02.21 Flood Areas (Edition 2019)

Overview

Exceptionally heavy or prolonged rainfall and snowmelt may lead to flooding. Floods are natural phenomena that cannot be prevented. The adverse effects of floods are aggravated both by the growing number of settlement areas and property assets in risk areas as well as the decreased natural water retention capacity of landscape and soil caused by intensified land use.

Floods in Berlin are caused by heavy or persistant rain, for example. Flood waves differ, depending on the nature of the rain. **Heavy rain** following storm fronts can often be observed during the summer months. It is characterized by the highest rainfall intensities, regionally contained and relatively short in duration. Heavy rain is the main cause of rapidly rising flood waves, e.g. at river Panke. Such floods form a lot faster due to the city's high degree of impervious soil coverage (cf. Environmental Atlas 01.02). **Prolonged rain** in larger catchment areas is the main cause of flooding at the Erpe (Neuenhagener Mühlenfließ), Tegeler Fließ and the rivers Spree and Havel. Such flood waves are much shallower but last longer in the waters affected.

No flood protection is perfect. Flood damage may only be reduced or prevented in the long run, however, if a comprehensive system to manage flood risks is in place. The **management of flood risks** is a communal project for society. It comprises various aspects such as prevention, protection, precaution and restoration / regeneration. The key to keeping flood damage at bay lies in the combination of state prevention and proactive individual citizens. Any person who may be affected by flooding is obliged, within the limits of the person's possibilities and reason, to take appropriate preventive measures in order to protect against adverse effects of flooding and to mitigate further damage, in particular to adapt the land use to the possible adverse flood effects for humans, the environment or material assets (Section 5 (2) of the Federal Water Act (Wasserhaushaltsgesetz, WHG)). Measures included in the flood risk management plan are conducive to superior flood control, and, beyond that, they contribute to improved flood precautions and flood risk prevention at river Elbe (FRM Plan, 2015).

Identifying **flood areas** is part of flood prevention and flood control. The Federal Water Act (WHG) stipulates that at least those areas must be defined by ordinance, which are statistically expected to be flooded at least once every 100 years (cf. Section 76 WHG). Defining flood areas serves the protection against the dangers of floods, i.e. by

1. preserving natural retention areas,
2. controlling flood discharge,
3. reducing existing and avoiding new damage potential, and,
4. flood-adapted handling of substances hazardous to water.

The use of flood areas must thus be adapted to minimize flood damage and to counteract the loss of water retention capacity. To keep the damage potential from rising, building restrictions have to be observed in flood areas, amongst other things. This prevents future damage. Identifying and publishing flood areas also aims at raising awareness of potential flood risks.

Only flood areas with a substantial risk of flooding are identified in risk areas. The flood risk assessment in accordance with Directive 2007/60/EC of the European Parliament and of the Council on the assessment and management of flood risks (FRMD) revealed that there is a **potential significant risk of flooding** in the following areas: Tegeler Fließ, Panke, Erpe, Lower Havel / Lower Spree and Müggelspree, including the Gosen waters including Seddin Lake. These were therefore defined as risk areas in accordance with Section 73 WHG (see Figure 1; SenUVK 2018).

