Target historic areas identified for ARCH

2.1. Overview

Speicherstadt and the adjacent Kontorhausviertel, the two target historic areas that have been identified for focus as part of the ARCH project, are two densely-built, central urban areas.

2.1.1. Description of the physical area

Speicherstadt, originally developed on a 1.1 km-long group of narrow islands in the Elbe River between 1885 and 1927 (and partly rebuilt from 1949 to 1967), is one of the largest unified historic port warehouse complexes in the world, at a total area of 300,000 m^2. The adjacent Kontorhausviertel is a cohesive, densely-built area made up mainly of eight very large office complexes that were built from the 1920s to the 1950s to house businesses engaged in port-related activities. Together, these neighbouring districts represent an outstanding example of a combined warehouse-office district associated with a port city. Speicherstadt, the “city of warehouses,” includes 15 very large warehouse blocks that are inventively historicist in appearance but advanced in terms of the technical installations and equipment that they house. The area also includes six ancillary buildings and a connecting network of streets, canals and bridges. Anchored by the iconic Chilehaus, the Kontorhausviertel’s massive office buildings stand out for their early Modernist brick-clad architecture and their unity of function. The Chilehaus, Messberghof, Sprinkenhof, Mohlenhof, Montanhof, former Post Office Building at Niedernstrasse 10, Kontorhaus Burchardstrasse 19-21 and Miramar-Haus attest to architectural and city-planning concepts emerging in the early 20th century. The effects engendered by the rapid growth of international trade at the end of the 19th century and the first decades of the 20th century are illustrated by the outstanding examples of buildings and ensembles that are found in these two functionally complementary districts.[23]

The design of the Speicherstadt is a uniform structure with slight differences between individual building structure types, long stretches of brick and clinker buildings with landside access and waterside access via canals. The foundation consists of approximately 1.2 million pine piles with a depth of up to 12 metres in the ground. The construction is mostly based on a skeleton construction, initially an iron grid structure, which was changed to a wooden beam structure with oak supports due to danger of collapse in the event of fire. During the third phase of construction, concrete-encased iron pillars were used, while in reconstruction and new construction after World War II reinforced concrete was used.[24] For an entire overview of the physical area please visit https://welterbefest.hamburg/.

[23] Homepage UNESCO: https://whc.unesco.org/en/list/1467/

[24] Homepage Hamburg World Heritage Site with Press releases: https://www.hamburg.de/welterbe/10055086/presse-unesco/

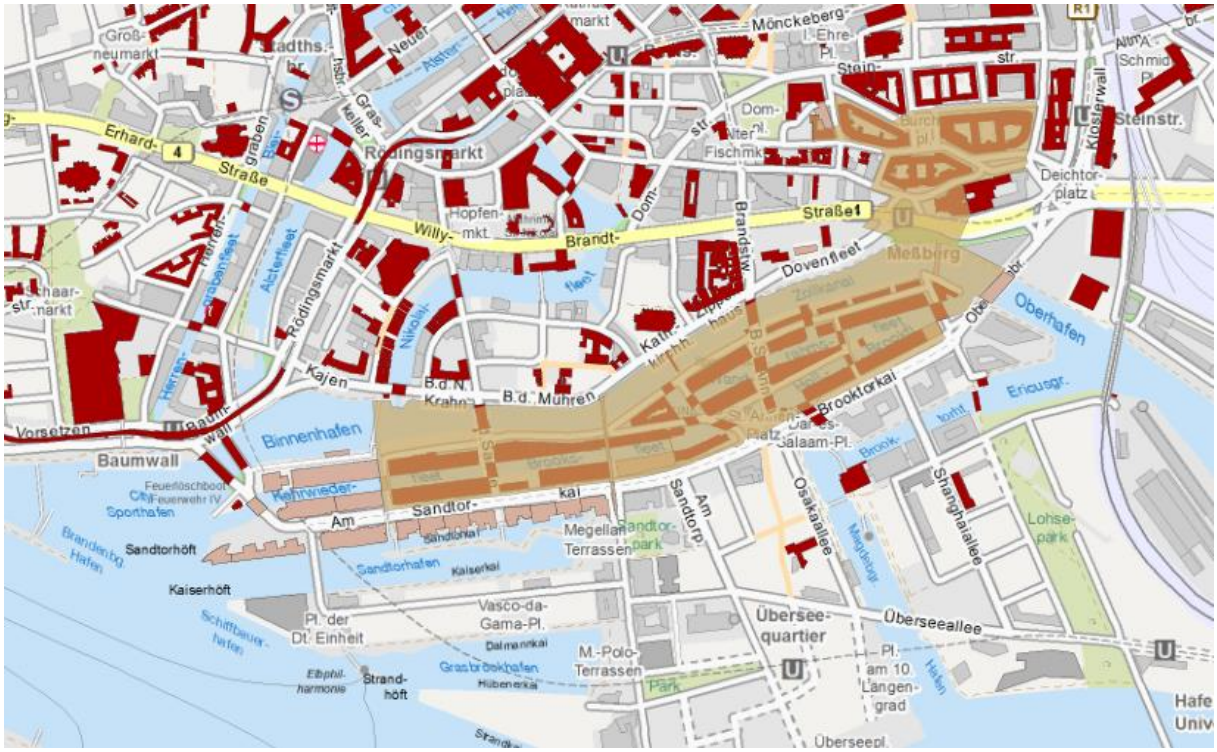

Figure 8 Official World Heritage Site area with Kontorhausviertel, canals and Speicherstadt marked by brown coloured layer (May 2020). Source: https://geoportal-hamburg.de/Geoportal/geo-online/#

Dark red: Buildings of heritage value

Light brown area: Inscribed UNESCO World Heritage Site (ARCH-relevant zone)

Figure 9 Impression of the illuminated Speicherstadt with Wasserschlösschen in the middle (source: City of Hamburg, Heritage Preservation Department)

2.2. Stakeholders

There are various stakeholders involved in different and/or overlapping aspects concerning the maintenance of the World Heritage Site, along with its buildings and infrastructure, including:

- Department of Heritage Conservation / Urban Heritage Conservation, City of Hamburg
- Ministry of Urban Development and Housing, City of Hamburg
- Ministry of Environment and Energy, City of Hamburg
- Ministry of Economy, Transport and Innovation, City of Hamburg
- Ministry of Internal Affairs and Sports, City of Hamburg
- Projekt – Realisierungsgesellschaft mbH (City-owned company)
- Owner of most of the warehouse district buildings: HHLA (Hamburger Hafen und Logistik AG)
- Borough of Hamburg Mitte
- Hamburg Port Authority
- Agency for Roads, Bridges and Waters in Hamburg, Germany

These and other key stakeholders have been mapped by the authors (see Table 3 below) and more detail will be provided in forthcoming report, *Local Partnership and Work Plan* (D3.2).

INTEREST/INFLUENCE MATRIX

High Interest / Low influence Clever Cities - Ministry of Environment and Energy Institute for Hygiene and Environment Air Observation Network GERICS BIM Control Centres (geoinformation, civil engineering, building construction) University of Hamburg Light Art Association Cultural Quarter Association (IG Kulturquartier) ICOMOS national World Heritage Sites Augsburg and Regensburg	**High Interest / High Influence** Heritage Preservation Department Agency of Roads, Bridges and Waters City Participatory Workshop Agency for Property Management and Real Estate (LIG) Hamburg Harbour and Logistics AG (HHLA) Agency for Geoinformation
IG Kontorhausviertel Hamburg Port Authority **Low Interest / Low Influence**	ReGe – Realisierungsgesellschaft mbH Bezirk Mitte **Low Interest / High Influence**

Interest

Influence

NB: In this grid we assess respective stakeholders' level of interest in the project theme and their ability to influence the outcome.

Adapted from the URBACT II Local Support Group Toolkit (2017). Available at: https://urbact.eu/urbact-local-groups

Table 3 Local Stakeholder matrix for the city case Hamburg

2.3. Hazards affecting the site

The particular hazards faced by the World Heritage Site result, on the one hand, from its geographical location, and on the other from the consequences of climate change in Hamburg. The Speicherstadt, which was built at the end of the 19th century on wooden piles into the Hamburg port area on the Elbe, may be threatened by the expected general rise in sea level. In the period from October to March every year, the area is also threatened by severe storms and storm surges, which can also lead to an increased occurrence of flooding in the inner-city area, which can also affect the Kontorhausviertel.

The average temperature has also risen between 1881 and 2013 by about 1.4°C in the Metropolitan region of Hamburg. In the future, rising temperatures and more "tropical nights," especially within the inner-city centre, are expected during the summer period. Depending on the future CO_2 emission rate, the average temperature throughout the year may increase by 1°C, or as much as 5°C. Extremely dry summer periods and heat waves may have a long-term effect on the building construction and the building materials used, which are sometimes exposed to a constant change between humid and dry environments.

In the winter, more frequent (and heavier) rainfall is expected, based on a specific study regarding vulnerability to storm surges, inland flooding and heavy rainfall that was carried out by the Hamburg Institute of International Economics (HWWI) in 2015[25].

Moreover, as a metropolis on the waterfront, Hamburg is confronted with the effects of sea level rise. At the level Cuxhaven Steubenhöft (German Bight) measurements have been carried out from 1981 – 2019 and the results already show a sea level rise of 20 cm per century. The *IPCC-special report on the ocean and the cryosphere within a changing climate* (SROCC) predicts a business as usual emission scenario of major sea rise on a global level. This suggests corresponding increases in the risk of storm surges as well as the upstream-directed transport of sediment, with implications for flood protection and future sediment management. Moreover, the brackish water zone, a mixed zone of saltwater and fresh water, will move further upstream as well.

Therefore, Hamburg needs to prepare for the inescapable consequences of climate change. As a foundation for this task, Hamburg is developing a monitoring programme to document the effects of climate change and to assess in how far adaptation measures undertaken so far have been effective.[26]

With respect to the effect of these climatic changes as they specifically impact the Speicherstadt and Kontorhausviertel, limited information was found in the course of developing this report. It follows that this limitation also applied to finding any corresponding measures to address these effects. In the past years, various investigations have been carried out by building owners and operators with regard to preservation and maintenance in general, however details were not available at the time of writing, and it is believed that these did not

[25] Rose, Julia; Christina B. Wilke: Climate change vulnerability in cities: The case of Hamburg; HWWI Research Paper 167, 2015 http://hdl.handle.net/10419/119458

[26] Erste Fortschreibung Hamburger Klimaplan, S. 6f (First revision of the Hamburg Climate Plan.; https://www.hamburg.de/klimaplan/nofl/13278658/c-7-downloads/

specifically concern the impacts of climate change. In general, the authors believe that several different local stakeholders would be interested in addressing this knowledge gap.

2.4. Gaps, needs and actions

Due to the complex situation in Hamburg, gaps and needs in the city administration's ability to support the resilience of the Kontorhausviertel and Speicherstadt – and corresponding supporting actions – can only be fully understood in direct exchange with the various project participants. However, based on the information available at the time of writing, the following scenarios for possible support from ARCH scientific partners are conceivable:

- Screening and monitoring of possible decomposition or corrosion effects acting on building masonry, supporting pile foundation or bridge abutments.
- Monitoring of the pile foundation and the subsoil with regard to the permanent load-bearing capacity of the foundation.
- Long-term measurements regarding facade structure and possible long-term changes such as cracks in the masonry, which can be caused by a variable load distribution of horizontal and vertical loads and changes in the foundation.
- Almost 50 bridges exist within this district. Many of them are currently in poor condition. Specific monitoring might help to identify methods for adequate bridge refurbishment in the historic district as well as how far the climate change impact might be responsible for the current state of the bridge construction (e.g. acceleration of decomposition processes).
- There is already a city administration-led plan to build a 3D-model of an important historic bridge in another location, with help of BIM (Building Information Modelling). Although outside the ARCH target historic area, the application of this method is relevant for the further management of the Speicherstadt and Kontorhausviertel, and hence the opportunity for ARCH scientific partners to integrate their tools and methodologies with this planned project should be explored. Collecting relevant data on building deterioration in connection with climate change might be a very valuable support for long-term analysis and anticipation of future impacts.

Monitoring of weather conditions with respect to an increased UV-/ or CO_2-level at the public squares of the World Heritage Site may also be useful, with a view to providing relevant advice to people visiting these areas. These aspects can possibly be addressed with the help of the various scientific institutions and their experts involved in the ARCH project. Furthermore, the ARCH project can hopefully serve as a catalyst for raising awareness of the basic topic in Hamburg. It would also be desirable for the project to play a coordinating role between the various stakeholders involved in the co-creative process.

3. Governance framework for cultural heritage management

This section looks at the governance framework for cultural heritage relevant to Hamburg´s identified sites. It elaborates existing policies, strategies, visions and action plans for the management, protection and use of cultural heritage in Hamburg at different governance levels – international, national, regional, local, and site level. Sections 3.3 and 3.5 in particular reflect on the interlinkages between the regional and site levels with key international governance instruments created by UNESCO.

The cultural heritage values of the Speicherstadt and Kontorhausviertel are protected through binding legal regulations, and the city administration observes several regional, national and international recommendations and regulations. These are outlined below. This chapter draws heavily on the Nomination Dossier (2014) and Management Plan therein (2013)[27], edited by the City of Hamburg as part of the nomination of the Speicherstadt and Kontorhausviertel for World Heritage status. Both can be found here: http://whc.unesco.org/en/list/1467 and http://welterbe.hamburg.

3.1. International

The following international policies and declarations are particularly relevant for the conservation of monuments in the Federal Republic of Germany and for the World Heritage site “The Speicherstadt and the Kontorhausviertel”: UNESCO World Heritage Convention and UNESCO Recommendation on the Historic Urban LandscapeThe Federal Republic of Germany is a signatory to all of these internationally important declarations.

3.1.1. World Heritage Convention

The Speicherstadt and the Kontorhausviertel were designated with World Heritage status in 2015, and therefore the **World Heritage Convention is an important tool in the safeguarding of the site.** The Convention is based on the idea that “parts of the cultural or natural heritage are of outstanding interest and therefore need to be preserved as part of the world heritage of [hu]mankind as a whole” (preamble to the World Heritage Convention).

An important step towards achieving this was made when the new Heritage Protection Act of Hamburg came into force in 2013, stating that:

> *„All measures and plans must take into account the obligation to protect the cultural heritage in accordance with the Convention Concerning the Protection of the World Cultural and Natural Heritage of 16 November 1972 (German Federal Law Gazette (BGBl), 1977 II, p. 215)”*

[27] Kloos, M.; Ritscherle, M.; Wachten, K. et al: UNESCO World Heritage Management Plan: The Speicherstadt and Kontorhaus District with Chilehaus (2013), http://whc.unesco.org/en/list/1467 and http://welterbe.hamburg, and hendrik Bäßler verlag, Berlin, 2017.

(Heritage Protection Act of 5 April 2013 of the Free and Hanseatic City of Hamburg, Official Hamburg Gazette, p. 142).

The **Operational Guidelines** for the Implementation of the World Heritage Convention, 8 July 2015, are an essential basis for achieving these objectives. They aim to facilitate the implementation of the World Heritage Convention. For this purpose, the procedures for the following operations were determined in particular:

- the inscription of World Heritage sites on the World Heritage List and the List of World Heritage sites in danger;
- the protection and conservation of World Heritage sites;
- the granting of International Assistance under the World Heritage Fund;
- the mobilisation of international support in favour of the World Heritage Convention.

The Operational Guidelines are periodically revised to reflect the decisions of the World Heritage Committee. They define the principal approaches towards managing the World Heritage site.

3.1.2. Charters and Declarations

The following international charters and documents issued by UNESCO and ICOMOS are of particular relevance to the “Speicherstadt and Kontorhausviertel with Chilehaus” (for more information on these charters and conventions please refer to www.icomos.org):

- the Venice Charter,
- the Florence Charter,
- the Washington Charter,
- the Nara Document on Authenticity,
- the Burra Charter,
- and the more recent Recommendation on the Historic Urban Landscape.

Of these, the Recommendation on the Historic Urban Landscape (HUL), adopted in 2011, is of particular interest for urban environments and hence for the ARCH focus areas. The approach adopted by the Recommendation is based on existing declarations and charters, and takes account of the fact that World Heritage sites in urban areas are part of a larger ‘urban ecosystem’ and subject to continuous change. It also recognises the role of communities living in and around urban World Heritage sites in the preservation and sustainable development of these places. By extension, people in these communities must be fully involved in developing and implementing strategies to protect and manage World Heritage sites in the interest of ongoing sustainable development. This approach is well-aligned with the ARCH project’s thematic intersection of cultural heritage management, disaster risk reduction and climate adaptation – since understanding the risks faced by sites of cultural heritage significance demands attention to a broader landscape of risk and vulnerability, and in the case of Hamburg, recognition that these sites are part of a complex wider city system.

