

Rainwater harvesting and management – policy and regulations in Germany

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ABSTRACT

This paper discusses the most important policies and regulations supporting the decentralized management, harvesting and utilization of rainwater in Germany, where such measures have been increasingly applied during the last few decades. The development and implementation of specific policies and regulations contributed significantly to that trend. They also work as incentives for the development of advanced technologies and businesses as well as the widespread and growing implementation of measures for decentralized rainwater management, harvesting and utilization by public and private actors. This development can generally be associated with environmental and economic concerns related with required adaptation to changes in climate, demographic structures and infrastructures as well as climate resilience including flood control and drought resistance. The addressed and supported measures can be assigned to the two focus areas 'Decentralized rainwater harvesting and utilization', aiming for saving of precious fresh water resources and centrally supplied drinking water, as well as 'decentralized rainwater retention and management', aiming for flood control and protection of existing infrastructures and ecosystems. The decentralized management of rainwater and its separation from combined sewer systems at the source is generally regarded as the state of the art and basic condition for sustainable municipal wastewater management.

Key words | decentralized rainwater, Germany, harvesting & utilization, policies & regulations, retention and management

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INTRODUCTION

The sustainable management of freshwater resources according to the principles of Integrated Water Resource Management (IWRM) is crucial for the maintenance and development of natural ecosystems and human settlements (Global Water Partnership 2000). In Europe, the principles of IWRM are included in the European Water Framework Directive (EWFd), which provides a framework for the integrated management of groundwater and surface water at a European level. It aims to resolve the water problems in the European Union, provides leadership for the National Governments of the member states and has to be implemented with participation of the citizens.

According to the EWFd, for each river basin district a 'river basin management plan' has to be established and updated every six years. The key objectives of the EWFd

on a European level are the general protection of the aquatic ecology, the specific protection of unique and valuable habitats as well as the protection of drinking water resources and bathing water. The protection of groundwater bodies is required regarding quantitative and qualitative criteria. The amount that may be extracted is limited to the 'total yearly groundwater recharge, which is exceeding the demand of connected ecosystems, like surface water bodies or terrestrial systems (e.g. forests or wetlands)' (European Parliament, Council 2000). However, different uses, such as essential drinking water supply and flood protection, can adversely affect the status of water and result in a competition between ecology and other uses.

The application of decentralized measures for rainwater harvesting and management (RWHM) is essential to avoid

such conflicts and achieve the goals of IWRM and EWFD. Particularly in urbanized areas the decentralized retention of rain- and storm water contributes to the ecological quality of surface water bodies through flood control. The discharge of polluted storm water and/or the overflow of combined sewer systems and the discharge of mixed sewage in surface water bodies can be prevented. The infiltration of rain- and storm water results in the augmentation of groundwater bodies and the protection of forests and wetlands. In case of groundwater extraction, overexploitation can be avoided. The decentralized collection and utilization of rainwater for the substitution of drinking water, results in savings of centrally supplied water and accordingly in the protection of freshwater resources.

The decentralized retention, and management of rainwater, including utilization and augmentation of freshwater bodies by infiltration and controlled discharge can therefore contribute significantly to the implementation of IWRM on local level and is therefore an indispensable part of sustainable water management (Schuetze *et al.* 2008). According to the many benefits of RWHM it could be expected that supportive policies and regulations would be widely implemented. However, the quality of rainwater for human use (potable and/or non-potable) isn't regulated by any standard that is internationally recognized (Birks *et al.* 2004). Therefore many country and region-specific guidelines have been developed. The content depends generally upon whether potable or non-potable uses are prevalent. Some countries such as Australia (Ward 2010), Canada and USA don't have national policies or regulations for rainwater quality. However some territories and states within these countries have devised guidelines for some quality parameters and support or encourage the harvesting and management of rainwater. In the USA, guidelines are, for example, available in Georgia and Texas, and in Canada, in Alberta and Ontario (Marsalek 2012).

