GeoPlanet: Earth and Planetary Sciences

Stefan Ignar
Mateusz Grygoruk *Editors*

Wetlands and Water Framework Directive

Protection, Management and Climate Change

Springer Open

GeoPlanet: Earth and Planetary Sciences

More information about this series at http://www.springer.com/series/8821

Stefan Ignar · Mateusz Grygoruk
Editors

Wetlands and Water Framework Directive

Protection, Management and Climate Change

Springer Open

Editors
Stefan Ignar
Department of Hydraulic Engineering
Warsaw University of Life Sciences
Warsaw
Poland

Mateusz Grygoruk
Department of Hydraulic Engineering
Warsaw University of Life Sciences
Warsaw
Poland

The GeoPlanet: Earth and Planetary Sciences Book Series is in part a continuation of Monographic Volumes of Publications of the Institute of Geophysics, Polish Academy of Sciences, the journal published since 1962 (http://pub.igf.edu.pl/index.php).

ISSN 2190-5193 ISSN 2190-5207 (electronic)
GeoPlanet: Earth and Planetary Sciences
ISBN 978-3-319-13763-6 ISBN 978-3-319-13764-3 (eBook)
DOI 10.1007/978-3-319-13764-3

Library of Congress Control Number: 2014957298

Springer Cham Heidelberg New York Dordrecht London

Printed on acid-free paper

Springer International Publishing AG Switzerland is part of Springer Science+Business Media (www.springer.com)

Series Editors

Managing Editor

Anna Dziembowska
Institute of Geophysics, Polish Academy of Sciences

Advisory Board

Kon-Kee Liu
Institute of Hydrological
and Oceanic Sciences
National Central University Jhongli
Jhongli, Taiwan

Teresa Madeyska
Research Centre in Warsaw
Institute of Geological Sciences
Warsaw, Poland

Stanisław Massel
Institute of Oceanology
Polish Academy of Sciences
Sopot, Polska

Antonio Meloni
Instituto Nazionale di Geofisica
Rome, Italy

Evangelos Papathanassiou
Hellenic Centre for Marine Research
Anavissos, Greece

Kaja Pietsch
AGH University of Science
and Technology
Kraków, Poland

Dušan Plašienka
Prírodovedecká fakulta, UK
Univerzita Komenského
Bratislava, Slovakia

Barbara Popielawska
Space Research Centre
Polish Academy of Sciences
Warsaw, Poland

Tilman Spohn
Deutsches Zentrum für Luftund
Raumfahrt in der Helmholtz
Gemeinschaft
Institut für Planetenforschung
Berlin, Germany

Krzysztof Stasiewicz
Swedish Institute of Space Physics
Uppsala, Sweden

Roman Teisseyre
Earth's Interior Dynamics Lab
Institute of Geophysics
Polish Academy of Sciences
Warsaw, Poland

Jacek Tronczynski
Laboratory of Biogeochemistry
of Organic Contaminants
IFREMER DCN_BE
Nantes, France

Steve Wallis
School of the Built Environment
Heriot-Watt University
Riccarton, Edinburgh
Scotland, UK

Wacław M. Zuberek
Department of Applied Geology
University of Silesia
Sosnowiec, Poland

Acknowledgments

This book was compiled within the project "Adaptive Management of Climate-induced Changes of Habitat Diversity in Protected Areas" (HABIT-CHANGE). We thank the European transnational funding programme INTERREG IV B Central Europe for co-funding this project (reference number 2CE168P3). Although the ideas and messages included in this book remain as straightforward clues for the managers and scientists involved in conservation of wetlands and floodplains, they crystallized from the broad, multi-aspect approach of managers, specialists and scientists of different backgrounds and experiences.

First and foremost, we thank Dr. Marco Neubert and Dr. Sven Rannow for their efficient supervision and guidance of the HABIT-CHANGE project that made the implementation process an unforgettable experience that consisted of multiple lessons of the research efficiency and a strict yet keen project management of big international research undertakings. We thank all project partners whose dedication and accuracy allowed the HABIT-CHANGE to be implemented and finalized. We thank the Director and the staff of the Biebrza National Park for their keen attitude towards the researchers and outstanding assistance with the project implementation. We are grateful for the professional advice by Prof. Tomasz Okruszko that allowed us to go smoothly through the book preparation process. We thank the reviewers of the book—Dr. Dorota Pusłowska-Tyszewska, Dr. hab. Piotr Banaszuk, Prof. PB and Mgr Grzegorz Wierzbicki, whose valuable advice and critical reviews allowed to assure the high scientific standard of the presented contributions. We thank all the authors for the amount of work they put in the preparation of particular chapters. We thank Mrs. Anna Dziembowska for her permanent assistance and patience in the whole process of the book preparation. We also thank the editor team of the Springer series "GeoPlanet: Earth and Planetary Sciences".

Warsaw, October 2014

Stefan Ignar
Mateusz Grygoruk

Contents

Chapter 1
Wetlands and Water Framework Directive: Protection, Management and Climate Change

S. Ignar and M. Grygoruk

Abstract In this chapter the general context of protection and management of wetlands in legal frameworks of water management is discussed. We present the background of the book, referring to its main conclusions and achievements. The main finding is that the existing regulations of the European environmental policy are sufficiently accurate and provide adequate tools to maintain good status of ecosystems as well as to restore the degraded ecosystems that provide a potential of reaching the favourable environmental status. However, implementation of these regulations requires attention and enhancement, as in selected cases it fails to fulfil their environmental objectives. We state that the main attention of the EU environmental policy the day before, when the good status of waters and aquatic ecosystems demanded by the water framework directive has to be met by the member states, should pay special attention at assessment of the implementation efficiency of existing legal regulations rather than at the development of the new ones. We conclude that in order to succeed with the adaptive management of wetlands facing climate change, social sciences should be more deeply involved in EU environmental policy inducing attitudes of managing authorities and users of valuable wetlands.

Keywords Wetlands · Water framework directive · Climate change · Environment · Conservation

S. Ignar · M. Grygoruk (✉)
Department of Hydraulic Engineering, Warsaw University of Life Sciences – SGGW, ul. Nowoursynowska 159, 02-776 Warsaw, Poland
e-mail: m.grygoruk@levis.sggw.pl

S. Ignar and M. Grygoruk (eds.), *Wetlands and Water Framework Directive*,
GeoPlanet: Earth and Planetary Sciences, DOI 10.1007/978-3-319-13764-3_1

1.1 Status of Wetlands: Missing Law or Failed Implementation?

In a contemporary world the number of environmental directives, laws and conventions allows one to suspect that the surrounding nature is protected better than any time before in the history and the only issue one can expect in environmental management is the increasing quality (or at least retaining a constant good ecological state) of Earth's ecosystems. Particularly in the case of valuable wetlands, there is a considerable number of legal agents allowing conservationists to look bravely towards the future. Starting from the international Ramsar convention on wetlands, through the European council directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora [referred to as the habitats directive (HD)], council directive 2009/147/EC on the conservation of wild birds [referred to as the birds directive (BD)] and directive 2000/60/EC of the European parliament and of the council of 23 October 2000 establishing a framework for community action in the field of water policy [the water framework directive (WFD)], ending at national and regional regulations (water acts, environmental conservation acts and regional authority's resolutions). However, a day-to-day experience in environmental conservation does not allow optimistic attitudes to dominate the practitioner's world: ecosystems, in general, deteriorate globally. On top of human-enforced pressures originating from contamination of waters, agriculture, forestry, landscape fragmentation and urbanization (Hassan et al. 2005), the new threats to ecosystems such as the ones related to the changing climate (Rannow et al. 2014) have been defined. These threats are vitally critical for wetlands—transitional ecosystems shaped by the physical and biological process typical for both terrestrial and aquatic environments. One could expect that in face of new challenges that wetlands are exposed to, the revision of legal frameworks regulating management and use of these ecosystems should be done and—perhaps—new directives should be developed. Beforehand, however, concerning the abundance of legal tools, one should verify whether the general threats for waters and wetlands do not raise from an improper implementation of existing, in a way much comprehensive, legal regulations concerning the environment. Then, answering the question "do regulations miss accuracy or does the implementation fail?" one can start the discussion on how to enhance the protection and management of wetlands, facing new challenges such as the human- and climate-related pressures.

1.2 Wetlands and Water Framework Directive

As stated by Joosten and Clarke (2002), among the continents the most significant loss of water-dependent ecosystems in the global scale was recorded in Europe, where the areal decline of wetlands reached over 50 % of their pristine extent. They also state that pressures originating from agriculture and forestry are responsible for approximately 80 % of these cases. Among the greatest challenges wetlands faced so far and are up to be exposed to in the near future, the drainage and declining water levels are considered as the most critical ones. As revealed, projected climatic changes expressed as increasing temporal and quantitative variability of extreme meteorological events are expected to significantly influence agriculture and forestry by challenging field works, species development and harvesting of crops gained from wetlands (Grygoruk et al. 2014). Changing environmental conditions of wetlands are projected either to require in-depth adaptation of existing management or to develop new approaches. It is likely that changing frequencies of floods and droughts, observed trends in snow accumulation and variability in the occurrence of seasons will primarily affect economic development, which will require actions to be undertaken in order to prevent negative influences of these changes to stakeholders. Then, the pressures oriented at water management, in Central Europe in principal oriented at mitigation of frequent floods, may result (and already do) in degradation of aquatic ecosystems (Biereżnoj-Bazille and Grygoruk 2013; Dembek 2015; Mioduszewski and Okruszko 2012). Pressures originating from agriculture on revitalization of land reclamation systems and training rivers in order to assure the continuous retrieval and transfer of water downstream have already induced conflicts between the need of implementation of WFD and social requirements (Dembek 2015). Although in national context it seems the win-win situations are achieved and contemporary measures undertaken at river management level (dredging, ditch revitalization) fulfil all the requirements of WFD, HD, BD and environmental impact assessments (EIA), the deeper detailed insights into such activities revealed that to meet the good ecological status of rivers and water bodies appears—sadly—the last thing to be achieved by 2015 (Biereżnoj-Bazille and Grygoruk 2013; Strużyński et al. 2015).

Examples from Poland and Germany presented in this book allow to foresee coming benefits for the environment originating from WFD implementation. However, the same examples allow to suspect that the future of WFD implementation without providing appropriate funding background, either by adjustment of national governmental mechanisms or EU-scale programmes aimed at subsidizing the implementing bodies, does not appear bright (Grygoruk and Okruszko 2015). In the current perspective and facing actions undertaken so far expressing WFD implementation, it is likely that on top of the biotic and hydrochemical aspects of water bodies, the hydromorphology and quantitative indicators of river status are ones whose connection to status of wetlands will be the strongest. Regardless of hydrological types of wetlands, from mires, through floodplains to estuaries, one should assure consideration of wetlands as inherent elements of river continua and include them in a catchment-scale environmental management.

1.3 Protection and Management

Although the considerable potential for synergies between the regulations regarding water resource management (WFD) and nature conservation (HD and BD) does exist, it is not fully exploited yet (Stratmann and Albrecht 2015). The concept of ecosystem services of wetlands may allow to sustain their high ecological quality by putting environmental features in economic terms, thus enhancing social perception of conservation of these ecosystems (Grygoruk et al. 2013; Maltby 2009). The links between wetlands acting as inherent elements of catchments improving quality of aquatic geosystems should, however, be revisited in WFD implementation (Meyerhoff and Dehnhardt 2007). Dembek (2015), making a step from environmental research towards social sciences, convinces that the management of agriculturally maintained wetlands requires more holistic approach, where the anthropocentric anticipation of use of wetlands should switch to attitudes concerning protection of wetlands as principal goal in wetland management. Bearing in mind that to conserve wetlands does not mean to lose them in economic perspective, we see that the integration of economic and environmental scopes of wetland management, especially interfered by the climate change, may be achieved in modern management of aquatic and riparian ecosystems. As stated by Strużyński et al. (2015), it is vital to continue river restoration in order to assure matter and energy transfer between rivers and floodplain wetlands. Despite the fact that increasing concern in river management is put to the catchment processes, still the great field to be explored is an interrelation of catchment-scale water management and habitat conservation (Grygoruk et al. 2013; Janauer et al. 2015).

1.4 Climate Change

WFD, despite of being a universal approach to water bodies conservation and management, does not comprehensively consider climate change as an aspect that might influence achievements of its goals to rivers or wetlands (Wilby et al. 2006). Such a status should be revisited, as projected climate-change-induced pressures to habitats reported in both European (Okruszko et al. 2011; Schneider et al. 2011) and regional context (Doroftei and Anastasiu 2014; Grygoruk et al. 2014; Kaligaric and Ivajnšic 2014; Malatinszky et al. 2014), together with actions undertaken by stakeholders mitigating climate change influences are foreseen to play a very important role in protected areas management in the near future. As reported by Grygoruk et al. (2014), not only direct pressures originating from the changing climate (such as global warming, flooding, droughts) challenge wetlands by affecting water balance and habitat conditions. Equally (if not more) relevant for wetland ecosystem status are actions undertaken by stakeholders allowing them to continue the use of wetlands, mitigating negative effects of the climate-related impacts. In a capitalistic world the only way of changing attitudes of stakeholders to management measures in order to keep the use of wetlands in an environmental sustainable, yet profitable manner, is to build their capacity towards consideration of climatic change as a local-scale issue. Numerous scientific and management projects implemented throughout the Europe, such as the HABIT-CHANGE project, attempted to enhance stakeholder dialogue between the environmental management institutions and particular groups of people, whose actions determine the use and status of valuable ecosystems. Changing of stakeholder's attitudes was done either by broadening their knowledge on climate-related impacts on habitats and management or by inducing their emotions stating that the climatic change is unavoidable and the lack of adaptation will result in further deterioration of ecosystems, wetlands especially, and reduction of income from activities done regardless of the variable impacts of climate.

However, the majority of national-level adaptation strategies lack connection to local actions (Rannow et al. 2014) and hence the management of valuable wetlands requires stronger insights coming from international climate-adaptation policy towards the single plots located on valuable wetlands.

1.5 Yesterday's Lessons and Tomorrow's Perspectives

Facing considerable abundance of regulations (that have been attempted to be) implemented in the geographical, societal, environmental and economic perspectives of Europe in the last 20 years, it seems that European union does not require any new directives concerning the interface of wetlands, water management and climatic change to be developed. Moreover, observing steadily increasing awareness of stakeholders regarding requirements and costs of implementation of existing environmental regulations, we doubt that any new regulations inducing obstacles for users of water and goods that origin from the natural wetland environment can be socially accepted and then developed and implemented in the near future. On the other hand, it is widely agreed in groups of practitioners and scientists from Europe that existing regulations, such as the WFD, HD and BD, contain sufficiently good regulations that, once efficiently implemented, may prevent degradation of wetlands and water bodies, assure sustainable water management in social and economic context as well as allow to mitigate climate-related primary and secondary pressures to ecosystems and catchments (Janauer et al. 2015). We hope the lessons presented in this book will allow readers to conclude which fields of management of wetlands facing their status in WFD and concerning prospective pressures originating in the changing climate require special attention. We also hope that the enhancement of efficiency in implementation of the existing environmental regulations in EU in the near future will assure good status of waters and wetlands as properly managed ecosystems, resilient to impacts originating from human pressures and climatic change.

References

Biereżnoj-Bazille U, Grygoruk M (2013) Scale matters: efficiency assessment of EU environmental directives implementation in a local-scale management of protected wetlands in Poland. Sci Ann Danube Delta Inst 19:5–12

Dembek W (2015) New vision of the role of land reclamation systems in nature protection and water management. In: Ignar S, Grygoruk M (eds) Wetlands and water framerwok directive: protection, management and climate change, GeoPlanet: Earth and planetary sciences. Springer, Berlin

Doroftei M, Anastasiu P (2014) Potential impacts of climate change on habitats and their effects on invasive plant species in Danube delta biosphere reserve, Romania. In: Rannow S, Neubert M (eds) Managing protected areas in central and eastern europe under climate change, advances in global change research 58. Springer, Berlin

Grygoruk M, Okruszko T (2015) Do water management and climate-adapted management of wetlands interfere in practice? Lessons from the Biebrza Valley, Poland. In: Ignar S, Grygoruk M (eds) Wetlands and water framework directive: protection, management and climate change, GeoPlanet: Earth and planetary sciences. Springer, Berlin

Grygoruk M, Mirosław-Świątek D, Chrzanowska W, Ignar S (2013) How much for water? Economic assessment and mapping of floodplain water storage as a catchment-scale ecosystem service of wetlands. Water 5:1760–1778

Grygoruk M, Biereżnoj-Bazille U, Mazgajski M, Sienkiewicz J (2014) Climate-induced challenges for wetlands: revealing the background for the adaptive ecosystem management in the Biebrza Valley, Poland. In: Rannow S, Neubert M (eds) Managing protected areas in central and eastern europe under climate change, advances in global change research 58. Springer, Berlin

Hassan R, Scholes R, Ash N (2005) Ecosystems and human well-being: current state and trends, millenium ecosystem assessment, vol 1. Islandpress, Washington DC

Janauer GA, Albrecht J, Stratmann L (2015) Synergies and conflicts between water framework directive and natura 2000: legal requirements, technical guidance and experiences from practice. In: Ignar S, Grygoruk M (eds) Wetlands and water framework directive: protection, management and climate change, GeoPlanet: Earth and planetary sciences. Springer, Berlin

Joosten H, Clarke D (2002) Wise use of mires and peatlands—background and principles including a framework for decision making. Int Mire Conserv Group Int Peat Soc 304:204

Kaligaric M, Ivajnšic D (2014) Habitat changes caused by sea level rise, driven by climate change in the northern Adriatic coastal wetlands, Slovenia. In: Rannow S, Neubert M (eds) Managing protected areas in central and eastern Europe under climate change, advances in global change research 58. Springer, Berlin

Malatinszky Á, Ádam S, Falusi E, Saláta D, Penksza K (2014) Suggested management measures for Natura 2000 habitats in Körös-Maros National Park, Hungary. In: Rannow S, Neubert M (eds) Managing protected areas in central and eastern Europe under climate change, advances in global change research 58. Springer, Berlin

Maltby E (2009) Functional assessment of wetlands: towards evaluation of ecosystem services. Woodhead Publishing Ltd., Cambridge, p 672

Meyerhoff J, Dehnhardt A (2007) The European water framework directive and economic valuation of wetlands: the restoration of floodplains along the river Elbe. Environ Policy Governance 17:18–36

Mioduszewski W, Okruszko T (2012) Protection of natural wetlands—the examples of conflicts. J Water Land Dev 16:35–42

Okruszko T, Duel H, Acreman M, Grygoruk M, Flörke M, Schneider C (2011) Broad scale ecosystem services of European wetlands—overview of the current situation and future perspectives under different climate and water management scenarios. Hydrol Sci J 53:1501–1517

Rannow S, Neubert M, Stratmann L (2014) Natural heritage at risk by climate change. In: Rannow S, Neubert M (eds) Managing protected areas in central and eastern Europe under climate change, advances in global change research 58. Springer, Berlin

Schneider C, Flörke M, Geerling G, Duel H, Grygoruk M, Okruszko T (2011) The future of European floodplain wetlands under a changing climate. J Water Clim Change 2:106–122

Stratmann L, Albrecht J (2015) Can natura 2000 sites benefit from river basin management planning under a changing climate? Lessons from Germany. In: Ignar S, Grygoruk M (eds) Wetlands and water framework directive: protection, management and climate change, GeoPlanet: Earth and planetary sciences. Springer, Berlin

Strużyński A, Książek L, Bartnik W, Radecki-Pawlik A, Plesiński K, Florek J, Wyrębek M, Strutyński M (2015) Wetlands in river valleys as an effect of fluvial processes and anthropopression. In: Ignar S, Grygoruk M (eds) Wetlands and water framework directive: protection, management and climate change, GeoPlanet: Earth and planetary sciences. Springer, Berlin

Wilby RL, Orr HG, Hedger M, Forrow D, Blackmore M (2006) Risks posed by climate change to the delivery of water framework directive objectives in the UK. Environ Int 32:1043–1055

Chapter 2
Synergies and Conflicts Between Water Framework Directive and Natura 2000: Legal Requirements, Technical Guidance and Experiences from Practice

Georg A. Janauer, Juliane Albrecht and Lars Stratmann

Abstract The EU water framework directive (WFD) is intensively connected with other European legal regulations and supporting documents. This close interrelationship calls for deeper considerations when WFD is implemented in locations of high conservation value, e.g. Natura 2000 sites. A comprehensive, but specific comparison of the goals of WFD with the aims of habitats directive (HD) and birds directive (BD) provides a sensitive overview on their peculiarities, with an outlook on potential synergies and conflicts. The sometimes complex guidance for solving complicated situations in the practical application of these differing legal provisions is also described. The representation of requirements for Natura 2000 sites as part of river basin management plans, and related up-to-date experience are given special attention. Finally recommendations and conclusions provide the reader with a complete view of this challenging chapter in European Policy. In the end, considerably more synergies than conflicts are identified between the objectives of WFD, HD and BD. Whenever conflicts should arise these directives prevent derogating from their requirements by cross-references. Therefore, firm and timely coordination between water and nature conservation authorities is necessary.