3.2. National level

Alongside the above international guidelines, general frameworks for urban development and construction are provided for at both national and regional level.

Due to the federal setup of Germany, many regulations and laws that are normally found on a national level are delegated to the *Länder* (states). Hamburg, being a City-state, is therefore responsible for heritage legislation.

For the Speicherstadt and the Kontorhausviertel, legislation at national and regional levels, along with urban planning, landscape planning, and monument conservation instruments all play a role in their protection and sustainable further development. Supporting legislation includes the Construction Code (*Baugesetzbuch*), the Federal Nature Conservation Act (*Bundesnaturschutzgesetz*, BNatSchG), the Hamburg Act for the Implementation of the Federal Nature Conservation Act (*Hamburgisches Gesetz zur Ausführung des Bundesnaturschutzgesetzes*, HmbNatSchG) the Landscape Programme (*Landschaftsprogramm*), the Zoning and Land-use Plan (*Flächennutzungsplan*) and the Local Development Plan (*Bebauungsplan*).

3.2.1. Federal Construction Code

The Construction Code of the Federal Republic of Germany (*Baugesetzbuch*), last amended on 28 March 2020, forms the legal basis of urban development planning in Hamburg. The provisions of the Construction Code therefore also play a decisive role in regulating urban building development in the Speicherstadt and the Kontorhausviertel, as well as the surrounding buffer zone. At the same time, the Construction Code appoints the instruments for their protection: i.e. urban development planning, ordinances on conservation and design, and further levels of action.

Significant for the ARCH target historic areas are the zoning and land-use plans (preparatory urban development planning) and the local development plans (binding urban development planning). The city state Hamburg does not have a spatial plan, which is unlikely. Here, the zoning and land-use plan instead serve the direct functions of the (usually) higher-ranking land use planning.

3.3. Regional level

Being a City-State, Hamburg is a regional authority and has ministerial competences. The *Ministry of Culture and Media (BKM)* holds the responsibility for the Speicherstadt and Kontorhausviertel UNESCO World Heritage site. In doing so, the BKM organises and coordinates all measures in this area, starting from communication activities, and including holding a Heritage Preservation Office and most importantly coordinating all activities planned and/or implemented there. Activities are governed by a Management Plan, which anticipates possible risks to the cultural heritage values of the area, as well as possible measures to deal with them, and provides guidance to the city administration on appropriate responses.

3.3.1. Hamburg Building Code

The most relevant regulation for all buildings in the area (protected and non-protected) is the Hamburg Building Code of 14 December 2005 (as last amended on 15 December 2009). The code establishes the legal rules governing plots of land and their development, and contains general building regulations as well as provisions on design and construction products and methods, e.g. walls, ceilings, roofs, escape routes and technical building equipment. It also stipulates the purposes for which buildings may be used.

3.3.2. Zoning and Land-use Plan

In accordance with Section 1, Paragraph III, and Section 5, Paragraph ff, of the Federal Construction Code, the Free and Hanseatic City of Hamburg has produced a zoning and land-use plan for the entire city (including the Speicherstadt and Kontorhausviertel and surrounding buffer zone) as part of a general development and construction framework. This plan establishes the essential guidelines for land use and building developments for the entire city centre. The most recent version of the zoning and land-use plan for the Free and Hanseatic City of Hamburg, which was published on 22 October 1997 (Official Hamburg Gazette, p. 485), still classifies the Speicherstadt area as part of the “port”. The zoning and land-use plan is being amended in parallel with the relevant local development plan, and in the future the area concerned will be classified as “mixed-use development”.

3.3.3. The Hamburg Heritage Protection Act

The Heritage Protection Act of the Free and Hanseatic City of Hamburg protects architectural monuments, ensembles, garden monuments and archaeological monuments, as well as movable heritage assets. Both the Speicherstadt and Kontorhausviertel are protected under this act.

Heritage Council: The Regional Ministry of Culture is assisted by a Heritage Council which acts as an independent advisory board on heritage protection and preservation.

The **Heritage Protection Act of Hamburg** came into force in 2013. According to the Act, the task of monument protection and preservation includes the scientific research of monuments. It remains unclear whether this research targets the complex layering of urban settlements, as suggested in the UNESCO Recommendation on the Historic Urban Landscape (HUL Recommendation). As described in the Act, monument protection should ensure that monuments are included in urban development, spatial planning and land management[28]. This reflects the HUL Recommendation to some extent, as heritage protection is to be integrated into various policy instruments and implemented by these means (Recommendation on the Historic Urban Landscape, p. 5). In addition, there is an obligation to maintain the monument within the bounds of what is considered to be reasonable action to protect it from hazards and to repair it. However, protection against specific natural hazards (e.g. climate change) and the inclusion of disaster risk management are not explicitly listed in the Act. The Act stipulates that measures and planning are subject to the obligation to preserve cultural heritage in accordance with the Convention Concerning the Protection of the World Cultural and Natural Heritage of 16 November 1972. Germany has ratified the Convention Concerning the Protection of the World Cultural and Natural Heritage[29].

The Heritage Council acts as an independent advisory board and is composed of specialists (e.g. in heritage protection, history and architecture) as well as citizens/residents. Every two years the senate reports to the citizens on the work of the Monument Council. In terms of the Heritage Protection Act of Hamburg, the involvement of citizens/residents does not go further than this. Other instruments of heritage protection allow for more extensive citizen participation, which would be more in line with the participatory approach of the HUL Recommendation.

3.3.4. The Management Plan for the Speicherstadt and Kontorhausviertel

A Management Plan aimed at safeguarding the potential Outstanding Universal Value of the Speicherstadt and Kontorhaus District with Chilehaus, its authenticity, and its integrity, and protecting its proposed buffer zone, entered into force on 28 May 2013.

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[28] Heritage Protection Act of 5 April 2013 of the Free and Hanseatic City of Hamburg, Official Hamburg Gazette, p. 142

[29] The Federal Republic of Germany ratified the Convention Concerning the Protection of the World Cultural and Natural Heritage in 1976. After the union of the two German States to one Sovereign State, they agreed that the treaties and agreements to which the Federal Republic of Germany is a contracting party remain in force and that their respective rights and obligations be applied to the whole territory of Germany (https://whc.unesco.org/pg.cfm?cid=246).

The Plan manages the property under market economy conditions (as a site of living heritage, the preservation of the buildings should be self-sufficient in terms of financing), as this is vital for the preservation of the large number of buildings, according to the nomination dossier. The objective of the Plan is therefore "to reconcile safeguarding the 'outstanding universal value' of the World Heritage site on the one hand, with taking the necessary measures to provide for its sustainable further development, on the other."

The Plan is a strategic document that defines objectives for preservation and sustainable development, assesses the work that needs to be done, identifies areas of conflict and potential synergies, and establishes priority measures and projects (see Figure 10 below)[30].

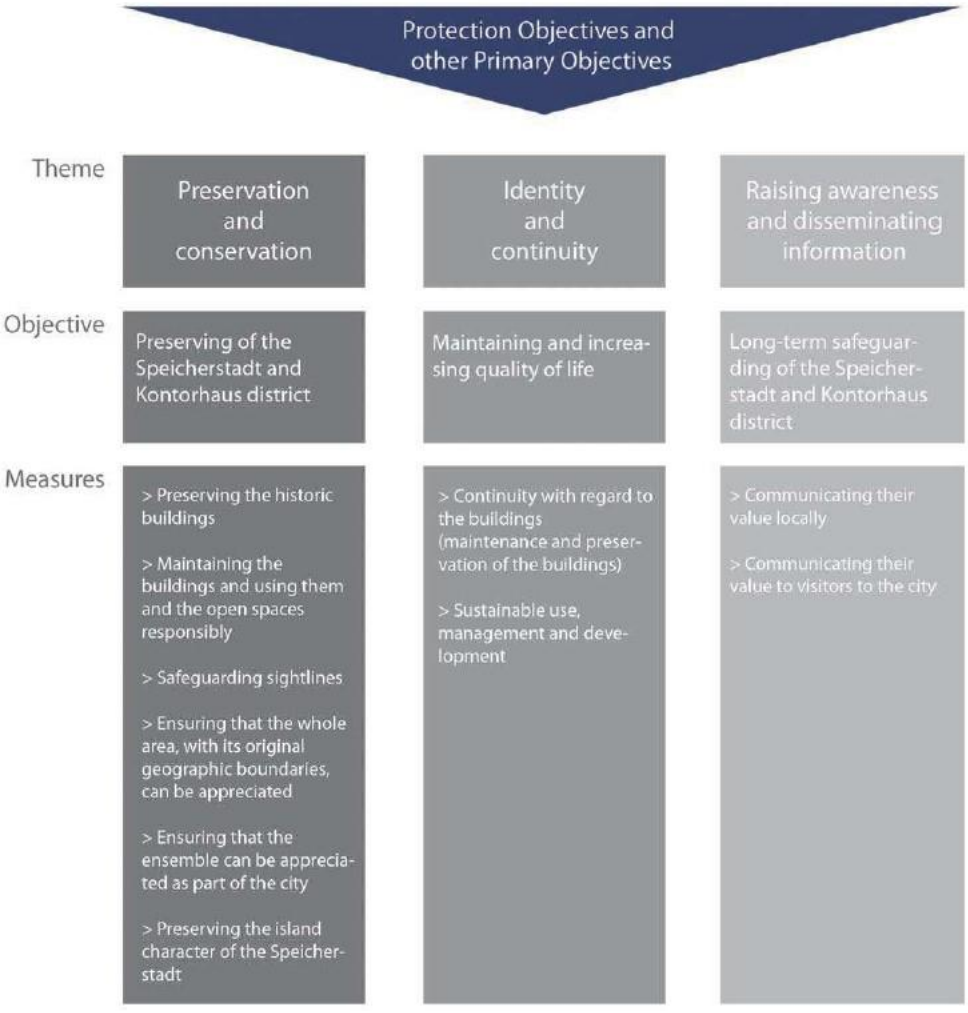

Figure 10 Three-pillar model of the protection objectives – and corresponding measures – planned for the "Speicherstadt and Kontorhaus district with Chilehaus". Source: M. Kloos, M. Ritscherle, and K. Wachten, "Management Plan: The Speicherstadt and Kontorhaus District with Chilehaus," 2015.

The objective of the current **Management Plan for the Speicherstadt and Kontorhausviertel** is protecting the 'outstanding universal value' of the World Heritage site

[30] https://www.hamburg.de/bkm/unesco-speicher-kontore/10531874/praktisches-download-bereich-en/

and providing for its sustainable further development. This consideration of economic factors and developments is relevant for the long-term preservation of the World Heritage site as mentioned in the HUL Recommendation (p. 3). The Management Plan identifies several charters relevant to the UNESCO World Heritage site: Venice Charter, Washington Charter, Nara Document on Authenticity, Burra Charter, and the aforementioned HUL Recommendation.

The three-pillar model of the protection objectives, as published in the Management Plan for the Speicherstadt und Kontorhausviertel, includes the theme of raising awareness. This fits in with the HUL Recommendation, which emphasizes the involvement of different stakeholders to safeguard their heritage and promote sustainable development.

Although no other international frameworks, agreements or treaties are explicitly mentioned in the Management Plan, disaster risk management and climate adaptation issues are considered to some extent.

Potential risks to World Heritage caused by things like flooding or tourism, are listed in chapter eight of the Management Plan and their impact potential is assessed as relatively low. However, flooding has occurred more frequently in the Speicherstadt in the past. These floods do not pose a threat to the substance of the buildings. However, for residential or hotel use, the introduction of area-wide flood protection as well as appropriate escape routes is prescribed by law (p. 78). Overall, disaster prevention and climate adaptation could be included even more comprehensively in the Management Plan. Parts of the Pplan will be updated in the years to come (scheduled for 2025 at the time of writing) and there is an opportunity for the ARCH project to contribute to this update by proposing the inclusion of climate change-related measures that have, thus far, played only a small part in the current version. A more in-depth consideration of possible further natural and human-made risks than in the current Management Plan makes sense for the protection of heritage in the long term – and this consideration is in progress by means of the ARCH project.

3.4. Local (district level)

3.4.1. Land-use plans (Flächennutzungsplan)

Land-use plans are prepared on the basis of the zoning and land-use plan and regulate the type and extent of construction and other uses of the ground or the properties. Their preparation follows a process in accordance with the Federal Construction Code (BauGB).

The Speicherstadt was removed from the scope of the Port Area Development Act (Hafenentwicklungsgesetz) on 10 October 2012, paving the way for the development plan (concept) specific to the Speicherstadt to be drawn up (see Part 3.5.1 below).

3.4.2. City Centre Concept[31]

For the larger area of the Hamburg inner city, a local development concept has been in place since 2010 (revised 2014) that outlines future use and development priorities for public spaces, transport, housing, etc. This concept is the main guidance tool for the overall social and infrastructure layout of the inner city (Hamburg Mitte).

Meanwhile, the City Centre Concept seeks primarily to integrate the new HafenCity development, which lies to the south of the city centre, in the neighbouring city centre district. The concept is intended to enable Hamburg's historic core and its new maritime district to grow together. Given the location of the Kontorhausviertel and Speicherstadt, with the city centre immediately to the north, and the HafenCity immediately to the south, it is clear that they play an important role in the City Centre Concept [32].

3.5. Site level (Speicherstadt)

3.5.1. Speicherstadt Development Concept (2012)[33]

The Development Concept (*Entwicklungskonzept*) for Hamburg's Speicherstadt, hereinafter referred to as the Speicherstadt Development Concept, was drafted by the then-Regional Ministry of Urban Development and the Environment (BSU, today BSW) in cooperation with the Hamburger Hafen- und Lagerhaus-Aktiengesellschaft (HHLA), other ministries in Hamburg and the district authorities and came into force in 2012. One of the main reasons for drafting it was the Speicherstadt's nomination for inscription on the World Heritage List. In addition, the Speicherstadt Development Concept is intended to serve as a basis for a local land use plan for the Speicherstadt (currently under development – see above), given that the Speicherstadt has been removed from the scope of the Port Area Development Act (*Hafenentwicklungsgesetz*). The Speicherstadt Development Concept is therefore of central importance, and complements the Management Plan mentioned earlier (see Part 3.3.4 above), because it summarises the facts, general conditions and guidelines, which are essential for fulfilling the preservation and sustainable development of the Speicherstadt.

When the new HafenCity development is completed, the Speicherstadt will constitute a link between it and the city centre. One of the challenges presented by this new status is that the Speicherstadt has hitherto been separated from the rest of the city and was built on an east-west axis. Historically, north-south through-routes played a subordinate role, but they are now becoming increasingly important and will be more actively used, presenting a risk to the historic integrity of the Speicherstadt area.

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[31] Only available in German (most recent edition 2015, original text 2010: Innenstadtkonzept - https://www.hamburg.de/konzepte-strategien/

[32] For more information on the City Centre Concept and the guiding principles see: https://www.hamburg.de/innenstadtkonzept/ (only available in German).

[33] Entwicklungskonzept Speicherstadt (only available in German): https://www.hamburg.de/contentblob/4056088/42fc628d89757fee90432b0b23cb224c/data/download-konzept.pdf

Additional challenges which are identified in the Speicherstadt Development Concept include recent changes in how the warehouses are used, specifically:

- A decline in transhipment and logistics, while an increasing number of service companies, trade operations and cultural attractions are establishing themselves there.
- Increased interest in living in the Speicherstadt. Large-scale residential use is, however, only possible if there is comprehensive flood protection[34].
- A need to maintain the quality of public spaces.
- A need to ensure that the heads of the wooden piles on which the Speicherstadt is built remain structurally stable.

While taking appropriate account of the Speicherstadt's World Heritage value, the Speicherstadt Development Concept also seeks to highlight opportunities for change and further development that can be undertaken without threatening the area's existing character. A concept has been drafted for transport infrastructure and the design of public spaces within the Speicherstadt, however at the time of writing there were no designs yet completed.

The Speicherstadt Development Concept contains planning and design guidance on the following aspects relevant to future development (bearing in mind that all changes require the permission of the heritage protection authorities):

- Allowed uses and changes of use (storage and trade, services, residential use, cultural institutions)
- Flood protection
- Safeguarding of the wooden piles supporting the quay walls and warehouses
- Transport (access, parked vehicles, design of parking areas, bridges)
- Open spaces and their design
- Lighting
- Existing flora and fauna

One of the main characteristics of the Speicherstadt is its aforementioned position between the historic urban centre and the new HafenCity. Its role within the urban area and potential to create a lively and urban district are emphasized by the Speicherstadt Development Concept. In order to achieve this aim, a mixed-use approach should be implemented – including cultural offerings, recreational use, showrooms and offices. This integrated approach is in line with the HUL Recommendation, which adopts the approach that World Heritage sites in urban areas are influenced by their surrounding areas and part of a larger urban system. According to the

[34] As part of the process of drafting the Development Concept for the Speicherstadt, a flood protection concept was also produced. However, it has not yet been assessed for its impact on heritage protection (Internal Memorandum 20/4388, p. 4). And the solution was abandoned due to the technical complexity of the implementation.