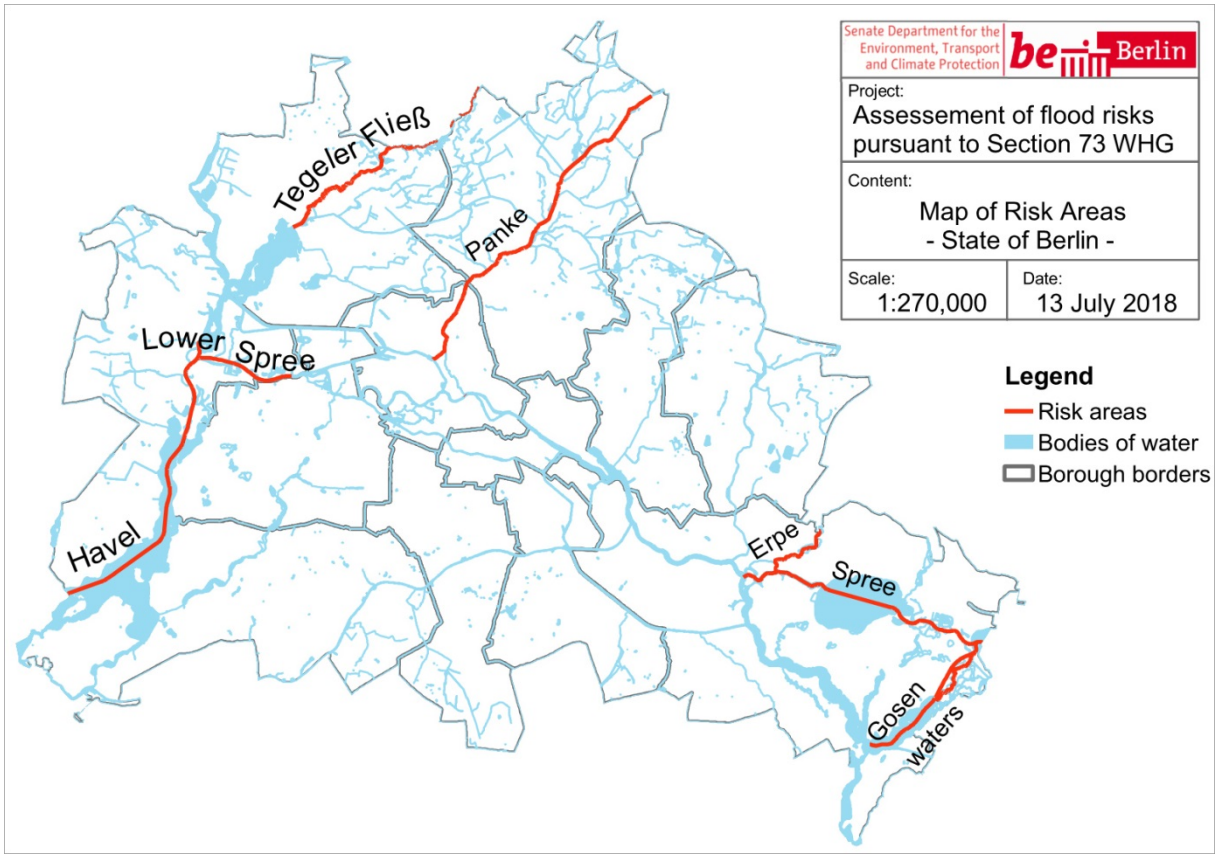

Fig. 1: Risk areas in Berlin (SenUVK 2018)

Statistical Base

The follwing resources provided the main basis for identifying the flood areas:

- digital terrain models – ATKIS DTM1 (Geoportal Berlin / ATKIS® DTM - Digital Terrain Model),
- 100-year flood water levels (IWU 2015, IWU 2014, IPS 2013, IPS 2009 and Koenzen et al. 2011),
- Gauge readings over time, and,
- Gewässerkarte (Map of Bodies of Water) (Geoportal Berlin / Gewässerkarte, as of May 1, 2017).

For a more detailed definition of the statistical base, please refer to the studies in Table 1.

Methodology

Determining the flood areas initially involved mirroring the water levels of a 100-year flood in order to derive a water surface. Subsequently, this information was collated with the current Digital Terrain Model (ATKIS® DTM) of the Senate Department for Urban Development and Housing. To differentiate between flooded areas and bodies of water, the Gewässerkarte (Map of Bodies of Water) was superimposed on this data.

The water levels of a 100-year flood were determined using several methods. This required, on the one hand, a joint approach with the State of Brandenburg, as some bodies of water flow from Brandenburg to Berlin and as the Havel flows back from Berlin into Brandenburg. On the other hand, this involved adapting the methodology to suit the natural conditions and data availability. The chapters focussing on the individual flood areas detail the methodological approaches taken. Table 1 provides an overview of all methods and references to further studies. Please refer to the respective studies for a more detailed description of each method.