Keywords Water framework directive · Habitats directive · Birds directive · River basin management plan · Natura 2000 sites · Implementation

G.A. Janauer (✉)
Department of Limnology and Biological Oceanography, University of Vienna, Althanstr. 14, 1090 Vienna, Austria
e-mail: georg.janauer@univie.ac.at

J. Albrecht · L. Stratmann
Leibniz Institute of Ecological Urban and Regional Development, Weberplatz 1, 01217 Dredsen, Germany

S. Ignar and M. Grygoruk (eds.), *Wetlands and Water Framework Directive*, GeoPlanet: Earth and Planetary Sciences, DOI 10.1007/978-3-319-13764-3_2

2.1 Introduction

The water framework directive (Directive 2000/60/EC, WFD) is not a stand-alone document of European legal regulation, but is in many ways integrated into a spider web of relationships with other directives and documents of European policy. This contribution aims at highlighting some of the more fundamental connections between relevant EU documents covering a wide scope that considers various aspects of water related issues, cross-linking water management with nature protection and conservation needs.

Due to its ecological approach, the WFD shows numerous connections with nature conservation. The WFD strives primarily for an improvement on the habitat quality and the diversity of species in surface waters by the criteria of good ecological and chemical status and corresponding measures in the programmes of measures (Art. 1 a); Art. 2 N°. 18; Art. 4 para. 1 a) ii) and iii); Annex 5 N°. 1.2 table 1.2 WFD), among other things provides protection against impairments for wetlands directly depending on the aquatic ecosystems (Art. 1 a) WFD) and refers to the management objectives for Natura 2000 sites (Annex IV part A and Annex V N°. 1.3.5 WFD). The interplay of WFD and Natura 2000 directives, i.e., the HD and the BD, is of high practical relevance, because measures according to WFD regularly take place within Natura 2000 sites.

Particularly interesting from an environment protection point of view are the special areas of conservation (SAC) and the special protection areas (SPA) that were to be allocated by the Member States as a coherent European ecological network according to the HD and the BD. Within the relevant sanctuaries all bird species listed in Annex I of the BD and special protection areas for commonly visiting migratory birds are protected by Article 4 BD. The protection out of Article 4 HD relates to either habitat types that are of collective conservation interest (Annex I) or to wild species deserving protection in accordance with Annex II and IV of the directive (Unnerstall 2003, p. 670; Louis 2000, p. 83 et seq.).

Main aims of the following contribution are to highlight potential synergies and conflicts of WFD implementation in Natura 2000 sites, to pass on some experience on this topic as well as to give recommendations for the coordinated implementation of the legal requirements. The contribution is subdivided into four sections. In Sect. 2.2, the goals of WFD and Natura 2000 legislation are compared, main interrelations highlighted and synergies as well as conflicts are shown. Section 2.3 gives an overview on legal provisions and guidance documents on the European level relating the question how to deal with synergies and conflicts between WFD and Natura 2000 in practice. In Sect. 2.4, the implementation of WFD in Natura 2000 sites as part of river basin management plans is discussed, up-to-date experiences are shared and recommendations given. Finally conclusions are drawn (Sect. 2.5).

2.2 Comparison of Goals of WFD and Natura 2000: Analogue and Antagonism

2.2.1 Goals of WFD, HD and BD

Goals of WFD are, when focused on the two most stringent ones, preventing further deterioration of aquatic ecosystems and associated wetlands as well as terrestrial environments and the enhancement of their ecological quality where a good, or better, ecological status is not reached at present (Art. 4 WFD).

Setting the reference conditions in conformity with the natural or near natural state of rivers and lakes, as regards surface waters, requests “re-regulation” of a great number of river reaches throughout all EU Member States. As a consequence, many activities covered by current river basin management plans are centred on river re-naturalisation. This includes not only the river course, which is often far from natural state due to regulation measures (e.g. straightening the course, cutting oxbows), but relates also to river bank enforcement (e.g. rip-rap) or groundsills and any other construction type by which river gradient needs to be attenuated to stop river bed incision processes. The other aspect of ‘hydro-morphological’ impacts relates to non-natural flow conditions, e.g. caused by diversion power plants, which reduce the discharge in affected river reaches to levels below ‘ecological flow’ (Gopal 2013), the amount of water needed to support all aquatic life characteristic for such a river part.

Ecological parameters are not the only aspect in WFD implementation, as accompanying environmental conditions supporting ‘good ecology’ must be met, too. For achieving a good surface water status, a chemical status of at least ‘good’, requiring the compliance with certain environmental quality standards (for details see Art. 2 N°. 24 WFD), is also obligatory (Art. 2 N°. 18 WFD).

Another aspect of WFD goals is the relevance given to groundwater, which is a valuable source for surface waters and associated terrestrial ecosystems (Art. 4 (1) b) WFD, Art. 2 N°. 27 WFD), but by far one of the most important drinking water resources for humankind. Regarding groundwater, its availability, its quantity (Art. 2 N°. 26 and 28, and table 2.1.2 Annex V), and its chemical status (Art. 2 N°. 25) are to be observed.

In combination with the intrinsic concept of integrating the river basin into all considerations on resulting surface and ground water quality this results in a much wider scope of interpretation of water quality than any other water quality regulation so far developed. However, this implies that land cover and land use aspects as determinants of water quality meet a level of importance which will result in far reaching influence on future general policies regarding the landscape in total.

Goals of the habitats directive 1992 (HD) are, in a focused view ‘ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora’ in the EU Member States. To reach these goals a ‘favourable conservation status’ of habitats and related species shall be maintained in the context of ‘long-term survival’ (Art. 1 (e) HD). This implies that ecologically valuable habitats—their value based on the composition of species and their physical setting—shall be protected and maintained if favourable conservation status is already accomplished, or measures shall be taken to reach this status in case the present condition is not in compliance with that goal.

Art. 2 HD proclaims in general terms that all measures taken by Member States pursuant to the directive 'shall be designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of community interest'. According to the Directive, the status of a habitat qualifies as 'favourable' when, among other things, its range is 'stable or increasing' and the 'structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future'. The conservation status of a species is deemed favourable when, inter alia, the species 'is maintaining itself on a long-term basis as a viable component of its natural habitats' and 'there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis'.

The BD (1979) in its present 'codified' version of 2009 (Directive 2009, based on the amended version of Council Directive 79/409/EEC of 2 April 1979) relates to the conservation of all species of naturally occurring birds in the wild state in the territory of the European Member States. It covers the protection, management and control of these species and lays down rules for their exploitation. The directive applies to birds, their eggs, nests and habitats (Art. 1 BD). Member States shall take the requisite measures to maintain the population of the bird species at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements, or to adapt the population of these species to that level (Art. 2 BD). Art. 1 and 2 BD do not contain the words 'favourable conservation status', but are generally understood to imply this purpose for wild birds (Trouwborst 2011, p. 70 et seq.).

A coherent European ecological network of SAC shall be set up under the title of "Natura 2000", composed of sites hosting the natural habitat types listed in Annex I and habitats of the species listed in Annex II (Art. 3 HD). These special areas of conservation protected by the HD include, inter alia, aquatic habitats such as stagnant and flowing water bodies and submerged vegetation, which are in the focus of the WFD, too (Friedrich 2003, p. 39). As designated in Art. 3 HD, the Natura 2000 network includes also the special protection areas classified by the Member States pursuant to the BD. Insofar, the bird's protection measures are integrated to the system that has been created by the HD. The coherent Natura 2000 designated areas must be secured by appropriate conservation measures. Relevant species and their habitats should be effectively protected from considerable harm and should maintain a favourable degree of conservation.

Both the BD and the HD are, at least in part, fundamentally connected with the WFD. The BD lists in its Article 4 that 'Member States shall pay particular attention to the protection of wetlands', including 'wetlands of international importance', but explicitly not addressing these latter types exclusively. Yet, as a large group of wild birds depends on wetlands, this Directive is also closely connected to the intrinsic topic of the Ramsar Convention of 1975 ('Convention on Wetlands of International

Importance 1971'). This convention highlights the importance of wetlands in a very broad sense. Important wetland types are 'lakes and pools; rivers and streams; bogs, marshes and swamps; and coastal lagoons', as listed in the web reference (see footnote 1). Yet, one basic feature of the BD is it being exclusively and solitarily focused on a single group of organisms which is just one group of many protected by the HD. This fact has shown in integrated planning teams that enforcing the interests of the avifauna above that of other groups of organisms becomes evident. Certainly a balanced consideration of the interest of all organisms of ecological value should be more desirable.

Regarding the HD this directive has a much wider scope than the BD as many habitat types of the HD relate to aquatic or wetland vegetation units and associated faunal elements, which depend either on surface water connection or groundwater supply. Yet not all the sites to which certain habitat types relate in principle are necessarily part of protected areas coherent with the Natura 2000 concept that forms the elementary backbone of the HD, as it assigns 'special areas of conservation' (Art. 3 HD).

Wetlands depending on surface waters or groundwater are considered an intrinsic part of the WFD, and therefore both the BD, with respect to avian life depending on wetlands, and the HD, which lists many types of wetland related vegetation types, have to be respected when developing management strategies to reach good ecological (and chemical) status of surface waters and good groundwater bodies. Yet, in its essence the WFD is a directive for water management in a very wide sense, but not a focal directive on nature protection. Therefore, the aims of the WFD are not in all cases and locations completely congruent with the exclusively ecological and/or conservational focus of—in a more general view—the HD, and equally not the BD.

2.2.2 Potential Synergies Between Goals of WFD and Natura 2000

After the WFD came into force, uncertainties with regard to the interaction of nature conservation and water management existed (Köhler 2003, p. 106; Schönauer 2007, p. 87). For a better use of synergies between WFD and Natura 2000 within the next planning phases of River Basin Management Plans (RMBP) and to avoid conflicts, it seemed appropriate, to assess potential synergies and conflicts between the goals of WFD and Natura 2000. In this and the following section these potentials are discussed, as were identified within the scope of an evaluation of both directives and all RBMPs in Germany.

The ecosystem approach of the WFD can contribute to the achievement of conservation objectives when reaching the good ecological status of surface waters which has positive effects on their function as habitat for animals and plants in relation to the HD (Kastens 2003, p. 292).

The exchange of populations as well as the development of a habitat network are aims of the Natura 2000 concept as well as of the WFD (‘river continuity’). With respect to the conservation areas Annex IV Number 1 lit. v) WFD explicitly refers to the Natura 2000 sites. The requirements of the WFD refer to the longitudinal and the lateral continuity of rivers. In accordance with the environmental conditions of good ecological status, unhampered migration of aquatic species and the transportation of sediments should be possible both from the river head to the water mouth and from the river to the wetlands attached to it. In connection with this situation, the importance of rivers and wetlands for the functioning of the habitat network has to be stressed. These linear elements are important for re-connecting isolated habitats (Busse 2009) acting as corridors for an active and passive, longitudinal and lateral spreading of species in general (Brunken and Meyer 2005, p. 111).

The restoration of dynamic floodplains and their drift zone is a further objective which contributes to both directives—the development of the Natura 2000 network as well as to achieve a good ecological condition for which the presence of fish is an important indicator. Alluvial forests (as mentioned in Annex I WFD) require pioneer sites for their establishment and Annex II of the habitats directive contains predominantly rheophylic fish species whose sustainable protection is only possible in dynamic water bodies (Korn et al. 2005, p. 77; Wendler and Albrecht 2012, p. 42).

Examples for the synergetic effects between the continuing implementation of the WFD and wildlife conservation measures in Germany can be found in reintroduction projects of the salmon (*Salmo salar*) (e.g. migratory fish project of the Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection of the German State of North Rhine-Westphalia), the beaver (*Castor fiber*) (e.g. projects in the Eifel region and at the lower Rhine) and wildlife conservation measures for water-dependent species such as freshwater pearl mussels (*Margaritifera margaritifera*) (q.v. Becker and Rebsch 2006). In the Rhine River especially the construction of the fish pass at the Iffezheim hydroelectric power plant supports the migration of salmon and other rheophylic fish species very efficiently and provides a paramount example for rehabilitating river continuity.

All in all considerably more synergies than conflicts can be identified between the objectives of the WFD and those of the environmental conservation (cf. Wendler and Albrecht 2012, p. 33 et seq. and p. 41). This is inter alia noticeable in the instruments’ approach as they focus both on the ecosystem, also in the development of rivers, brooks, alluvial plains and shores as well as in the expansion of the habitat network and the protection and further development of Natura 2000 sites. Particularly for the indigenous species and habitats, synergies are to be expected. Furthermore, the objectives of the WFD and the Natura 2000 directives serve the purposes of preventive flood protection, climate change mitigation and climate adaptation. These synergies can take effect because a large number of rivers and parts of the respective valleys are protected through the HD as special areas of conservation and therefore are subjected to the overlapping spatial scope of both directives (Albrecht et al. 2012; Hofmann and Schmidt 2012, p. 195).

2.2.3 Potential Conflicts Between Goals of WFD and Natura 2000

However, the objectives of the WFD on the one hand and the Habitats and birds directives on the other hand may also evoke opposing effects, especially if water dependent Natura 2000 sites with secondary biotopes or species of cultural landscapes are concerned (Fuchs et al. 2010, p. 113 et seq.; Wirth et al. 2000 seq): The WFD concept of reference conditions is based on existing natural or near-natural river reaches. If such examples are missing at present, historical information—where available—or modelling approaches can be applied to reconstruct historical conditions. If neither of these ways can be followed successfully, expert judgement is requested to define reference conditions. The requirements of HD relate to the present and not to any historical conditions of the relevant habitats. This difference can lead to conflict of interest.

In aquatic systems, especially those represented by regulated rivers and their floodplain water bodies, e.g., cut-off side channels and oxbows, WFD calls for re-establishing the historical situation, which was characterised by permanent interconnection of most floodplain waters. Therefore, still water environments, which is the character of former river bends or loops turned into oxbows by regulation measures, are not the near natural condition defined for high ecological status, and do certainly not conform with the definition of 'good ecological status', demanding that: "The values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions" (Annex V N°. 1.2 table 1.2 WFD). The present condition of cut-off meanders and river channels deviates more than just 'slightly' from their former structure and hydrology, and 'good ecological status' defined by WFD cannot be appointed to these aquatic habitats. In such cases, the conservational values regarding the HD (and sometimes the BD) compete against a full reclamation of river dynamics when strictly implementing WFD aims.

On the other hand, recent studies in the Austrian 'Danube National Park' (by appointment of IUCN) revealed two diverging situations. Floodplain waters characterised by high connectivity with the main river channel were either free of aquatic plant growth or showed very low diversity and abundance of these plants. In contrast, water bodies with moderate to low connectivity with the main river channel are inhabited by highly valuable aquatic vegetation and its associated fauna, from invertebrate level to amphibians, birds and mammals, which developed since river regulation was finalised in the mid-1870s.

In the first type of floodplain waters the situation of aquatic plants is comparable with that of main river courses and active side channels. WFD would require little or no changes in morphology and/or connectivity conditions, whereas the conservation status may well comply with a 'favourable' situation.

In the second type of floodplain waters, which were active side channels in pre-regulation time, WFD would require action towards considerably intensifying connectivity with the main river stem, i.e. towards a near-natural status. This would lead to an extreme decrease or even the terminal loss of the present aquatic vegetation and its associated fauna, but good or high ecological status in full accordance with running water conditions would be reached. On the other hand, our study showed that the present conservation status can be classified as favourable in the majority of that type of water bodies. This condition shall not be deteriorated by any human intervention according to HD. Yet, the enhancement of the ecological status à la WFD towards pre-regulation conditions with high connectivity with the main river channel would terminate the present diversity and abundance of aquatic flora and fauna. This would be a clear opposite to the goals of HD.

The most prominent EU document focusing on potential conflicts between WFD and HD/BD comprises a multitude of aspects related to this important topic (EC DG-Env 2011). Yet, practical application is in no way easily achieved, as the WFD aim of good status requires biological quality elements to 'deviate only slightly from those normally associated with … undisturbed conditions' (Annex V N°. 1.2 table 1.2 WFD). Concerning water bodies in river floodplains this means to implement permanently running water conditions again. Yet, as already stated above, numerous examples exist where 'regulation-artefacts' like oxbows have developed over a long time into habitats of highest conservational value, regarding their aquatic flora and fauna. In such cases, conflicting goals must be dealt with.

2.3 Implementation of the WFD in Natura 2000 Sites: Legal Provisions and Guidance of the European Commission

2.3.1 Legal Requirements for Implementing the Environmental Objectives in Natura 2000 Sites

After having detected the overlap between the objectives of the WFD and Natura 2000 as well as potential synergies and conflicts in Sect. 2.2, it needs defining which legal requirements exist for the coordinated implementation of the WFD in Natura 2000 sites.

First of all it has to be stated that the objectives of Art. 4 WFD apply to surface water bodies or groundwater, i.e. elements of precisely defined spatial extent (e.g. lakes, reservoirs, streams, rivers, canals, aquifers or part of them; (Art. 2 N°. 10 and 12 WFD). Natura 2000 sites are only affected by the WFD if they are part of such water bodies or can be qualified as ground water dependent ecosystems. Regarding Natura 2000 sites in floodplains the WFD is unclear to which extent they are part of the surface water body. In a wide interpretation, floodplains may be considered as part of a surface water body (normally a river) as far as they are functionally connected (EC 2003a, p. 14).

Nevertheless, the interdependencies between water bodies and flood plains call at least for protecting floodplains indirectly to achieve the good ecological status of surface water: Floodplains are important as a habitat for fishes like eel or pike, for instance. Their abundance may decrease significantly in the absence of natural flood dynamics (Krug and Ehlert 2003, p. 56; Schäfer 2004, p. 9). Therefore, recreation and restoration of wetland areas are important measures which have to be taken to achieve the good ecological water status (cf. Annex VI part B (vii) WFD). However, species living outside water bodies like amphibians or 'water-bound' mammals (e.g. beavers) are not in the focus of the WFD.

If the objectives of the WFD are applicable in Natura 2000 sites, Art. 4 para. 1 c) WFD regulates that Member States shall achieve compliance with any standards and objectives of the WFD at the latest by 2015, unless otherwise specified in the Community legislation under which the individual protected areas have been established. Where more than one of the objectives under Art. 4 para. 1 WFD relates to a given body of water, "the most stringent shall apply" (Art. 4 para. 2 WFD). This regulation aims to ensure that eventually more strict regulations of nature conservation law are not weakened by the WFD.

The legal situation is different if the objectives of the WFD ("good water status") and Natura 2000 law ("favourable conservation status") are in conflict. For this case, the directives do not regulate any general priority of the objectives of the WFD or of Natura 2000 law (Fuchs et al. 2010, p. 100 et seq.; Möckel 2007, p. 606 et seq.). However, the directives provide instruments how to handle conflicts in the individual case. The preconditions of these instruments are introduced in the following section.

The objectives of the WFD and Natura 2000 may be in conflict, for instance, if the removal of barriers, such as dikes and dams, is necessary to restore the original (hydromorphological) status of the water body as it is required by the good ecological status (Art. 4 para. 1 WFD). This may cause negative impacts on the conservation status of Natura 2000 sites, because, for example, secondary biotopes which are protected by the HD may have developed alongside artificially retained rivers. If the retaining structures are removed to restore river continuity with the aim to improve ecological water status, this may have negative impacts on the conservation status of the protected Natura 2000 site.

The legal instrument to solve such conflicts is the HD Assessment (Art. 6 para. 3 and 4 HD) (Fuchs et al. 2010, p. 107 et seq.). As designated in Art. 6 para. 3 HD any project not directly connected with or necessary to the management of the Natura 2000 site but likely to have a significant effect thereon shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. The above-mentioned construction measures will regularly be qualified as projects in the sense of Art. 6 para. 3 WFD. In spite of a negative assessment of the implications for the site and in the absence of alternative solutions, such a project may be approved, if it must nevertheless be carried out "for imperative reasons of overriding public interest". The achievement of the objectives of Art. 4 WFD may justify an overriding interest and can even be allowed if the concerned site hosts a priority natural habitat type and/or a priority species, as it may have beneficial consequences of primary importance for the environment (cf. Art. 6 para. 4 sent. 3 HD). However, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected and shall inform the Commission of the compensatory measures adopted (Art. 6 para. 4 sent. 1 and 2 HD).

