Sustainable rainwater management in the Emscher river catchment area

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Abstract The wastewater management system of the Emscher region is currently being radically restructured. The receiving waters currently surviving as open sewers are to be freed of their wastewater burden and reconstituted to a state as natural as possible, while the wastewater is to be routed underground to the treatment plants. Great importance is attached to the most natural possible rainwater management, in order to buffer extreme run-off situations in the watercourses and to minimize the costs for residential-area water management engineering. Rethinking, which in many cases percolates through only slowly, is necessary in many respects for this purpose. A contest has been set up in the Emscher catchment area in order to accelerate this in the existing residential areas. Seepage, decentralized retention, disconnection and discharge into bodies of water and watercourses have been financially supported. The results are presented and the further procedure deriving from them discussed.

Keywords Costs; disconnection; rainwater management; reconstitution of bodies of water and watercourses; retention; run-off events; seepage; start-up financing

The origin and history of the Emscher system

The wastewater management system in the Emscher catchment area (Figure 1) originated 100 years ago from the necessity of creating an effective drainage system for immense quantities of heavily polluted industrial wastewater. The Emscher system, which survived into the 1990s with its open sewers, originated as a result of the fact that mining and mining-induced subsidence made underground installation of drain and sewer conduits not only uneconomical but actually impossible. Subsidence gradually ceased as, starting in the 1970s, mining migrated in a northerly direction, and the conveyance of wastewater in underground conduits – customary in most other places – became possible here, too. The 400 km long wastewater system consisting of the Emscher and tributaries can now be restructured in such a way that decentralized treatment plants will be able to clean the wastewater before it is discharged into waters. The former technically optimized, unnatural receiving waters, which divide the landscape now become a network of watercourses which will constitute an aesthetic and natural amenity enrichment for both the natural and urban landscape. All in all, restructuring will therefore be intended to achieve not only the wastewater-management rehabilitation of the Emscher region necessary in water-management and legal terms, but also contribute to the improvement of this highly urbanized region. The overall wastewater-management restructuring of the 865 km^2 Emscher catchment area will cost around DM 9 billion and is to be completed by around the year 2020.

The scope and nature of the modification of the bodies of water depends essentially on the land potentials available and on the off-run conditions and, in particular, the influx of clean water. The low-water level of the watercourses freed of contaminated water is severely impaired as a result of the still increasing surfacing of their catchment areas, while high-water peaks are growing, as a result of diversions from combined sewer and drain systems. Both of these extremes must be moderated in order to achieve a natural reconstitution of the watercourses. The costs and effort involved in rainwater management in the sewer system are immense, while on the other hand the rainwater is missing in the natural balance of these

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Figure 1 The Emscher catchment area and its location within Germany

waters. The handling of rainwater therefore plays an extremely significant role in the restructuring of the Emscher system in terms of flood peak flow and low flow and with respect to investments for wastewater-management provisions.

The decision for the rehabilitation of the Emscher system taken in 1990 – with the essential target of achieving the greatest possible separation of wastewater and stream water – also brought the realization that a trend reversal in public consciousness would also be necessary (Kommission der Europäischen Gemeinschaften, 1997). The need no longer to permit rainwater to disappear into the drain and sewer system but instead to supply it to naturally constituted watercourses became more than obvious. The important target for restructuring of the system was and remains that of developing appropriate planning strategies as universally as possible throughout the riverine area and incorporating them into urban drainage practice.

Strategy and potential solutions

It is undisputed that, for technical and economic reasons, the restructuring of the Emscher system will need to take into account and utilize existing drainage structures (primarily combined sewer systems), but that it will also in terms of rainwater treatment possess the opportunity and, indeed, the obligation of examining and implementing the broad range of possible management forms (Figure 2).

A planning strategy which produces a permanent strengthening of the water cycle must firstly completely exhaust the many diverse and proven conceptual solutions for sustainable rainwater management Geiger and Dreiseitl (1995). The relatively high planning input for such provisions is quickly justified by low investment costs and a significant gain in environmental quality. Where the background conditions make naturally oriented rainwater management unprofitable or impossible, the nonetheless still contemporary conventional methods of wastewater disposal and rainwater treatment can be used. Also in this field, too, new and intelligent methods exist which are not generally implemented – as a result, in some cases, of lack of courage or as a result of restrictive administrative regulations. Innovative combination solutions, aimed, for instance, at the various substance fractions in rainwater and mixed water, can also be pursued here. If contamination-burden-oriented treatment is set as the target, they need not be afraid of financial assessment against the construction of basin-storage capacity.