Tab. 1: Flood areas and methods used		
Flood area	**Method**	**Study**
Müggelspree and Gosener Wiesen	hydrodynamic model	IWU 2015
Lower Havel / Lower Spree	gauge statistics	IWU 2014
Erpe	precipitation-runoff model combined with hydraulic model	IPS 2013
Panke	precipitation-runoff model combined with hydraulic model	IPS 2009
Tegeler Fließ	precipitation-runoff model combined with hydraulic model	Koenzen et al. 2011

Tab. 1: Flood areas and methods used

Müggelspree and Gosener Wiesen flood area

Berlin's Müggelspree and Gosen Canal are located in the backwater areas of the Mühlendamm impoundment. The water levels are mainly controlled by the weirs and locks at the Mühlendamm lock, the Kleinmachnow lock and the Oberschleuse (upper lock). Due to the impoundment's control system and its large retention capacity, the annual flow throughput and water levels are not always directly linked. Flood damage does not necessarily have to be linked to abnormally high Spree inflows. Previsouly, control was adjusted depending on the situation and other premises.

In the process of defining flood areas, comprehensive investigations were carried out into the potential influence of purposeful weir control, aiming at minimizing the risk of adverse flood effects. Using the hydro-numerical model GERRIS/HYDRAX of the German Federal Institute of Hydrology and one-dimensional non-stationary calculations, the influence of controlling water levels during flooding was investigated for three severe floods in 1975, 1994 and 2011. Control strategies were developed in collaboration with the Wasserstrassen- und Schifffahrtsamt Berlin (Waterways and Navigation Authority) based on past events and taking into account existing objectives and restrictions: in the event of flooding, flood damage in settlement areas is to be minimized, damage to timber building supports is to be prevented by lowering the water level in the weir of the Mühlendamm lock as required and navigation is to be continued for as long as possible.

The results demonstrate that the effects of flood discharge from the Spree can be reduced by controlling the weirs accordingly. The spatially distributed water levels shown in the flood area maps of a 100-year flood are based on the water level gradient. An administrative agreement was concluded between the Generaldirektion Wasserstraßen und Schifffahrt (General Directorate Waterways and Navigation) as the authority overseeing the Berlin Wasserstraßen und Schifffahrtamt (Waterways and Navigation Authority) (which operates weirs and locks) and the Senate Department in order to decrease adverse effects of flooding by proactively controlling the water levels of the Berlin impoundment.

The results of the State of Brandenburg were taken over for the Gosener Wiesen area, as, in the event of flooding, the border between Berlin and Brandenburg is flooded, too, and the developed method does not cover this area (IWU 2015).

Lower Havel / Lower Spree flood area

The Lower Havel / Lower Spree flood area is within the responsibility of the Brandenburg impoundment. The strategy was adapted to that of the State of Brandenburg in order to guarantee a methodically uniform approach for the Brandenburg impoundment. For the period from 1964-2013, a statistical analysis of water level outliers was carried out for seven gauges (Charlottenburg Unterpegel (UP, Downstream Gauge), Sophienwerder, Spandau UP (Downstream Gauge), Freybrücke / Tiefwerder, Pfaueninsel, Potsdam Abz. (Outer District) and Potsdam Lange Brücke). These flood levels serve as supporting points for the water level gradient of a 100-year flood. The water levels were derived by linear interpolation of the supporting points taking into account the gradient change caused by different flows and cross-sections. The flood area was divided into flow-through (Lower Havel I flood area) and impounded (Lower Havel II flood area) sections in order to standardize specific exceptions to use restriction based on hydraulic conditions (IWU 2014).

Erpe, Panke and Tegeler Fließ flood areas

The methodology for determining the Erpe, Panke and Tegeler Fließ flood areas is fundamentally the same. In order to determine the flow rates for a 100-year flood, a hydrological precipitation runoff model was developed for the corresponding catchment area, taking into account the relevant runoff-forming factors such as land use, topography, soil conditions, impervious soil coverage as well as influences of management and rainwater discharges. This model was calibrated and verified using precipitation and climate data as well as recorded runoffs. The runoff measurements were then used as input variables for the hydraulic model to calculate water levels and flow conditions. One-dimensional non-stationary models were used. The hydraulic models are mainly based on geometric data on flow cross-sections, flow conditions and roughness. For this purpose, cross-sections used during measuring using DTMs were extended to include foreshore areas. The hydraulic model was also calibrated and verified referring to the existing water level hydrographs and water levels recorded in the measuring process. Using this model, the water levels for a 100-year flood were calculated (IPS 2009, IPS 2013 and Koenzen et al. 2011).