2.3.1.1 Exemptions from the Good Water Status

If, vice versa, the prerequisites of Art. 6 para. 4 HD are not fulfilled, e.g. because there is no overriding public interest for deteriorating the Natura 2000 site to achieve the good water status, this may imply the omission of necessary river improvement measures for the achievement of the good (ecological) water status. The resulting failure to reach good water status may be justified by the deviating objective of the good ecological potential in accordance with Art. 4 para. 1 c) and para. 3 WFD or by exemptions in accordance with Art. 4 para. 4 to 7 WFD.

The achievement of the good ecological potential instead of the good ecological status (cf. Art. 4 para. 1 c) WFD) might be justified if the concerned water body could be classified as heavily modified or artificial water body (for natural water bodies the objective of the ecological potential is not applicable). The good ecological potential is achieved if the values of the relevant biological quality elements of the river, for instance, reflect, as far as possible, those associated with the closest comparable surface water body type, given the physical conditions which result from the artificial or heavily modified characteristics of the water body (1.2.5. Annex V WFD). The classification as heavily modified or artificial is possible if the changes to the hydromorphological characteristics of the concerned water body being necessary for achieving the good ecological status would have significant adverse effects on the wider environment (cf. Art. 4 para. 3 a) (i) WFD), which may include also the deterioration of the ecological status of Natura 2000 sites. However, the Member States have to substantiate that the beneficial objectives for nature conservation served by the artificial or modified characteristics of the water body cannot, for reasons of technical feasibility or disproportionate costs, reasonably be achieved by other means, which are a significantly better environmental option (Art. 4 para. 3 b) WFD). The designation as artificial or heavily modified and the reasons for it shall be specifically mentioned in the river basin management plans required under Art. 13 WFD and reviewed every 6 years.

If the omission of necessary hydromorphological restoration measures due to the protection of Natura 2000 sites impedes the achievement of the good water status in other water bodies than those which have been classified as heavily modified or artificial water bodies, this failure might also be justified by the exemptions designated in Art. 4 para. 4 and 5 WFD. Insofar, Art. 4 para. 4 WFD allowing extending the deadline for achieving the good status (i.e. 2015) under some preconditions by a maximum of 12 years seems to be less relevant, as the Natura 2000 sites have to be protected permanently, not only until 2027. In contrast, Art. 4 para. 5 WFD gives the opportunity to achieve less stringent environmental objectives beyond 2027 when they are affected by human activities, or their natural condition is such way that the achievement of these objectives would be infeasible or disproportionately expensive.

It can be argued that the achievement of the good ecological status of a water body is infeasible, if it requires construction works in the river bed or in the flood plains which would destroy or deteriorate the conservation status of a Natura 2000 site. However, in such cases the Member States have to ensure that the targeted environmental needs (i.e. the maintenance of the Natura 2000 site) cannot be achieved by other means, which are a significantly better environmental option. Furthermore, the least possible changes to the water status have to be achieved, no further deterioration must occur in the status of the affected water body and the establishment of less stringent environmental objectives, and the reasons for it, have to be specifically mentioned in the river basin management plan and those objectives have to be reviewed every 6 years (Art. 4 para. 5 WFD).

To sum up it can be stated that both the HD and the WFD contain appropriate legal instruments and sufficient discretionary leeway to find environmentally sound decisions in the individual case, considering both the objectives of the WFD and Natura 2000. Water and nature conservation authorities should cooperate in elaborating these decisions and should justify them carefully.

2.3.2 Guidance from the European Commission

The problem of how to implement the objectives of the WFD in Natura 2000 sites also drew the attention of the European Commission (DG Environment) and guidance is provided through some documents. First notes for an integrated implementation of the goals of Natura 2000 and WFD were formulated already in the CIS guidance document N° 12 (EC 2003b). Based on the first experiences with synergies and conflicts within the first planning phase, open questions were taken up and more detailed advice for the following planning phases were given (EC DG-Env 2010a, b, 2011).

Except for the more general reference to the two conservation-oriented Directives there is no direct link to Natura 2000 sites in WFD Annex VI, and of how to deal in specific situations. It was realised that the ecological conditions of wetlands across Europe are so highly diverse that a management principle of ‘one size fits all’ does not consider specifics of national importance, and e.g. the consideration of environmental flow was to be worked out as a CIS Guidance document N° 12 (EC 2003b, specifically Chap. 5). As a first step, this guidance provides criteria which types of wetlands covering Natura 2000 habitats and species are qualified under the WFD, which are habitats directly depending on the status of water (Table 8 in the cited document). In the same chapter taking account of these types of wetlands is requested as an essential part of river basin management plans (RBMP). Basic advice for dealing with spatially overlapping aims of the WFD and of Natura 2000 wetlands are given. It is stated, that “the most stringent objective will apply”. Furthermore the importance of RBMPs for improving the ecological coherence of the Natura 2000 network is highlighted. Rivers with their banks are named as essential structures as well as ponds functioning as stepping stones (cf. Art. 10 HD).

On the basis of experiences and case studies from the first phase of implementation the overall conclusions of a workshop report (EC DG-Env 2010b, p. 12) cover a series of positive findings. In the workshop apparent conflicts could be identified at a local level only. According to the authors of the report those conflicts were caused, in part, by misunderstandings.

While ensuring the proper application of Article 4 para 7 of WFD, noting the particular requirements related to Natura 2000 and other protected areas is an essential need for the future that should finally lead to a more integrated "… work with nature …" and resulting opportunities could be realised in a "… win-win-win …" situation. This accentuation made by the authors of the workshop report (EC DG-Env 2010b, p. 6) addresses chances offered by sustainable floodplain management as a tool which integrates navigation, flood protection and adapted agricultural land use, as well as the possible protection of habitats.

The workshop report is completed by a background document which introduces several case studies (EC DG-Env 2010a). On the basis of more than 20 examples for e.g. "differences and commonalities in objectives and scope of the WFD and BHD" and the "coordination of measures in the context of integrated planning to achieve the WFD and BHD objectives" possible actions are illustrated.

In the final conclusion for dealing with incompatibilities of goals of these Directives aiming at the same aquatic ecosystems one finds the following advice (EC DG-Env 2011).

As many HD Annex I habitats are aquatic areas or water-dependent systems, the measures proposed under BD, HD and WFD may be partly the same. As far as water bodies in water-dependent protected areas are concerned, measures under these directives need to be coordinated between the responsible authorities for nature conservation and water management, and included in the WFD programme of measures. It is advisable to start dialogue on the programme of measures of WFD at an early stage in order to avoid conflicts that could arise from misconceptions of the objectives of WFD and BD or HD. Regarding the Danube National Park area that covers the river and the floodplains east of Vienna this coordination is implemented on a broad scale (see Sect. 2.2.3). Regarding the National RBMP these issues are not covered in detail, as strategic and operational structures already exist between public, planning and the responsible legal bodies.

On the other hand, aquatic habitats in active river floodplains with moderate to low connectivity with the main river channel are a rare ecosystem type throughout Europe where rivers have been regulated for navigation and/or flood protection purposes. Many of these water bodies bear high conservational value but often they are not part of protected areas under HD regulation. Therefore, no legal conflict exists when assigning priority to WFD goals in all such situations as an a priori. Even when not—yet—protected by HD, a dialogue on the programme of measures as part of WFD implementation should be a firm request in order to save ecological highlights.

Furthermore, the guidance document (EC DG-Env 2011, p. 9) provides a lot of detailed and instructive knowledge, offering ecological criteria for the identification of water-dependent Natura 2000 sites. The same document states that the "… WFD does not change what Member States must achieve for the BHD, but it provides a joint framework for the implementation of measures needed by both WFD and BHD in water dependent Natura 2000 sites …" (ibid, p. 9). According to this aim it is summarized that the "… WFD in itself does not allow derogating from the requirements set under the BHD, and vice versa …". Everything planned and decided under the WFD "… must take account of the possible impact on the objectives of the BHD, and vice versa." (ibid, p. 25).

In addition it is explained that "the objectives in the WFD and the BHD are not defined in the same way. In the BHD the overall objectives refer to species and habitat types at the level of the biogeographical region, but also objectives are set on site level to achieve those, whereas the objectives of the WFD refer to water bodies. The objectives for a given water body resulting from the WFD and the Habitats and birds directives have to be aligned in order to assess which measures must be taken" (ibid, p. 11). Generally, the restoration towards good ecological status according to WFD prevails. But there can be exceptions to this general rule "when it would become impossible to maintain a species or habitat type of community interest at a favourable conservation status or, where necessary, to restore such a status". It is important to note that each case has to be decided individually and that it is "advisable to have a clear track record of how judgements are made and what were the considerations made that led to this judgement" (ibid, p. 11). The favourable conservation status of species and habitats is assessed referring to biogeographical regions and not to the site-level. In the workshop report it is recommended to use the water body type and its characteristics as a basis for joint objectives for overlapping water bodies and Natura 2000 sites (ibid, p. 11).

Finally this guidance document highlights the importance of coordination and consultation between the different stakeholders affected by the implementation of BHD and WFD (EC DG-Env 2011, p. 22) and it recommends joint monitoring activities in order to save resources also in a trans boundary context (ibid, p. 26). All in all this paper about frequently asked questions is indeed a very useful guidance document which is practice-oriented and illustrated by several particular cases and practical experiences.

2.4 Experiences in the Implementation of WFD in Natura 2000 Sites and Recommendations

2.4.1 River Basin Management Planning in Austria

Member States of the EU are required to develop river basin management plans (RMBP) and programmes of measures. The first RMBP had to be delivered in 2009, whereas the programmes of measures developed thereafter need to cover the elements described in detail in Annex VII of WFD.

Regarding activities in Natura 2000 sites, the Austrian National RBMP covers the necessary management in a context of supervision, integrated into the more basic obligations under WFD implementation and measures for enhancing water policy, especially for developing regional planning programmes. The best example and the largest regarding area are the activities in the Danube National Park, which cover the river reach between Vienna and Bratislava. In this reach the regulation of the Danube carried out in the late 19th century caused still progressing riverbed incision (long-time average 2 cm per year; Jäger 2013, Fig. 5.3), which results in groundwater level reduction in the adjacent riparian forest and oxbow ensemble along ca. 60 km of river course. This phenomenon threatens the hydrological basis of the National Park as well as several aspects of commercial navigation. Stopping or at least substantially reducing this deepening process is the goal of the technical solution sought, which has to be achieved without impounding the river, and without causing detrimental effects to the benthic life in the river bottom. Promising solutions have been worked out so far and a pilot study is in full progress. Special legal and environmental requirements effective for this river reach called for special ways of consulting and clearance, and extensive stakeholder involvement, including NGOs. The needs of integration between HD (comprising the substance of BD, too) and WFD are met by a sensitive step-by-step approach. This procedure links ecological, conservation and technical expertise from universities, as well as a special 'consulting citizens forum', and the relevant units of provincial and federal government (G. Janauer, K. Reiter, I. Korner, 2011, FFH-Lebensraumkartierung. Endbericht, Bauabschnitt 1. Flussbauliches Gesamtprojekt. viadonau und Bundesministerium für Verkehr, Innovation und Technologie (bmvit/Österreich), Unpublished report). The status of the Danube River as the assigned European Transport Corridor VII is also respected and technically integrated in all planning steps. Every single step of executing the present pilot project needs full agreement by governmental bodies responsible for conservation issues, navigation aspects, details of material to be used in the construction of groynes and the re-granulation of the river bottom, etc., as well as clearance by the 'consulting citizens forum'. Following this line, and by cross consulting of the different bodies involved in the decision supporting process finally a consensus is worked out which allows the basic balance between ecological, hydrological, and navigation needs.

Another example is the Austrian/Hungarian cross-border National Park Neusiedler See/Fertö To, where water management under the regulation of the WFD and considering the needs of the HD is an integrated task for the two responsible federal water management organisations, the Austrian Federal Agency for Water Management and the Hungarian North-Transdanubian District Environment and Water Directorate (Pannonhalmi and Rojacz 2012; Pannonhalmi 2013). The process of working out sustainable solutions for lake management was based on many years on fact finding and collection of environmental and hydrological data. This information was analysed and commented during official meetings of experts and governmental representatives assigned to the Austrian/Hungarian Border-Water Commission. Specific requirements of habitats ranging from the shallow lake water body, the extensive reed belt to the soda flats, ponds and wetlands in the closer surroundings and their complex and often cross-border interaction had to be integrated. This efficient long-time collaboration and final mutual decision on the essential ecological water level conditions sustains today not only the lake and the National Park cross-border compound, but also the wetlands used by migratory birds in a Europe-wide step-stone ensemble that reaches from Eastern Europe via the Hungarian Balaton lake and the Fertö/Neusiedler See to the Oostvaardersplassen wetland area in the Flevoland Province of The Netherlands (Veen 2012).

Of course the National RBMP for Austria is not restricted to Natura 2000 areas as was the HABIT-CHANGE Project (Rannow et al. 2014). It comprises all river basins and their surface and groundwater objects registered under WFD requirements. Under the umbrella of the Federal Ministry of Agriculture, Forest Management, Environment and Water Management all the nine Provinces of Austria have prepared their contributions to the National RMBP (2014).

2.4.2 River Basin Management Planning in Germany

As the research project analysing the 2009 established documents of river basin management planning (see Sect. 2.2.2) has shown, most management plans in Germany contain for the most part only general information about how protection and conservation aims of the protected areas were taken into account at the RBMP and during the definition of management aims, and if they were coordinated with the planning of measures. In Schleswig-Holstein, e.g., all measures according to WFD are coordinated with all affected Natura 2000 areas by the responsible conservation authorities. If they identified any conflicts they strived for solutions which don't stand contrary to the objectives of the Natura 2000 sites. The same applies to measures of nature conservation which are coordinated with the objectives of WFD (LU M-V 2009, p. 118; Hofmann and Schmidt 2012, p. 219).

In the RBMP of the Weser River it is documented that in case of conflicting aims coordination was undertaken between the water management and nature conservation authorities concerned. In the result, a solution was found to either fitting both aims or for deciding which of the aims is prior-ranking. Furthermore, it was considered which synergies of conservation aims and objectives of the RBMP of the Weser can be made accessible by suitable measures. Moreover, the Natura 2000 aims for water dependent ecosystems and aquatic habitats are supported by taking into account the protection and conservation objectives, particularly for hydrophilic species and their habitats in the context of monitoring and of planning of measures as well as by coordination with the conservation authorities (Stratmann et al. 2012b, p. 104).

Altogether, the RBMPs in Germany show that regarding the Natura 2000 sites a cooperation of nature conservation and water management has taken place in all Federal States. However, the intensity might have been very different and is reflected only partly in the formal documents (Hofmann and Schmidt 2012, p. 220).

Since, in general, details on coordination activities are not documented in the RBMP or in the programmes of measures, it is not comprehensible, whether possible conflicts between Natura 2000 and WFD were already solved during the preparation of the programmes of measures or whether they are rather passed on to the subsequent planning levels. Thus, one can assume that a considerable amount of probably unsolved conflicts of objectives is remaining as part of the RBMPs and programmes of measures.

2.4.3 Recommendations for the Implementation and Future Management Planning

A look at the first generation of RBMPs in Germany and Austria has shown that the relationship between WFD and BHD was already considered and coordination between water management and nature conservation has taken place. However, the information given in the plans is not very detailed and provides still room for improvement. To avoid conflicts and to utilize synergies in further implementation and planning, the following recommendations can be given on the basis of hitherto planning experience, especially gained in the above-mentioned project on the analysis of German river basin management planning 2009 (see 2.2.2):

1. Network areas and protected areas for Annex IV species should be included.
   Representatives of nature conservation have repeatedly demanded that the list of protected areas according to Art. 6 of the WFD should include network areas according to Art. 10 of the HD and protected areas for Annex IV species according to Art. 12 of the HD, as well as the national categories of protected areas, despite this is not being required by European law. This has not yet occurred in Germany, neither, for instance, in Austria or Poland. The inclusion of such areas would, however, encourage the timely harmonisation of objectives and thus the smooth implementation of both directives. On the part of nature conservation, criteria should therefore be developed according to which a consistent approach and selection of the relevant areas can occur (Stratmann et al. 2012a, p. 307). These areas include those of the national biotope network and various national categories of protected areas, in particular nature conservation areas, national parks, biosphere reserves and landscape conservation areas. Once network elements or protected areas that form these network elements are identified, it is also necessary to decide which objectives related to the hydrological regime are critical for their function and should be integrated into agreements with water management.
2. Implementation of measures in Natura 2000 sites should be closely coordinated and prioritised.
   The sensitivity of species included in Annex II of the HD to the types of measures (included in the catalogue compiled by LAWA the German Working Group on water issues of the Federal States and the Federal Government) has been

investigated and showed that in Germany various forms of sensitivity were expected for 60 % of the 90 species considered. Thus, in addition to very beneficial effects for the development of semi-natural biotopes, there may be conflicts involving, in particular, changes in location, loss of area and changes in the open-land biotopes and habitats of the cultural landscape or secondary biotopes. In both cases it is important to ensure a firm and timely coordination between nature conservation and water management in relation to Natura 2000 at subsequent planning stages. This is particularly so because the highly abstract nature of the spatial locations of measures given in the programmes of measures limits the conclusions that can be drawn from these sources. It is thus impossible at present to determine the extent to which conflicts in objectives have already been resolved or—especially—the extent to which the potential of complimentary objectives has been deliberately exploited. Water management should therefore involve nature conservation as thoroughly and promptly as possible in measures for Natura 2000 sites or measures which influence Natura 2000 sites, and thus ensure compatibility with the conservation objectives of Natura 2000 sites. At the same time it is to be recommended that measures having positive effects from the perspective of both the WFD and the Habitats or birds directives should be prioritised, also in terms of implementation. Lower Saxony, for instance, provides an example of how measures can be prioritised in consideration of Natura 2000 sites. One criterion for prioritizing measures for the improvement of hydromorphology and river continuity was their location within water dependent habitats protected by the HD (Hofmann and Schmidt 2012, p. 219 f.).

3. Further development of management plans for Natura 2000 sites.
   In many cases, management plans for the Natura 2000 sites were not completed at the first phase of WFD management planning. This means that the objectives of the protected areas could not be assessed for compatibility. Therefore, HD management plans should be further developed so that they contain conservation objectives in a form appropriate for use by management planning. On the one hand, this would enable the timely consideration of nature conservation issues during WFD implementation. On the other hand, functionally and spatially specific conservation objectives for the Natura 2000 sites can be seen as a further WFD objective (WFD Art. 4 para. 2); thus it is recommended that management plans for the water-dependent Natura 2000 sites should be urgently developed at an appropriate level of specification (Stratmann et al. 2012a, p. 308). In this way groundwater levels and qualities relevant to the protection or development of groundwater-dependent terrestrial ecosystems within the Natura 2000 network can also be stipulated by nature conservation and integrated into WFD implementation. These specific stipulations are also a concrete step towards satisfying the prohibition on deterioration and thus meeting the objectives of the WFD for groundwater bodies on which terrestrial ecosystems depend.

Cooperation of water management and nature conservation in practical implementation: The example of the “Landshuter Modell”.

A good example of cooperation between water management and nature conservation is the practice-oriented “Landshuter Modell”, which was developed in Southern Germany (Landshut in Bavaria). The basis of this model was developed within a project for restoration of river banks along the river “Große Laber” started in 1995. The water management administration of Landshut and the Government of Lower Bavaria, division of nature conservation, established a successful cooperation during a longer process of planning and implementation partly together with additional partners (Schacht and Lorenz 2013, p. 1). The model shows concrete starting-points and defines a method for the future cooperation between the different authorities and stakeholders. This comprises, e.g., coordination of priorities as regards content, financial and personnel capacities and responsibilities before the kick-off of the project as well as the joint preparation of the scope of services for specific planning tasks and the invitation for offers for project implementation. Insofar, it substantiates the current RBMPs regarding the coordinated implementation with nature conservation on the local and regional level. The “Landshuter Modell” integrates the Natura 2000 management planning and the planning tasks according to WFD in one plan for development of the ecological functions of surface waters (Schacht and Lorenz 2013, p. 4 et seq.). Following this model, four so-called “ecological development concepts” (“Ökologische Entwicklungskonzepte”, “ÖEK”) were established at the Isar, the Danube and the Vils between 2003 and 2013. In contrast to traditional sectoral water plans the “ÖEK” provide area-wide mapping of biotope types and differentiated faunistic and floristic investigations, and thus allow for the requirements of Natura 2000 management planning. Vice versa, they overcome the restrictions of Natura 2000 management planning widening their content and spatial scope with regard to the needs of the WFD. On this basis, planning procedures and approvals for the implementation of the designated measures are easier to coordinate. The “Landshuter Modell” is judged to be a successful model since it has made possible and simplified the often intensive and difficult process of coordination between nature conservation and water management. The early coordination of the cooperating administrations as well as an intensive integration of the public and stakeholders are stressed positively. The experiences made show that extensive cooperation allows for more profound solutions as regards conflicting contents and later on for faster planning processes on subsequent planning levels. Therefore, the approach of the “Landshuter Modell” for planning and cooperation seems suitable to be applied to the implementation of RBMP.