Currently Japan, Germany and Australia are the leading countries regarding the production, implementation and study of rainwater harvesting (RWH) systems (Ward 2010). In Australia, the National Water Initiative (NWI) was established in 2004 by the National Water Commission (NWC) to encourage innovation in water supply, including RWH and to ensure water security (Marsden Jacob Associates 2007). Furthermore a national Research Program for Water

Conservation and Reuse was initiated (Mitchell 2004). The NWC enacted the National Rainwater and Greywater Initiative, which supports the retrofitting of RWH systems with financial subsidies (DER 2009). In some states, as in New South Wales, the installation of RWH systems became compulsory. From 2009 the subsidy program was renewed and a funding of 250 million AUD has been made available until 2014. Subsidies of up to 500 AUD can be received for domestic RWH systems and up to 2,500 AUD for installations in Surf Life Saving Clubs. Furthermore, guidance on appropriate systems as well as advice for installation and utilization is provided (Ward 2010). The financial support resulted in the construction of many RWH installations in all states, for both potable and non-potable use. By 2006 Brisbane City Council had subsidized 21,000 domestic RWH systems (White 2009). According to estimations, 1.3 million domestic RWHM systems have been installed in Australia up to 2006 and 2.1 million additional households were considering the installation of such. To support the widespread distribution and installation of RWH systems a standard was developed by the Master Plumbers' and Mechanical Services Association (MPMSAA) of Australia and the Australian Rainwater Industry Development Group (ARID). (Standards Australia 2006; Chapman *et al.* 2008).

In Japan, the success of RWHM results from the successful work of the 'Rain Network Japan' (Murase 2009), including municipalities, citizens, architects, manufacturers and plumbers. Furthermore the implementation of such systems is stimulated by corporate and income tax benefits, low interest loans and subsidies (De Graaf 2009). Existing standards for RWHM in public and big buildings have been complemented since July 2011 with the 'Guideline for Rainwater Harvesting Architecture' for private, small and middle scale buildings, published by the Architectural Institute of Japan (AIJ). It covers design, construction and operation of facilities as well as products for RWHM for potable and non-potable use, retention, flood and pollution control. Dependent on the kind of use, specific requirements for collection, storage, system arrangement and distribution are addressed (Kamiya 2012).

Measures for decentralized RWHM have been increasingly applied in Germany during the last few decades. Policies and regulations facilitating and promoting their

extensive application have contributed significantly to that development. This paper discusses the most important regulations and policies in Germany, which contributed to the development of advanced technologies and businesses as well as an area wide and growing implementation of measures for decentralized rainwater management, harvesting and utilization by public and private actors. Furthermore the drivers for specific regulations and policies are discussed.

The described research is based on the qualitative and quantitative analysis of policy and regulations, which are related to the management, harvesting and utilization of rainwater in Germany. This includes the analysis of literature, policy documents and regulations, which were published in different forms of printed and electronic media.

RESULTS AND DISCUSSION

During the last few decades growing numbers of facilities for rainwater management and utilization have been installed in Germany. Specific policies and regulations have contributed significantly to the increasing application as well as development of advanced technologies, systems and businesses for the decentralized management, harvesting and utilization of rainwater. The main important motivation for the development of related policies and regulations are corporate and environmental objectives. They are behind the organized support for decentralized retention and use of rainwater aiming for efficient and sustainable use of fresh water resources.

Centralized combined sewer systems, for example, transport both wastewater and rainwater. To cope with incidental heavy rainfall, the instantaneous capacity of sewers and treatment facilities would have to be much larger than for the treatment of the sewage flow alone. Generally this expensive over-capacity is not available and therefore, in case of excessive rainfall, a large part of the sewage is disposed of directly into the environment without treatment. Hence, sewerage firms often support the separation of rainwater from the sewage stream by a decentralized retention of rainwater. The individual collection and use of rainwater for the substitution of drinking water may also be stimulated to cope with permanent, temporary or seasonal water scarcity in centralized water supply systems, or due

environmental concerns regarding the overexploitation of limited freshwater resources for centralized supply.