Map Description

The map of flood areas defined for the State of Berlin shows the location of the five flood areas as stipulated on 23 October 2018 (GVBl. 27 November 2018):

- Erpe flood area
- Müggelspree and Gosener Wiesen flood area
- Panke flood area
- Tegeler Fließ flood area
- Lower Havel / Lower Spree flood area

The protective provisions of Section 78 WHG shall apply upon the determination of the flood areas. They include structural restrictions, use restrictions and water protection. The provisions of the individual ordinances, which determine the flood areas, supplement and in part mitigate these protective provisions. Depending on the size of the area, each ordinance includes between 2 to 14 maps. The maps show the area and boundaries of the defined flood areas at a scale of 1 : 2,500. Figure 2 shows an overview of the individual map sheets (tiles).

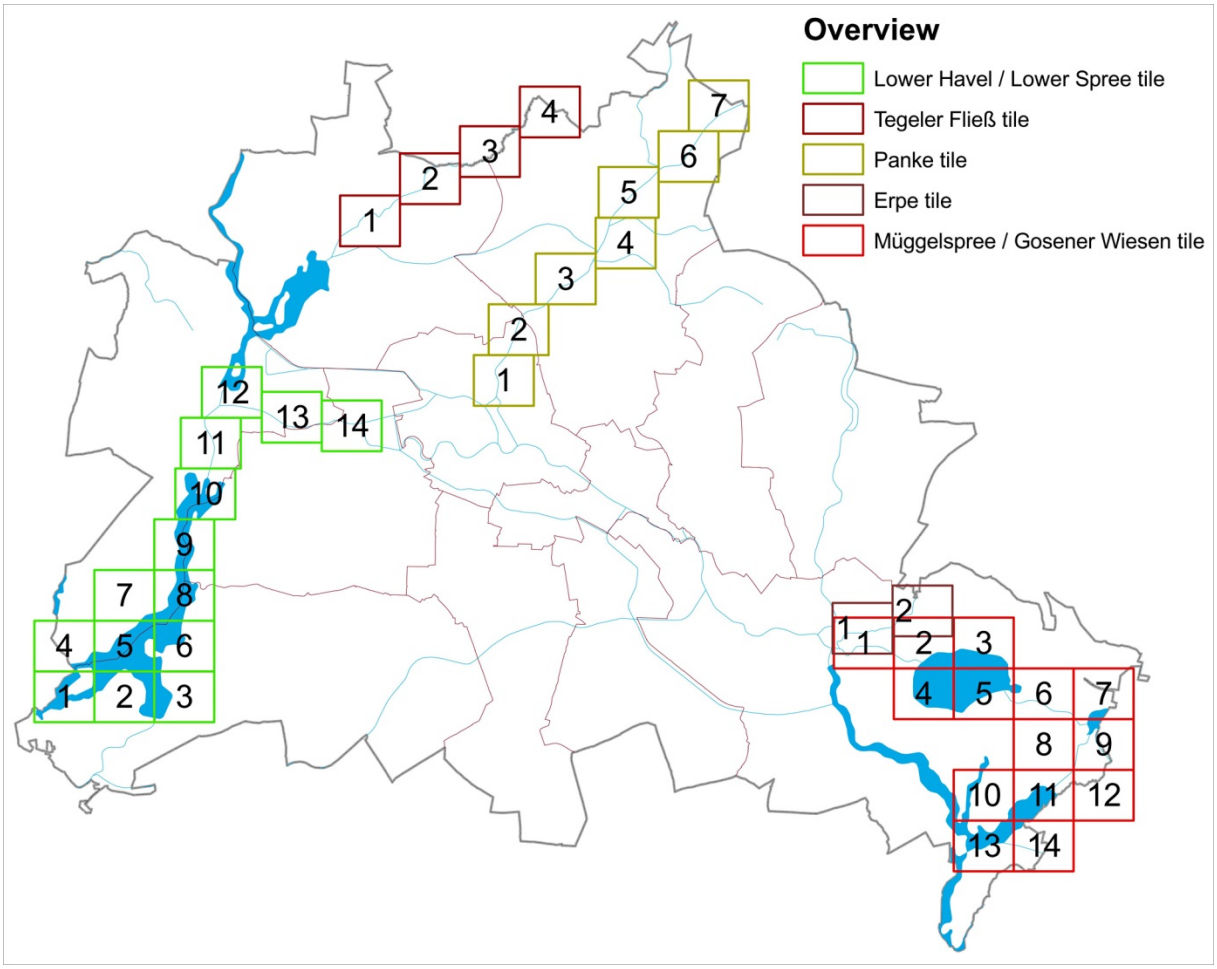

Fig. 2: Overview of map sheets (tiles) for each flood area (SenUVK 2018)