2.5 Conclusions

All in all, an analysis of the regulations and the river basin management plans of the first planning phase of the WFD has shown that considerably more synergies than conflicts can be identified between the objectives of the WFD and those of the environmental conservation. Both instruments focus on the ecosystem, on the development of rivers as well as on the expansion of the habitat network. Particularly for the indigenous species and habitats synergies are to be expected. Furthermore, the objectives of the WFD and the Natura 2000 Directives serve the purposes of preventive flood protection, climate mitigation and climate adaptation.

If conflicts arise, the WFD does not allow derogating from the requirements set under the BHD in general. Therefore, everything planned and decided under the WFD must take into account the possible impact on the objectives of the BHD, and vice versa. Considering a qualified mutual coordination it is necessary that management plans for water-dependent Natura 2000 sites are developed at an appropriate level of specification. Generally, restoration towards good ecological status according to WFD prevails. But there can be exceptions when it would become impossible to maintain a species or habitat type of community interest at a favourable conservation status or, where necessary, to restore such a status.

Summing up it can be stated that both the HD and the WFD contain appropriate legal instruments and sufficient discretionary leeway to find environmentally sound decisions in the individual case. Water and nature conservation authorities have to cooperate in these decisions to avoid conflicts and justify their decisions carefully. Therefore, firm and timely coordination between water and nature conservation authorities is highly recommended.

References

Albrecht J, Schmidt C, Stratmann L, Hofmann M, Posselt S, Wendler W, Roßner D, Wachs A (2012) Die Wasserrahmenrichtlinie aus Sicht des Naturschutzes—Analyse der Bewirtschaftungsplanung 2009. In: Naturschutz und Biologische Vielfalt, vol 120, Bonn—Bad Godesberg, p 346

Becker R, Rebsch S (2006) Wasserrahmenrichtlinie überall—Die Anwendung der Richtlinie in verschiedenen Rechtsbereichen. In: Wassernetz NRW, Handbuch Wasserrahmenrichtlinie Nordrhein-Westfalen, Chapter 3, p 38

Birds Directive (1979) Council Directive 79/409/EEC of 19 November 1979, Convention on the Conservation of European Wildlife and Natural Habitats. In: J Communities L 103, p 27

Birds Directive (2009) Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (codified version). In: Official J Eur Union L20, p 19

Brunken H, Meyer L (2005) Die Bedeutung der Durchgängigkeit von Auenlebensräumen für die Fischfauna. NNA-Berichte 18(1):105–113

Busse M (2009) Nur auf dem Papier? Die Umsetzung der Wasserrahmenrichtlinie aus Sicht der Umwelt- und Naturschutzverbände, Tagung Naturschutz und Wasserrahmenrichtlinie—wie wächst zusammen, was zusammengehört? Alfred Toepfer Akademie für Naturschutz (NNA) in Zusammenarbeit mit dem Niedersächsischen Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz (NLWKN) 22/23 September 2009 Schneverdingen. http://www.nna. niedersachsen.de/servlets/download?C = 59341103&L = 20. Accessed 30 June 2013

Convention on wetlands of international importance especially as waterfowl habitat (1971) Ramsar Convention. http://www.ramsar.org/cda/en/ramsar-documents-texts-convention-on/main/ramsar/1-31-38%5E20671_4000_0. Accessed 17 Sep 2013

EC—European Commission (2003a) Common Implementation Strategy for the Water Framework Directive (CIS). Guidance document N°. 2. identification of water bodies, p 24

EC—European Commission (2003b) Common Implementation Strategy for the Water Framework Directive (CIS). Guidance document N°. 12. The Role of Wetlands in the Water Framework Directive, p 69

EC DG-Env—European Commission, Directorate-General for the Environment (2010a) Workshop: biodiversity and water—links between EU nature and water legislation, case studies. Representation of Northrhine-Westfalia to the EU, 17–18 June 2010, Brussels, p 58

EC DG-Env—European Commission, Directorate-General for the Environment (2010b) Workshop: biodiversity and water—links between EU nature and water legislation, workshop report. Representation of Northrhine-Westfalia to the EU, 17–18 June 2010, Brussels, p 12

EC DG-Env—European Commission, Directorate-General for the Environment (2011) links between the water framework directive and nature directives—frequently asked questions, Brussels, p 29

Friedrich G (2003) Wasserrahmenrichtlinie und Naturschutz. In: Grüne Liga e.V. (ed) Die EG-Wasserrahmenrichtlinie, vol 1, Bewertungsmethoden, Naturschutz, Hochwasserschutz, Revitalisierung von Flussläufen, Berlin, p 39–40

Fuchs M, Preis S, Wirth V, Binzenhöfer B, Pröbstl U, Pohl G, Muhar S, Jungwirth M (2010) Wasserrahmenrichtlinie und Natura 2000, Gemeinsame Umsetzung in Deutschland und Öster-reich am Beispiel der Grenzflüsse Salzach und Inn. In: Naturschutz und Biologische Vielfalt, vol 85, Bonn—Bad Godesberg, p 318

Gopal B (ed) (2013) Environmental flows: An introduction for water resources managers. National Institute of Ecology, Delhi, India, p 248

Habitats Directive (1992) Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. In: J Communities L 43, p 66

Hofmann M, Schmidt C (2012) Vertiefende Analyse ausgewählter Schnittstellen, Natura 2000. In: Albrecht J, Schmidt C, Stratmann L, Hofmann M, Posselt S, Wendler W, Roßner D, Wachs A (2012) Die Wasserrahmenrichtlinie aus Sicht des Naturschutzes—Analyse der Bewirtschaftungsplanung 2009. In: Naturschutz und Biologische Vielfalt, vol 120, Bonn—Bad Godesberg, p 193–223

Jäger B (2013) River floodplain habitats and theri aquatic macrophyte vegetation: biodiversity and conservation status defined by connectivity. Diploma thesis, Vienna

Kastens B (2003) Die Wasserrahmenrichtlinie—neue Chancen durch horizontale Interaktion von Wasserwirtschaft und Naturschutz. In: Moss T (ed) Das Flussgebiet als Handlungsraum. Institutionenwandel durch die EU-Wasserrahmenrichtlinie aus raumwissenschaftlichen Perspektiven. Münster, p 289–319

Köhler R (2003) Wasserrahmenrichtlinie und Naturschutz. Ziele, Schnittstellen und Defizite. In: Naturschutz und Landschaftspflege in Brandenburg 12/3, p 101–106

Korn N, Jessel B, Hasch B, Mühlighaus R (2005) Flussauen und Wasserrahmenrichtlinie, Bedeutung der Flussauen für die Umsetzung der europäischen Wasserrahmenrichtlinie. In: Naturschutz und Biologische Vielfalt, vol 27, Bonn—Bad Godesberg, p 258

Krug A, Ehlert T (2003) Auenschutz und Hochwasservorsorge durch die Wasserrahmenrichtlinie. In: Grüne Liga e.V. (ed) Die EG-Wasserrahmenrichtlinie, vol 1, Bewertungsmethoden, Naturschutz, Hochwasserschutz, Revitalisierung von Flussläufen, Berlin, p 56–57

Louis H-W (2000) Bundesnaturschutzgesetz, Kommentar, 1. Teil, §§ 1 bis 19, 2. Auflage, Braunschweig

LU M-V—Ministerium für Landwirtschaft, Umwelt und Verbraucherschutz des Landes Mecklenburg-Vorpommern, MLUR—Ministerium für Landwirtschaft, Umwelt und Ländliche Räume des Landes Schleswig-Holstein (2009) Maßnahmenprogramm (gem. Art. 11 EG-WRRL bzw. § 36 WHG) der Flussgebietseinheit Schlei/Trave

Möckel S (2007) Umsetzung der Wasserrahmenrichtlinie bei FFH- und Vogelschutzgebieten. Natur und Recht 29:602–608

National RMBP (2014) NGP—Nationaler Gewässerbewirtschaftungsplan Österreich. WEB-Reference: http://www.bmlfuw.gv.at/wasser/wasser-oesterreich/plan_gewaesser_ngp/nationaler_gewaesserbewirtschaftungsplan-nlp.html

Pannonhalmi M, Rojacz H (2012) Wasserwirtschaft im Grenzbereich Österreich—Ungarn. In: Kárpáti L, Fally J (eds) Fertő-Hanság—Neusiedler See—Seewinkel National Park. Monograph, Szaktudás kiadó Ház, Budapest, p 16

Pannonhalmi M (2013) Hungarian-Austrian Water Commission on the example of the cross border lake Fertö to/Neusiedler See, North-Transdanubian Water Directorate, Györ, p 4

Rannow S, Macgregor NA, Albrecht J, Crick HQP, Förster M, Heiland S, Janauer G, Morecroft MD, Neubert M, Sarbu A, Sienkiewicz J (2014) Managing protected areas under climate change: challenges and priorities. Environmental management. doi: 10.1007/s00267-014-0271-5

Schacht H, Lorenz W (2013) Das „Landshuter Modell“, Ökologische Entwicklungskonzepte mit integrierten Gewässerentwicklungskonzepten und FFH-Managementplänen. In: Auenmaga-zin 4/2013, 4–9. http://www.auenzentrum-neuburg-ingol-stadt.de/Auenzentrum/uploads/ media/Auenmagazin_04_2013_online.pdf. Accessed 30 June 2013

Schäfer T (2004) Der Schutz von Feuchtgebieten und grundwasserabhängigen Ökosystemen nach der Wasserrahmenrichtlinie. In: Grüne Liga e.V. (ed) Die EG-Wasserrahmenrichtlinie, vol 2, Grundwasser, prioritäre Stoffe, Umsetzung der Wasserrahmenrichtlinie in den Flusseinzugsgebieten, Öffentlichkeitsbeteiligung, Berlin, p 8–10

Schönauer S (2007) Wasserrahmenrichtlinie und Naturschutz—getrennte Aufgaben, gemeinsames Handeln. NNA-Berichte 20(1):82–88

Stratmann L, Hofmann M, Posselt S, Wendler W, Schmidt C, Albrecht J (2012a) Zusammenfassung der Kernempfehlungen. In: Albrecht J, Schmidt C, Stratmann L, Hofmann M, Posselt S, Wendler W, Roßner D, Wachs A (2012) Die Wasserrahmenrichtlinie aus Sicht des Naturschutzes—Analyse der Bewirtschaftungsplanung 2009. In: Naturschutz und Biologische Vielfalt, vol 120, Bonn—Bad Godesberg, p 304–316

Stratmann L, Wendler W, Posselt S, Albrecht J (2012b) Vergleichende Auswertung der Bewirtschaftungspläne. In: Albrecht J, Schmidt C, Stratmann L, Hofmann M, Posselt S, Wendler W, Roßner D, Wachs A (2012) Die Wasserrahmenrichtlinie aus Sicht des Naturschutzes—Analyse der Bewirtschaftungsplanung 2009. In: Naturschutz und Biologische Vielfalt, vol 120, Bonn—Bad Godesberg, p 86–119

Trouwborst A (2011) Conserving european biodiversity in a changing climate: the Bern convention, the European Birds and habitats directives and the adaptation of nature to climate change. Rev Eur Community Int Environ Law 20(1):62–77

Unnerstall H (2003) Der Schutz von Auen nach der EU-Wasserrahmenrichtlinie und dem Bundesnaturschutzgesetz—ein Vergleich. In: Natur und Recht, p 667–677

Veen A (2012) Personal communication, Rijkswaterstaat water framework directive (2000) Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for community action in the field of water policy. In: J Eur Communities L 327, p 72

Wendler W, Albrecht J (2012) Ziele von Wasserrahmenrichtlinie und Naturschutz. In: Albrecht J, Schmidt C, Stratmann L, Hofmann M, Posselt S, Wendler W, Roßner D, Wachs A (2012) Die Wasserrahmenrichtlinie aus Sicht des Naturschutzes—Analyse der Bewirtschaftungsplanung 2009. In: Naturschutz und Biologische Vielfalt, vol 120, Bonn—Bad Godesberg, p 23–44

Wirth V, Preis S, Muhar S, Jungwirth M, Pröbstl U (2000) Umsetzung von WRRL und Natura 2000 am Beispiel der Grenzgewässer Salzach und Inn. In: Natur und Landschaft 87, vol 4, p 156–160

Chapter 3
Can Natura 2000 Sites Benefit from River Basin Management Planning Under a Changing Climate? Lessons from Germany

Lars Stratmann and Juliane Albrecht

Abstract Goals for nature conservation and development are set for several rivers and lakes which are situated within protected areas. Concurrently these areas have to meet the requirements of the Water Framework Directive. Between the goals of both scopes there are often synergies but partially conflicts. In addition, climate change, which touches both water management and nature conservation at the same time, has to be taken into account during the river basin management planning, too. Against this background it is discussed in consideration of climate change, how the goals of nature conservation and of the Water Framework Directive can be achieved in such a way that conflicts are avoided to a large extent and synergies used. The following discussion and its results are based on an evaluation of the river basin management plans and programmes of measures in the ten river catchment areas of Germany. Altogether, it can be noticed that potential synergies are already put to good use. However, there are even more unused possibilities for the improvement of the interplay of nature conservation and Water Framework Directive as well as for the consideration of climate change effects.

Keywords Water framework directive · Nature conservation · River basin management plan · Programme of measures · Climate change

3.1 Introduction

At present, the Water Framework Directive (WFD) is implemented in the Member States of Europe. In this context, programmes of measures and river basin management plans had to be drawn up by 2009 for the attainment of a good water

L. Stratmann · J. Albrecht (✉)
Leibniz Institute of Ecological Urban and Regional Development, Weberplatz 1, 01217 Dresden, Germany
e-mail: j.albrecht@ioer.de

S. Ignar and M. Grygoruk (eds.), *Wetlands and Water Framework Directive*, GeoPlanet: Earth and Planetary Sciences, DOI 10.1007/978-3-319-13764-3_3

status. In doing so, spatial overlapping of nature conservation goals and of goals of the WFD is recognised within many floodplains and wetlands in Europe. The question arises: To what extent a content-related coordination of overlapping goals of nature conservation and WFD has been carried out within the first planning phase until the end of 2009. Such coordination seems reasonable to avoid conflicts between measures of the WFD and aims of nature conservation areas as well as to use synergy potentials specifically. The integration of climate change in the river basin management planning according to WFD and in the management planning for Natura 2000 areas is increasingly meaningful. This applies particularly to the current phase of up-dating of plans and programmes in accordance with WFD until the end of 2015. For current and future planning activities it is important to assess how the goals of WFD, of nature conservation and of climate change adaptation and mitigation were integrated into the plans and programmes till now.

Therefore, the German Federal Agency for Nature Conservation has commissioned a research project regarding the assessment of the river basin management plans (RBMP) and programmes of measures (PoM) in the German river basin districts in view of the consideration of aspects of nature conservation. The project is entitled “Implementation of the WFD from the Perspective of Nature Conservation—Analysis of the River Basin Management Planning” (FKZ 3509 83 0100) and was conducted by the Leibniz Institute of Ecological Urban and Regional Development (IOER) in cooperation with the Chair of Landscape Planning at the Technische Universität Dresden (Albrecht et al. 2012). The project focused on identifying the overlap between river basin management planning and nature conservation and included the assessment of the plans with regard to the consideration of nature conservation aspects. Recommendations for the optimal integration of nature conservation into the planning documents in the future were given. The project revealed important knowledge regarding the content and procedure of planning as well as the consideration of the aims of nature conservation, especially in Natura 2000 sites. The findings will be reported in the following article and are intended to be used in the second planning period.

The following essay is subdivided into three sections. At first the river basin management planning is introduced as a planning instrument for the attainment of the aims of the WFD. In this chapter, the contents of the RBMP and the PoM and the different levels of planning in accordance with WFD are explained (Sect. 3.2). The second section explains the implementation of river basin management planning within protected areas. Therefore, the consideration of protected areas throughout the implementation of the WFD is described in detail, and cooperation and participation means for the integration of conservation aspects into river basin management planning are introduced (Sect. 3.3). Then it is examined how the goals of the WFD can be accomplished even under the influence of a changing climate. In fulfilling this task, opportunities in the context of the scheduled planning instruments and steps are discussed and recommendations given (Sect. 3.4). Finally, conclusions are drawn and an outlook on future implementation is given (Sect. 3.5).

3.2 RBMP As a Key Instrument to Achieve the Objectives of the WFD

The WFD provides two planning instruments for achieving the objectives of Art. 4: the programme of measures (Art. 11 WFD) and the river basin management plan (Art. 13 WFD). Together, these two planning instruments form the basis for a coherent, all-embracing management concept for river basins. Article 3 WFD establishes the river basin as the spatial unit for water management planning. Member States have to identify river basins within their territory and assign them to river basin districts (Art. 1 para. 3 WFD).

River basin management planning and especially the selection of appropriate measures are key instruments to achieve the objectives of Article 4 WFD and have to be coordinated with the objectives of nature conservation. In EC-DGEnv (2010), a dialogue on the programme of measures of WFD at an early stage was identified as a tool for the coordination of the objectives of the WFD on the one hand and the objectives of the HD and BD on the other hand. Since the end of 2009, programmes of measures (Art. 11 WFD) and river basin management plans (Art. 13 WFD) are available in most Member States of the EU.

3.2.1 Content of the Programmes of Measures and River Basin Management Plans

The programme of measures sets out the actions to be taken during the implementation period to achieve the objectives of Art. 4 WFD (Czychowski and Reinhardt 2010, Section 82 marginal no. 2). Each programme of measures contains basic and, where necessary, supplementary measures (Art. 11 para. 2 WFD). Basic measures have to be carried out regardless of the present status of water bodies (Rechenberg et al. 2000, p. 41). This is to avoid impairing the quality of ecologically intact water bodies. Supplementary measures are defined in Article 11 para. 4 sentence 1 of the WFD as measures that are planned and realized by Member States to achieve the objectives of Article 4. Such measures have to be taken if the basic measures are not sufficient to achieve the good water status (Seidel and Rechenberg 2004, p. 213, 219). The river basin management plan concretises the objectives of Article 4 WFD for each water body and documents all steps of river basin management planning (cf. Art. 13 WFD). A summary of the PoM is included in the RBMP, too (cf. Annex VII No. 7 WFD).

Public consultation plays an important role during the whole implementation process of the WFD. Thus, Member States shall encourage the active involvement of all interested parties in particular in the preparation, review and updating of the RBMP (cf. Art. 14 para. 1 WFD). Regarding the production, review and updating of the PoM, public participation is not explicitly mentioned in Art. 14 WFD. However, programmes of measures are subject to Strategic Environmental Assessment (SEA) according to Article 2 a, Art. 3 para. 1, 2 a, b and para. 5, and Annex II SEA-Directive, which also requires public participation (Art. 6 SEA-Directive) (cf. Carter and Howe 2006, p. 288 et seq.). Therefore, the PoM is subject to public participation, too. Moreover, the PoM can be also subject to the Habitats Regulations Appraisal according to Article 6 para. 3 HD.

The RBMPs and the PoMs had to be finalized and published by 22 December 2009 at the latest (Art. 13 para. 6 and Art. 11 para. 7 WFD). They are to be reviewed and updated until 22 December 2015 and every 6 years thereafter (Art. 13 para. 7 and Art. 11 para. 8 WFD). Their cyclical updating is a refining process based on improved data and understanding and allowing for real changes of circumstances in the river basins (Foundation for Water Research 2012).

3.2.2 Levels of River Basin Management Planning

River basin districts cross not only the borders of a number of Federal States, but in some cases also national borders. Cross-border cooperation is thus obligatory for both states and countries when drawing up management plans and programmes of measures (Art. 3 and 13 WFD). This requires the coordination of the contents of PoMs and management plans across both state and national boundaries. Parts of a total of ten river basin districts lie in Germany (Danube, Elbe, Rhine, Eider, Schlei/Trave, Weser, Oder, Meuse, Ems, Warnow/Peene).

The WFD stipulates that for river basin districts that lie wholly within the territory of a Member State, a management plan (national management plan) must be produced for the river basin district in question (Art. 13 para. 1 WFD). The drawing up of a single plan for international river basins is also desirable (international management plan). If no joint plans are produced, then the plans should at least cover that part of the river basin district that lies within the territory of the Member State (national management plan for part of the river basin district) (cf. Art. 13 para. 2 WFD). In Germany there are several cases where a number of planning documents have been produced that at different levels cover the same area of the river basin in question and also cases where a number of planning documents have been produced covering smaller, adjoining sub-areas of one river basin. For instance, for the Elbe a joint plan for the entire (international) river basin district has been published; in addition, a national management plan and its associated PoM including an environmental report have been produced; and, furthermore, supplementary plans for various sub-areas of the same river basin district have been produced and circulated at the level of the Federal States. For the national river basin of the Rhine there is no complete plan; the relevant plans have instead been produced for four national and five international planning areas. As a result, the first of the three planning phases of WFD implementation (up to the end of 2009) saw substantially more than ten PoMs and ten RBMPs being produced for the ten river basins in Germany (Posselt et al. 2012, p. 75 et seq.). There are, in addition, the environmental reports made on the PoMs within the framework of the SEA.