Germany is located in Northern Europe, has a land surface area of 357,121 km² and a population of 81,751,602 (Statistische Ämter des Landes und des Bundes 2012). It is Europe's most populous country, before France with 65,397,912 and United Kingdom with 62,989,550 citizens (Eurostat 2012). The climate is moderate with a precipitation rate of 789 mm per year and a fairly uniform distribution of rainfall over the year. The driest months are February with 49 mm and October with 56 mm. During June and July the rainfall of 85 and 78 mm is above the monthly average of 66 mm (DWD 2012). The total renewable water resources per capita are 1,870 m³/year (GreenFacts 2012). Therefore Germany is not affected by water stress except for occasional regional droughts. However, the average yearly rainfall could decline by 10% until 2080 due to climate change. Furthermore the flood risk caused by extreme precipitation will presumably rise in all areas, particularly during the winter months. It is predicted that declining precipitation, higher temperatures and evapotranspiration will lead to seasonal droughts during the summer months, mainly in the North Eastern and South Western parts of Germany (DWD 2005). RWHM measures can play an important role to cope with these challenges and to adapt successfully to climate change.

Governance and water management in Germany

For readers who are not familiar with Germany and the governance of water management, subsequently the political system and its structure, which is closely related to the organization of water management, is briefly discussed. Water management in Germany is traditionally organized around political-administrative units. Responsibilities, regulatory, planning, policy-making and enforcement powers are divided between numerous different water authorities, representing state and municipal governments (Moss 2003).

Germany is a democratic, representative, parliamentary federal republic with the federal constitution as basic law. Since the reunification of the German Democratic Republic and the Federal Republic of Germany (founded in 1949) in 1990, it consists of 16 federal states. Most of them are parliamentary republics governed by a cabinet, led by a

Minister-President together with a unicameral legislative body, the state diet (assembly). The legislatures are popularly elected. Based on a majority vote of the state diet, the Minister-President is chosen. He appoints the cabinet, which runs the state agencies and carries out the executive duties of the state's governments ([Bundesministerium der Justiz 2012](#)).

Different terms are used for the governments of the different federal states. In the city-states of Berlin, Hamburg and Bremen they are called 'senates', in the federal-states Bavaria, Saxony and Thuringia they are referred to as 'state governments' and in the other 10 states (Baden-Wuerttemberg, Mecklenburg-Western Pomerania, North Rhine-Westphalia, Saxony-Anhalt, Hesse, Rhineland-Palatinate, Schleswig-Holstein, Brandenburg, Lower Saxony and Saarland) they are designated by the term 'Land Government'. The state governments of some states are subdivided into Area Associations (in North Rhine-Westphalia and Mecklenburg-Western Pomerania), and/or into Governmental Districts (in Baden-Wuerttemberg, Bavaria, Hesse, North Rhine-Westphalia and Saxony). The city-states of Berlin and Hamburg are subdivided in boroughs. Bremen consists of two urban districts (Bremen and Bremerhaven). All other states consist of rural administrative districts (313). District free Towns/Cities (116), are the cities that are districts in their own right or local associations of a special kind. There are in total 429 rural districts consisting of an elected council and an executive. Every rural district is subdivided into municipalities, while every urban district is a municipality on its own. Germany consists of 11,442 municipalities with average numbers of inhabitants per municipality ranging from 1,754 in Rhineland-Palatinate, up to 1,786,448 in Hamburg and a maximum of 3,460,725 in Berlin. However, the majority of municipalities (82,5%) count a comparatively low number of inhabitants between 1,000 and 10,000 inhabitants ([DESTATIS 2011](#)).

According to the EU regulations, most standards applicable to the water sector are set in Brussels. In compliance with the German political system and its structure also the legislative and executive responsibilities for water management are divided between the single states and the local authorities. The water authorities at the different administrative levels have a high degree of formal political legitimacy resulting in problems of institutional diversity between the

16 states and challenging the integrated management of water across political borders, according to IWRM and the UWFD ([Moss 2003](#)).

The municipalities are responsible for both water supply and wastewater management, including municipal sewage and storm water, based on the application of national acts, regulations and industrial standards. According to the number and different sizes of the municipalities in Germany, also the technical and organizational structures for drinking water supply and wastewater management vary significantly. There are about 6,400 public water service providers, with approximately 6,900 sanitation service providers. Water and sanitation services are generally provided by different entities, but both the drinking water and sanitation bills are collected by the water supply utility on behalf of the sanitation entity.

Sanitation services are a sovereign core responsibility of municipalities in Germany. Accordingly the majority (90%) are managed by municipal sanitation departments, 10% have signed operating contracts with private companies and no utilities are under private law. There is a recent trend to create commercial public utilities under private law and to modernize the water sector, which does include also systematic benchmarking ([ATT et al. 2008](#)).