HUL Recommendation, there is an inherent, constant change of the urban system. This ongoing urban development also influences World Heritage sites like the Speicherstadt and Kontorhausviertel with Chilehaus. In order to preserve this World Heritage site, the Speicherstadt Development Concept includes different current and possible future uses in its vision. Already two thirds of the Speicherstadt has been converted and is now repurposed for different uses/users, such as offices and service providers.

The Speicherstadt Development Concept is primarily a synthesis of expert reports that were established in order to evaluate possible concepts for an area that was in full transition from an industrial harbour site and custom-free zone to an integrated urban area. The concept was presented, discussed and voted on in the City Council. In view of today's approaches, a larger public participation that has since become standard in Hamburg does stand out as missing in this particular case.

As mentioned before, the Speicherstadt Development Concept incorporates and recognises the possible necessity for flood protection. The current status, possible flood protection options, and the legislation for such measures are outlined in the concept. Multiple benefits are listed in the Development Concept, which highlights the necessity for integrating the Speicherstadt into the flood protection system of the inner city centre and the HafenCity (p. 33 ff.). According to the Sendai Framework for Disaster Risk Reduction, the potential risks for the World Heritage site caused by flooding should be assessed in all their dimensions. However, the Speicherstadt Development Concept is not the appropriate document to incorporate a detailed assessment of the vulnerability, capacity, and exposure of heritage. Furthermore, the need for in-depth investigations to finally determine the best flooding protection measures and the rather high costs of the analysed flood protection measures are mentioned in the document and are currently under research by the administration[35].

[35] Entwicklungskonzept Speicherstadt (only available in German): https://www.hamburg.de/contentblob/4056088/42fc628d89757fee90432b0b23cb224c/data/download-konzept.pdf page 38

3.5.2. Ordinance on the Design of the Speicherstadt (2008)

The Ordinance on the Design of the Speicherstadt stipulates that any alterations to warehouses must be compatible with heritage protection. It contains provisions on:

- Façades,
- roofs,
- building technology,
- advertising and vending machines, and
- the design of the surrounding external space.

3.5.3. Design Manual for the Speicherstadt (*Gestaltungshandbuch Speicherstadt*) (2002)

While it is not legally binding, the The Design Manual for the Speicherstadt is regularly used by the Hamburger Hafen- und Lagerhaus- Aktiengesellschaft (HHLA), which owns all property in the Speicherstadt, to guide design and development decisions.

Overall, the management of the Speicherstadt and Kontorhausviertel works well based on the procedures, guidelines, charters, legal provisions and other elements outlined above. Nevertheless, climate change and the effects of related hazards were not a main priority in the current Management Plan (with the exception of some provisions for flooding), nor in the different ordinances. Gaps and needs (along with possible corresponding actions of relevance to the ARCH project) can be summarised as follows:

- Integration of climate change and related hazards could be an integral part within the future revised Management Plan and associated periodic reporting to UNESCO in the years to come. A related objective is to identify the different plans the City has in this respect, as well as to examine the Management Plan for gaps with respect to resilience-building and propose potential actions and strategies for inclusion in a future update of the Plan.
- Tools and procedures already exist to support management of data about the existing historic built fabric, and ongoing remedial or development measures, but these could be expanded and improved. For example, by constructing digital 3D models of existing structures using Building Information Modelling (BIM).
- Cooperation with archaeological department concerning research about remains of the industrial heritage of the late 19th/ early 20th century is currently limited and could be strengthened.
- Greater awareness raising regarding the relevance of climate change to the Speicherstadt and Kontorhausviertel is desirable, and there is an opportunity to design and implement events in the context of the ARCH project.

4. Governance framework for disaster risk reduction

4.1. International

This section examines the governance framework for disaster risk reduction (DRR) with relevance to Hamburg´s identified sites. It elaborates the relevant policies, strategies, visions, and action plans for disaster risk reduction in Hamburg at different governance levels. Among these, the Sendai Framework is of particular interest at the international level, and reflection on it with regard to local strategies is presented at the end of this section.

At the international level, there are three main types of governance frameworks for disaster risk reduction: global, European, and other bi- or multilateral frameworks of several nations.

4.1.1. Global frameworks

Global frameworks for disaster risk reduction are implemented by international organisations like the United Nations (UN) and the World Health Organisation (WHO)[36]. Most relevant for inclusion in this report is the United Nations Office for Disaster Risk Reduction (UNDRR, formerly UNISDR). The mission of UNDRR is to "bring[s] governments, partners and communities together [to] reduce disaster risk and losses to ensure a safer, sustainable future".

UNDRR supports:

- coordination mechanisms like the Global Platform for Disaster Risk Reduction[37] and the National Platforms for Disaster Risk Reduction,
- the implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030[38], and
- other institutions, including governments and civil society.

For Europe, the European Forum for Disaster Risk Reduction 2015-2020 published a Roadmap for the Implementation of the Sendai Framework in 2016[39].

The Sendai Framework is based on four priorities:

(1) Understanding disaster risk,
(2) Strengthening disaster risk governance to manage disaster risk,
(3) Investing in disaster risk reduction for resilience, and
(4) Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and construction.

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[36] World Health Organisation: https://www.who.int (last visited 13.5.2020)

[37] UN Global Platform for Disaster Risk Reduction, a biennial multi-stakeholder forum: https://www.unisdr.org/conference/2019/globalplatform/about (last visited 13.5.2020)

[38] Sendai Framework: https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030 (last visited 13.5.2020)

[39] Roadmap for the Implementation of the Sendai Framework: https://www.undrr.org/publication/european-forum-disaster-risk-reduction-efdrr-roadmap-2015-2020 (last visited 13.5.2020)

A tool for supporting implementation of the Sendai Framework is the Disaster Resilience Scorecard for Cities[40]: a set of assessments that allow staff working in local government to monitor and review progress and challenges in the implementation of the Sendai Framework, and assess their city's disaster resilience. The Scorecard is structured around UNDRR's Ten Essentials for Making Cities Resilient and is also being used in the ARCH project's city cases (also see preliminary assessment using the Scorecard at Part 7 below).

4.1.2. European frameworks

At the level of the European Union, the Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG ECHO) is in charge of actions in the domains of civil protection and humanitarian aid. The overview of the legal framework[41] lists more than 30 elements. Here, we will focus on the most important ones.

The **European Civil Protection Mechanism** is an instrument for strengthening the collaboration between the EU member states, six other participating countries, and the United Kingdom during its transition phase, in the domain of civil protection. If a disaster or emergency exceeds the response capacity of a participating country, it may ask for assistance via this Mechanism. The delivery of such assistance is coordinated via another element, the Emergency Response Coordination Centre (ERCC). The resources for disaster assistance come from the European Civil Protection Pool, the European Medical Corps, and the new rescEU element. The latter provides firefighting planes and helicopters and medical evacuation planes, as well as a stockpile of medical equipment and field hospitals that can respond to health emergencies, and chemical, biological, radiological, and nuclear incidents. DG ECHO is also active in the domain of preparedness and prevention.

4.1.3. Multilateral frameworks

Support for civil protection for European countries is provided by North Atlantic Treaty Organisation (NATO), a multilateral military alliance between 30 European and North American countries. This is done both in the areas of prevention and preparation and in operations. NATO's principle is not to develop parallel structures to existing civilian capacities (e.g. of the UN and EU). In the field of civil protection, NATO works closely with its partner nations. The responsible operative divisions at the NATO headquarters in Brussels are "Civil-Military Planning and Support" (CMPS) and "Euro-Atlantic Disaster Response Coordination Centre" (EADRCC). Civil protection prevention and preparedness are mainly the responsibility of CMPS, while the EARDCC takes care of operational issues like joint international trainings of emergency responders.

NATO partner countries also collaborate in the area of civil emergency planning. For that purpose, NATO has established the Committee for Civil Emergency Planning (CEPC) and

[40] UNDRR Disaster resilience scorecard for cities: https://www.undrr.org/publication/disaster-resilience-scorecard-cities (last visited: 13.05.2020)

[41] DG ECHO Legal Framework: https://ec.europa.eu/echo/who/about-echo/legal-framework_en (last visited: 13.05.2020)

several subordinate planning groups: Civil Protection, Transport, Public Health, Food and Water, Industrial Resources and Communications.

Directive on the Assessment and Management of Flood Risks (2007/60/EC)

The Directive on the Assessment and Management of Flood Risks (2007/60/EC), or the Flood Risk Management Directive establishes a common framework for dealing with flood risk within the EU, with the aim of reducing the adverse consequences of floods for four protected areas: human health, environment, cultural heritage and economics.

This risk is particularly high in Hamburg, where the metropolis' close ties to water meet with the metropolitan agglomeration of residential, commercial and industrial areas.

The EC directive also requires that not only frequent and medium-frequency, but also rare or extreme flood events be considered. Their possible effects should be shown in hazard and risk maps.

As a third step, the EC directive requires the development of a transnational management plan for dealing with the hazards and risks of floods.

This framework is implemented in Hamburg through a Flood Management Plan, with associated risk assessments (including mapping of flood risks) updated every 6 years. The first cycle was completed with the preparation of the Management Plan in December 2015. The second implementation cycle started with the review of the risk assessment, the results of which were published on December 22, 2018. The updated hazard and risk maps were published on December 22, 2019.[42]

4.2. National

In Germany, civil protection is a shared responsibility at several levels of the national governance structure. A unique feature of this shared responsibility is the distinction between civil protection on one hand and disaster management and prevention on the other. These shared responsibilities are ruled by a single German national law: the Civil Protection and Disaster Assistance Act. Civil protection in its meaning of civil defence is a sub-area of the overall defence of the Federal Republic of Germany and thus a focus task at the national level. The responsible agency is the Federal Office of Civil Protection and Disaster Assistance (BBK)[43], established in 2004 within the remit of the Federal Ministry of the Interior. Disaster management and prevention in peacetime, on the other hand, are duties of the federal states, carried out under federal contract administration. Since the Free and Hanseatic City of Hamburg is a federal state, it is thus responsible for disaster management and prevention in its territory, as explained in the next section.

The BBK's duties at the national level are ruled by the national law establishing the Federal Office of Civil Protection and Disaster Assistance. Its tasks include, but are not limited to,

[42] Homepage of City of Hamburg: https://www.hamburg.de/hwrm-rl/2102808/hochwasserrisikomanagement/ (last visited 26.08.2020)
[43] Home page of BBK: https://www.bbk.bund.de/EN/Home/home_node.html (last visited 12.05.2020)

informing residents living in Germany on aspects of disaster preparedness (including issuing warnings as needed), protecting cultural heritage, implementing measures for health protection, and providing an emergency supply of drinking water. For conveying warnings and other official information, the BBK has launched the warning app NINA for mobile devices. This app, for instance, can be used to read about current rules for behaviour regarding the Covid-19 pandemic. The BBK also conducts training for crisis managers and first responders in its academy for crisis management and national cooperation: AKNZ. The BBK has also established a Joint Reporting and Situation Centre, the GMLZ (Gemeinsames Melde- und Lagezentrum von Bund und Ländern) which gathers situation information from distributed situation centres at the national level (federal ministries and agencies) and the federal state level (state ministries and agencies) and redistributes the combined information to all sources.

Practical disaster assistance is provided by national organisation Bundesanstalt Technisches Hilfswerk (THW), Federal Agency for Technical Relief, which is ruled by national THW Law (see Annex 10.2). For disasters involving fire, the national Fire Service regulation FwDV 100 implements standards of uniformity in terms of response capacity across all federal states and municipalities in Germany.

Last but not least, disaster prevention and management may also refer to non-binding guidelines such as “Flood and heat prevention through urban development” and the “Implementation plan CRITIS of the National Plan for the Protection of Information Infrastructures”. Critical infrastructure protection (CIP), which overlaps with disaster risk reduction, is addressed by German sector-specific laws such as the IT Security Act (IT-Sicherheitsgesetz[44]).

4.3. Regional

Civil defence at the state level comprises the preparation and implementation of all civil defence measures for the Free and Hanseatic City of Hamburg. The Ministry of the Interior and Sport is responsible for implementation at the state level. The legal basis is found in the Basic Law, supplemented by the provisions of the Emergency Constitution, the Federal Benefits Act, the Security Acts (e.g. on food and drinking water supply, transport organisation), the Civil Protection and Disaster Relief Act (ZSKG) and the implementing ordinance to the ZSKG. There are also numerous contracts and agreements in the NATO area.

The tasks of these bodies include, in particular:

- civil defence,
- maintenance of state and government functions (including civil alert planning),
- supply of essential goods and services to the civilian population, and
- support of the armed forces.

[44] IT-Sicherheitsgesetz, information at BSI: https://www.bsi.bund.de/DE/Themen/KRITIS/IT-SiG/it_sig_node.html (last visited 13.05.2020)

The regulatory framework for disaster protection in Hamburg is the respective state law, the Hamburg Disaster Protection Act (Hamburgisches Katastrophenschutzgesetz[45], last revised on 24.01.2020). The framework is compliant with national and EU law. The Hamburg Disaster Protection Act specifically mentions several EU directives, including DIRECTIVE 2012/18/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC. In case of a major disaster, Hamburg may receive support from the national level, including more than 110 supplemental disaster protection vehicles and 1,400 trained staff for manning these vehicles, provided by relief organisations such as Arbeiter-Samariter-Bund (ASB), Deutsche Lebensrettungsgesellschaft (DLRG), Deutsches Rotes Kreuz (DRK), Johanniter Unfallhilfe (JUH) and Malteser Hilfsdienst (MHD).

Beside the more general Hamburg Disaster Protection Act, Hamburg as a sea harbour city has also adopted several specific acts and regulations that contribute to prevention and management of disasters (also see Annex 10.2). These include:

- Hamburg Water Act,
- Hamburg Dyke Regulation,
- Hamburg Polder Regulation,
- Flood Protection Ordinance HafenCity, and
- Storm surge protection in the Hamburg harbour.

4.4. Local

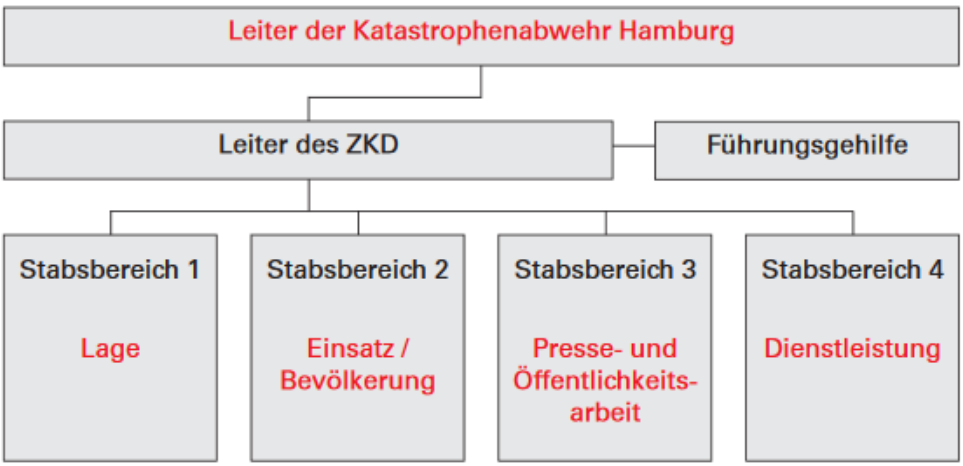
4.4.1. Organisation

Civil protection is the task of all ministries and departments of the Free and Hanseatic City of Hamburg. A special position in civil protection is held by the Ministry of Internal Affairs. Its State Councillor, as the head of the entire disaster management unit, is responsible for the uniform control of all defensive measures in the city. Its task is to set tactical, political and administrative goals.

In case of need, the State Councillor is authorised to issue instructions to all Hamburg Ministries and has the authority to issue Senate resolutions by way of disposition. This enables the Councillor to take necessary measures (e.g. driving ban) immediately and with minimal administrative delay. In the interest of effective hazard prevention, this deviates from the rule laid down in the Hamburg constitution that the Senate makes decisions in its entirety (collegial principle). The Head of Disaster Management is supported and advised by the Central Disaster

[45] Hamburg Disaster Protection Act (in German): http://www.landesrecht-hamburg.de/jportal/portal/page/bshaprod.psml?showdoccase=1&doc.id=jlr-KatSchGHArahmen&st=lr (last visited 12.05.2020)

Service Staff (ZKD) of the Ministry of Internal Affairs.