Particularly in existing systems, rehabilitation and, therefore, a significant improvement

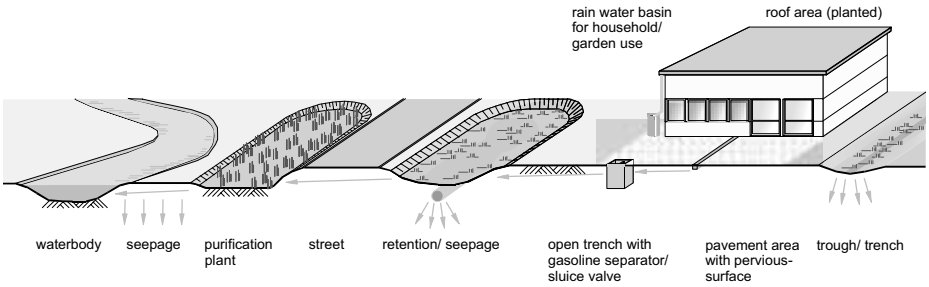

Figure 2 Possibilities for naturally oriented rainwater management

in flow conditions, can also be achieved by means of simple and robust concepts for run-off control. Existing storage capacities in the drainage system will be better utilized, and the interaction of rainwater treatment and the treatment plant will be optimized. In many cases, this will make it possible to dispense with the construction of further concrete basins.

Activities

The planning strategy pursued by Emschergenossenschaft assumes a high level of commitment on the part of all those involved. It must also be actively supported by local government, business and, ultimately, the individual citizen. It will, in this field, be necessary to overcome a large range of uncertainties and scepticism. Emschergenossenschaft has attempted to reduce deficiencies in this respect at all levels effected by means of a large number of activities and publicity campaigns dealing with the long-term handling of rainwater in residential areas. In 1994, Emschergenossenschaft itself took the initiative in the form of the organization of a contest, in order to reinforce theoretical considerations with practical action.

The "Ecologically oriented rainwater management in urban areas" contest

The objective of the competition was, on the one hand, that of obtaining information on various seepage methods in on-the-spot utilization in the conurbation and, on the other hand, of motivating citizens to imitate this behavior by means of the largest possible number of "implemented" examples. Subsidies of DM 9 million were provided for the Emscher region for the implementation of these projects up to 1999. The subsidies amounted to DM 10. per square metre of impervious disconnected from the drainage system. Since 1994, eighteen towns have participated with a total of 82 different projects; forty-seven projects have been or are being implemented (Figure 3). The total disconnection potential for these projects amounts to around 130 hectare.

Around 23 hectare of impervious has been disconnected from the drainage system in the context of the twenty projects completed up to now. Set against the overall impervious area of the Emscher catchment region of around 200 km^2, this is only little; but the – difficult – start has been made. Experience shows that functioning examples (which also save charges) perform better public-relations work than large volumes of theoretical arguments. Despite the many and diverse restrictions in the Emscher region (dense population, high groundwater tables and "polder" land areas in some cases, extensive proven and suspected contamination of sites, unfavorable soils), provisions distributed all across the entire riverine region can be implemented in flow-relevant quantities (Sieker and Pesch, 1992).

The "Rainwater Route"

In order to intensify efforts at publicizing sustainable drainage concepts, the "Rainwater Route" support program was started in cooperation with the state of NRW in 1998, follow-

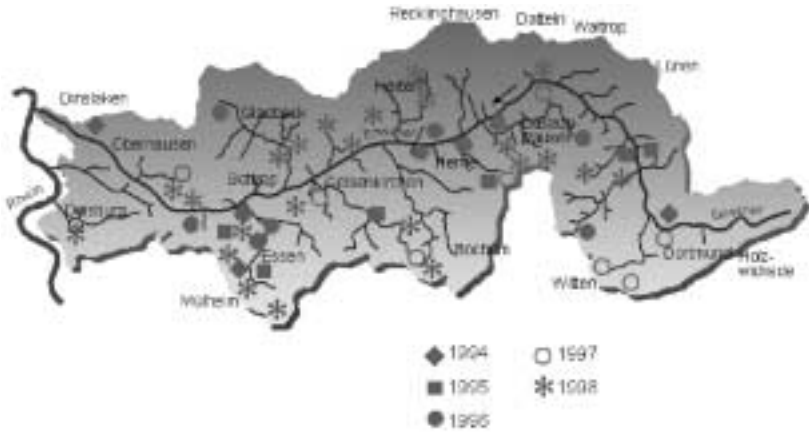

Figure 3 Projects subsidized under the competition

ing the competition described above. A project for sustainable rainwater management was promoted with massive financial support in each of the seventeen towns in the Emscher zone. Since the projects achieve high aesthetic standards under the difficult background conditions of the region, they also illustrate the immense potential of these water-management concepts and the necessary creativity and willingness among all the parties involved to develop joint solutions which can then be advanced by means of an overall urban-planning concept. The press reports regularly on the provisions implemented; various PR campaigns assist in disseminating the ideas – and the achievement – of long-term water management (Figure 4).