Supportive policies and regulations for rainwater utilization

Approximately 75,000 new RWH and utilization facilities are installed in Germany per year. So far, a total of more than 1.6 million functioning facilities exist ([Lesjean et al. 2009](#)) in almost 4% of the 39.5 million households in Germany ([Statistisches Bundesamt Deutschland 2007](#)). Approximately 2/3 of all new single-family and double houses in Germany are equipped with rainwater systems. Already in 2006 the number of facilities in these building types was estimated to be 1.5 million ([FBR Dialog GmbH 2011](#)).

A major element in the support of decentralized solutions for RWH and utilization is to provide certainty to all stakeholders, including the users, the installers and the operators of both the decentralized as well as the centralized drinking water supply and sewage discharge systems, with which the decentralized technologies have to be combined.

Regulations, which provide clear rules, can be very effective in supporting the installation of decentralized systems.

RWH Systems have been successfully introduced in the German Industrial Standards (DIN). Since 2003 the planning, installation, maintenance and operation of such systems has been regulated via various standards, the DIN 1989 (DIN 2002) RWH Systems, the DIN 1986 Rainwater Pipes (DIN 2003) and the DIN 1988 Drinking Water Installation (DIN 1988). This has provided an effective technical and institutional framework for the application of facilities for rainwater utilization, facilitating an easy planning and installation process for the end-users and service providers. The owners of such systems have to announce the construction to the water supply companies, but without having to apply for a permit. This procedure facilitates direct design, planning and construction practices by companies, and avoids bureaucratic barriers or delays for the customers and users.

According to DIN 1989 (DIN 2002) rainwater may be used without limitations as service water for non-drinking purposes such as flushing toilets, cooling, washing, cleaning and irrigation. However, according to the German Drinking Water Act, drinking water is to be made available for cleaning objects that do not just temporarily come into contact with the human body when used as intended. As this includes per definition laundry as well as the cleaning of cloths, towels and dishcloths, accordingly in every household an opportunity for washing laundry with drinking water has to be provided. It is up to the consumer himself whether an additional connection that supplies water of lower quality (such as harvested rainwater) exists and is used instead of drinking water. After long-lasting discussions and recurrent actions taken by some drinking water supply companies in Germany, targeting the prohibition of rainwater utilization for the washing of clothes, the legal use of rainwater for laundry purposes has been finally confirmed by the German Federal Administrative Court in January 2011 (Bundesverwaltungsgericht 2011).

The installation of systems for RWH, utilization, retention and infiltration is generally not required by state building codes. However, a regulation can be included, for example in the framework of the construction of new buildings or renovation measures. Therefore the state building codes have to comprise an authorization. In

Baden-Wuerttemberg, for example, the municipalities are since 1996 qualified to regulate the installation of systems for RWH, utilization and infiltration by law, either for zones or for the whole area (Baden-Wuerttemberg 2010). Authorizations exist also in Bremen (Bremen 2011) and Saarland (Saarland 2010) for the regulation of rainwater systems for management and utilization; and in Hamburg (Hamburg 2001) and Hessen (FBR 2011) for decentralized management of rainwater (retention and infiltration).

Additional to legal requirements and environmental concerns, also monetary incentives support the construction of rainwater utilization facilities. Specific tariff structures for drinking water and sewage fees facilitate the users of RWH systems to achieve considerable monetary savings. A good example of the consequences of the tariff structure for drinking water supply and wastewater management can be found in Hamburg. Here, the charges for domestic wastewater management and water supply are related to the quantity of drinking water consumed. In total, 4.42 Euros (including tax) can be saved by the substitution of drinking water with decentralized collected rainwater. This amount consists of the regular fees per cubic metre drinking water (1.67 Euros) and sewerage (2.75 Euros) (Hamburg Wasser 2012). Such significant savings can stimulate individual consumers to apply decentralized RWH for non-drinking purposes such as toilet flushing, laundering, the irrigation of their lawns and car cleaning. A family with three persons could substitute an amount of about 54 litres of drinking water per day, per person. Annually, this would save a household consisting of three people about 60 m³ of drinking water and 265 Euros of fees. However, in other countries, such as in The Netherlands and in South Korea, sewage fees are fixed and accordingly can not be reduced by lowering the consumption of drinking water. Taking only the fees for drinking water into account, the savings in the Hamburg case would only be about 100 Euros per year and therefore less stimulating for the installation of rainwater utilization systems. The possible savings on drinking water and sewage fees make up a total amount of 5,300 Euros over a 20 year period. Despite these relatively large savings on water and sewage fees, the installation and operation of rainwater utilization systems is generally not economically profitable for private households. Nevertheless, the achievable savings work as financial incentives for citizens, who