Various national and international institutions (international river basin commissions, transboundary water commissions, national river basin associations) have been tasked with the coordination of plans (Posselt et al. 2012, p. 76). The aim of coordination is to draw up a management plan, including the PoM that contains binding specifications for all management measures and decisions within the river basin district (Ell 2003, p. 72; Spillecke 2000, p. 32). In order to achieve this, the specialist quality goals are aligned at the beginning of the planning process. This is ensured by a bottom-up approach in which responsible state authorities communicate results gathered, prepared and evaluated at the level of the district in question to the coordinating authorities (LAWA 2001, p. 10; Knopp 2005, pp. 25–26). This is at the same time associated with constant generalisation owing to the decreasing scale of perspective (Ell 2003, p. 71).

3.3 Implementation of RBMP in Protected Areas

The following discussion clarifies how protected areas are integrated into management and measures planning in Germany and what effects the programmes of measures can have on the protected areas. The section concludes with consideration of the environment assessment instruments: Strategic Environmental Assessment (SEA) and Habitat Regulations Appraisal (HRA).

3.3.1 Consideration of Protected Areas in the Implementation of RBMP

Evaluation of management plans and PoMs has shown that the requirements and goals of protected areas, particularly the Natura 2000 sites, are affected in many ways by management planning.

- *Determining and mapping protected areas in the first cycle of management planning*

With reference to the Habitats Directive, there are various opinions about which areas should be included in the list of protected areas in WFD management plans. Several authors include not only those areas protected under European law (Natura 2000 sites) but also elements of the biotope network (Art. 10 HD) and areas protected under national law that—based on Article 12 of the HD—serve to protect species listed in Annex IV of the Habitats Directive (Korn et al. 2005; Fuchs et al. 2010). In contrast, for instance, the German Working Group on Water Issues of the Federal States and the Federal Government (LAWA 2003) specifies that only all formally identified Natura 2000 sites should be considered.

The minimal requirements of Annex IV of the WFD are applied in Germany; generally speaking: all plans include information on Natura 2000 sites, but just one plan includes further protected areas in its list of protected areas. All management plans list and describe in text the water-dependent Natura 2000 sites, but only the management plan of the Oder included all Natura 2000 sites (also, e.g., dry grassland). The Warnow-Peene plan considers only Natura 2000 sites that have been approved by the EU Commission. The Ems management plan additionally identifies water-dependent protected areas based on national legislation (Section 23 Federal Nature Conservation Act). In numerous plans, there was no description of the method used to determine the water-dependent protected areas; reference was rather made to background documents (Stratmann et al. 2012b, p. 94).

In most plans, information about protected areas was also provided in a printed map, in a few plans there was only a reference to an online map server. The presentations on the map servers were often linked to further attributes (e.g. standard spread sheets). Some but not all plans included a clear presentation of water body boundaries and protected areas together. As a result, a clear assignment of protected areas to water bodies was not always possible. In such cases the impact of planned measures on individual protected areas is thus not clearly identifiable, a factor that must be negatively assessed from a nature conservation perspective (Stratmann et al. 2012b, p. 96).

- *Practices of Federal States with regards to the nomination of water-dependent Natura 2000 sites*

There is great variety between some of the Federal States of Germany in terms of the choice of WFD relevant Natura 2000 sites intended to conserve habitats and species directly dependent on water. Most of the German non-city States base their choice of areas on water-dependent habitat types or species, but Saxony nominated all the Natura 2000 sites. The situation seems similar for Brandenburg. Saxony-Anhalt though used the depth of the water table as the criterion for determining the choice of the Natura 2000 sites with habitats and species directly dependent on water. When the range of species considered is examined, it becomes clear that North Rhine-Westphalia and Saarland list species from Annex IV of the HD, while the other states only consider species from Annex II. When nominating water-dependent bird protection areas, six non-city states considered not only the bird species from Annex I of the Birds Directive but also migratory birds as mentioned in Art. 4 para. 2 of the BD. In contrast Schleswig-Holstein and Thuringia restrict consideration to species from Annex I. There are also area-related criteria. Hesse and Thuringia explicitly mention that they set no minimum size for consideration, but in Bavaria and Baden-Wuerttemberg a minimum area of 5 ha of water-dependent habitat types per protected area was stipulated. These, however, only affected special areas of conservation (SACs) with no relevant water-dependent species (Hofmann and Schmidt 2012, p. 216).

In the documents investigated there is usually only brief mentioning of the procedure followed when nominating the relevant protected areas. It can be assumed that there are other more detailed differences between the procedures of the Federal States in addition to those that can be identified from these sources. For instance, the list of Annex I (HD) water-dependent habitat types found in Hesse includes woodrush and woodruff beech woods as well as bedstraw-oak-hornbeam woods as habitat types that are in some cases groundwater-dependent; however, these habitat types are not included in the list of water-dependent habitat types for Baden-Wuerttemberg or Bavaria (Hofmann and Schmidt 2012, p. 216).

Differences in the nomination of protected areas can lead to differences in terms of conservation objectives for protected areas. It is possible that the heterogeneity of nomination may cause delays in the first cycle of management planning due to supplementary assessments and appeals based on species conservation legislation (Fuchs et al. 2010, p. 38 et seq.). According to Fuchs et al. (2010), there are also significant differences in nomination procedures between the various European countries.

- *Economic analysis of environmental costs for species and habitat types covered by the HD*

The WFD intends that economic framework conditions are considered in management plans (the so-called economic analysis). The economic analysis is to be carried out as part of the inventory and should consider and present the four areas: economic significance of water uses, baseline scenario (forecast) of water uses up to 2015, recovery of costs of water services, and cost effectiveness of measures (cf. Annex III WFD).

From a nature conservation perspective this information can be of interest in a number of areas. Information about the economic significance of water uses and their future development (baseline scenario) may provide a basis for assessing current and future impacts on protected assets (Wendler et al. 2012, p. 50). On the one hand, the needs of nature conservation are to be considered when determining environmental and resource costs, and should also be included in the criteria used to assess the cost efficiency of measures. On the other hand, current forecasts about the future development of nature conservation issues (e.g., with regards to climate) form the basis of the baseline scenario, which in turn provides information about the future development of water supplies, are taking into account the influence of climate change. This section thus provides indications about whether objectives for certain planning units or water bodies may require modification in the future and also aids in the choice of measures that will be effective in the long-term (Stratmann et al. 2012b, p. 107).

However, there is currently a general lack of pragmatic, easy to handle, methodological approaches for including in the economic analysis environmental costs for species and habitat types covered by the HD. Furthermore, the terms ‘water services’ and ‘water uses’ are very narrowly interpreted in Germany, so that numerous impacts on species and habitats are not considered from an economic perspective (e.g. by hydroelectric power, flood defences). For these reasons, the environmental impacts and costs regarding Natura 2000 are not included in the economic analysis sufficiently. As long as these environmental costs are not internalised, protected areas will not be adequately assessed when decisions about uses are made (Stratmann et al. 2012a, p. 308 et seq.).

Climate change is named as a basis for all or nearly all the baseline scenarios of water uses in the management plans. But so far climate change is said to have no influence on questions of water uses in the first phase of management planning (Stratmann et al. 2012b, p. 112). Therefore, climate change effects did not influence environmental costs for species and habitat types in Germany, but this might change in the next phases of management planning.

- *Aspects and consequences of the planning of measures for Natura 2000 sites*

As reference conditions for ecologically sound surface waters, the WFD uses waters largely undisturbed by humans, and thus formulates guiding principles that assume and promote self-driven processes and developments up to and including biocenoses specific to the individual water body type. It can therefore be assumed that the retention and development of natural and near-natural biocenoses in and on water bodies will benefit from far-reaching synergies between Natura 2000 and the WFD measures.

Nature conservation in Natura 2000 sites is concerned not only with the protection, management and development of natural biocenoses and habitats, but also in some cases with the protection of anthropogenically influenced biocenoses and the conservation and development of habitats and species of cultural landscapes. In addition, there are secondary biotopes that have developed in a fashion atypical to their locations following human intervention. These may be contrary to the process orientation of the WFD and its reference conditions for good ecological status, i.e., undisturbed by human activity. Conflicts in the implementation of Natura 2000 and the WFD could occur here and would need to be resolved (Hofmann and Schmidt 2012, p. 195 et seq.).

Key to achieving a good status for surface waters is the removal of hydromorphological impairments within the framework of the planning of measures in accordance with the WFD. Straightened river courses, cut-off side channels and floodplains that have been isolated by dykes are to be dealt with, for instance, by measures intended to improve aquatic habitats by adapting river courses, banks and beds, measures to initiate or allow the development of self-sustaining dynamic rivers, or measures to improve habitats within the development corridor (including the floodplain) of the water course. As well as the very positive effects of this in terms of natural water conditions, however, the use of such measures may lead to somewhat negative effects for species and habitats that are more culturally determined and for secondary biotopes that have developed atypically for their locations. Critical in this context are effects that lead to successive vegetation change on and around the waters towards vegetation types that are potentially natural today. Equally critical are changes to restore river regimes and the water logging or drying up of secondary biotopes. Furthermore, the reconnection of cut-off side channels, for instance, can end previous isolation from predators or illness (Hofmann and Schmidt 2012, p. 196 et seq.).

About 90 species from Annex II of the HD are relevant to surface waters or floodplains. Of these, it is predicted that about 40 % will either be positively affected by the measures of the management plans and programmes of measures, or will experience no impact. About 60 % of the species of community importance in Germany are considered to be in various ways sensitive to certain types of management planning measures. In individual cases these species could also be damaged by a lack of coordination between nature conservation and water management (Hofmann and Schmidt 2012, p. 214).

In order to substantiate this statement, certain types of measures were chosen for closer study. The results vary considerably. For instance, the planning units used for measures (and accompanying measures) to initiate or allow the development of self-sustaining dynamic rivers overlap with 90 % of the areas protected under the HD in which potentially sensitive species of community importance are present. When reducing the backwater area is considered, it is found that this type of measure affects only 3 % of the areas protected under the HD in which potentially sensitive species are present. The frequency of overlap obviously also reflects the basic frequency of the use of the measure in question (Hofmann and Schmidt 2012, p. 214).

This frequent overlapping of sensitive HD areas with planning units in which a potentially conflicting measure is to be undertaken does not, however, necessarily reflect the actual distribution density of conflicts. It is rather an initial indication of the large scale of the planning units and the abstract nature of the PoM. In the Federal States Bavaria, Brandenburg, Saxony und Schleswig-Holstein, where a detailed assignment of measures to water bodies was possible, the overlapping is much reduced. Indeed, then only 10–32 % of the sensitive HD areas overlap with water bodies where potentially conflicting types of measures were planned. It can be assumed that a spatially accurate assignment of the planned measures in other Federal States would also reveal a much reduced level of conflict (Hofmann and Schmidt 2012, p. 214 et seq.).

It is nonetheless regrettable that even in Federal States that work with spatially accurate assignments, there remains a not insignificant number of cases for which it is currently impossible to say whether the implementation of WFD measures would lead to conflicts with the conservation objectives of the Natura 2000 sites or not. In the management plans there are many references to coordination having taken place with nature conservation. However, the findings clearly show that in the further course of management plan implementation deepened coordination between water management and nature conservation is required to ensure that measures are compatible with the HD. Remaining issues can and must be rectified at the lower level, e.g. in the approval procedures (Hofmann and Schmidt 2012, p. 215).

- *Consideration of nature conservation aspects in the SEA of the programme of measures*

A strategic environmental assessment (SEA) is required for the programme of measures. This involves assessing the significant environmental effects expected from the contents of the PoM and comparing them to appropriate alternative measures. In order to achieve an effective assessment, the SEA must be integrated into the process of preparing the PoM.

All of the PoMs investigated in Germany had undergone a SEA. Analysis of the environmental reports drawn up in the course of the SEAs showed that for the most part they contained the necessary information. However, the analysis also showed that the SEA was usually conducted on a smaller scale than that of the PoM. In most cases the assessment was carried out for planning units, coordination areas or the entire planning region. If the objects of assessment used for the SEA were more specific, then the environmental assessment could provide more detailed indications of significant effects on nature conservation issues. In addition, a targeted assessment of relevant cumulative effects on numerous successive or neighbouring water bodies, and also of the effects of single measures on entire river systems, would represent a qualified assessment of cumulative effects that could provide system-relevant information about the development of special nature conservation issues (Stratmann et al. 2012c, p. 143).

There is no documentation of the assessment of alternatives in any of the environmental reports. In all the reports the assessment of alternatives was displaced either sideways (into the management plan that is not subject to the SEA) or in some cases downwards (to the next planning permission procedure). The examination of alternatives in the management plan was, however, not carried out in the formal framework of an environmental assessment, but rather in the planning stages of the river basin management plan and informal agreements with nature conservation. There was thus no documentation of assessments of conceptual, systematic or spatial alternatives. A significant element of the SEA was thus not applied (Stratmann et al. 2012c, p. 147 et seq.).

In the context of the sideways displacement of the examination of alternatives into the management plan, it was stated many times that alternatives had been discussed and evaluated during the management planning process, particularly at the local and regional level, and that alternatives had therefore already been assessed “outside” the planning of the PoMs. The argument is not fully convincing, because the planning period for both management plan and PoMs is the same. The documentation and review of comparisons with alternatives in terms of integrating aspects of nature conservation would thus have been possible (Stratmann et al. 2012c, p. 147).

Similarly to the examination of alternatives, the spatially defined, quantitative prognosis of effects was displaced to the next specific planning stage in all the environmental reports. This corresponds with the level of specification of the programme of measures, but it means that necessary agreements, for instance with nature conservation, had not yet been possible. The concern here is that, firstly, more time will be needed for agreement at the next planning stage, which could delay prompt implementation, and, secondly, desirable synergies or important conflicts will only be identified at this later planning stage where large-scale alternatives can no longer be chosen. This problem is further compounded by the fact that no water body specific environmental assessment is carried out, but only one at the scale of the planning units (Stratmann et al. 2012c, p. 147 et seq.).

- *Habitats Regulations Appraisal and its role in integrating the objectives of RBMP and Natura 2000*

If stipulations of the PoM are spatially and content wise specific enough for a prognosis of their effects on the areas protected by the Habitats Directive to be possible, then effects relevant to nature conservation are also to be assessed using the framework of a Habitats Regulations Appraisal, in accordance with Art. 6 para. 3 of the HD and Sections 34 and 36 of the Federal Nature Conservation Act. For instance, the interaction of a number of WFD measures or types of measure along an extended river course, that mainly represents one Natura 2000 site, can be better assessed at a higher planning level than at the next small-scale concrete level where measures are implemented. The objects of assessment are the effects on protected habitat types (Annex I HD) and species (Annex II and IV HD) (Wendler et al. 2012, p. 62 et seq.).

The Habitats Regulation Appraisal was displaced to the next planning stage in almost all environmental reports. In only two cases was there a preliminary examination of the compatibility of the WFD measures with the objectives of the potentially affected Natura 2000 sites. The Habitats Regulation Appraisal was thus neither integrated in, nor linked to, the SEA for the PoM, but is for the most part to be carried out subsequently in connection with the environmental impact assessment of the planning approval procedure. This means that many of the necessary agreements and the integration of the objectives of the WFD areas with those of the Natura 2000 sites can only be undertaken at the time of project approval and not in advance. There was made no strategic distinction between Natura 2000 sites which protect natural processes and those which are conservation oriented on the level of the PoM or for specific water bodies. Subsequently the respective differences in compatibility of these categories of Natura 2000 objectives with measures of the PoM are not considered. It will be necessary to resolve conflicts of this sort at later planning stages, for instance through spatial separation and in certain circumstances the juxtaposition of naturally determined and culturally determined areas (Stratmann et al. 2012c, p. 148).

With management planning being undertaken for the first time, it was found that management plans with established objectives had not been finalised for numerous Natura 2000 sites. This represented a further hindrance to the coordination of Natura 2000 objectives with WFD activities. When the plans are next updated and continued—from 2013 onwards—it will be possible to use the objectives and measures of the existing Natura 2000 management plans for coordination. An attempt can be made to ensure that the WFD supports or integrates the measures contained therein (Stratmann et al. 2012c, p. 148).

3.3.2 Cooperation and Participation to Include Nature Conservation in RBMP

In addition to the issues of content and method already discussed, the involvement of nature conservation authorities and public participation can influence the integration of nature conservation matters into management planning. The following section thus considers several aspects related to the involvement of authorities and public participation.

- *Short overview: Cooperation and integration of conservation and water management in RBMP in Germany*

In order to ensure compatibility with the conservation objectives of the Natura 2000 sites, it is to be recommended that water management involve nature conservation at an early stage for measures in Natura 2000 sites or for measures that may influence such areas. Furthermore, can be recommended to prioritise the implementation of measures that have a positive effect in terms of both: the WFD and the HD and/or the BD. Lower Saxony provides an example of a state where procedures are based on consideration of Natura 2000 sites when prioritising measures (Hofmann and Schmidt 2012, p. 221).

The texts of the German management plans show that cooperation between nature conservation and water management for Natura 2000 sites is basically to be found in all the Federal States. Obviously the intensity of cooperation differed considerably from state to state and is reflected in the formal documents to a limited extent only. Firm cooperation between nature conservation and water management in terms of Natura 2000 and other specific nature conservation issues has not yet been established. But a close cooperation between nature conservation and water management will be of great significance in order to realise synergy effects in subsequent stages as planning becomes more concrete (Hofmann and Schmidt 2012, p. 221 et seq.).

Most of the management plans contain information about the way in which protection and conservation objectives of nature conservation areas were considered during management planning and the development of management aims. For example, the Weser management plan states that conflicting objectives were discussed between water and nature conservation authorities responsible. Either a solution was found that satisfied both sets of objectives, or a decision reached as to which objective was most important. In addition, in the course of planning measures for the Weser, an assessment was made of synergies between the objectives of the protected areas and management objectives, and it was determined which of these synergies it may be possible to exploit through the use of appropriate measures. Furthermore, the Natura 2000 objectives for water-dependent terrestrial ecosystems and aquatic habitats are given support. This is achieved by consideration of protection and conservation objectives, particularly for water-loving species and habitats within the frame of operational monitoring and when compiling the PoM and coordination of objectives with the nature conservation authorities (Stratmann et al. 2012b, p. 104).

Usually agreement with regards to the objectives of the Natura 2000 sites was reached early on with the authorities responsible for nature conservation. This is generally documented. Whether this mostly involved conservation (preservation of the status quo) or whether developmental aspects (e.g. protection of natural processes) with regards to Natura 2000 were also considered is not recorded in the management plans. It is therefore not possible to determine here whether the management plans primarily promote developmental aspects in Natura 2000 sites or whether conservation objectives in these areas are also supported, and if so to what extent (Stratmann et al. 2012b, p. 105).

However, not every management plan reveals the extent to which adequately concrete nature conservation objectives have contributed to the specification of management plan objectives. In order to understand the true facts of each case, it would be necessary to assess background documentation and/or conduct interviews (Wendler and Albrecht 2012, p. 37).

- Further needs for coordination and good practice examples

Potential conflicts can usually be solved if measures are coordinated—spatially and contentwise—synchronised and adapted to one another (cf. also Fuchs et al. 2010). In the course of drawing up the management plans, the necessary processes for agreement between water management and nature conservation have clearly begun, but they can in no way be regarded as complete. For a total of six types of measure in Germany as a whole there is, for example, overlapping between the planning units stipulated for the measure and between 67 and 95 % of HD areas with species protected under the directive that are sensitive to the measure in question. Therefore, solutions have to be found on subsequent planning levels for the conflicts documented in the management plans (Hofmann and Schmidt 2012, p. 220 et seq.).

The intensive involvement of representatives of nature conservation on all levels of water management planning is the basic precondition for the emergence of win-win situations. A positive example of this is the specialist agreement made between water management and nature conservation administrations in Bavaria with regards to the hydromorphological programme of measures (Stratmann et al. 2012b, p. 117). In the course of drawing up this programme, Natura 2000 sites representing water-dependent habitat types where the habitat type was influenced by surface waters were considered. The water-relevant Natura 2000 conservation objectives specific to the areas in question were translated into corresponding hydromorphological measures, and agreement between the water management and nature conservation administrations reached. This procedure was documented in the environmental report for the PoM.