Stabsorganisation des ZKD

Figure 11 Organisation of the Central Disaster Management of the Ministry of Internal Affairs, Hamburg: Overall management is the responsibility of the State Councillor, who is advised by the head of the central disaster management unit. The four staff divisions 1 - 4 (situation, operation/population, press and public relations and services) are coordinated from there. The head is supported by a management assistant.

Source: https://www.hamburg.de/contentblob/104268/c7b87c1603af71835412577d0f902830/data/broschuere-katastrophenschutz.pdf

The Central Disaster Management Unit (ZKD in German):

- coordinates the Hamburg-wide measures of all participants,
- prepares decision bases and solution proposals for the head of disaster control,
- controls the orders placed and monitors their execution,
- makes additional resources accessible if required,
- maintains contact with the bodies involved and any neighbouring federal states (Lower Saxony and Schleswig-Holstein) that may be affected,
- undertakes central press and public relations work,
- initiates nationwide information provision, including the issue of warnings, e.g. through radio reports, the establishment of a personal information centre, and the operation of a public hotline.

In addition to the Ministry of Internal Affairs, other Ministries are involved, including those responsible for:

- Urban development / Building
- Environment
- Health

- Economics

The competent port authorities and the district authorities also perform special tasks both during operation and in the context of planning.

4.4.2. Specialist staff and regional disaster service staff

Specialist staff are employed at the competent authorities in the event of an emergency. They advise the ZKD on the following areas of responsibility:

- Dike construction and flood protection
- Operation of bridges, tunnels and roads
- Water and environmental protection
- Nuclear Technology
- Dangerous goods in producing, handling and storing companies
- Healthcare, Hospitals
- Supply and disposal
- Shipping and air traffic

The regional disaster service units formed at the district departments are responsible for all planning and measures relating to the population. They guarantee issuance of regional warnings and information; and the accommodation, care and support of the population during evacuation.

4.4.3. Fire brigade and Police

The General Guideline for Civil Protection also regulates the distribution of tasks and responsibilities at the site of damage.

All defensive measures required at the site of the damage are directed or carried out by the fire brigade until the primary hazards (e.g. major fire, explosion hazard) have been eliminated.

The fire brigade provides the overall emergency response manager at the site of the damage. If necessary, representatives of the police and / or other specialists are added. In this way, the specialist knowledge required to deal with the damage situation is bundled on site.

The police take over the command of the operation in the vicinity of the place of damage. Here, they take on all tasks for the protection of the population and enable the forces working on the scene to work unhindered.

4.4.4. Force potential

With around 8,000 employees, the forces of the daily service of the fire brigade and police form the basis for effective emergency response in the Free and Hanseatic City of Hamburg.

These task forces are supported by experts from other disaster control authorities as well as by volunteers from voluntary fire brigades, aid organisations, the Federal Agency for Technical Relief, the Hamburg Dike Guard and the German Federal Armed Forces.

Up to 5,800 volunteers are available to the Hamburg Disaster Control Department when needed. The volunteers are an integral and indispensable part of Hamburg's disaster response and are integrated into existing planning accordingly.

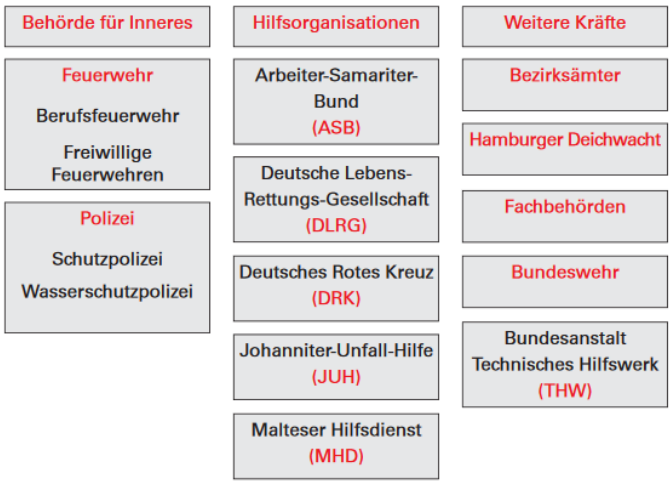


Figure 12 Overview of all parties which are involved into disaster risk management in Hamburg; Left column, order from the top: Ministry of Internal Affairs > Fire Brigades and volunteering Fire Brigades > Police subdivided into Security Police and Water Security Police; Column in the middle: different Aid Organisations; Right column, order from the top: Further Forces > District Offices > Dike Guardiancy > Ministries of the City state > German Armed Forces

Source: https://www.hamburg.de/contentblob/104268/c7b87c1603af71835412577d0f902830/data/broschuere-katastrophenschutz.pdf

4.4.5. Tasks of the emergency services on site

The diverse range of tasks of the emergency services includes: Dike defence; Warning and information of the population; Provision and operation of shelters, Support and care of the population; Registration; Information on persons; Health protection / Vaccinations; Rescuing people; Recovering objects; Technical damage control; Firefighting; Measuring and sensing; Decontamination; Traffic control and guidance; Harbour pilotage and lockage; Investigation of causes[46].

4.4.6. Specific Disaster Scenario Planning

The Hamburg authorities have prepared themselves for the following possible scenarios and have drawn up guidelines that regulate the cooperation of all parties involved in an emergency:

[46] Brochure on the organisation of disaster control in Hamburg, in German: https://www.hamburg.de/contentblob/104268/c7b87c1603af71835412577d0f902830/data/broschuere-katastrophenschutz.pdf page 4 - 9

- Storm surges;
- Oil spills;
- Emergencies in establishments whose facilities may pose hazards (e.g. refineries);
- Aircraft accidents;
- Railway accidents;
- Genetic engineering;
- Toxic gases;
- Biohazards.

Of course, existing plans for certain events cannot cover all conceivable dangers. They are therefore based on the risk potential defined for Hamburg and the probability of its occurrence. All measures to be initiated by the civil protection authorities in the event of a storm surge are planned in particular detail. Graduated according to expected possible water levels of the Elbe, the existing plans range from dike defence, traffic control and regulation to measures for warning and protection as well as evacuation, care and supply of the population if necessary.

For example, in the event of a very severe storm surge with a water level of 7.30 m above sea level, the deployment of more than 3,000 helpers and the evacuation of about 20,000 people is planned. This occurrence is unlikely, but cannot be ruled out.

4.4.7. General disaster planning

In addition to planning for specific disaster events, there are also guidelines that apply to all such events. The guidelines include preliminary planning for measures to be taken regardless of the type of loss event.

According to the Staff Directive, the disaster control authorities have each appointed a head of disaster control, set up disaster service staff according to uniform guidelines and defined their availability and reporting channels in dedicated alarm calendars. The evacuation and care guidelines include detailed planning to protect the population. They regulate the course of possible evacuations as well as the accommodation, care and support of evacuees in the district emergency shelters (usually schools). The pre-planning ensures that people in the affected area can be evacuated promptly if necessary. The Directive on the establishment and operation of a Person Information Office (PAST) defines its tasks and functions. All information on the whereabouts of people who have been evacuated, or are missing, injured or deceased, can be recorded in the system. The PAST receives enquiries about missing persons and provides information to their relatives. Overall, Hamburg has a comprehensive crisis management system that has proven its worth in numerous missions and exercises in recent years. It has been shown that the existing plans for concrete damage events meet the special requirements of the city state. The pre-planned procedures and the cooperation of all parties involved are optimally adapted to the existing structures.

Administration and politics cannot prevent the occurrence of a disaster. The authorities responsible in Hamburg are, however, optimally prepared for an emergency. They continually update their plans and adapt them to current requirements.[47]

4.4.8. Informing the public

The storm surge information sheet of the Department of the Interior contains important information for the population in the Elbe tidal area.[48] A total of eight regional editions provide information on the correct behaviour in the event of a storm surge for the following areas: Altona; Hamburg-Mitte; Innenstadt; HafenCity; Finkenwerder; Wilhelmsburg; Harburg, Süderelbe and harbour; Bergedorf and Vier- und Marschlande.

The information sheets are available from the district departments. With the exception of the regional editions for Altona and HafenCity, the leaflets are also available there in the following foreign language translations: Polish; Turkish; Serbo-Croatian; English; Russian.[49]

The Sendai Framework warrants some consideration here as the main international framework for action to prevent new and reduce existing disaster risks. The framework is based on seven targets, four priorities for action with supporting rationale, and 13 guiding principles. Although a global framework, there are particular strategies outlined under the four priorities that target local authorities. The four priorities are:

Priority 1: Understanding disaster risk

Priority 2: Strengthening disaster risk governance to manage disaster risk

Priority 3: Investing in disaster risk reduction for resilience

Priority 4: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction[50]

At the local level, different plans and strategies addressing disaster risk reduction were identified by the authors of this report. Overall, the management of disaster risk by the municipality of Hamburg can be rated as comprehensive and fairly detailed. This is underlscored by the continuous updates of the plans. The involvement of various parties in disaster risk reduction – parties which are in charge of specific tasks – makes for a well-structured approach to disaster management. As already mentioned, this disaster management system has proven its functionality in numerous missions and exercises in recent years. Overall, especially priorities 1 and 2 of the Sendai Framework are met to a great extent based on the authors' perception. The following excerpt from the Sendai Framework highlights

[47] Brochure on the organisation of disaster control in Hamburg, in German; page 11f.

[48] Brochure on the organisation of disaster control in Hamburg, in German: https://www.hamburg.de/contentblob/3425452/45daab7ca53950c90e21de9c8bc49400/data/sturmflut-download-sturmflutschutz.pdf

[49] Brochure on the organisation of disaster control in Hamburg, in German; page 16

[50] Sendai Framework for Disaster Risk Reduction 2015–2030: https://www.preventionweb.net/files/resolutions/N1516716.pdf page 8.

the role of stakeholders and their encouragement to participate in reducing disaster risk by states:

> *States should encourage the following actions on the part of all public and private stakeholders: Civil society, volunteers, organized voluntary work organizations and community-based organizations to participate, in collaboration with public institutions, to, inter alia, provide specific knowledge and pragmatic guidance in the context of the development and implementation of normative frameworks, standards and plans for disaster risk reduction;*

The crisis management system in Hamburg draws on a large number of volunteers (as mentioned above). In the event of an emergency, experts are formed at the competent authorities, whose knowledge and experience are integrated by advising the ZKD. Furthermore, civil society is informed about risks and hazards (e.g. a storm surge) as well as the correct behaviour in different languages (as mentioned above). This selection of involvement and information of different actors in crisis prevention and management shows that Hamburg appears to meet the demands of the Sendai Framework on the city level, as far as this can be assessed by the authors. However, no information has been found that concerns disaster response for the Speicherstadt and Kontorhausviertel in the report. The effectiveness of the engagement with the civil society, volunteers and community-based organisations cannot be assessed based on the report. Furthermore, it remains unclear how volunteers are trained and if there are deficiencies in certain parts of the city.

5. Governance framework for climate change adaptation

This section looks at the governance framework for climate change adaptation of relevance to Hamburg. It identifies the relevant policies, strategies, visions and action plans for climate change adaptation in Hamburg at different governance levels. It concludes with a reflection on the extent to which local governance of climate change adaptation takes into consideration key international governance instruments like the 2015 Paris Agreement (see Part 5.4).

5.1. International

The international community recognised early on the need for adapting to the consequences of climate change: In the 1990s, under the UN Framework Convention on Climate Change (UNFCCC) the global community - Germany included - committed to initiate measures for adaptation to climate change.

Adaptation to climate change is a relevant topic at the European level too, and has been integrated into the further development of the European Climate Change Programme. On 29 June 2007, the European Commission published the Green Paper "Adapting to Climate Change in Europe - options for EU action"), which makes suggestions for first approaches to address the impacts of climate change. Following a comprehensive public consultation on the Green Paper, the European Commission has compiled proposals for joint action in a White

Paper. The White Paper Adapting to climate change: Towards a European framework for action, published on 6 April 2009, proposes laying the groundwork for a Europe-wide adaptation strategy in a first phase up to 2012, and implementing it as early as the beginning of 2013.

The aim of the White Paper is to specify in a step-by-step process an adaptation strategy which will allow decision makers to react to the consequences of climate change in a timely manner all over Europe and to thus mitigate them.

The White Paper advocates action in four areas:

Creating a knowledge base. The focus is on gathering knowledge about the consequences of climate change and the costs and benefits of potential measures. For this purpose, a Clearing House Mechanism is envisaged which will provide structured access to information, data and examples from Member States and EU institutions. Another aim is to develop, by 2011, methods, models, data sets, prediction tools and indicators to monitor the consequences of climate change.

Integrating the aspect of adaptation into important policy areas of the EU, for example by means of appropriate infrastructural measures in coastal or marine areas and changes to agricultural and forestry practices.

Ensuring the effective implementation of the adaptation process by making use of market-oriented instruments and public-private partnerships.

Intensifying international cooperation on the adaptation process by making use of market-oriented instruments and public-private partnerships.[51]

5.2. National

In 2008 the German Federal Cabinet adopted the *German Strategy for Adaptation to Climate Change:* a national framework for adapting to the impacts of climate change[52]. The German Adaptation Strategy (DAS) aims to reduce vulnerability to climate change impacts, sustaining or enhancing the adaptive capacity of natural, societal and economic systems. In Germany, adaptation to climate change is a permanent task established along an agreed and politically-adopted institutional and methodological framework. Scientific research programmes, participation and consultation processes as well as the establishment of ongoing reporting systems have been set up. On the national level, nearly all federal ministries are represented in the “Inter-ministerial Working Group on Adaptation to Climate Change” (IWG Adaptation), led by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. To coordinate adaptation activities with the federal states, the Conference of Environmental Ministers established in June 2009 a standing committee for adaptation to climate change impacts.

An Adaptation Action Plan (APA) has followed on from the DAS, and specifies how the Strategy will be implemented: i.e. current and future measures on the federal level to adapt to climate change, as well as links with other national processes. The implementation of the measures described in the APA is in the responsibility of the relevant ministries.

The APA is informed by a **climate impact and vulnerability analysis (KWVA)**, which identifies in which fields of action, which climate impacts exist and which regions are

[51] German Federal Ministry of the Environment: https://www.bmu.de/en/topics/climate-energy/climate/adaptation-to-climate-change/

[52] German Federal Ministry for the Environment: https://www.bmu.de/en/topics/climate-energy/climate/adaptation-to-climate-change/

particularly affected, with a corresponding strong need for preventive action. The first KWVA was developed in 2015. An update is planned every six years. The Strategy and its implementation are evaluated every four years, according to a methodology adopted by the inter-ministerial working group on adaptation, and results in a monitoring report. The APA is updated every five years.[53] In 2015, the Federal Government of Germany adopted the first progress report of the DAS. This report gives an overview of the primarily federal activities since the adoption of the DAS in 2008 and the Adaptation Action Plan APA I (2011).

5.3. Regional and local

In July 2013, Hamburg adopted the first Action Plan on Adaptation to Climate Change in the Senate and brought it to the community's attention (Bürgerschafts-Drucksache 20/8492).

In 2015, a dedicated Climate Plan was published, bringing together both climate mitigation and climate adaptation measures.

A climate impact monitoring framework for Hamburg is being developed on an ongoing basis. It consists of indicators in three categories: state, impact and response. The first set of 'impact' indicators have been defined and the results are available online at https://www.hamburg.de/klimafolgen-monitoring/. Climate impact monitoring is being continuously expanded and is currently being supplemented by definition of the first 'response' indicators.

[53] Climate ADAPT, Sharing Adaptation Information Across Europe: https://climate-adapt.eea.europa.eu/countries-regions/countries/germany , country profile of Germany last updated Nov. 2019

In December 2019, an evaluated version of the 2015 Climate Plan was published and sets even higher requirements for a reduction of the CO2 emission until 2030 and 2050. As an extract of the climate plan reflects:

> *"Goals for reducing emissions were already adopted by the Hamburg Senate in the 2015 Climate Plan. This stated that Hamburg's CO2 emissions should be halved by 2030 in comparison with 1990 and reduced by at least 80 per cent by 2050.17 In light of the current findings of the Intergovernmental Panel on Climate Change, these goals must be developed further based on an appropriate contribution by Hamburg. The Senate takes its lead on this from the German Federal Government's national goals in order to achieve the 1.5 °C target. The Senate has therefore set the following new CO2 reduction targets for Hamburg:*

Time axis	CO2 reduction targets (with reference to the consumption account and the reference year 1990)	
	Previous target (2015 Climate Plan)	New target (2019 revision)
2030	50% CO2 reduction	55% CO2 reduction
2050	Minimum 80% CO2 reduction	Climate neutral i.e. min. 95% CO2 reduction

Table 4: New CO2 reduction targets for 2030 and 2050 in Hamburg.