In the flood area map, the outer edges of a hatched area determine the boundaries of the respective flood area. The body of water itself including its shores are not part of the flood area. The maps also display the contour lines of the water levels for the flood areas Lower Havel / Lower Spree and Müggelspree / Gosener Wiesen. The Lower Havel / Lower Spree flood area is divided into flood areas Lower Havel I and Lower Havel II, in order to standardize specific exceptions to use restriction based on hydraulic conditions.

The five flood areas of Berlin cover a total area of 6.8 km² and account for almost 0.8 % of the total city area (see Table 2).

Tab. 2: Size of defined flood areas

Flood area	Size [km²]
Müggelspree and Gosener Wiesen	2.6
Lower Havel / Lower Spree	2.2
Erpe	0.5
Panke	0.5
Tegeler Fließ	1.0
Total	**6.8**

Tab. 2: Size of defined flood areas

Literature

[1] **Directive 2007/60/EC of the European Parliament and of the Council** of 23 October 2007 on the assessment and management of flood risks
Internet:
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007L0060&from=EN
(Accessed on 12 December 2018)

[2] **FRMD plan, 2015:**
Hochwasserrisikomanagementplan gem. § 75 WHG bzw. Artikel 7 der Richtlinie 2007/60/EG über die Bewertung und das Management von Hochwasserrisiken für den deutschen Teil der Flussgebietseinheit Elbe [Flood risk management plan pursuant to Section 75 WHG or Section 7 of Directive 2007/60/EC on the assessment and management of flood risks for the German Elbe River Basin District]
Internet:
https://www.fgg-elbe.de/hwrm-rl/hwrm-plan.html [only in German]
(Accessed on 20 December 2018)

[3] **GVBl. [Law and Ordinance Gazette] 27 November 2018:**
Senate Department for Justice, Consumer Protection and Anti-Discrimination (ed.). 74(28). 27 November 2018. Berlin.
Internet:
https://www.berlin.de/sen/justiz/service/gesetze-und-verordnungen/2018/ausgabe-nr-28-vom-27-11-2018-s-657-672.pdf [only in German]
(Accessed on 12 December 2018)

[4] **IPS (Engineering bureau Prof. Sieker mbh) 2009:**
Modellanpassung und Aufstellung eines integralen Hochwasserschutz- und Regenwasserbewirtschaftungskonzepts Panke. [Model adaptation and compilation of an integrated flood protection and rainwater management concept “Panke”]. Unpublished.

[5] **IPS (Engineering bureau Prof. Sieker mbh) 2013:**
Hydrologische und hydraulische Berechnungen für den Unterlauf der Erpe. [Hydrological and hydraulic calculations for the lower course of river Erpe]. Unpublished.

[6] **IWU (Ingenieurbüro für Wasser und Umwelt) [Engineering office for water and the environment] 2014:**
Zuarbeiten zur Erstellung von Hochwasserrisiko- und –gefahrenkarten für Abschnitte der Unterhavel und der Spree durch die SenStadtUm Berlin. [Contributions towards the development of flood risk and flood hazard maps for sections of the Lower Havel and river Spree by the Berlin Senate Department for Urban Development and the Environment]. Unpublished.

[7] **IWU (Ingenieurbüro für Wasser und Umwelt) [Engineering office for water and the environment] 2015:**
Zuarbeiten zur Erstellung von Hochwasserrisiko- und –gefahrenkarten für Abschnitte der Spree und der Gosener Gräben durch die SenStadtUm Berlin. [Contributions towards the development of flood risk and flood hazard maps for sections of the Spree and the Gosener Graben by the Berlin Senate Department for Urban Development and the Environment]. Unpublished.