Frequently, however, it is not possible to determine the nature of cooperation between water management and nature conservation, at least not from the management plans and PoMs. This is partly because in many plans the composition of advisory boards is not detailed and individual actors remained unnamed. However, in all cases where the composition of advisory boards or forums or other participatory institutions was documented, then nature conservation representatives were included. In addition, representatives of agriculture, industry and commerce, mining, shipping, and cities and municipalities were involved (Stratmann et al. 2012b, p. 117 et seq.).

Formal public participation in the drafting of management plans varied greatly. In Bavaria, ca. 7,000 opinions were submitted and over 10,000 completed questionnaires were returned by post from France and Wallonia regarding the RBMP for the Rhine River. In the light of this considerable amount of participation, it should be analysed how best to achieve a significant increase in participation in the future in regions with low participation—also in order to know that the interests of nature conservation are more strongly represented among the local population (Stratmann et al. 2012b, p. 118).

In the opinions expressed formal, procedure-related and content-related aspects were addressed. The range of suggestions encompassed all topics touched upon by the WFD. A few management plans chose to document the opinions and technical suggestions through combining an aggregated summary of the most important aspects with a tabular list of all opinions received, and including also the administrative decisions as to how these opinions were integrated into planning. It was, however, not possible to detect any nature conservation focuses among the technical suggestions submitted (Stratmann et al. 2012b, p. 118).

3.3.3 RBMP As a Tool for Achieving WFD Objectives in a Changing Climate

Management planning offers many possible ways to adapt watercourses and groundwater, and their uses, to a changing climate. On the one hand, it is possible to influence the quantity and quality of water that will be available and be used in the future. On the other hand, the adaptation requirements of water-dependent habitats and species can be fulfilled.

Climate change issues are not explicitly mentioned in the WFD regulations that came into force in the year 2000. In the meantime, dealing with the effects of climate change is seen as one of the greatest challenges of the 21st century (cf. Schuchardt et al. 2008). Scenarios of the global effects of climate change (cf. IPCC 2007) and their regionalisation (e.g. Endlicher and Gerstengarbe 2007) prove that for long-term strategies and measures there is an urgent need for action. The field of water management is particularly affected, because consequences for both water quality and water quantity are expected, accompanied by changes in ecological status, usability and the occurrence of extreme events such as flooding and low water levels (LAWA 2010). The report of the European Environment Agency on “Climate Change and Water Adaptation Issues” expresses the belief that in the light of climate change there is urgent need for European water management issues to be integrated with climate change adaptation measures (cf. EEA 2007). Taking into account climate change requires an integrated view of ecological and chemical water status and other fields such as flood risk management and land-use management (BMU 2007).

The European Commission has published two documents with far-reaching recommendations for CC adaptation: The Policy Paper “Climate Change and Water” (EC 2008) and the Guidance Document No. 24—“River Basin Management in a Changing Climate” (EC 2009). In general, it is stated in the documents that the step-wise and cyclical approach of the WFD makes it well suited to handle climate change (EC 2008, p. 4; similarly Reese 2011, who however postulates strict legal obligations for climate adaptation in water management). Climate change should at least be considered in the first planning cycle of river basin management planning, paving the way for more actions in the second and third cycles (EEA 2007, p. 27; BMU 2007, p. 4).

Requirements arising from climate change should thus be included in management planning. The recommendation for the current planning cycle is that the current state of knowledge and the effects of climate change should be described (cf. BMU 2007, p. 4; EC 2008, p. 4; EC 2009, p. 39). This can be included in discussion of the pressures on water bodies and the further development of assessment methods for ecological status (cf. Gammeltoft 2007).

Further WFD planning steps and instruments relevant to the focus on climate change are: monitoring and assessment of water status (Art. 8 WFD, Annex V), objective setting and making use of exemptions (Art. 4 WFD), the economic analysis (EC 2009, p. 39 et seq.).

Climate related objectives should be particularly considered when formulating and implementing environmental objectives and measures. On the one hand, it is necessary to reduce and avoid further climatic warming; and, on the other hand, adjustments to climate change must be attempted. Measures should thus be preferred that, in addition to their effectiveness in relation to WFD objectives, also reduce emissions of greenhouse gases (win-win measures) at the same cost. Similarly, preference should be given to measures with a high tolerance of climate change and that also remain effective and expedient despite greatly differing types of climatic change (no regret measures) (EC 2009, pp. 63–64).

Nature conservation and WFD can be well combined to achieve the greatest possible adaptability of water bodies and wetlands to climate change. Although there may be conflicts in individual cases (see above), in general, both strive to attain the goal of intact aquatic ecosystems, the qualities of which make a contribution to climate change adaptation. Such systems are characterised by varied hydromorphological structures, thus providing a retreat for aquatic fauna in stress situations, such as flooding or low water events. The continuity of watercourses allows resettlement by water-type specific species through migration, for instance after periods of drought. In the context of the apparent increasing necessity of low water management, further measures to improve water retention in the catchment should be planned. Such measures are of significance both to nature conservation and to the aims of the WFD, firstly in connection to the retention of diffuse substances in the catchment area and, secondly, in connection to the various environmental objectives of nature conservation, such as the extensive protection of a diversely structured landscape, soil protection and the safeguarding of balanced precipitation-runoff processes (Wendler et al. 2012, p. 55).

The issue of climate change and the necessary adjustments it implies have further connotations for nature conservation. It can be predicted that climate change will cause further changes in groundwater processes; these must then be incorporated in the planning of groundwater management and consideration of the effects on groundwater-dependent surface waters and terrestrial ecosystems (cf. LAWA 2009).

Climate change can result in changes in habitats (e.g. for salmonids) and biocenoses in watercourses and lakes (e.g. through invasive species). This can in the long-term lead to a change in the reference conditions away from those laid out in the inventory. Clear conclusions can, however, not yet be drawn. Climate change scenarios forecast changes in the precipitation regime. This would then change runoff hydrographs with consequences for watercourses, and lead to longer periods of dry-weather runoff conditions, longer periods of high runoff in winter and more frequent flooding events (Wendler et al. 2012, p. 55). Investigation of the consequences for aquatic biocenoses has hardly begun (Wulfhorst 2010, p. 89).

A further connection between management planning and nature conservation objectives is to be found with the issue of the protection and development of zones where cold and fresh air is produced. The presence and effectiveness of these zones depend partly on the distribution of water-dependent ecosystems, i.e. from surface water bodies and water-dependent terrestrial ecosystems. These zones are particularly important in the context of adaptation to climate change because even in adverse weather conditions they provide pollution-free, fresh air for polluted settlement areas and can prevent the overheating of urban regions. If water-dependent ecosystems become dryer, then it is to be expected that their potential for climatic balancing will also decline (Wendler et al. 2012, p. 55 et seq.).

3.4 Recommendations for Integrating Climate Change in RBMP

In the first river basin management planning documents, climate change was addressed only seldom in most cases mentioned as a potential threat. But within the second planning cycle until 2015 climate change shall be integrated systematically. Therefore, the following recommendations can be given from the perspective of nature conservation (cf. Stratmann et al. 2012a, p. 305 et seq.):

1. Adjusting reference conditions for water bodies and methods for status assessment. Aspects of climate change should be included when assessing the status of water bodies. This should involve the adjustment of climate scenarios for use in the river basin, parameters for monitoring the water-related effects of climate change being incorporated in the monitoring programme, the adjustment—where necessary—of water type specific reference conditions, and the adjustment of status assessment methods. This will create a basis for further planning of objectives and measures that enable climate protection and the effects of climate change to be considered in an integrated manner. This will then allow the formulation of effective measures that are win-win and no regret in terms of climate change.
2. Adjusting risk assessments for groundwater-dependent terrestrial ecosystems. At the moment water extraction that has continued at a constant rate over many years is not further monitored in Germany for instance. Climate change can,

however, lead to alterations in groundwater levels and runoff from watercourses that over time result in significant damage to groundwater-dependent terrestrial ecosystems. It is thus recommended that the next phase of management planning should include more careful consideration of climate change when carrying out risk assessments for groundwater-dependent terrestrial ecosystems.

3. Adjusting strategies for goal attainment and management objectives. When formulating strategies for goal attainment and aligning management objectives, attention should be paid to further aspects relevant to nature conservation, e.g. climate change and flood protection. These should occur early in the planning process. The timely integration of nature conservation objectives within the frame of coordinated management and measures planning allows to simultaneously achieve these nature protection objectives. If the relevant background documents are clearly named and easily available, then it is probable that the stated objectives will be successfully integrated into further planning stages, particularly the stipulation of measures.
4. Adjusting calculations of the environmental costs of water uses. The effects of climate change on the hydrological regime should be included in the baseline scenario on the basis of up-to-date (regionalised) climate forecasts. As climate change effects can vary in strength according to region, it will probably be necessary to use regionally differentiated adjustments for individual river basins. If regionally significant climate change effects occur, it may be necessary to reassess the environmental costs of water uses, because these may need to be differently measured if water supply changes. In addition, changed climatic conditions may have an influence, e.g. on the setting of environmental objectives, on the prioritisation of measures from a nature conservation perspective and on the planning of measures overall.
5. Conduct a climate check for measures. The process by which measures for the programme of measures are chosen should include a climate check based on up-to-date regionalised climate forecasts, to ensure that measures are primarily chosen that for the area in question have positive effects in terms of climate change and protection (win-win) or that will be effective under the influence of different climatic developments (no regret). Such a climate check is recommendable because WFD measures should also be effective over the medium to long-term. Measures should thus be chosen that are also effective under changed climatic conditions. This can indirectly ensure that intended synergies with nature conservation also come into effect under the influence of climate change. The adaptation of aquatic habitats to changed climatic conditions can thus, under the auspices of nature conservation, be particularly encouraged. The German Strategy for Adaptation to Climate Change (Die Bundesregierung 2008), for instance, demands for surface waters that their continuity and diversity of structure be increased and floodplains be regained and reinvigorated. “Appropriate measures (…) should be intensified and implemented in cooperation with the authorities responsible for nature conservation, agriculture and water management and land users” (Die Bundesregierung 2008, p. 27). Furthermore climate protection measures should be preferentially selected (e.g. conservation and

restoration of wetlands or wet upper soil layers), because current climate protection activities fall far behind the objectives that have been set. In Poland, the Strategic Adaptation Plan is now created on the level of the ministry of environment in order to reveal and mitigate possible negative influences of the climate change to all sectors, including the biodiversity of aquatic ecosystems. However, due to the vast delay of adaptation measures implementation in Poland if compared to the other EU countries, the goals of the programme are only to be achieved before 2020.[1]

3.5 Conclusion and Outlook on Coordination of Nature Conservation and WFD Implementation

It can be summarized, that there is great potential for strengthening synergies between water resource management and nature conservation in river basin management planning. This concerns primarily the ecosystem based approach of both WFD and nature conservation and, as regards contents, the ecological development of rivers and streams as well as of banks and meadows, the improvement of habitat networks and the conservation of Natura 2000 sites. In particular, there are many interconnections between Natura 2000 sites and measures of the WFDs programmes of measures. The examination of sensitivities of Appendix II species (Habitats Directive) with respect to the types of measures listed for implementation in accordance with WFD showed that varying sensitivities are to be expected for about half of the protected species concerned.

The potentials for synergies between water resource management and nature conservation are not fully exploited yet. Therefore the degree of substantive detail and the spatial allocation of planning content should be increased. It can be recommended to relate special nature conservation issues, such as Natura 2000 area boundaries including networking elements clearly to the content of water management planning, for example water body boundaries. Furthermore, pragmatic methodological approaches for including costs for species and habitat types covered by the Habitats Directive in the economic analysis should be provided. Last but not least, the participation of the public could be improved, especially as regards nature conservations interests.

But since the measures planned are mostly spatially unspecific so far, potential conflicts and synergies could not yet be discussed in concrete terms. In such cases, determined coordination between nature conservation and water resource management is especially important at subsequent planning levels.

[1] Further information available at (visited 28th May 2013): http://www.mos.gov.pl/kategoria/5145_adaptacja_do_zmian_klimatu.

Climate change causes new framework conditions both for implementing the programmes of measures and for the setting of aims for protected areas, for, e.g., Natura 2000 sites. We have to accept the challenge of climate change, thus climate related objectives should be particularly considered when formulating and implementing environmental strategies and measures. On the one hand, it is necessary to reduce and avoid further climate warming; and, on the other hand, adjustments (according) to climate change must be attempted. Measures should thus be preferred that, in addition to their effectiveness in relation to WFD objectives, also reduce emissions of greenhouse gases (win-win measures) at the same cost. Similarly, preference should be given to measures with a high tolerance to climate change, remaining effective and expedient also under changing climate conditions. In general, due to the ambitious ecological objectives of Art. 4 WFD river basin management planning contributes to increasing the resilience of aquatic and water-dependent ecosystems against climate induced stresses.

The planning instruments are suitable to cope with the requirements named above. The cyclical updating of the plans and programmes and the given flexibility of aims and measures allow for a continuous integration of climate change aspects based on updated data and understanding, and for real changes of circumstances in the river basins.

In conclusion it can be said that nature conservation can benefit from river basin management to great extent. Therefore, the potential synergies should in future be tapped by more concrete planning and presentation, by integrating further aspects of nature conservation in the individual methodological modules of river basin management planning and by good communication and participation.

References

Albrecht J, Schmidt C, Stratmann L, Hofmann M, Posselt S, Wendler W, Roßner D, Wachs A (2012) Die Wasserrahmenrichtlinie aus Sicht des Naturschutzes – Analyse der Bewirtschaftungsplanung 2009. In: Naturschutz und Biologische Vielfalt Bonn – Bad Godesberg, vol 120

BMU—Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (2007) Conclusion from the international symposium "time to adapt – climate change and the European water dimension". http://www.climate-water-adaptation-berlin2007.org/documents/conclusions.pdf. Accessed 11 June 2013

Carter J, Howe J (2006) The water framework directive and the strategic environmental assessment directive: exploring the linkages. Environ Impact Assess Rev 26(3):287–300

Czychowski M, Reinhardt M (2010) Wasserhaushaltsgesetz, Kommentar, 10th edn, Munich

Die Bundesregierung (2008) Deutsche Anpassungsstrategie an den Klimawandel, vom Bundeskabinett am 17. Dezember 2008 beschlossen. http://www.bmu.de/klimaschutz/downloads/doc/42783.php. Accessed 11 June 2013

EC—European Commission (2008) Climate change and water (CIS). Policy paper

EC—European Commission (2009) River basin management in a changing climate (CIS). Guidance document no. 24

EC-DGEnv (2010) Directorate-General Environment, Directorate B—Nature. Links between the Water Framework Directive (WFD 2000/60/EC) and Nature Directives (Birds Directive 2009/147/EC and Habitats Directive 92/43/EEC) – Frequently Asked Question. Draft version 3.4, 1 June 2010. European Commission, Brussels: 16 pp

EEA—European Environment Agency (2007) Technical report no 2/2007. Climate change and water adaptation issues, Copenhagen

Ell M (2003) Wasserrechtliche Planung. Die rechtliche und organisatorische Umsetzung der Wasserrahmenrichtlinie, Baden-Baden

Endlicher W, Gerstengarbe FW (2007) Der Klimawandel – Einblicke, Rückblicke und Ausblicke, Potsdam

Foundation for Water Research (2012) The water framework directive. http://www.euwfd.com/html/what_is_the_wfd-.html. Accessed 11 June 2013

Fuchs M, Preis S, Wirth V, Binzenhöfer B, Pröbstl U, Pohl G, Muhar S, Jungwirth M (2010) Wasserrahmenrichtlinie und Natura 2000. Gemeinsame Umsetzung in Deutschland und Österreich am Beispiel der Grenzflüsse Salzach und Inn. In: Naturschutz und Biologische Vielfalt, vol 85

Gammeltoft P (2007) Towards an EU policy framework for adaptation. speech 13 february (head of unit water and marine DG environment, European Commission) German presidency conference "climate change and water". Berlin

Hofmann M, Schmidt C (2012) Vertiefende Analyse ausgewählter Schnittstellen, Natura 2000. In: Albrecht J, Schmidt C, Stratmann L, Hofmann M, Posselt S, Wendler W, Roßner D, Wachs A (eds) Die Wasserrahmenrichtlinie aus Sicht des Naturschutzes – Analyse der Bewirtschaftungsplanung 2009. In: Naturschutz und Biologische Vielfalt, vol 120, Bonn – Bad Godesberg: 193–223

IPCC (2007) 4. Sachstandsbericht des Zwischenstaatlichen Ausschusses für Klimaänderungen

Knopp GM (2005) Bewirtschaftung von Flussgebietseinheiten: Aufgaben, Instrumente und Probleme. In: Bohne E. Ansätze zu einer Kodifikation des Umweltrechts in der Europäischen Union: Die Wasserrahmenrichtlinie und ihre Umsetzung in nationales Recht. Beiträge zum 3. Speyerer UGB-Forum vom 15. bis 16. September 2003 an der Deutschen Hochschule für Verwaltungswissenschaften Speyer. Berlin: 23–33

Korn N, Jessel B, Hasch B, Mühlighaus R (2005) Flussauen und Wasserrahmenrichtlinie, Bedeutung der Flussauen für die Umsetzung der europäischen Wasserrahmenrichtlinie. In: Naturschutz und Biologische Vielfalt, vol 27, Bonn – Bad Godesberg

LAWA—Länderarbeitsgemeinschaft Wasser (2001) Handlungskonzept zur Umsetzung der Wasserrahmenrichtlinie

LAWA—Länderarbeitsgemeinschaft Wasser (2003) Arbeitshilfe zur Umsetzung der EG-Wasserrahmenrichtlinie. 14 October 2003. http://www.wasserblick.net/servlet/is/195. Accessed 11 June 2013

LAWA—Länderarbeitsgemeinschaft Wasser (2009) Musterkapitel "Klimawandel" für die Bewirtschaftungspläne. Ständiger Ausschuss der LAWA "Hochwasserschutz und Hydrologie (AH)"

LAWA—Länderarbeitsgemeinschaft Wasser (2010) Strategiepapier "Auswirkungen des Klimawandels auf die Wasserwirtschaft". Bestandsaufnahme und Handlungsempfehlungen. beschlossen auf der 139. LAWA-VV am 25/26 März 2010 in Dresden. http://www.lawa.de/documents/LAWA_Strategiepapier_1006_d07.pdf. Accessed 23 September 2010

Posselt S, Albrecht J, Stratmann L (2012) Die Bewirtschaftungsplanung in den zehn Flussgebietseinheiten Deutschlands. In: Albrecht J, Schmidt C, Stratmann L, Hofmann M, Posselt S, Wendler W, Roßner D, Wachs A, Die Wasserrahmenrichtlinie aus Sicht des Naturschutzes – Analyse der Bewirtschaftungsplanung 2009. In: Naturschutz und Biologische Vielfalt, vol 120, Bonn – Bad Godesberg, pp 75–80

Rechenberg J, Markard C, Irmer U (2000) Die neue Wasserrahmenrichtlinie (II). In: Wasserwirtschaft, Wassertechnik mit Abwasser-technik (wwt awt) 1/2000, pp 41–42

Reese M (2011) Die Anpassung an den Klimawandel im Bewirtschaftungssystem der Wasserrahmenrichtlinie. Zeitschrift für Was-serrecht (ZfW), pp 61–82

Schuchardt B, Wittig S, Mahrenholz P, Kartschall K, Mäder C, Hasse C, Daschkeit A (2008) Germany in the Midst of climate change: adaptation is necessary. Umweltbundesamt, KomPass (Competence Centre on Climate Impacts and Adaptation), pp 4–13

Seidel W, Rechenberg J (2004) Rechtliche Aspekte des integrativen Gewässermanagements in Deutschland. In: Zeitschrift für Umweltrecht (ZUR), pp 213–221

Spillecke H (2000) Rechtliche Umsetzung der EU-Wasserrahmenrichtlinie. Wasser und Abfall (WuA) 4(2000):30–33

Stratmann L, Hofmann M, Posselt S, Wendler W, Schmidt C, Albrecht J (2012a) Zusammenfassung der Kernempfehlungen. In: Albrecht J, Schmidt C, Stratmann L, Hofmann M, Posselt S, Wendler W, Roßner D, Wachs A (2012) Die Wasserrahmenrichtlinie aus Sicht des Naturschutzes – Analyse der Bewirtschaftungsplanung 2009. In: Naturschutz und Biologische Vielfalt, vol 120, Bonn – Bad Godesberg, pp 305–318

Stratmann L, Wendler W, Posselt S, Albrecht J (2012b) Vergleichende Auswertung der Bewirtschaftungspläne. In: Albrecht J, Schmidt C, Stratmann L, Hofmann M, Posselt S, Wendler W, Roßner D, Wachs A, Die Wasserrahmenrichtlinie aus Sicht des Naturschutzes – Analyse der Bewirtschaftungsplanung 2009. In: Naturschutz und Biologische Vielfalt, vol 120, Bonn – Bad Godesberg, pp 86–119