Success and water-management benefits

The rates of disconnection achieved within the various schemes exhibit extremely high fluctuation bandwidths. In densely populated areas, in the case of multi-storey apartment construction in inner city areas, for instance, the rate of disconnection is only 2 to 3%.

Figure 4 The official start of construction work on the "Hiberniaschule" project, in Herne

Unfavorable background conditions, combined with in many cases still large reservations on the part of house- and landowners, permit implementation here only in individual cases. For many schemes involving commercial projects, site pollution still exists due to previous utilization. The resulting additional costs quickly make disconnection financially uninteresting.

Higher levels of disconnection can be achieved, for instance, in the case of larger individual commercial sites and in the case of land owned by housing associations. Here, disconnection successes of 50% or more can be achieved. In addition, the provisions implemented are concentrated on a significantly smaller area than in residential areas involving scattered individual schemes.

A disconnection potential of 10% 21 km^2 on average of the impervious areas in the Emscher region appears to be entirely realistic in the long term when the complete range of schemes implemented up to now is examined.

With this disconnection potential, the flood peak flow in the tributaries of the Emscher could be reduced already by as much as 40% in the case of minor floods with a two-year return period. The resulting significant reduction in the flow-erosion of the bed of the watercourse is of immense ecological importance for the tributaries of the Emscher. It is important for a stable and self-regulating ecological water system that the frequently occurring floods do not result in drift-induced major losses of microorganisms. Naturally oriented rainwater management is, therefore, capable of making a decisive contribution to the strengthening of the natural water cycle, with a view to the achievement of integrated waterway and watercourse management.

In the case of the Emscher itself, the reduction of peak flow is significantly lower, depending on frequency of occurrence, since the flood situation is dominated here by long-term rainfall. In the case of such rain occurrences, natural and permeable land areas are also significantly involved in the run-off event.

Long-term rainwater management also exhibits effects on the low flow (Figure 6). There is a danger, as a result of the low rate of groundwater replenishment in the Emscher catchment area, of complete drying out of the tributaries, particularly in the dryer months of the year. In this field, the disconnection of impervious areas from the combined sewer systems has a positive beneficial effect.

Figure 5 Example of seepage in multi-storey apartment construction

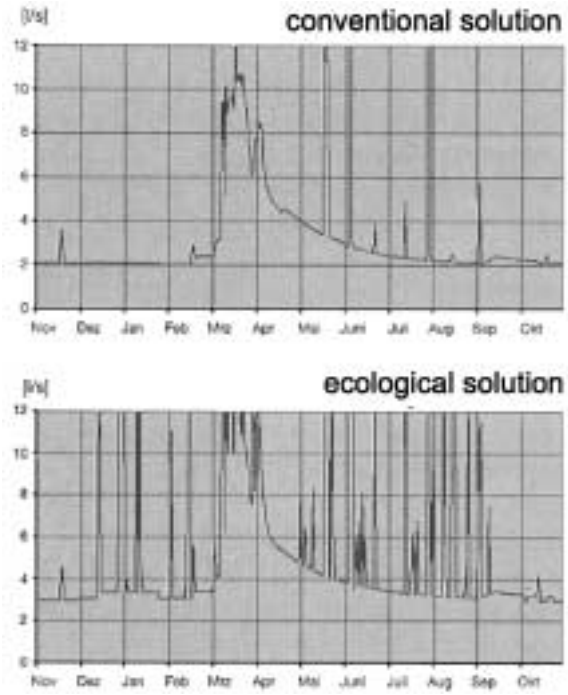

Figure 6 Run-off scenario using the example of the Deininghauser Bach without (above) and with (down) disconnection

The consistent implementation of an ecologically oriented rainwater management system for the entire riverine region of the Emscher will result, particularly in the case of the tributaries, in:

- a significant buffering of the peak flow in flood events and
- a notable improvement of low flow conditions; small rivers and streams, in particular, will remain perceptible as watercourses even in dry periods.

Further aspects, such as the improvement of the microclimate and living quality, also make a contribution to the improvement of the Emscher region.

Economic considerations

With all the positive and also undoubtedly undisputed aspects which sustainable rainwater management offers, it must nonetheless also be economically justifiable if it is to succeed against conventional provisions. A cost comparison is extremely difficult, since provisions for sustainable rainwater management may exhibit extremely large cost bandwidths, due to the varying background condition. The experience gained up to now in the Emscher region does make it possible to perform an observation of the economics, however. The support of naturally oriented rainwater management provisions will also be cost-effective for Emschergenossenschaft if they result in savings in the field of provisions for wastewater and rainwater treatment. These quickly exceed expenditure for subsidies. They are also augmented by lower operating costs for pumping stations and wastewater treatment plants.