> *To reach these ambitious targets is a task for the entire city and only possible for the Senate as a collaborative effort in a process involving all Hamburg's citizens. The methodology for implementing the transformation paths and their measures described in the annex will be elaborated in the following section. The calculations for the CO2 reduction targets in the sectors and transformation paths presented below show the reductions that it is currently possible to define. In some areas, reliable calculations on the CO2 savings to be achieved can only be made in the course of implementation and further development. In terms of the long-term nature of the measures, these predictions also contain uncertainties. Assuming that additional measures will be introduced at Federal Government level, and that additional innovative benefits will arise from technical progress, the implementation of further research results and the scaling of projects which so far have only been feasible as pilots, then the proposed measures will be enough to reach the stated reduction targets."*[54]

[54] First revision of the Hamburg Climate Plan; p. 14 (English version is attached) https://www.hamburg.de/contentblob/13899086/749a6e50662c96eee81d370f1b0cb631/data/d-first-revision-hamburg-climate-plan.pdf

Key messages regarding the Climate Plan include:

Since 1881, **temperatures** in the Hamburg metropolitan region have risen by about 1.4 degrees Celsius, of which about 1.2 degrees are attributable to the period after 1951. Depending on the success of global climate protection policy, by the end of the century (2071-2100) the temperature in Hamburg and northern Germany will have risen by a further one to five degrees Celsius compared with today (1961-1990).

The **amount of precipitation** has increased in Hamburg and northern Germany, especially in winter, and dry periods in spring now last longer than a few decades ago. For the future, significantly increased precipitation is expected, especially in the winter months. Heavy precipitation and rainy days may also increase.

So far, there is no evidence of systematically **stronger storms** throughout the year. Since the 1960s, a slight increase in storm frequency and intensity has been observed. In the long-term context (100 years), however, this is within the range of natural fluctuations.

In the **urban area of Hamburg,** it is on average about 0.1 degrees Celsius warmer than in the surrounding area, with local peaks of 1.2 degrees in the city centre. This urban effect is hardly changed by climate change. However, temperature limits are exceeded more quickly, so that hot days occur more frequently in the city than in the surrounding area. In addition, heavy precipitation can increase. This should be taken into account in future urban planning.

On the **German coasts**, the water surface temperature has risen in recent decades and the sea level has risen by 15 to 20 centimetres in the last century. The water on German coasts will continue to warm up in the future and sea levels may rise by a further 20 to 80 centimetres by 2100. As a result, slight storm surges may occur more frequently. In the Elbe, the consequences of climate change have so far been difficult to detect due to hydraulic engineering measures and natural dynamics.

In **terrestrial ecosystems** it is expected that beech will continue to be the predominant tree species in the North German forests. However, oak and spruce may become more prevalent if summer precipitation is significantly lower. In addition to climate change, the **aquatic ecosystems** are particularly affected by fishing.

Energy supply and climate change are interrelated. Currently, 82 percent of Hamburg's electricity is generated from fossil fuels. In response to climate change and in view of the Paris Climate Agreement, an expansion of renewable energies is to be expected. This would increase dependence on prevailing weather conditions (duration of sunshine, wind strengths, cloud formation, swell). These can change as a result of climate change, which in turn has an impact on energy production. Power plants on rivers can be affected by low water levels and high water temperatures.

In Hamburg, **drinking water** is obtained exclusively from groundwater. During prolonged periods of drought, the groundwater level can drop. It then becomes more difficult to obtain drinking water. In addition, heavy precipitation can impair water quality. Drainage systems should be geared to higher precipitation levels in future.

Hamburg's **sustainability policy** with a 20-year history offers approaches to link climate change and sustainable development. These can be further developed on the basis of scientific proposals.[55]

Among four 'transformation paths' there is a path on climate adaptation with a particular focus on *RegenInfraStrukturAnpassung* (Rain InfraStructure Adaptation or RISA), and a table of corresponding measures in the following areas:

- Planning instruments: water plan and water management support plan
- Comprehensive implementation of tried and tested RISA measures
- Storm surge protection
- Inland flood protection
- Operational capability / disposal capacity of wastewater removal
- Security of supply in the drinking water supply
- Security of supply in the energy infrastructure
- Civil protection: disaster reduction and disaster management
- Green networking (with a focus on heat island prevention and the promotion of natural water cycles)
- Roof and façade greening
- Trees in the city
- Building-related measures
- New functions for public services

5.3.1. Responsibilities

The Ministry for Environment and Energy with its Centre for Climate Issues was charged by the Senate to assume a coordinating and controlling function over all ministries. This includes the compilation and evaluation of measures and financial controlling, and climate impact and CO2 monitoring. The progress of the measures, details of funding and any CO2 reductions achieved are reported annually. Reports with detailed information are required for measures which have been funded from the central programme of the Hamburg Climate Plan.[56]

[55] Source of the Key Messages in German: https://link.springer.com/book/10.1007/978-3-662-55379-4
[56] First revision of the Hamburg Climate Plan; p. 12

5.3.2. Flood risk in Hamburg

Inhabitants of Hamburg are aware of flooding, especially during the period from September – April. But Hamburg is also confronted with storm surges – or rather storm tides – which cause substantial damage. Flooding turns into a storm tide in Hamburg when the level St. Pauli exceeds 3.40 metres above normal zero (NN). A level from 4.50 metres above NN upward is known as a heavy storm tide, and from 5.50 metres above NN, as a very heavy storm tide. Approximately 109,000 households and businesses belong to the areas of Hamburg affected by flooding. Disaster risk management is included in the tasks of all ministries and departments. Nevertheless the ministry of internal affairs and sport holds a special position in this area. In case of catastrophes, this ministry is responsible for any coordination of all defence measures.[57]

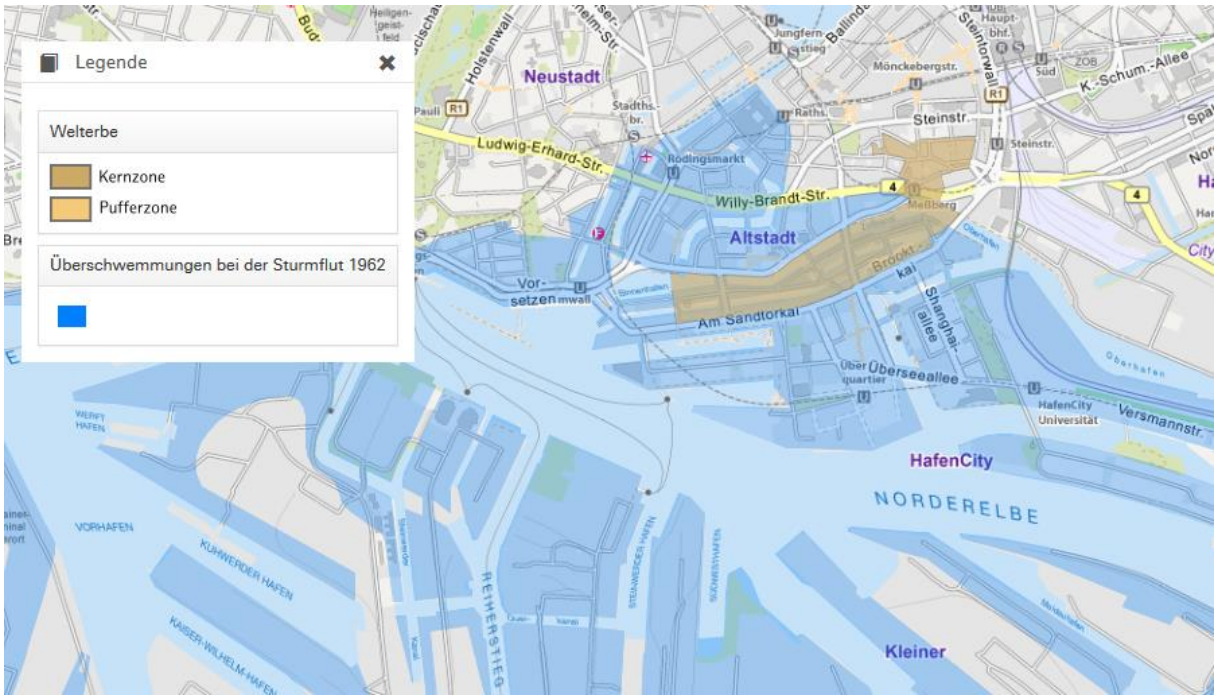


Figure 13 Storm flood from 1962 and its impact on the City of Hamburg and WHS with warehouse district (here marked in beige colour). https://geoportal-hamburg.de/Geoportal/geo-online/#

A storm tide from 1962 did not only shape the personal fates of many people, but also marks a turning point concerning the flood water protection of Hamburg. Because of the catastrophe, the topic became an issue of high priority for the city: many new structures were implemented and long-term running programmes were set up. Up to the night of February 16, 1962, inhabitants felt safe behind the dykes: the last extreme storm tide had been 107 years before. Since then, no damage had occurred by storm surges. This deceptive security led to the fact that dykes were not maintained properly and in bad shape by 1962. Moreover, it became usual that existing buildings got the priority to be preserved instead of erecting or enhancing the dyke. For some parts on the dykes themselves, buildings were erected or used as farming land.

[57] Source: https://www.hamburg.de/sturmflut-1962/4357752/hochwasserschutz/

The storm tide catastrophe from 1962 led to a massive investment and reorganisation of high water protection in Hamburg. All tasks concerning the public high water protection took the city over completely. During the past 50 years Hamburg worked almost constantly on the reinforcement of the public high water protective systems. Thanks to these efforts the threat from storm tides is lower than ever before in the history of the city. Since the year 1962 there were eight more storm tides with peak water levels higher than the one of February 16, that year. Yet no serious damage occurred at the main dyke line. Therefore, Hamburg has nowadays an effective protection against flooding events of all kinds. The public-owned flood protection line stretches for a length of 103 km, and many buildings forms the backbone of this flood protection system in Hamburg.

After a building period of more than 25 years the “building program flood protection for a measured water level of NN+ 7,30 metres at the level St. Pauli” was finished in 2018: The high water protective line was enhanced after new measured water levels were determined in 1991. A long building period like this describes how intensive and permanent the task is for Hamburg. Climate change and the expected sea level raise will keep the challenges high and make it a permanent job for the city for the future. This future task becomes even more important as city development makes progress in inner city close and lower areas. With projects like HafenCity and “Jump across the river Elbe” residential areas entered into the focus of the department for city planning, which have to be protected constantly against consequences of climate change.[58]

5.3.3. Flood risk management – spatial mapping

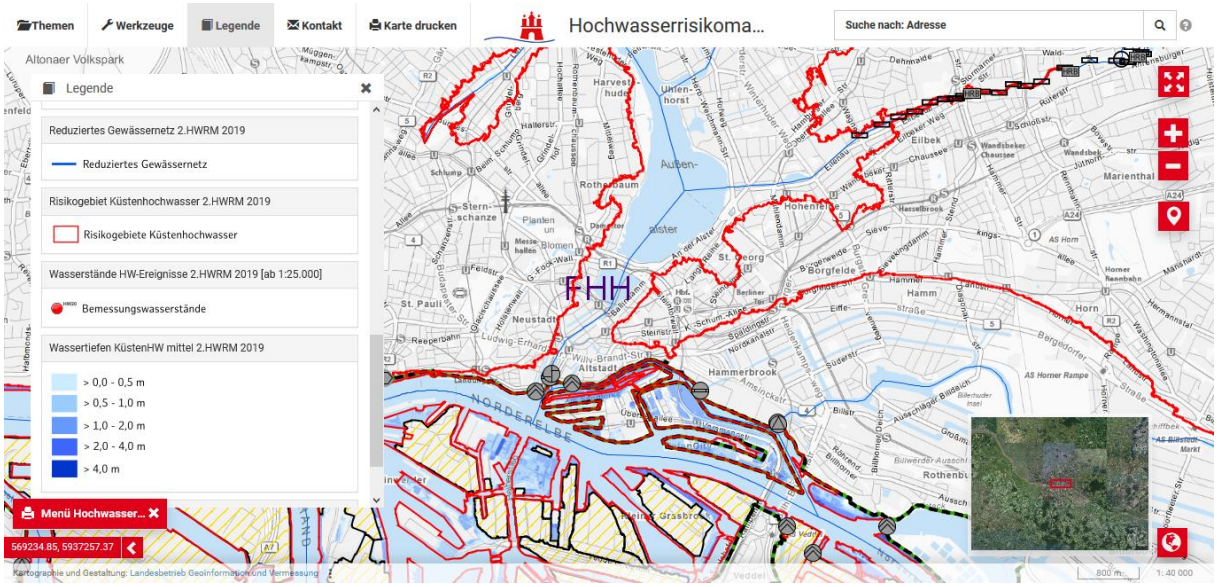


Figure 14 Example scenario that shows the effect of medium heavy coastal flooding on the inner city.

[58] Source: https://www.hamburg.de/sturmflut-1962/4357752/hochwasserschutz/

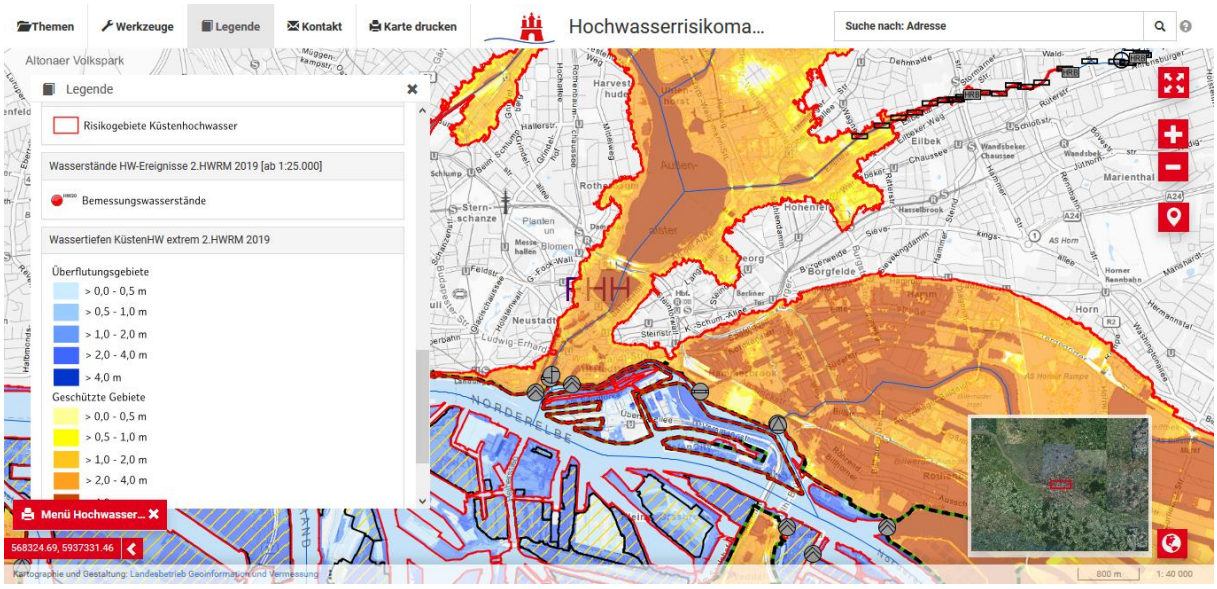


Figure 15 Example scenario that shows the effect of extreme coastal flooding on the inner city.