are not only interested in economic profit but also contributing to the protection of the environment.

Some federal states or municipalities support the installation of decentralized facilities for RWH and utilization, either direct or indirect to stimulate the protection of freshwater resources for drinking water production (such as groundwater), pollution control of water bodies and flood control. Subsequently a brief overview about some selected subsidy programs is provided.

In the city-state Bremen, the 'senate for building, environment and traffic' supports the installation of rainwater systems in new or existing households with subsidies of 1/3 of the total costs for civil works, material and installation, up to a maximum amount of 2,000 Euros, if the following criteria are fulfilled:

- The building is located in Bremen or Bremerhaven.
- The applicant is the building owner or a tenant with agreement of the building owner, or a public organization.
- The rainwater is used for toilet flushing and a minimum one additional purpose (e.g. irrigation and/or laundry).
- Connection of a roof surface area of at least 50 m² and a rainwater tank capacity of minimum 2 m³.
- The installation is voluntary and not required in the framework of the building license.
- Subsidy is not provided for components made from PVC (due to environmental concerns) and self-help work.
- The subsidy is applied before the start of construction work. Required appendixes are the estimation of costs, as well as a floor- and site plan with a location sketch of the facility.

This subsidy is part of the program 'Ecological Rainwater Management', which aims for area wide decentralized rainwater management and the extensive decoupling of areas from the public sewer network (Bremer Umwelt Beratung 2011).

The federal state Thüringen supports the construction of systems for RWH and utilization by special loans in the framework of their residential property program 'Wohnigentumsprogramm (WEP)' if the general subsidy criteria are fulfilled. Loans up to 5,000 Euros can be received for a yearly interest rate of only 2% (Freistaat Thüringen 2009).

Since 2001 the federal state Saarland has indirectly supported measures for the decentralized retention and management of rainwater through subsidies, which can be provided by municipalities. Even though the general aim is flood control, also measures for the utilization of rainwater may be supported (Saarland 2001).

In Schleswig-Holstein the construction of facilities for rainwater utilization and infiltration are financially supported by means of loans with low interest rates and a contract period of 25 years in the framework of their social housing program 'ownership measures', if the specific criteria are fulfilled (Schleswig-Holstein 2010).

Compared with the total number of federal states in Germany the portion of states supporting the collection and utilization of rainwater is quite small. The question why some states have supportive regulations and others do not is difficult to answer. Reasons may be the specific structures of public water supply, regional freshwater availability as well as the environmental concerns of citizens and politicians in different federal states.

Supportive policies and regulations for decentralized rainwater management

The separation of rainwater from sewage streams and its separated management is regarded generally as state of the art for sustainable municipal wastewater management. It is also a substantial part of the DWA (German Water Association) initiative 'novel sanitation systems', aiming for development and implementation of sustainable alternatives to existing water and sanitation systems (DWA 2008).

A growing number of wastewater companies in Germany introduced split wastewater fees for rainwater, which work as financial incentives and motivate property owners to invest in measures for decentralized rainwater retention and management. These regulations are effective tools to cope with the challenges of flood control and to reduce the need to provide more combined sewage retention capacities in existing centralized sewer infrastructures.