Stratmann L, Wendler W, Posselt S, Albrecht J (2012c) Vergleichende Auswertung der Umweltberichte. In: Albrecht J, Schmidt C, Stratmann L, Hofmann M, Posselt S, Wendler W, Roßner D, Wachs A, Die Wasserrahmenrichtlinie aus Sicht des Naturschutzes – Analyse der Bewirtschaftungsplanung 2009. In: Naturschutz und Biologische Vielfalt, vol 120, Bonn – Bad Godesberg, pp 141–160

Wendler W, Albrecht J (2012) Ziele von Wasserrahmenrichtlinie und Naturschutz. In: Albrecht J, Schmidt C, Stratmann L, Hofmann M, Posselt S, Wendler W, Roßner D, Wachs A, Die Wasserrahmenrichtlinie aus Sicht des Naturschutzes – Analyse der Bewirtschaftungsplanung 2009. In: Naturschutz und Biologische Vielfalt, vol 120, Bonn – Bad Godesberg, pp 23–44

Wendler W, Albrecht J, Stratmann L (2012) Naturschutzrelevante Inhalte der Bewirtschaftungsplanung. In: Albrecht J, Schmidt C, Stratmann L, Hofmann M, Posselt S, Wendler W, Roßner D, Wachs A (2012) Die Wasserrahmenrichtlinie aus Sicht des Naturschutzes – Analyse der Bewirtschaftungsplanung 2009. In: Naturschutz und Biologische Vielfalt, vol 120, Bonn – Bad Godesberg, pp 45–64

Wulfhorst J (2010) Klimawandel, Hochwasser und Trockenfallen von Fließgewässern: Einfluss eines Abfluss-Regimes mit geringer Vorhersagbarkeit und sehr hoher Unregelmäßigkeit auf die Lebensgemeinschaften von zwei Waldbächen im Westharz. Treffpunkt Biologische Vielfalt IX. In: BfN-Skripten, vol 265, Bonn – Bad Godesberg, pp 89–96

Chapter 4
Do Water Management and Climate-Adapted Management of Wetlands Interfere in Practice? Lessons from the Biebrza Valley, Poland

Mateusz Grygoruk and Tomasz Okruszko

Abstract In this chapter the authors deal with the implementation of Water Framework Directive in the catchment of the Biebrza River (north-east Poland) that covers 7,120 km^2. Special attention was paid to the context of conservation of riverine and wetland ecosystems facing pressures driven by the climatic change. Measures foreseen by the National Water-Environment Programme for the catchment of Biebrza are analysed in order to reveal whether the actions planned, expressing the implementation of Water Framework Directive, anticipate potential pressures originating from the observed and defined, climate-related pressures such as increasing frequency of summer flooding, ongoing decrease in summer sums of precipitation and increasing frequencies of extremely high summer rainfalls. The DPSIR feedback loops presenting selected relations between the climate-related pressures and potential negative responses of geoecosystems of the Biebrza catchment are described in order to verify whether the measures implemented aimed at conservation and improvement of the state of water bodies and water-dependent ecosystems are capable for assuring their good status. Basing upon the observations and facts analysed, the authors derive lessons learnt from the process of Water Framework Directive implementation, showing that the improvement of allocation of funds to the water management actions is needed in order to assure good ecological status of aquatic and wetland ecosystems, concerning qualitative and quantitative elements of the water-related environments, facing direct and indirect climate-related pressures.

Keywords Biebrza · Wetlands · Water framework directive · Climate change · DPSIR

M. Grygoruk (✉) · T. Okruszko
Department of Hydraulic Engineering, Warsaw University of Life Sciences—SGGW, ul. Nowoursynowska 159, 02-776 Warsaw, Poland
e-mail: m.grygoruk@levis.sggw.pl

S. Ignar and M. Grygoruk (eds.), *Wetlands and Water Framework Directive*,
GeoPlanet: Earth and Planetary Sciences, DOI 10.1007/978-3-319-13764-3_4

4.1 Introduction

Environmental management of the complex systems, such as wetlands, requires anticipation of the broadest possible set of factors that may induce status and responses of ecosystems. This includes hydrological processes responsible for the continuity of water supply and drainage, human-related actions oriented at economic use of wetlands, geomorphology and soil-forming processes as well as the climate and global environmental dynamics. Existing legal agents require consideration of the environmental and human-enforced challenges influencing the environment. Water Framework Directive (WFD; Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy) put special attention to the achievement of a good status of waters and water related ecosystems. Habitat Directive (HD; European Council Directive 92/43/EEC) and Bird Directive (BD; European Council Directive 2009/147/EC) have referred to the conservation of the total environment in the most valuable zones, by the implementation of protection plans, assuring stakeholders' awareness. National and regional regulations as to the environmental protection, by incorporation of the European law, assure implementation of particular procedures oriented at minimization of possible negative responses of the elements of the environment to the defined pressures. Finally, the national plans oriented at adaptation to the changing climate (ACC) require to be considered in the general approaches of the integrated environmental management.

However, although the legislation regarding environmental management appears to be comprehensive enough to anticipate and mitigate the negative effects of nearly all possible stressors, the implementation of integrated actions reflecting legal requirements of environmental policy seems to fail, especially if the local scale is considered (Biereżnoj-Bazille and Grygoruk 2013). This situation originates from the fact that bodies responsible for implementation of WFD, HD, BD and ACC undertake non-integrated actions. Inconsistencies are reported in the cases of flood risk management implemented as dredging the rivers of a high environmental conservation status, intensification of agricultural practices that affect the environment in the areas covered by Natura 2000, or in the application of measures which, although aim at conservation of good status of species and habitats, do not consider prospective stressors originating in the impacts of a changing climate. Such inconsistencies in the implementation of environmental policy allow to foresee certain risks for a successful environmental management and therefore should be unraveled in order to enhance the potential effects of ecosystem conservation and restoration. Especially facing the fact, that the future of the environment of European wetlands was sketched as critically related to the climatic change (Okruszko et al. 2011; Schneider et al. 2011).

The main aim of this chapter is to analyze the status of WFD implementation in reference to conservation and assuring appropriate ecological status of rivers and water-dependent ecosystems in the catchment of the Biebrza (NE Poland), facing direct and indirect environmental impacts of climate change. We provide a drivers-pressures-state-impact-response (DPSIR) analysis referring to the defined pressures driven by the changing climate, where the main impact concerned is the threat to the good status of the Biebrza catchment's rivers and wetlands which are substantial elements of biodiversity conservation in the Central Europe. Referring to the feedback relations defined, we interpret the undertaken and planned actions that reflect WFD implementation and discuss whether they cover the set of required actions originating from the deteriorating status of aquatic and water-dependent ecosystems. We compare the allocation of funds in the set of the WFD-related actions in order to assess which types of actions have priorities and which of them are likely to remain challenges for good status of rivers and related ecosystems. Finally we provide concise lessons learnt from the analysed process of WFD implementation in the catchment scale, considering climate change impacts, protection of species and habitats, and defined conflicts occurring at the interface of water management, agriculture and environmental conservation.

4.2 Physiographic Outline of the Study Area

The catchment of the Biebrza river (Fig. 4.1), covering 7,120 km^2, which is nearly 2.5 % of the area of Poland, consists of variable landscapes. Upper, northernmost parts of the catchment belong to the Baltic Lakelands of a fresh glacial relief, formed approximately 10,000 years BC whilst the eastern ridges of the catchment are located within the landscapes formed by the older glaciations (ca. 120,000 years BC, Żurek 1984). The core of the catchment is the vast lowland depression—Biebrza Valley, that due to unique hydrogeological and ecological conditions consists of well-preserved wetlands of unique ecological status in the scale of the continent (Wassen et al. 2006). Elevations in the analysed area vary from some 310 m a.s.l. to some 90 m a.s.l., making the area of research a lowland geoecosystem. Predominantly mineral, tilly and sandy soils cover the majority of the area of catchment, but the Biebrza Valley is one of the broadest coherent extents of peatlands in Europe. Average annual air temperature reaches some 5.7 °C with the extremes recorded in July (some 33 °C) and February (some −25 °C), which allows to classify the climate of the Biebrza Valley as temperate, with strong continental influences (Jaszczuk 2014). Average annual sum of precipitation in the catchment of Biebrza calculated on the basis of rainfall records from 1951 to 2010 reach some 556 mm, with the maximums noted in summer (May–September; 315 mm) (Jaszczuk 2014). Average potential evapotranspiration in the catchment of Biebrza calculated with the Thornthwaite's algorithm (Wojciechowski 1968) for the data from 1961 to 2010 exceeds 560 mm (Jaszczuk 2014), which allows to state that water resources of the catchment of Biebrza valley are nearly equally balanced and thus require monitoring and actions in order to assure appropriate amounts of water to the final users: society, economy, agriculture and—primarily—the environment. Average outflow from the catchment of Biebrza reaches some 33 m^3/s, varying up to some 600 m^3/s during the most important flood events (Grygoruk et al. 2013b).

Fig. 4.1 Study area—catchment of the Biebrza river: water bodies and environmental conservation

Hydrological features of the Biebrza Valley as well as recorded dynamics of floods allow to conclude that inundation remains an important yet frequent phenomenon (Grygoruk et al. 2013a; Ignar et al. 2011). Among the most valuable and important water-dependent ecosystems in the catchment of Biebrza there are eutrophic ox-bow lakes, fens of the type *Caricion davallianae* (concentrated both in the Biebrza Valley and in the random locations in the fresh glacial landscape in the north-western part of the catchment), bogs, riparian Alder forests *Ribeso nigri-alnetum*, reedbelts and riparian sedge communities *Magnocaricion* (Wassen et al. 2006).

Water bodies belonging to the catchment of Biebrza river are managed by different authorities, of which the most important are Regional Water Management Authority in Warsaw (in Polish: Regionalny Zarząd Gospodarki Wodnej; RZGW), Voivodeship Board of Land Reclamation and Hydrotechnics in Białystok (in Polish: Wojewódzki Zarząd Melioracji i Urządzeń Wodnych w Białymstoku, WZMiUW), Biebrza National Park (BNP) and—to certain limited extent—local subjects of national administration—communes. Whilst to the competences of the first three institutions (RZGW, WZMiUW and BNP) belongs the implementation of WFD, communes are mostly responsible for the maintenance of ditches and minor rivers and streams and WFD, although should, is not directly considered.

4.3 Climate Change, Water Management and Ecosystems' Response

Climatic change impacts to the ecosystems of the Biebrza Valley, although already defined as a challenge for valuable wetlands in NE Poland (Grygoruk et al. 2014a; Ignar et al. 2011), has hardly been anticipated so far neither in the environmental conservation management in the basin of the river Biebrza nor in the Water Framework Directive implementation in this area. First steps towards the design and application of climate-adapted management of protected areas of wetlands in this region were done in the Biebrza National Park, by implementing the HABIT-CHANGE project (Rannow and Neubert 2014) and by preparation of the draft document—Climate Adapted Management Plan for the Biebrza National Park (Grygoruk et al. 2013b). Main findings of the project pointed out that the majority of climate-related threats for valuable wetlands result from the quantitative alterations of water cycle, either as a direct result of naturally evolving hydrological processes (increasing frequency of summer flooding, ongoing decrease in summer sums of precipitation, increasing frequencies of extremely high summer rainfalls) or indirectly, as the reaction of stakeholders on these processes (Grygoruk et al. 2014a).

In order to attempt the assessment of whether the actions implemented reflecting WFD are capable to deal with the prospective defined climate change stressors, the DPSIR matrix of general feedback loops was developed. Such an approach was proven to be a suitable tool in detecting WFD-implementation-related risk assessment (Borja et al. 2006). It anticipates climate-related pressures to habitats (after Grygoruk et al. 2014a) that induce the state of ecosystems, to which the negative impact to be considered in the water management was defined as the "threat to the good status of rivers and wetlands" (Fig. 4.2). The analysis was assumed to reflect the most critical climate-related pressures, which was the observed and projected increased recurrence of extreme hydrological events (summer floods, deep droughts and heavy rainfall events), reduction of the snow pack and the ongoing earlier occurrence of thaw floods and observed and projected general increase of the air temperature in winter. Among the elements of aquatic and wetland ecosystems' state reflecting the defined pressures, there are reactions that origin from the interfaces of economic, social and environmental spheres. First and foremost, climate-related pressures defined result in the negative response of stakeholders:

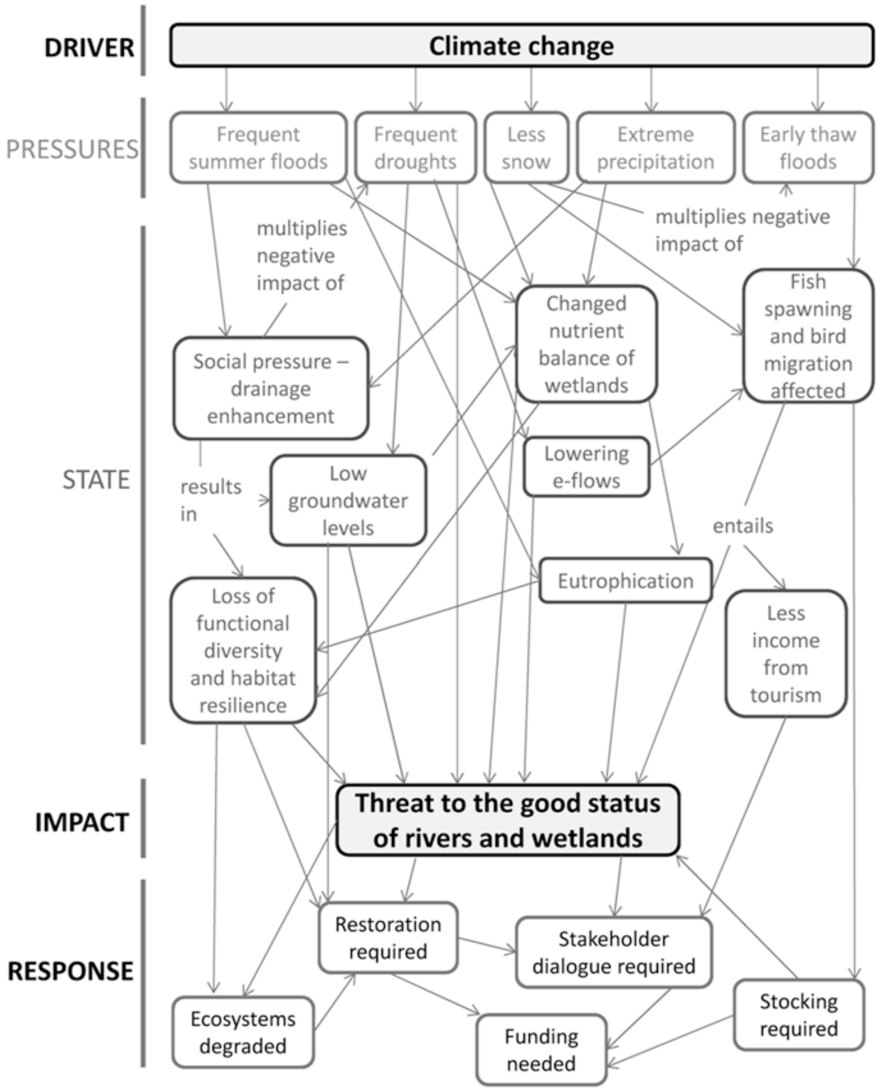

Fig. 4.2 DPSIR loops—defined selected states and responses to the negative impacts of prospective climate change to ecosystems of the Biebrza Valley

frequent flooding, which has much stronger, short-term negative influence to economic use of wetlands (e.g. mowing) than forecasted long-lasting and frequent deep droughts. It is due to the fact that flooding and general high (ground) water level negatively affects the possibility of wetland meadow mowing and hay removal, which reduces farmers' income and underlies complications in agro-environmental schemes implementation.

High saturation of the soil remains an obstacle for using mechanic gear (tractors and large-track mowers), which—although positive from the environmental perspective (Kotowski et al. 2013)—does not allow the broad areas of wetlands to be maintained by mowing. This particular process forces land users and farmers to mitigate the negative influences of inundation to the local economy, by putting pressure to water managers in order to increase efforts oriented at river dredging and restoration (reconstruction) of the existing networks of ditches (Dembek 2015). This action, directly driven by the climatic factors, observed especially during and after wetter summers, critically affects the status of water bodies (Biereżnoj-Bazille and Grygoruk 2013; Mioduszewski and Okruszko 2012) and might be considered as one of the most important, social-perception-related pressures to aquatic and wetland ecosystems in the basin of the river Biebrza, requiring efforts such as enhanced stakeholder dialogue. Expanding pressures to the enhancement of drainage and river dredging is expected to multiply the effect of summer droughts, which—although recorded in the years 2013 and 2014—have not been considered by water management authorities as a major threat to the ecosystems and water quality.

In the drained parts of the catchment, where peat layers decomposed into muck, the flood-drought balance is expected to affect the soil nutrients' circulation. Frequent saturation of the decomposed peat, either in response to natural phenomena (increasing groundwater level, flooding) or human-related issues (fen rewetting and management of land reclamation systems) interrupts nutrient balance by favoring soluble fractions of phosphorus to be released from organic soils to pore water, groundwater and—finally, in certain geochemical conditions—to surface waters (Zak et al. 2010). In result, the eutrophication of aquatic and wetland ecosystems should be expected and mitigated. For mineral-rich, but nutrient-poor fen ecosystems, the eutrophication entails the switch in the geochemical limitations of biocenoses: habitats which have formerly been not suitable for species requiring eutrophic conditions are projected to be exposed for the loss of their resilience and though—to the evolution from oligotrophic to eutrophic wetlands. In result, habitats of the high conservation status such as *Caricion davallianae* are exposed to climate- and water-management-related risk of deterioration. Consequently—limited resilience of fens staying under the influences of eutrophic waters originating from resaturated muck soils is suspected underpins a loss of their natural capacity to buffer the external pressures, which altogether induces these ecosystems to be vulnerable to any environmental disturbances. The response of the aquatic and wetland ecosystems in the cases analysed (Fig. 4.2) will be negative in both short- and long-run and will reflect with the requirement of ecosystem restoration.

Increasing frequency of droughts is likely to affect the environmental flows in the whole catchment, which is expected to be critically important in the headwater reaches of the area analysed, where river water is dammed in lakes and is collected in order to refill the fishponds. The affected environmental flows would not have that significant influence for the downstream reaches of rivers, especially the

Biebrza and its tributaries flowing in the near neighborhood of the Natura 2000 sites, if the hydromorphology of rivers was properly maintained. Reported conflicts at the interface of river management and the requirements of environmental conservation (Biereżnoj-Bazille and Grygoruk 2013; Mioduszewski and Okruszko 2012) showed, however, that in cases of certain rivers (e.g. Brzozówka, Klimaszewnica), where hydromorphology of river channels was decently disrupted as a result of social-demand of river management, the decrease of volumes of lowest flows (and though—the environmental flows) can be expected and underlay a significant risk to aquatic species. Hence, also in the dimension of river management implemented so far in the area of research, regarding possible mitigation of climate-affected increasing recurrence of droughts, no actions were taken in order to minimize the negative effects of climate-related pressures to ecosystems' state.

Among the most significant, climate-driven pressures to biota in the area analysed there are temporal changes of the spring thaw floods (Ignar et al. 2011; Grygoruk et al. 2013b) which were defined as a threat to migratory birds and fish spawning. Due to the earlier occurrence of spring floods and projected decrease in their volume and duration (Grygoruk et al. 2014a), the role of Biebrza Valley as a stopover spot for waterfowl birds is expected to lose its relevance. Moreover, if the balance of flooded and dry areas was considered as an important aspect of biotopes for certain species of birds of prey (e.g. Spotted Eagle and Lesser Spotted Eagle), this climate-related process may affect the condition of their population (Maciorowski and Mirski 2014). In a long run, the affected populations of migratory birds in the Biebrza Valley are expected to result in the decrease of tourism intensity, and though—a partial loss of the international importance of Biebrza Wetlands. In the case of fish, especially the European pike (*Esox lucius*), and concerning the fact that the spring floods were observed and are expected to keep decreasing in terms of volume and duration, the lack of appropriate spawning habitats (flooded meadows) may invoke the need of stocking. So far, as the population of fish in the Biebrza river and its principal tributaries (lower Ełk, lower Jegrznia) developed with no significant genetic and structural disturbances originating from the artificial fish supply, stocking was not required and considered environmentally negative for the native populations. Facing the pressures originating in changing climate, fish stocking and the related restoration of aquatic habitats and spawning grounds may be required in order to mitigate the negative impacts related to the altered flow regime.