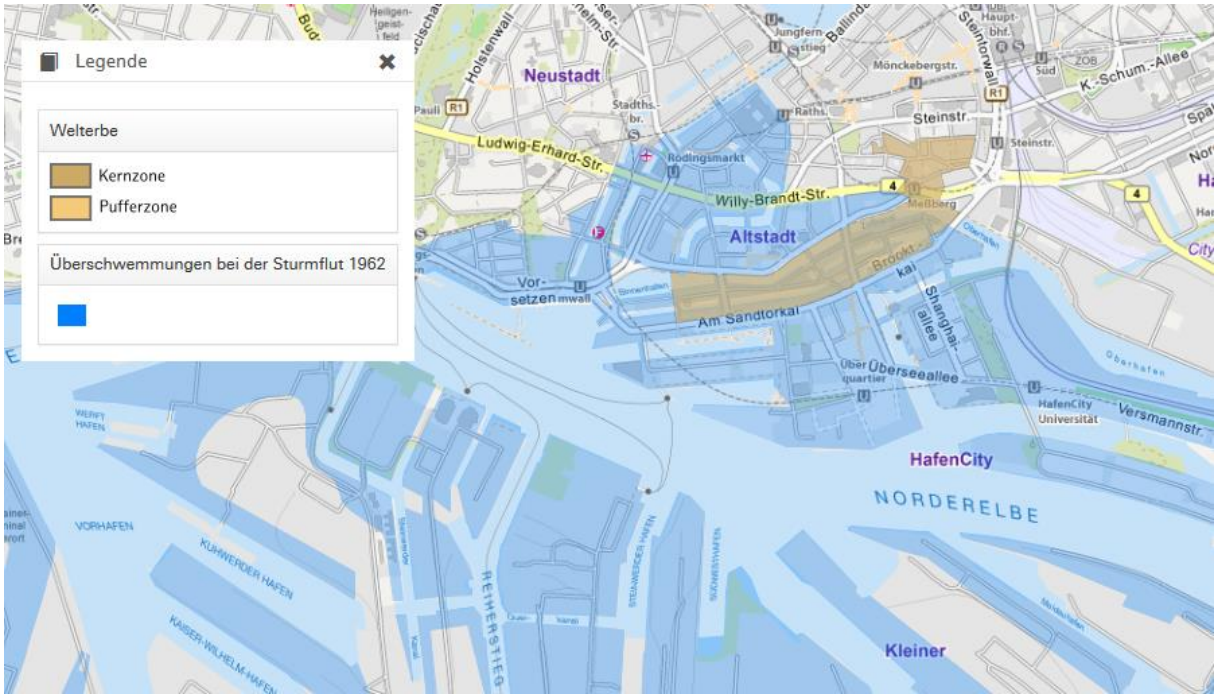


Figure 16 Storm flood from 1962 and its impact on the City of Hamburg and WHS with warehouse district (here marked in beige colour). All maps, if not otherwise indicated, come from: https://geoportal-hamburg.de/Geoportal/geo-online/#

Scenarios like the examples above can be created and modified individually at https://geoportal-hamburg.de/hochwasserrisikomanagement/# which is based on recent scientific models (2019) and was launched in January 2020. These hazard maps describe the impact of flooding events in its expansion throughout the city and the occurring depth of water. The risk maps display in which way the affected areas are normally in use, where industrial businesses and protected goods (Schutzgüter) are located as well as the number of potentially affected inhabitants. Both maps also display the built flood protection systems (e.g. dykes, privately owned polders and flood protection walls) and their effect. For detailed background

information about this online map portal see the Risk Map PDF (German only) which can be downloaded here (https://www.hamburg.de/gefahren-risiko-karten/).

Furthermore, to raise more awareness among tourists and inhabitants a simulation program has been developed. People standing or sitting on the newly-built dyke at Baumwall can use the program on their mobile devices and better appreciate the impact of flooding water events directly at that site. (https://moinzukunft.smartvr.de/smartvr.html)

5.4. Gaps and needs

In the context of Hamburg's governance framework for climate adaptation, the need to protect cultural heritage from climate change impacts is not adequately recognised, either by ministries or by scientific institutes that deal with one or the other topic mainly.

A comparable conclusion can be read in the latest conference publication of Fraunhofer IWM:

"However, in-depth interdisciplinary and transdisciplinary research on how to adapt [cultural heritage] to climate change on local, regional, national and European levels continues to be lacking." [59]

This issue is not unique to Hamburg, but reflects a broader situation at other levels of governance and also in other European cities. Nevertheless, it has to be stated that cultural heritage preservation is neither mentioned as a topic nor as a challenge for the future within the revised Hamburg Climate Plan from 2019 (which includes both mitigation and adaptation measures). Clearly there is potential for cultural heritage sites to receive greater attention in terms of the City's specific plans to adapt to climate change.

The Paris Agreement sets out a framework of fundamental international significance for climate action at all levels of government, and hence warrants some reflection in terms of its relevance at the local level. It primarily targets climate mitigation, and directly addresses nation states, with a focus on nationally-determined contributions to emissions reduction by parties to the agreement. Article 7 and 8 of the agreement, however, deal explicitly with climate adaptation, and with the loss and damage associated with climate impacts.

Article 7 notes the following areas of cooperation between parties:

> *(a) Sharing information, good practices, experiences and lessons learned, including, as appropriate, as these relate to science, planning, policies and implementation in relation to adaptation actions;*
>
> *(b) Strengthening institutional arrangements, including those under the Convention that serve this Agreement, to support the synthesis of relevant*

[59] "However, in-depth interdisciplinary and transdisciplinary research on how to adapt [cultural heritage] to climate change on local, regional, national and European levels continues to be lacking." Editorial; Fraunhofer IMW: Cultural Heritage in Crisis – Cultural Heritage Research at European Level – Challenges in Times of Climate Change and Digitalization; April 2020, p.6; online accessible: https://www.imw.fraunhofer.de/content/dam/moez/de/documents/innovationsakzeptanz/Konferenzband_Villa_Vigoni_2020.pdf#page=14

information and knowledge, and the provision of technical support and guidance to Parties;

(c) Strengthening scientific knowledge on climate, including research, systematic observation of the climate system and early warning systems, in a manner that informs climate services and supports decision-making;

(d) Assisting developing country Parties in identifying effective adaptation practices, adaptation needs, priorities, support provided and received for adaptation actions and efforts, and challenges and gaps, in a manner consistent with encouraging good practices; and

(e) Improving the effectiveness and durability of adaptation actions.

Article 8 notes that 'areas of cooperation and facilitation to enhance understanding, action and support may include:

(a) Early warning systems;

(b) Emergency preparedness;

(c) Slow onset events;

(d) Events that may involve irreversible and permanent loss and damage;

(e) Comprehensive risk assessment and management;

(f) Risk insurance facilities, climate risk pooling and other insurance solutions;

(g) Non-economic losses; and

(h) Resilience of communities, livelihoods and ecosystems.

The above fields of action can be understood as a framework in which all nations that are party to the Paris Agreement are expected to take action. In that sense, they are of limited use as an implementation guide for local governments, however it can be assumed that such national governments are working to establish national policy frameworks for action that will in turn demand regional and local levels of government to implement complementary strategies. Although Hamburg has adopted various plans and action plans for climate mitigation and adaptation, cultural heritage sites are not explicitly included in them. Overall, the need to protect cultural heritage from climate change impacts is not adequately recognised yet. A greater focus can be placed on this in the future.

6. Expected impacts of climate change and environmental hazards

The purpose of this section is to report and review the preliminary collection of relevant information about hazards, exposed elements, as well as impacts provided by ARCH city partners in collaboration with their local research partners, in order to offer an initial overview of the risks that might affect the selected historic areas and their communities. This section is structured as follows: a description of the methodology is provided, followed by a Risk Profile Table, outlining hazards, exposed elements, impacts, and corresponding resilience-building measures already planned or implemented to date. Next follows a review, interpretation, and validation of the information provided in the Risk Profile Table. Finally, an outlook is provided concerning further risk analysis work in the context of the ARCH project.

6.1. Methodology

In order to elicit relevant information for risk analyses from city partners, ENEA, Fraunhofer, ICLEI, and Tecnalia developed a Risk Profile Table template (see Part 6.2 below) based on the central risk components identified in the 5th Assessment Report of the Intergovernmental Panel on Climate Change[60]: hazards, exposed elements, impacts (physical, societal, functional, economic, and intangible), as well as corresponding resilience-building measures already planned or implemented to date. This template was filled out by city partners and provides a starting point from which to conduct more detailed risk analyses. Furthermore, it allows to provide a useful starting point for the data, models, methods, and tools to be developed during the project.

The information provided in the Risk Profile Table was reviewed and harmonised by ENEA in order to provide a comparable description across all city cases and ensure relevance to (and validity for) similar on-going and/or future initiatives and projects in the field of disaster risk reduction, climate change adaptation, and cultural heritage preservation.

The following standards, reference material, and tools were identified as most suitable for this exercise:

- The C40–city Climate Hazard Taxonomy for classification of hazards[61];
- The UNDRR QRE Tool[62] and ISO standard 37120[63] for the classification of exposed elements and impacts; and

[60] C40 Cities and Arup, “City climate hazard taxonomy,” 2015, [Online]. Available: http://www.c40.org/researches/city-climate-hazard-taxonomy
[61] C40 Cities and Arup, “City climate hazard taxonomy,” 2015, [Online]. Available: http://www.c40.org/researches/city-climate-hazard-taxonomy
[62] UNDRR, “Quick Risk Estimation (QRE) Tool.” https://www.unisdr.org/campaign/resilientcities/toolkit/article/quick-risk-estimation-qre (accessed Jul. 20, 2020)
[63] ISO, “ISO 37120:2018 - Sustainable cities and communities — Indicators for city services and quality of life.” 2018, Accessed: Jul. 20, 2020. [Online]. Available: https://www.iso.org/standard/68498.html

- The ICOMOS CCHWG classification[64] and INSPIRE directive[65] [6] for the classification of heritage assets;

Based on the harmonised information, initial proposals for risk analysis focus actions (e.g. which methods and tools to apply for which part/issue of a historic area) were formulated by ENEA. The initial proposals will be further defined during the co-creation process and in exchange with the relevant local stakeholders.

[64] Climate Change and Cultural Heritage Working Group International Council on Monuments and Sites, "The Future of our Pasts: Engaging cultural heritage in climate action," I*nternational Counc. Monum. Sites*, pp. 1–96, 2019, [Online]. Available: https://indd.adobe.com/view/a9a551e3-3b23-4127-99fd-a7a80d91a29e

[65] INSPIRE Thematic Working Group Building, "Infrastructure for Spatial Information in Europe D2 . 8 . I . 2 Data Specification on Geographical Grid Systems – Technical Guidelines," 2011

6.2. Risk profile table

Heritage site (historic area)	**Hazard**[66]	**Exposed element** [67] (e.g. buildings, people, intangible or tangible cultural heritage, road network, natural environment)	**Impacts** (Describe all impacts in the relevant category)					**Corresponding resilience-building measure undertaken** (planned or implemented. This may be a specific measure planned to address a specific hazard, e.g. construction of a flood protection barrier, or a general one that indirectly addresses the hazard, e.g. greening of paved surfaces)	**Notes/Evidence** (including source of the information e.g. historical data on previous hazardous events related to the damages and impacts caused, climate projections, risk assessment.)
			Physical	Societal	Functional	Economic	Intangible	Description **(please indicate specific S or general G)**	
Speicherstadt	Tidal changes / prolonged low water	Tangible cultural heritage / Quay walls	Damage to wooden poles at the base of the buildings due to intrusion of wood destroying fungi; associated damage to buildings			Loss of tourism revenue and loss of business income due to damaged premises	Loss of cultural heritage value resulting from physical damage	S: Restoration of the wooden poles, barrages	Prolonged low water might result in (part of) the poles not being saturated with water anymore, which might result in built-up of wood destroying fungi. →This needs more examination.
Speicherstadt	Flooding	Tangible cultural heritage / Buildings (storehouses)	Damage to buildings;			Loss of tourism revenue and loss of business income due to damaged premises	Loss of cultural heritage value resulting from physical damage	S/G: Early warning system, disaster risk management plan for flooding,	
Speicherstadt	Flooding	Transport network	Damage to infrastructure	Loss of access to workplace or public space for leisure	Disruption of transport services	Loss of salary due to inability to work			
Speicherstadt	Flooding	Electricity network	Damage to infrastructure	Loss of use of workplace	Disruption of electricity services	Loss of business income			No emergency electricity system in Speicherstadt
Speicherstadt	Flooding	Communications network	Damage to infrastructure as a cascading effect of damage to electricity system						

[66] Note: the UN Office for Disaster Risk Reduction (UNDRR)'s Resilience Scorecard defines 'hazard' as 'a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation'. Of these, the ARCH project is addressing natural and climatic hazards.

[67] Note: the UN Office for Disaster Risk Reduction's Resilience Scorecard defines 'exposure' as 'the situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas'.

Heritage site (historic area)	**Hazard**[66]	**Exposed element** [67] (e.g. buildings, people, intangible or tangible cultural heritage, road network, natural environment)	**Impacts** (Describe all impacts in the relevant category)					**Corresponding resilience-building measure undertaken** (planned or implemented. This may be a specific measure planned to address a specific hazard, e.g. construction of a flood protection barrier, or a general one that indirectly addresses the hazard, e.g. greening of paved surfaces)	**Notes/Evidence** (including source of the information e.g. historical data on previous hazardous events related to the damages and impacts caused, climate projections, risk assessment.)
			Physical	Societal	Functional	Economic	Intangible	Description **(please indicate specific S or general G)**	
Speicherstadt	Flooding	People		Injuries and/or death Health impacts due to interior mould growth Loss of livelihood (if materials/equipment/goods destroyed)		Loss of business income due to higher number of employees not able to work		S/G: Early warning system, disaster risk management plan for flooding,	
Speicherstadt	Storm surge	Tangible cultural heritage / Buildings	Damage to buildings;			Loss of tourism revenue and loss of business income due to damaged premises	Loss of cultural heritage value resulting from physical damage	S/G: Early warning system, disaster risk management plan for flooding,	No emergency electricity system in Speicherstadt
Speicherstadt	Storm surge	Transport network	Damage to infrastructure		Disruption of transport services				
Speicherstadt	Flooding	Electricity network	Damage to infrastructure		Disruption of electricity services				No emergency electricity system in Speicherstadt
Speicherstadt	Flooding	Communications network	Damage to infrastructure as a cascading effect of damage to electricity system						Communication emergency network in place
Speicherstadt	Storm surge	People		Injuries and/or death				S/G: Early warning system, disaster risk management plan for flooding,	
Speicherstadt	Sea level rise	Tangible cultural heritage / Buildings	Damage to buildings; Damage to critical infrastructure (e.g. electricity system)			Loss of tourism revenue and loss of business income due to damaged premises	Loss of cultural heritage value resulting from physical damage	S/G: Early warning system, disaster risk management plan for flooding,	For this instance, a long term solution with a barrage system is in planning (see Entwicklungskonzept Speicherstadt and Management Plan)
Speicherstadt	Extreme temperatures	Tangible cultural heritage / Copper roofs of the buildings	Damage to materials due to extreme heating						Question: Do copper roofs have an intensifying effect for heatwaves?

Heritage site (historic area)	**Hazard**[66]	**Exposed element** [67] (e.g. buildings, people, intangible or tangible cultural heritage, road network, natural environment)	**Impacts** (Describe all impacts in the relevant category)					**Corresponding resilience-building measure undertaken** (planned or implemented. This may be a specific measure planned to address a specific hazard, e.g. construction of a flood protection barrier, or a general one that indirectly addresses the hazard, e.g. greening of paved surfaces)	**Notes/Evidence** (including source of the information e.g. historical data on previous hazardous events related to the damages and impacts caused, climate projections, risk assessment.)
			Physical	Societal	Functional	Economic	Intangible	Description **(please indicate specific S or general G)**	
Speicherstadt	Extreme temperatures	People		public spaces become hostile and abandoned		public spaces become hostile and abandoned	public spaces become hostile and abandoned		
Kontorhaus district	Flooding	Tangible cultural heritage / Buildings	Damage to buildings; Damage to critical infrastructure (e.g. electricity system)			Loss of tourism revenue and loss of business income due to damaged premises	Loss of cultural heritage value resulting from physical damage	S/G: Early warning system, disaster risk management plan for flooding,	
Kontorhaus district	Flooding	Transport infrastructure	Damage to infrastructure		Disruption of transport services			S/G: Early warning system, disaster risk management plan for flooding,	
Kontorhaus district	Flooding	People		Injuries and/or death				S/G: Early warning system, disaster risk management plan for flooding,	
Kontorhaus district	Storm surge	Tangible cultural heritage / Buildings	Damage to buildings; Damage to critical infrastructure (e.g. electricity system)			Loss of tourism revenue and loss of business income due to damaged premises	Loss of cultural heritage value resulting from physical damage	S/G: Early warning system, disaster risk management plan for flooding,	
Kontorhaus district	Storm surge	Transport infrastructure	Damage to infrastructure		Disruption of transport services			S/G: Early warning system, disaster risk management plan for flooding,	
Kontorhaus district	Storm surge	People		Injuries and/or death				S/G: Early warning system, disaster risk management plan for flooding,	
Kontorhaus district	Extreme temperatures	People		public spaces become hostile and abandoned		public spaces become hostile and abandoned	public spaces become hostile and abandoned		

6.3. Preliminary classification of hazards, exposed elements and impacts

The purpose of this section is to review, interpret, validate, and harmonize the information provided in the Risk Profile Table as a sound basis for the project to address Hamburg's risks for the two historical districts that will be examined, i.e. Speicherstadt and Kontorhaus district. This screening covers:

a) hazards,

b) elements exposed to those hazards, and

c) impacts that the identified hazards might cause on the exposed elements.