In the field of municipal drain and sewer systems, the observation of the economics speaks in favour of naturally oriented rainwater management if, in the case of solely hydraulic overloading of drains and sewers, the existing conduit can remain in use as a result of the disconnection of land areas. The same applies if a simpler and lower-cost rehabilitation of conduits needing repair becomes possible as a result of lower flows of water. A significant cost advantage arises in favor of long-term rainwater management, as can be

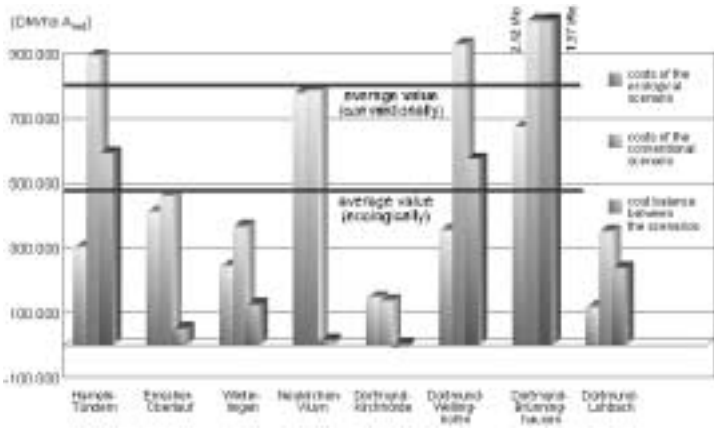

Figure 7 Cost comparison of drainage for selected case examples

seen from the various studies (Ing.-Büro Fischer, 1993; Adams, 1996) and examples cited (Ing.-Büro Fischer, 1996; Davids, Terfrüchte & Partner, 1997); see Figure 7.

Target perspectives

Consistent pursuance and implementation of the principles of naturally oriented rainwater management will, in the long-term, also produce significant financial benefits in addition to the ecological gains for the Emscher region. Emschergenossenschaft, as the water-management body responsible for this region, sees this as its obligation.

The processes of rethinking in the field of rainwater and wastewater management in the Emscher region initiated with the "Ecologically oriented handling of rainwater in residential areas" competition (which was implemented in accordance with its schedule for the last time in 1998) and intensified in 1998 with the "Rainwater Route" will be continued as from 2001 within the framework of a new support program. A further DM 10 million is to be provided for this purpose for a project period of five years. The route, resulting from the completed projects and enlarged by means of further provisions on the subject of "Handling of rainwater" will ultimately also become tangibly perceptible in the direct personal field (Figure 8). The efforts at making the intention and purpose of sustainable rainwater management understandable for a broad public, and thus placing implementation on an ever wider basis, are being continuously intensified.

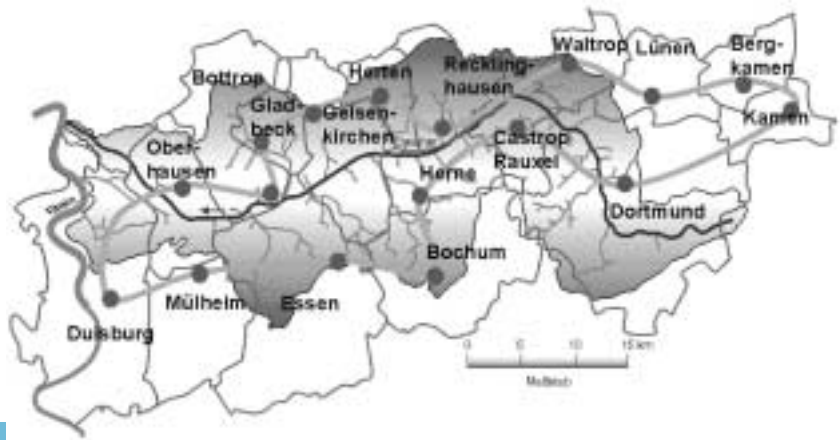

Figure 8 The "Rainwater Route"

Conclusions

The experience gained from the previous projects is to be used to accelerate predominantly naturally oriented rainwater management provisions primarily at points where direct financial benefits can be derived in the field of conventional residential-area water management. As many persons and bodies as possible are to be motivated by means of intensive presentation of the provisions in all the media to support the "New ways for rainwater". All these offensive procedures in the handling of rainwater intended to contribute to the achievement of the targeted objective of 10% disconnection of impervious areas are an important step on the way to a more sustainable rainwater management in the riverine region within the next twenty years.

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