[8] **Koenzen, Steinrücke, Kinst, Amberge and Vogel 2011:**
Vorbereitende Maßnahmenplanung im Einzugsgebiet des Tegeler Fließes [Preparatory action planning in the catchment area of Tegeler Fließ].
Internet (Short report):
https://www.berlin.de/sen/uvk/_assets/umwelt/wasser-und-geologie/europaeische-wasserrahmenrichtlinie/fliess_planbericht-kurz.pdf [only in German]
(Accessed on 7 March 2022)

[9] **SenUVK (Senate Department for the Environment, Transport and Climate Protection) 2018:**
Überprüfung der vorläufigen Bewertung des Hochwasserrisikos und der Risikogebiete in Berlin [Flood risk and flood risk areas in Berlin – check and preliminary assessment]
Internet:
https://www.berlin.de/sen/uvk/_assets/umwelt/wasser-und-geologie/hochwasser/bewertung_hochwasserrisikos_berlin.pdf [only in German]
(Accessed on 7 April 2021)

[10] **Verordnung zur Festsetzung des Überschwemmungsgebietes Erpe:**
(Überschwemmungsgebietsverordnung Erpe). [Ordinance for the definition of the Erpe flood area: (Erpe flood area ordinance)] of 23 October 2018.
Internet:
https://www.berlin.de/sen/uvk/_assets/umwelt/wasser-und-geologie/hochwasser/ueberschwemmungsgebietsverordnung_erpe.pdf [only in German]
(Accessed on 7 April 2021)

[11] **Verordnung zur Festsetzung des Überschwemmungsgebietes Müggelspree und Gosener Wiesen:**
(Überschwemmungsgebietsverordnung Müggelspree/Gosener Wiesen). [Ordinance for the definition of the Müggelspree and Gosener Wiesen flood area: (Müggelspree / Gosener Wiesen flood area ordinance)] of 23 October 2018.
Internet:
https://www.berlin.de/sen/uvk/_assets/umwelt/wasser-und-geologie/hochwasser/ueberschwemmungsgebietsverordnung_mueggelspree-gosener_wiesen.pdf [only in German]
(Accessed on 7 April 2021)

[12] **Verordnung zur Festsetzung des Überschwemmungsgebietes Panke:**
(Überschwemmungsgebietsverordnung Panke). [Ordinance for the definition of the Panke flood area: (Panke flood area ordinance)] of 23 October 2018.
Internet:
https://www.berlin.de/sen/uvk/_assets/umwelt/wasser-und-geologie/hochwasser/ueberschwemmungsgebietsverordnung_panke.pdf [only in German]
(Accessed on 7 April 2021)

[13] **Verordnung zur Festsetzung des Überschwemmungsgebietes Tegeler Fließ:**
(Überschwemmungsgebietsverordnung Tegeler Fließ). [Ordinance for the definition of the Tegeler Fließ flood area: (Tegeler Fließ flood area ordinance)] of 23 October 2018.
Internet:
https://www.berlin.de/sen/uvk/_assets/umwelt/wasser-und-geologie/hochwasser/ueberschwemmungsgebietsverordnung_tegeler_fliess.pdf [only in German]
(Accessed on 7 April 2021)

[14] **Verordnung zur Festsetzung des Überschwemmungsgebietes Berliner Havel ab Schleuse Spandau und Untere Spree ab Schleuse Charlottenburg mit ihren Nebengewässern:**
(Überschwemmungsgebietsverordnung Untere Havel/Untere Spree). [Ordinance for the definition of the Berlin Havel flood area from Spandau lock and the Lower Spree flood area from Charlottenburg lock including its backwaters: (Lower Havel / Lower Spree flood area ordinance)] of 23 October 2018.
Internet:
https://www.berlin.de/sen/uvk/_assets/umwelt/wasser-und-geologie/hochwasser/ueberschwemmungsgebietsverordnung_untere_havel-untere_spree.pdf [only in German]
(Accessed on 7 April 2021)

[15] **WHG (Gesetz zur Ordnung des Wasserhaushalts (Wasserhaushaltsgesetz) [Federal Water Act]:**
Wasserhaushaltsgesetz vom 31. Juli 2009 (BGBl. I S. 2585), das zuletzt durch Artikel 2 des Gesetzes vom 4. Dezember 2018 (BGBl. I S. 2254) geändert worden ist [Federal Water Act (WHG) of 31 July 2009 (Federal Law Gazette (BGBl.) I p. 2585., last amended by Article 2 of the law of 4 December 2018 (BGBI.) p. 2254]
Internet:
https://www.gesetze-im-internet.de/whg_2009/ [only in German]
(Accessed on 12 December 2018)