A related purpose is to identify possible data gaps, and proposals for focus project actions in the context of the city case.

6.3.1. Hazards

The different hazard types recognised in the Risk Profile Table are classified in Table 5 according to the *C40 City Climate Hazard Taxonomy* that identifies 6 main hazard categories and breaks them down further into hazard types, and hazard sub-types.

Different hazards identified for Kontorhausviertel, i.e. extreme temperature, extreme precipitations and storm surges, are grouped under the meteorological category in Table 5 while flooding under the hydrological one; the same hazards are a concern for the Speicherstadt, and further than these, sea level rise and tidal changes are recognised as possible hazards and have been identified in Table 2 under the Climatological category.

Hazard categories	Hazard Types	Hazard sub-type
Meteorological	Extreme precipitation	Heavy rain
	Storm surges	Convective storms, rainstorm
	Extreme hot	Heatwave, drought
Climatological	Sea-level rise	Sea flooding, saline intrusion,
Hydrological	Flooding	coastal flood and flash floods
Biological	Pests and plagues	Bacteria, fungi

Table 5 Hazard categories, types identified for Speicherstadt and Kontorhaus district.

During the Hamburg meeting the bacteria attack to the timber-pile foundations, oak logs, of the Speicherstadt buildings (Figure 17), possibly worsened by the sudden and frequent tidal changes and/or by the polluted water of the channels (due to the numerous tourist boats) was mentioned as a possible concern. To reflect that Table 5 includes also the biological hazard category.

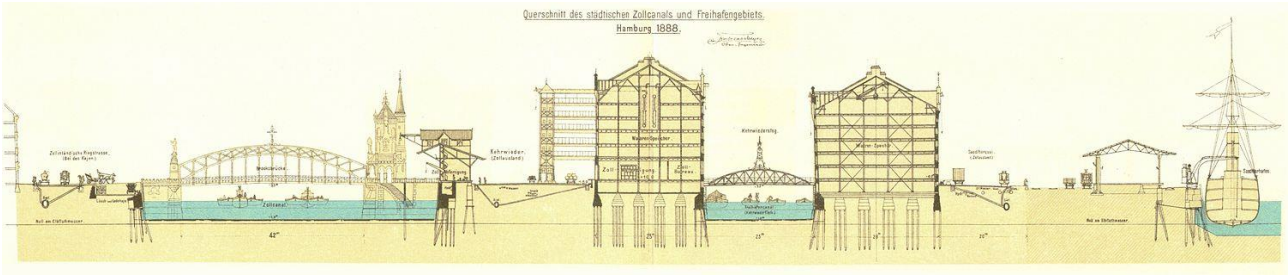


Figure 17 A cross-section view of the Speicherstadt from 1888 (source Wikipedia)

6.3.2. Exposed Elements

The elements exposed to the aforementioned hazards, identified within the Risk Profile Table for Speicherstadt and Kontorhausviertel have been reorganised in Table 6, according to the following categories:

- *Natural Environment*
- *Built Environment: critical Infrastructures and Buildings;*
- *Cultural heritage;*
- *Services (essential or basics and productive);*
- *Human and social aspects.*

In Table 6, the cultural heritage category subsumes all exposed elements that are in themselves heritage, i.e. exposed elements declared as heritage are only categories as such and not as any of the other.

Exposed Element Categories	Exposed Element Types
Natural Environment	Ecosystem
Built Environment	Buildings
	Road, railroad and other transport infrastructures (loading canals (German: *Fleete*).
	Electricity network
	Communications network
Cultural Heritage	Tangible and Intangible elements (see Table 4)
Services, essential and productive	Warehouses
	Offices
	Museums
	Touristic services (Boats and Launcher [Barge])
Human and Social Aspects	External people (e.g. tourists,)
	Local people

Table 6 Exposed elements identified for both Speicherstadt and Kontorhausviertel

Table 7 reports in further detail the exposed elements categorised as cultural heritage. Here, reference has been made to the six categories identified by the ICOMOS Climate Change and Cultural Heritage Working Group, CCHWG (2019). For Speicherstadt and Kontorhausviertel, four out of the six CCHWG categories are of particular relevance, i.e.: **Archaeological resources**, **Building and Structures, Cultural Landscapes and Intangible Heritage**. These cultural heritage categories have been broken down further into cultural heritage types (i.e.

Archaeological heritage and Associated and Traditional Communities) to provide a more detailed picture.

Exposed Cultural Heritage Categories	Exposed Cultural Heritage Types
Archaeological resources	archaeological materials (e.g. lifting tools for the warehouses)
	archaeological sites
	archaeological monuments (archaeological industry, archaeological electric power plant)
Buildings and structures	buildings, quay walls, warehouses, canals,
Cultural landscapes	combined works of nature and humankind
Intangible heritage	knowledge and skills to produce traditional crafts
	social practices
	cultural heritage value
	performing arts
	festive events
	knowledge and practices concerning nature and universe

Table 7 Categories and sub-categories of the cultural heritage exposed elements identified for Speicherstadt and Kontorhausviertel.

6.3.3. Impacts

Table 8 reports, in a succinct way, the different impacts identified for Speicherstadt and Kontorhausviertel under the five categories of impacts, included in the Risk Profile Table for the different exposed elements categorised according to the classification reported in Table 6.

		Impacts				
Exposed Elements		***Physical***	***Functional***	***Societal***	***Economic***	***Intangible***
Natural Environment	Ecosystem	Increase in existing pests /diseases. Costal Erosion. Physical damage to banks and quay walls. Evapotranspiration & eutrophication of canal water				
Built Environment	Buildings	Physical Damage			Direct Economic loss due to physical damage	
	Road, railroad, canal	Physical Damage	Loss/ disruption of service	Loss of access to key services		
	Electricity and communication network	Physical Damage	Loss/ Disruption of service	Loss of access to key services		
Cultural Heritage	Tangible and Intangible elements	Physical Damage	Loss/ Disruption of service	Loss of access to culture	Direct Economic loss due to physical damage and LoR* from Tourism sector	Loss of cultural heritage values
Services, essential and productive	Offices and Warehouses	Physical Damage	Loss/ Disruption of service	Loss of access to services	Direct economic loss & LoR*	
	Museums	Physical Damage	Loss/ Disruption of service	Loss of access to services	Tourism Sector: direct economic loss & LoR	Loss of traditional attraction
	Boats & Jetties	Physical Damage	Loss/ Disruption of service		Tourism Sector: direct economic loss & LoR	Loss of Traditional leisure activity
	Warehouse Equipment	Damage to Traditional lifting equipment				Loss of Traditional lifting practices and values
Human and Social Aspects	External	Illness (e.g. heatstroke), injury and mortality		Loss of Tourism	LoR from tourism sector	
	Local	Illness (e.g. heatstroke), injury and mortality		Loss of Jobs	Impact on Local Economy	

Table 8 Physical, Functional, Societal, Economic and Intangible impacts identified for the different exposed elements in the Speicherstadt and Kontorhausviertel.

Risk analyses, implemented with different methods and levels of complexity (depending on the available data, knowledge, time, and personnel) will be needed to quantify the likelihood, level and extent of the expected impacts, as briefly indicated in the following section.

6.4. Outlook and implications for further risk analyses within ARCH

Based on the information provided in the Risk Profile Table and building on the joint meetings between Hamburg and the research partners, ARCH work for Hamburg is envisaged to be conducted at different levels of analysis (Table 9).

Study Areas/Buildings	Possible Analysis	Possible Tools
Municipality Scale	Impact Chain Analysis to assess interrelation and interdependencies between Speicherstadt and Kontorhaus districts and the surroundings (both natural and built environment)	IVAVIA impact chain creator (Adapted for ARCH) ARCH DSS (i.e. CIPCast)
Speicherstadt and Kontorhaus district.	Scenario simulations Damage identified in the buildings of Speicherstadt and Kontorhaus district may be caused by geological problems, due to: Geological and anthropic subsidence Burial of the canals (that are however continuously dredged to allow for the circulation touristic boats and jetties.	ARCH DSS Satellite Images and and/or survey supported by drones
Prototypical Building Scale - identified within Speicherstadt and Kontorhaus districts	Continuous data collection integration and processing from sensors and images acquired from drones or laser scanner	Sensors Survey supported by drones Photogrammetry laser scanner and/or survey supported by drones
Two buildings of interest – (one for Speicherstadt and one for Kontorhaus district)	3D Building model with identified damage pattern and dynamic monitoring of damage Finite element analysis of the buildings to support retrofitting interventions	Sensors installation of low-cost and traditional structural health monitoring sensors (e.g. MEMS, optic fibre and accelerometers) ; Chemical and mechanical characterisation of constructive materials; 3D models

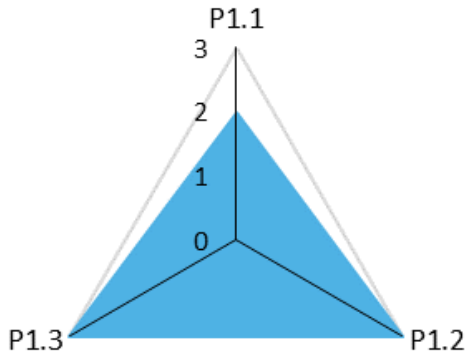
Table 9 Possible analysis and possible tools to be implemented for ARCH work in Hamburg City

Table 9 provides initial ideas of possible examples of the work that can be undertaken in Hamburg as part of ARCH project. What proposed in Table 6 will need, of course, to be discussed and agreed with Hamburg City and ARCH research partners; it is also strictly influenced by data availability.

7. Preliminary assessment of the resilience of historic areas selected for the local activities in Hamburg

The following resilience assessment was developed using the preliminary version of the UNDRR Disaster Resilience Scorecard for Cities[68]. The preliminary assessment was conducted during a webinar between the municipality of Hamburg, ICLEI, and Fraunhofer on February 11, 2020. As the original Scorecard is aimed at city-level, not all questions were immediately applicable on the level of historic areas or single heritage assets. Wherever possible, answers were provided for the historic areas under examination (e.g. with regard to hazard scenarios). For all other questions, answers were provided on city-level (e.g. with regard to city masterplans). The results give a first indication of the overall resilience of the city with some – but not exclusive – focus on the historic areas examined by ARCH. In addition, the application of the Scorecard will be used as input for the development of the ARCH Resilience Assessment Framework specifically focused on historic areas. Lastly, the preliminary resilience assessment results presented in the baseline reports should not be employed to develop resilience action plans, as not all necessary stakeholder groups were involved in the assessment process.

7.1. Essential 01: Organize for resilience



P1.1	Does the City master plan (or relevant strategy/plan) adopt the Sendai Framework?	2
P1.2	Is there a multi-agency/sectoral mechanism with appropriate authority and resources to address disaster risk reduction?	3
P1.3	Is resilience properly integrated with other key city functions / portfolios?	3

Figure 18: Results for Essential 01.

Regarding Essential 01, Hamburg achieves a resilience score of 8/9. The city has a stand-alone disaster risk reduction plan complying with national strategies and laws (score of 2 for P1.1). The city also has a well-established multi-agency mechanism to address disaster risk reduction. Specifically, the Ministry of Interior and Sports is responsible for coordinating all disaster risk reduction measures and is authorised to issue instructions to all other Hamburg

[68] UNDRR, "Disaster Resilience Scorecard for Cities." https://www.unisdr.org/campaign/resilientcities/toolkit/article/disaster-resilience-scorecard-for-cities (accessed Jun. 19, 2020)

authorities in case of an emergency (score of 3 for P1.2). Lastly, although no information is publicly available, the city includes resilience (semi-) explicitly in all the decision-making processes (score of 3 for P1.3).

7.2. Essential 02: Identify, understand and use current and future risk scenarios

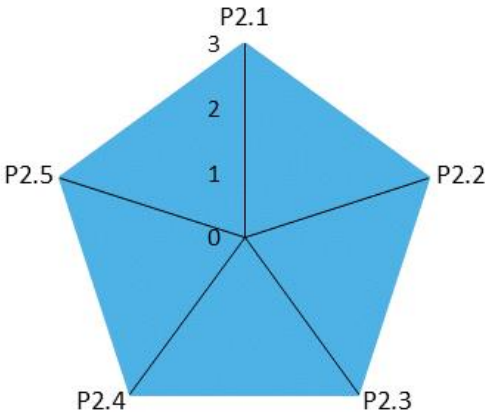


Figure 19: Results for Essential 02.

P2.1	Does the city have knowledge of the key hazards that the city faces, and their likelihood of occurrence?	3
P2.2	Is there a shared understanding of risks between the city and various utility providers and other regional and national agencies that have a role in managing infrastructure such as power, water, roads and trains, of the points of stress on the system and city scale risks?	3
P2.3	Are their agreed scenarios setting out city-wide exposure and vulnerability from each hazard, or groups of hazards (see above)?	3
P2.4	Is there a collective understanding of potentially cascading failures between different city and infrastructure systems, under different scenarios?	3
P2.5	Do clear hazard maps and data on risk exist? Are these regularly updated?	3

For Essential 02, Hamburg achieves the maximum resilience score of 15/15. The city understands its main hazards, and updates related information regularly (score of 3 for P2.1). There is also a shared understanding of risks between the city and its utility providers, although information on this process is not publicly available (score of 3 for P2.2). Related to P2.1, the city also maintains a set of agreed disaster scenarios (score of 3 for P2.3) and understands the resulting cascading effects (score of 3 for P2.4). Lastly, the city has detailed hazard maps and data for the most relevant hazards and updates them regularly (score of 3 for P2.5).

7.3. Essential 03: Strengthen financial capacity for resilience

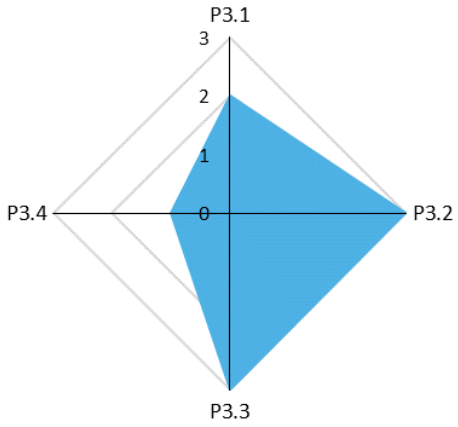
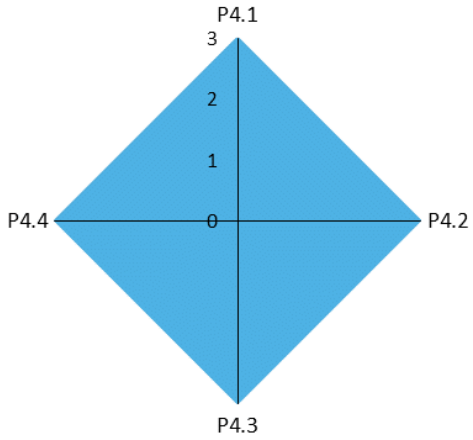


Figure 20: Results for Essential 03.

P3.1	The city / lead agencies understand all sources of funding, and the "resilience dividends", are well connected, understand all available routes to attract external funding and are actively pursuing funds for major resilience investments.	2
P3.2	Does the city have in place a specific 'ring fenced' (protected) budget, the necessary resources and contingency fund arrangements for local disaster risk reduction (mitigation, prevention, response and recovery)?	3
P3.3	What level of insurance cover exists in the city, across all sectors – business and community?	3
P3.4	What incentives exist for different sectors and segments of business and society to support resilience building?	1

For Essential 03, Hamburg achieves a resilience score of 9/12. The city is aware of different funding streams for Disaster Risk Management (DRM); these are organised by the Ministry of the Interior and Sports (score of 2 for P3.1). In addition, the city's financial plan has a specific section for DRM that describes in detail, which resources are to be used for which DRM area (score of 3 for P3.2). Insurance coverage in the Speicherstadt is high across all sectors, because the Hamburger Hafen und Logistik AG, as owner of the warehouse district, requires insurance coverage as part of its rent contracts (score of 3 for P3.3). Lastly, as the information about resilience incentives is limited, it is assumed that only some incentives exist (score of 1 for P3.4).