Supportive policies and regulations for decentralized rainwater management aim for the total retention and infiltration of rainwater on properties and the avoidance of rainwater discharge in sewer systems. They are widely supported and implemented with a growing tendency in

Germany. Generally, such measures are more supported than the measures only aiming for the utilization of rainwater. Federal states and/or municipalities supporting the installation of facilities for rainwater utilization also support the decoupling of storm water from public sewer systems and the installation of facilities for rainwater retention and infiltration. However, the majority of the numerous public authorities, supporting the decentralized retention and infiltration of rainwater do not support the installation of facilities for rainwater utilization. This is due to the common consensus of experts that the total separation of rainwater from domestic sewage is effective for avoiding combined sewer overflows and flooding and facilitates the appropriate treatment of domestic sewage, particularly in the framework of climate change. In opposition to that, systems aiming for the utilization of rainwater alone can contribute only partly to retention of rainwater as well as the control of flood and pollution of surface water bodies. For the retention of all storm water on a property, these systems have to be combined with additional measures for decentralized rainwater management, such as extended retention and infiltration facilities. Subsequently some selected examples for policies and regulations, which provide incentives for such decentralized rainwater management systems and the creation of storm water discharge free properties are presented.

In the framework of the program 'Ecological Rainwater Management' in Bremen the senate for building, environment and traffic supports the installation of facilities for the infiltration of rainwater and the transformation of impervious surfaces into pervious surfaces with subsidies of 1/3 of the total costs for civil works, material and installation, up to a maximum amount of 3,000 Euros. The maximum subsidy per sealed square metre property area is 12.5 Euros. For these measures the same application criteria apply as for the subsidies provided for rainwater utilization facilities (as described in the previous section).

North Rhine-Westphalia invested a total amount of 35 million Euros and up to 7 million Euros per year in measures for decentralized rainwater management and infiltration in the period from 2006 to 2011. The joint aim of the state and the so-called 'Emscher' cities, including Essen, is to decouple 15% of the total storm water discharge from the public sewer systems by 2020 (Rathaus Essen 2011).

In Hamburg, the sewage discharge fee is reduced from 2.75 Euros to 2.30 Euros per m^3 wastewater if it can be proven that all rainwater is managed on site and no rainwater is discharged in the city's sewer system. Accordingly the discharge of rainwater is charged at 0.45 Euro per m^3 , which is similar to 16% of the total sewerage fee (Hamburg 2010). The rainwater fee in Berlin is calculated independently from the quantity of consumed drinking water and discharged wastewater. The sewage fee is 2.467 Euros per m^3 and a yearly fee of 1.897 Euros per m^2 property draining in the sewerage system (Berliner Wasserbetriebe 2012). In both cities these regulations foster the implementation of decentralized rainwater retention and management measures in existing urban environments and in new developments, where the decentralized retention and infiltration of rainwater might be even mandatory.

In the framework of this paper only some selected examples of supportive policies and regulations for decentralized rainwater management in Germany could be presented, due to the absence of a register and the thousands of municipalities, and water supply and sanitation providers with their own rules.

CONCLUSIONS

Specific policies and regulations stimulate private investments in facilities for rainwater management, harvesting and utilization. Based on environmental and economic criteria, combined measures for decentralized rainwater management and utilization are preferred to separate measures. The total construction costs can be reduced and maximum savings can be achieved regarding water resources as well regarding fees for drinking water, wastewater and storm water (if separated fees are applied in the specific designated areas).

If households economize on their water as well as the sewage bill, the income of the water supply and wastewater management companies declines. The investment in decentralized rainwater management systems makes therefore only sense if it contributes to savings in the centralized infrastructures or if a total shift from centralized to decentralized water systems is intended. If investments in centralized systems are necessary, the companies have to raise the fees for

drinking water and sewage to compensate their declining income and to cover their fixed cost. Higher fees would encourage the use of alternative water resources even more. Hence, the centralized system would be increasingly problematic to finance.

Despite the comparatively high achievable savings on water fees in Germany, the installation and operation of rainwater systems provide few economic benefits for private households. However, the installation of RWH facilities is in Germany also popular in areas where no financial subsidies are provided by municipalities. Apparently, installing an environmentally friendly, water saving and possibly 'self-reliant' water provision for non-drinking purposes appeals to users. Furthermore, decentralized RWHM facilities also serve the interests of the water companies to control their capital-intensive discharge capacity requirements. The policies and regulations that apply to household RWHM facilities reduce uncertainty for the parties involved and provide a forceful driver for individual decisions of users to invest in them. Therefore regulations and government policies influence the process of adoption of decentralized rainwater management, harvesting and utilization systems.

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