7.4. Essential 04: Pursue resilient urban development

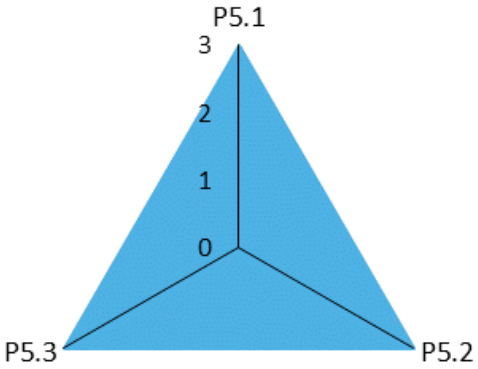


P4.1	Is the city appropriately zoned considering, for example, the impact from key risk scenarios on economic activity, agricultural production, and population centres?	3
P4.2	Are approaches promoted through the design and development of new urban development to promote resilience?	3
P4.3	Do building codes or standards exist, and do they address specific known hazards and risks for the city? Are these standards regularly updated?	3
P4.4	Are zoning rules, building codes and standards widely applied, properly enforced and verified?	3

Figure 21: Results for Essential 04.

Regarding Essential 04, Hamburg achieves the maximum resilience score of 12/12. The city is zoned according to existing risk maps and this zoning plan is updated regularly (score of 3 for P4.1). In addition, there exists a clear development plan for the Speicherstadt and the Office for City Development is developing city-wide plans (score of 3 for P4.2). Lastly, there exist strict local codes and standards (score of 3 for P4.3), which are always enforced (score of 3 for P4.4).

7.5. Essential 05: Safeguard natural buffers to enhance the protective functions offered by natural ecosystems



P5.1	Beyond just an awareness of the natural assets, does the city understand the functions (or services) that this natural capital provides for the city?	3
P5.2	Is green and blue infrastructure being promoted on major urban development and infrastructure projects through policy?	3
P5.3	Is the city aware of ecosystem services being provided to the city from natural capital beyond its administrative borders? Are agreements in place with neighbouring administrations to support the protection and management of these assets?	3

Figure 22: Results for Essential 05.

For Essential 05, Hamburg reaches the maximum score of 9/9. There exist city-wide public zoning plans and flood maps that take ecosystem services into account. In addition, there exist several habitat systems within the city limits (score of 3 for P5.1). However, with regards to the Speicherstadt, there is a clear conflict between increasing ecosystem services and heritage preservation. This is also the case for the city-wide integration of green and blue infrastructure. Hamburg implements the latter measure by conducting local workshops and providing guidance material on how to integrate blue / green infrastructure (score of 3 for P5.2). Lastly, the city is well aware of the natural capital beyond its administrative borders; multiple habitat systems of the city reach across its administrative borders (score of 3 for P5.3).

7.6. Essential 06: Strengthen institutional capacity for resilience

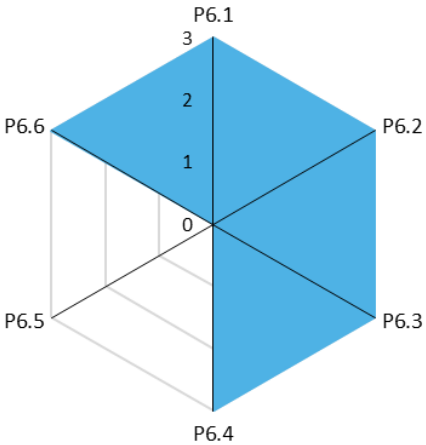
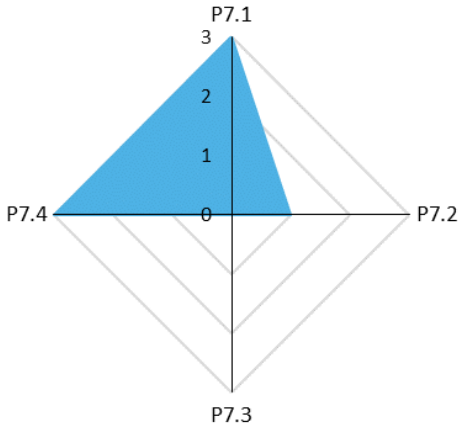


Figure 23: Results for Essential 06.

P6.1	Does the city have clear access to all the skills and experience it believes it would need to respond to reduce risks and respond to identified disaster scenarios?	3
P6.2	Does a co-ordinated public relations and education campaign exist, with structured messaging and channels to ensure hazard, risk and disaster information (that can be understood and used) are properly disseminated to the public?	3
P6.3	Extent to which data on the city's resilience context is shared with other organizations involved with the city's resilience.	3
P6.4	Are there training courses covering risk and resilience issues offered to all sectors of the city including government, business, NGOs and community?	3
P6.5	Are training materials available in the majority of languages in common use in the city?	0
P6.6	Is the city proactively seeking to exchange knowledge and learn from other cities facing similar challenges?	3

Regarding Essential 06, Hamburg achieves a score of 15/18. The city has established multiple partnerships with professional and volunteer first-responders and there exists a national mechanism for assistance between federal states in case of an emergency (score of 3 for P6.1). The city also conducts regular coordinated public relations activities, which reach most households (score of 3 for P6.2). With regards to data sharing, the city hosts a public geo portal, an open data hub, and a portal for risk reduction (score of 3 for P6.3). The different ministries within the city provide training courses covering risk and resilience. In addition, the Hafenstab – the coordinated crisis management unit for the Hamburg harbour – conducts regular trainings for all involved parties (score of 3 for P6.4). However, training material is mostly provided in German (score of 0 for P6.5) and partly in German sign language. Lastly, Hamburg is part of multiple city networks and research projects to share experiences and best practices (score of 3 for P6.6).

7.7. Essential 07: Understand and strengthen societal capacity for resilience



P7.1	Are “grassroots” or community organizations participating in risk reduction and post-event response for each neighbourhood in the city?	3
P7.2	Are there regular training programmes provided to the most vulnerable populations in the city?	1
P7.3	What proportion of businesses have a documented business continuity plan that has been reviewed within the last 18 months?	-
P7.4	How effective is the city at citizen engagement and communications in relation to DRR?	3

Figure 24: Results for Essential 07.

Hamburg achieves a score of 7/12 for Essential 07. For the Speicherstadt, community organizations are included in risk reduction and post-event response activities (score of 3 for P7.1). While the city knows its most vulnerable population groups, there is no publicly available information about specific regular training programs. In addition, information about vulnerable population groups is harder to come by for the Speicherstadt, because there are no residents living there, as it is mostly a tourism and business area (score of 1 for P7.2). With regards to business continuity plans, there was no information available during this preliminary resilience assessment (score of “-“ for P7.3). Lastly, the city uses multiple channels to engage citizens for disaster risk reduction (score of 3 for P7.4).

7.8. Essential 08: Increase infrastructure resilience

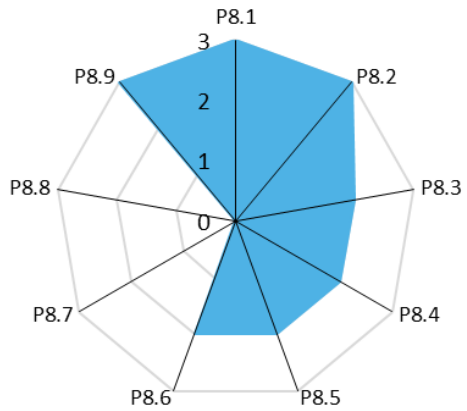


Figure 25: Results for Essential 08.

P8.1	Is critical infrastructure resilience a city priority, does the city own and implement a critical infrastructure plan or strategy?	3
P8.2	Is existing protective infrastructure well-designed and well-built based on risk information?	3
P8.3	Would a significant loss of service for these two essential services be expected for a significant proportion of the city under the agreed disaster scenarios?	2
P8.4	Would a significant loss of service be expected for a significant proportion of the city in the 'worst case' scenario event? In the event of failure would energy infrastructure corridors remain safe (i.e. free from risk of leaks, electrocution hazards etc.)?	2
P8.5	Would a significant loss of service be expected for a significant proportion of the city in the 'worst case' scenario event? In the event of failure would transport infrastructure corridors remain safe (i.e. free from risk of flood, shocks etc) and passable?	2
P8.6	Would a significant loss of service be expected for a significant proportion of the city in the 'worst case' scenario event?	2
P8.7	Would there be sufficient acute healthcare capabilities to deal with expected major injuries in 'worst case' scenario?	-
P8.8	% of education structures at risk of damage from "most probable" and "most severe" scenarios	0
P8.9	Will there be sufficient first responder equipment, with military or civilian back up as required?	3

For Essential 08, Hamburg reached a score of 17/27. The city, as well as the Speicherstadt, have a critical infrastructure protection plan (score of 3 for P8.1), and there exists protective infrastructure for the most relevant risks (score of 3 for P8.2). It is assumed that water, energy, transport, and communication services will exhibit some loss of services under the "most severe" scenario, which is a storm surge event (scores of 2 for P8.3, P8.4, P8.5, and P8.6). Healthcare capabilities are not a relevant issue for the Speicherstadt (score of "-" for P8.7) and under the "most probable" scenario – a flood – most of the Speicherstadt would be shut down, including teaching facilities (score of 0 for P8.8). Lastly, all first-responders would be sufficiently equipped in case of an emergency (score of 3 for P8.9).

7.9. Essential 09: Ensure effective disaster response

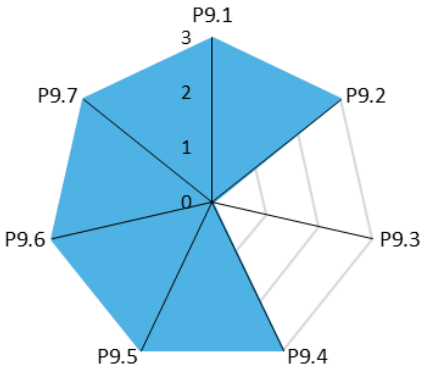
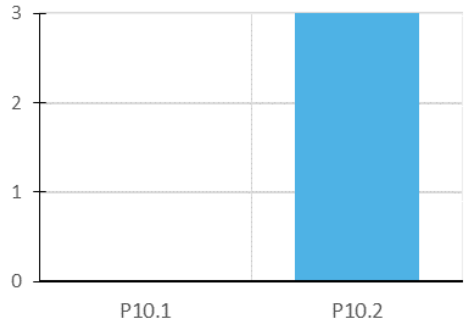


Figure 26: Results for Essential 09.

P9.1	Does the city have a plan or standard operating procedure to act on early warnings and forecasts? What proportion of the population is reachable by early warning system?	3
P9.2	Is there a disaster management / preparedness / emergency response plan outlining city mitigation, preparedness and response to local emergencies?	3
P9.3	Does the responsible disaster management authority have sufficient staffing capacity to support first responder duties in surge event scenario?	-
P9.4	Are equipment and supply needs, as well as the availability of equipment, clearly defined?	3
P9.5	Would the city be able to continue to feed and shelter its population post-event?	3
P9.6	Is there an emergency operations centre, with participation from all agencies, automating standard operating procedures specifically designed to deal with “most probable” and “most severe” scenarios?	3
P9.7	Do practices and drills involve both the public and professionals?	3

For Essential 09, Hamburg achieves a resilience score of 18/21. The city estimates that it will reach over 90% of its population with its early warning systems, which stretch across multiple channels – from smartphone apps, to TV and radio, as well as sirens and other measures (score of 3 for P9.1). As already discussed for P1.2, there is a well-established DRM plan (score of 3 for P9.2). No answer for P9.3 could be given as this issue is too specific for the Speicherstadt and is regulated at the national level (score of “-“ for P9.3). As concerns equipment and supply needs, the city and the Speicherstadt are well stocked (scores of 3 for P9.4 and P9.5). There is also a sufficiently resilient operations centre, although no public information is available (score of 3 for P9.6). Lastly, the different ministries in the city conduct annual drills together with professional and volunteer first-responders (score of 3 for P9.7).

7.10. Essential 10: Expedite recovery and build back better



P10.1	Is there a strategy or process in place for post-event recovery and reconstruction, including economic reboot, societal aspects etc.?	0
P10.2	Do post-event assessment processes incorporate failure analyses and the ability to capture lessons learned that then feed into design and delivery of rebuilding projects?	3

Figure 27: Results for Essential 10.

For Essential 10, Hamburg achieves a score of 3/6. There is no public information available on the existence of a strategy or process for post-event recovery (score of 0 for P10.1).

However, there are clear processes in place to capture lessons learned from post-event failures (score of 3 for P10.2)

7.11. Overall resilience of Hamburg

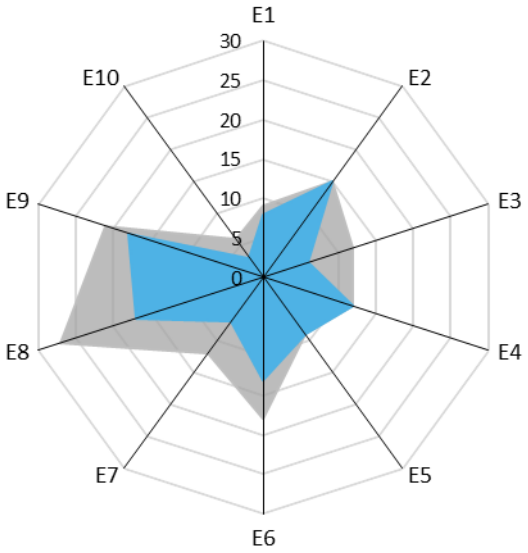


Figure 28: Combined results for Essential 01-10 for Hamburg.

Overall, Hamburg achieves a resilience score of 113/141, with full scores in Essentials 02, 04, and 05. The city understands the present and future risks it is facing very well, with significant information about disaster scenarios available and shared among different stakeholders. In addition, the city – and the Speicherstadt specifically – follows a strict zoning plan that considers risks scenarios and enforces building codes and standards. Lastly, the city is well aware of the functions that natural buffers within and outside its borders provide.

The most room for improvement can be found in Essentials 03, 07, and 08. There is a need for better information about incentives for resilience building measures and training programs for vulnerable population groups. In addition, it is assumed that at least some loss of service would be expected for most infrastructures under the “most severe” scenario. At the same time, there was not enough information available during the preliminary assessment to fully score Essentials 07, 08, and 09, i.e. the low scores for these has to be considered carefully.

8. Conclusion

The results of the initial investigation presented here correspond to the priorities and expectations that were already formulated during the preparation of the project. Discussions held in the meantime with local authorities, owners, companies and other stakeholders have confirmed and, in some cases, further substantiated the need for such investigations. As a result, some planned actions can be identified even more clearly as priorities.

With regard to any actions planned for Hamburg's target historic areas, it is advisable for the long-term success of the project to adapt to existing practices and regulations in Hamburg. This is especially true for the processing of digitally collected values and data in the city's topic-specific information and modelling systems.

The present initial investigation has shown that in Hamburg there are only very limited links between the governance frameworks described (management of cultural heritage, disaster risk management and climate adaptation). Only disaster risk management against floods after storm surges has been elaborated in great detail for the defined project area: the Speicherstadt and Kontorhausviertel.

Discussions with various responsible parties have shown that there is a further need for coordination to improve linkages and transparency between the frameworks, and that local stakeholders consulted so far view the integration of various information positively.

The following strategies and actions should therefore be priorities for the ARCH project:

- Integration of climate change and related hazards as an integral part within the future revised Management Plan and associated periodic reporting to UNESCO in the years to come. A related objective is to identify the different plans the City has in this respect, as well as to examine the Management Plan for gaps with respect to resilience-building and propose potential actions and strategies for inclusion in a future update of the Plan.

- Tools and procedures already exist to support management of data about the existing historic built fabric, and ongoing remedial or development measures, but these could be expanded and improved. For example, by constructing digital 3D models of existing structures using Building Information Modelling (BIM).

- Cooperation with archaeological department concerning research about remains of the industrial heritage of the late 19th/ early 20th century is currently limited and could be strengthened.

- Greater awareness-raising in the community of the relevance of climate change to the Speicherstadt and Kontorhausviertel is desirable, and there is an opportunity to design and implement events in the context of the ARCH project.

In Hamburg, the annual monitoring by ICOMOS Germany will be carried out for the relevant project area as a milestone, and periodic reporting to UNESCO will also begin in 2022.

The authors hope that the main changes for the project area will be the integration of analysis and proposed actions for climate adaptation and disaster prevention into the management plan

for the World Heritage Site, to support the implementation of future measures. Furthermore, it would be desirable to increase the transparency and visibility of the interdependencies between the respective governance frameworks, so that the consequences of climate change are also addressed in the Hamburg Climate Plan with regard to regional cultural heritage in the future.

Although both the Management Plan for the Speicherstadt and Kontorhausviertel, and the Hamburg Climate Plan, are not planned to be updated until ca. 2025/24 (respectively), preparation for their revision will begin well in advance. In this regard, there is potential for the ARCH project team to contribute advice on suggested additions for future integration in the plan, based on the analysis to be undertaken in coming months.

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10. List of Figures

11. List of Tables

12. Annexes

12.1. Key documents for cultural heritage management (See chapter 3)