Presented feedbacks of climate-induced challenges to aquatic and wetland ecosystems require special attention of water management authorities. Focusing at so-far planned and implemented actions for the Biebrza Catchment originating from the National Water-Environment Programme, one can conclude that a vast majority of threats originating in climatic drivers remains—however—not anticipated.

4.4 Actions of the National Water-Environment Programme for the Catchment of Biebrza

National Water-Environment Programme (NWEP; in Polish: Program Wodno-Środowiskowy Kraju) in the scale of both the whole country of Poland and of the Biebrza Catchment (NWEP 2010), along with the Catchment-scale Water Management Plans remains one of the principal planning documents in water management. It directly reflects the implementation of WFD in terms of necessity of preparation and application of measures oriented at achievement of the environmental goals required by this regulation (Table 4.1). This document defines and describes basic and additional measures required for the enhancement or conservation of the good status of waters in particular water regions of Poland. By definition, the Water-Environment Programme anticipates quantitative, qualitative, social and economic measures oriented at the assurance of appropriate implementation of WFD's environmental goals. Comprehensive approach of the National Water-Environment Programme is geared towards

Table 4.1 Actions implemented by the responsible authorities reflecting the requirements National Water-Environment Plan in the region of the catchment of Biebrza in order to assure the good status of aquatic and wetland ecosystems (NWEP 2010)

Group of actions	Particular actions
Sewage management	Sewage system extension and modification
	Construction of small sewage treatment plants
	Collection of leakages from industrial areas
	Construction of new sewage treatment plants
	Control of the sewage collection agendas and plans
	Inventory of septic tanks and individual sewage containers
Waste management	Liquidation of illegal waste disposals
	Modernization of waste disposals and landfills
Agriculture	Popularization of modern agricultural practices
	Capacity building—agro-environmental schemes
	Popularization of sustainable agriculture
Water management	Preparation of the Regional Regulations of use of Waters
	Construction of a fish-pass
Spatial planning	Preparation of the local spatial planning regulations
Environmental conservation—Natura 2000	Preparation of the Natura 2000 protection plans
Forestry	Implementation of the regional afforestation programs
	Afforestation of abandoned agricultural lands
Environmental conservation	Enhancement of the capacity of environmental conservation
	Day-to-day environmental conservation

the increase of sewage and waste management, aims at promotion of sustainable agriculture, spatial planning, forestry and environmental conservation as well, describing particular individual actions located in defined parts of the catchment. Actions described, reflecting the planning and application of water resources management by the National Water-Environment Programme for the region of the catchment of Biebrza, are divided into certain groups. Altogether there are 275 actions defined. Analysis of this document revealed that the major attention is put to the conservation and increase of qualitative status of water bodies (Table 4.1, Fig. 4.3a). Sewage and waste management measures are oriented in principle at the extension and enhancement of municipal sewage systems, collection of leakages from the industrial sites, construction of sewage treatment plants, inventories of septic tanks and the liquidation of the illegal waste disposals and landfills combined with the restoration of the present ones. Comparing to the other actions defined by the National Water-Environment Programme referring to the space of the catchment of the river Biebrza, such as the ones reflecting agriculture, direct water management (e.g. planning of the regional conditions of water use), spatial planning, forestry and environmental conservation with special regard to Natura 2000, actions oriented at sewage and waste management cover more than a half of all the actions described by this document (Fig. 4.3a).

Actions referring to the agriculture, provided by the National Water-Environment Programme, aim at activities implementing the stakeholder dialogue, including popularization of modern, competitive and sustainable agricultural practices and capacity building towards the implementation of the European Union's agro-environmental schemes. Direct measures related to water management in the catchment of Biebrza are oriented at preparation of Regional Regulations of use of Waters (in Polish: Warunki Korzystania z Wód Regionu Wodnego). Worth noticing is the single action oriented at the recovery of longitudinal river continuity, which is the fish-pass construction in the course of the river Ełk (Rudzki Canal), in the close neighborhood of the Biebrza Valley. One can regret that among the 275 actions there is only one measure of this type planned, especially facing the number of functioning weirs, dams and spillways that efficiently affect longitudinal ecological continuity of aquatic ecosystems in the catchment of Biebrza.

Still, however, the planned fish pass is to be constructed with the newly-designed weir, which does not allow to conclude that particular actions were undertaken in order to bring back the former longitudinal continuity of rivers in the region analyzed. In the other words—the negative role of obstacles in the courses of rivers in the catchment of Biebrza was not anticipated, so their influence on fish and macroinvertebrates is not going to be mitigated in result of the WFD implementation in this area. Although the wish to construct one fish pass allows to foresee growing interest of water-policy implementing authorities in assuring ecological connectivity of river continua, the major attention should be paid to multiple constructions (weirs and dams) which were designed in the past and underpin the fragmentation of river continua in the region.

National Water-Environment Programme provides also the measures reflecting spatial planning, expressed as preparation of local strategies. In terms of reflectance

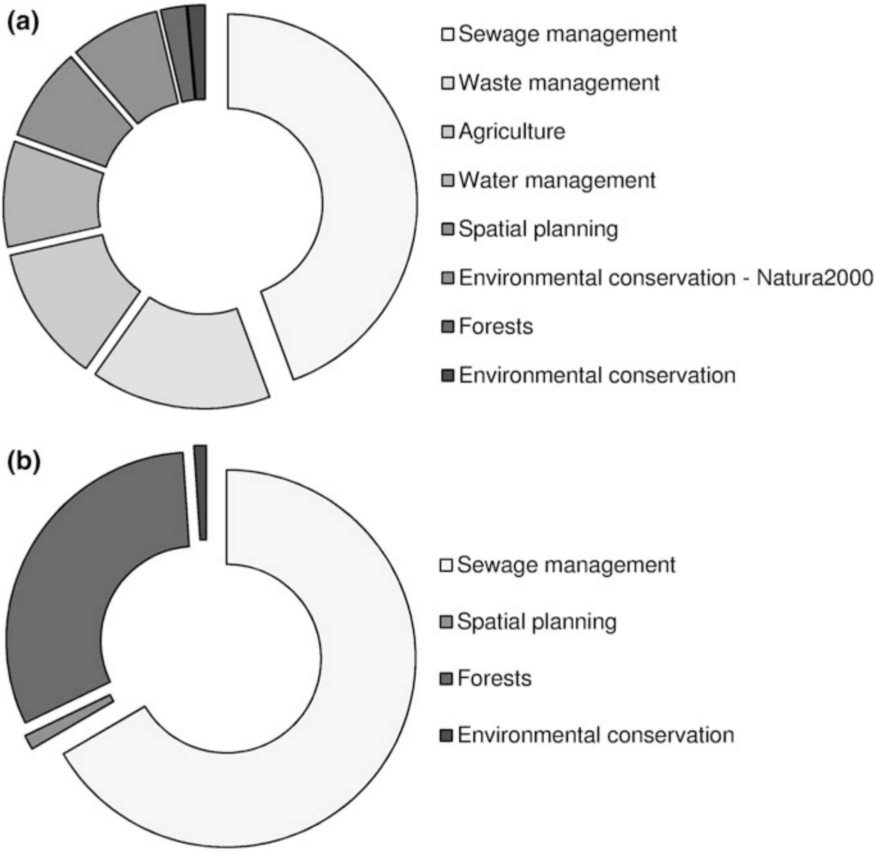

Fig. 4.3 Groups of actions planned in order to implement the National Water-Environmental Program for the region of the Biebrza catchment; **a** number of measures in particular groups of actions; **b** total costs of actions (referred to the total budget of NWEP implementation in this region—as specified in the data of the NWEP 2010)

of climate- and environmental-conservation-related challenges, the most important in this level appears to be to assure that the floodplains are not planned as the space for the settlements' development. Actions reflecting environmental conservation, with special focus to the BD and HD implementation, emphasize preparation of the Natura 2000 areas protection plans and pay attention to the day-to-day environmental management. Such actions are expected to benefit the local dimensions of climate-related management adaptation, as the day-to-day management in protected areas should anticipate challenges of a stakeholder dialogue by inducing their positive attitudes towards the local-scale influences of the global climatic changes.

Actions prescribed by the NWEP in the context of the catchment of Biebrza, oriented at sustainable forestry, predominantly promote at afforestation of the abandoned agricultural lands. This sort of actions, although desirable within the extents of mineral soils, may provide the hydrological stress for mire meadows, especially in the periods of drought (Grygoruk et al. 2014b), which are foreseen to occur more frequently in the future.

Implementation of the National Water-Environment Programme requires funding. Noteworthy, according to the information given in the NWEP (2010), only four out of eight groups of actions have particular budget assigned (Fig. 4.3b). The most significant share of funding is related to the sewage management which also expresses the high priority of this group of actions (Fig. 4.3a). Surprisingly, the actions related to the afforestation have also received the significant financial contribution which may be considered unproportional, if the number of all the actions provided by the National Water-Environment Programme was considered. Remaining actions foreseen in this document are to be implemented within the existing budgets of local authorities and external projects and no additional funding originating from the pure implementation of the WFD implementation is planned. Among them there are actions oriented at the enhancement of agriculture, direct water management and environmental conservation. Analyzing the structure and content of NWEP (2010) one can conclude that no particular attention is paid to the potential climate-related challenges to WFD implementation.

4.5 What Is Missing?

The major flaw of the set of actions analysed above is that majority of proposed measures are economy-oriented (e.g. majority of funding is related to the forthcoming actions consisting of the construction works such as sewage treatment systems). Actions related to the improvement of the environmental quality which deteriorated as a response of ecosystems to the former stresses, such as hydromorphological changes of river channels (dredging, land reclamation, lowering water levels), are in general omitted. This reflects the finding of Dembek (2015) who claims that the balance of water-related policies should switch from the anthropocentric approaches towards the attitudes considering the environment as a priority. In this regard one can also conclude that the climate-related threats of the ecosystems are not anticipated by the National Water-Environment Programme (NWEP 2010). No direct attention is paid to the prospective changes in the recurrence of floods and droughts, which, together with stationary approach to the environmental flows, may result in inevitable changes of ecosystems dependent on groundwater and baseflow (among them there are all aquatic ecosystems that keep to be under stress in low flow periods). The fact that the regional plans of irrigation and drainage, which in general assume the improvement of the function of draining role of land reclamation systems and rivers (and thus may multiply the negative effects of droughts) also do not keep to be in the accordance with the requirements of WFD, HD, BD and—surprisingly—also with the National Water-Environment Programme. This was already proven in numerous reports (e.g. Biereżnoj-Bazille and Grygoruk 2013; Mioduszewski and Okruszko 2012). Wishing to keep aquatic ecosystems of the region of Biebrza Catchment in a good ecological status, assuring their resilience to prospective climate-related pressures, water management authorities should foresee actions oriented at restoration of formerly degraded wetlands and rivers, providing appropriate funding. So far, in the perspective of environmental policy implementation and at the interface of environmental conservation and management of valuable ecosystems, we conclude that the regulations resulting mostly from the WFD, HD and BD are not interrelated in their implementation, which causes vast selectivity in implementations of measures and thus—results only in the partially positive responses of the managed wetlands and aquatic ecosystems.

4.6 Lessons Learnt and Implications for the Management

1. Contemporary environmental management programmes resulting from Water Framework Directive as well as from the Natura 2000 regulations, either do not anticipate climatic change at all (Water-Environment programme for the Biebrza Catchment) or consider this phenomenon to the very limited extent (Natura 2000 management plans). Although regulations seem to be strict and comprehensive enough in order to assure the adaptation to the prospective climatic change, both implemented so far and planned actions do not reflect anticipation of the impacts of changing climate neither to ecosystems nor to society and local economy.
2. Climatic change and related actions, although normally being considered in the scale of continents and countries, should be presented to local societies as challenges of the local scale in order to assure public acceptance of mitigation and adaptation measures.
3. No interlinks between the water management plans and Natura 2000 protection plans were observed in the region analyzed, especially in terms of climate-related adaptive management and river continuity (fish passes). Although some actions were undertaken in order to assure restoration of formerly drained wetlands and to restore the continuity of rivers to biota, this type of actions is in general neglected in regional water management policy, requiring to be improved.
4. Reactions of water management authorities to floods and conditions of high water levels are much quicker and influential to the environment than the ones oriented towards the droughts. So far no response form water management authorities occurred in the catchment of the river Biebrza in order to mitigate the negative effects of droughts, for both society and ecosystems. This should be considered as a flaw of the WFD implementation which should anticipate droughts as an important threat for water resources in the environmental (e.g. environmental flows) and socio-economic context (e.g. water supply to agriculture and aquaculture, drinking water supply).
5. The majority of threats to rivers in wetland landscapes originate from the EU-subsidized intensification of grassland farming. It is observed that the degradation of rivers results from social pressures of farmers and land users receiving payments for the so-called sustainable use of wetlands. One can expect that in order to

enhance the implementation of Water Framework Directive either the form of subsidies should be changed and farmers will be paid for storing water on their wetland meadows, or the future financial perspectives of EU will not cover any payments oriented at the grassland farming. As the latter is a way less possible and further degradation of rivers in agricultural wetland landscape is to be expected, WFD requirements should be emphasized in order to preserve as much rivers in a "good status" as possible. The role of NGOs in this process is crucial.
6. Climatic change projections as well as the designed and implemented climate-adapted environmental management plans reach the time horizon 2070–2100. However, one should expect that achieving and sustaining good status of water bodies and related wetland ecosystems can only be reached if appropriate actions resulting from WFD and Natura 2000 legislative recommendations were started immediately, from tomorrow, not being postponed to (nor resulting from) the next financial perspective of the EU. Regardless of the fact that new scientific and research initiatives are beneficial for institutions responsible for environmental management we stress that the actions reflecting conservation and sustainable use of waters and wetlands should originate from the local-scale mechanisms that are well-established in the Natura 2000 and WFD frameworks and are sustainable in terms of implementation, being economically self-sustainable, not being dependent on externally financed projects.
7. Water management and climate-related adaptive management in the Biebrza Catchment do not interfere to the extent that would assure the beneficial implementation of WFD, HD, BD and National Water-Environment Programme to the environment. Revision of the match between the legal requirements and actions undertaken is required.

References

Biereżnoj-Bazille U, Grygoruk M (2013) Scale matters: efficiency assessment of EU environmental directives implementation in a local-scale management of protected wetlands in Poland. Sci Ann Danube Delta Inst 19:5–12. doi:10.7427/DDI.19.01

Borja A, Galparsoro I, Solaun O, Muxika I, Tello EM, Wriarte A, Valencia V (2006) The European Water Framework Directive and the DPSIR, a methodological approach to assess the risk of failing to achieve god ecological status. Estuar Coast Shelf Sci 66:84–96

Dembek W (2015) New vision of the role of land reclamation systems in nature protection and water management. In: Ignar S, Grygoruk M (eds) Wetlands and water framework directive: protection, management and climate change, GeoPlanet: Earth and Planetary Sciences. Springer, Berlin

Grygoruk M, Mirosław-Świątek D, Chrzanowska W, Ignar S (2013a) How much for water? Economic assessment and map ping of floodplain water storage as a catchment-scale ecosystem service of wetlands. Water 5(4):1760–1779. doi:10.3390/w5041760

Grygoruk M, Sienkiewicz J, Hattermann F, Stagl J. (2013b) Climate adapter management plan (CAMP) for Biebrza National Park. HABIT-CHANGE 5.3.1 report, 99 p. (http://www2.ioer.de/download/habit-change/HABIT-CHANGE_5_3_1e_BNP_CAMP_for_Biebrza_NP.pdf)

Grygoruk M, Biereżnoj-Bazille U, Mazgajski M, Sienkiewicz J. (2014a) Climate-induced challenges for wetlands: revealing the background for adaptive management of ecosystems in the Biebrza Valley, Poland. In: Rannow S, Neubert M (eds) Managing protected areas in Central Europe under climate change. Advances in Global Change Research 58, Springer, Berlin. doi:10.1007/978-94-007-7960-0_14

Grygoruk M, Batelaan O, Mirosław-Świątek D, Szatyłowicz J, Okruszko T (2014b) Evapotranspiration of bush encroachments on a temperate mire meadow—a nonlinear function of landscape composition and groundwater flow. Ecol Eng 73:598–609. doi:10.1016/j.ecoleng.2014.09.041

Ignar S, Maksymiuk-Dziuban A, Mirosław-Świątek D, Chormański J, Okruszko T, Wysocki P (2011) Temporal variability of selected Floyd parameters in the Biebrza River valley. Ann Warsaw Univ Life Sci—SGGW 43:135–142

Jaszczuk E (2014) Analysis of the climate of the Biebrza Valley in the context of flow-influencing aspects. Diploma thesis, Warsaw University of Life Sciences—SGGW, 65 p

Kotowski W, Jabłońska E, Bartoszuk H (2013) Conservation management in fens: do large tracked mowers impact functional plant diversity? Biol Conserv 167:292–297

Maciorowski G, Mirski P (2014) Habitat alteration enables hybridisation between lesser spotted and greater spotted eagles in north-east Poland. Bird Conserv Int 24:152–161

Mioduszewski W, Okruszko T (2012) Protection of natural wetlands—The examples of conflicts. J Water Land Dev 16:35–42

NWEP (2010) Program Wodno-Środowiskowy Kraju, Krajowy Zarząd Gospodarki Wodnej, Warszawa. (www.kzgw.gov.pl/files/file/Programy/PWSK/Program_wodno-srodowiskowy_kraju.pdf. Accessed on 13.05.2014)

Okruszko T, Duel H, Acreman M, Grygoruk M, Flörke M, Schneider C (2011) Broad-scale ecosystem services of European wetlands—overview of the current situation and future perspectives under different climate and water management scenarios. Hydrol Sci J 56 (8):1501–1517. doi:10.1080/02626667.2011.631188

Rannow S, Neubert M (eds) (2014) Managing protected areas in Central Europe under climate change. Advances in global change research 58, Springer, Berlin, 308 p. ISBN 978-94-007-7960-0

Schneider C, Flörke M, Gerling G, Duel H, Grygoruk M, Okruszko T (2011) The future of European floodplain wetlands under a changing climate. J Water Clim Change 2(2–3):106–122. doi:10.2166/wcc.2011.020

Wassen MJ, Okruszko T, Kardel I, Chormański J, Świątek D, Mioduszewski W, Bleuten W, Querner EP, El Kahloun M, Batelaan O, Meire P (2006) Eco-hydrological functioning of the Biebrza Wetlands: lessons for the conservation and restoration of deteriorated wetlands. In: Bobbink R, Beltman B, Verhoeven JTA, Wigham DF (eds) Wetlands: functioning, biodiversity conservation and restoration. Springer, Berlin, pp 285–310

Wojciechowski K (1968) Zagadnienia metody bilansu wodnego Thornthwaite'a i Mathera w zastosowaniu do Polski (Problems of Thornthwaite's and Mather's water balance methods in application to Poland). Państwowe Wydawnictwo Naukowe, Warszawa (in Polish)

Zak D, Wagner C, Payer B, Augustin J, Gelbrecht J (2010) Phosphorus mobilization in rewetted fens: the effect of altered peat properties and implications for their restoration. Ecol Appl 20:1336–1349

Żurek S (1984) Relief, geologic structure and hydrography of the Biebrza Valley. Polish Ecological Studies, 10:239–251

Chapter 5
Wetlands in River Valleys as an Effect of Fluvial Processes and Anthropopression

Andrzej Strużyński, Leszek Książek, Wojciech Bartnik, Artur Radecki-Pawlik, Karol Plesiński, Jacek Florek, Maciej Wyrębek and Mateusz Strutyński

Abstract The aim of the article is to show how the fluvial processes in rivers and their valleys can support wetland restoration activities. The exemplary objects were localized in the Upper Vistula Basin (Poland) and dealt with riverbed stability, channel capacity as well as revitalization of rivers with their valleys regarding wetland restoration. All of the mentioned parameters depend on the intensity of fluvial processes in rivers, especially meandering, anastomozing or braided. Rivers always tend to reach the state of hydrodynamical balance reflecting the actual river dynamics. The nature of channel transformation is quite complex. For example, the curvature of natural river increases proportionally to the transported load alimentation and inversely to the slope of the river. The human-modified rivers also tend to increase the curvature of their channels. Interestingly, all rivers create wetlands in the areas naturally connected to the main channel. Those wetlands are regularly watered by flood events. As a result, the areas with wetlands are a perfect natural environment for fauna and flora. River channels which are situated close to such an environment are also rich in fish and invertebrates. Wetlands in mountainous areas are rare or unique unlike in lowlands where they are more likely to be found. The channel incision reduce a possibility of wetland formation in the river valley, especially after bank enforcement. The presented case studies are the effect of different projects running by the Department of Water Engineering and Geotechnics, the University of Agriculture in Kraków on the rivers and streams: Vistula, Nida, Porębianka, Czarny Dunajec. These rivers differ in many aspects; however, each of the them is located in an area where wetlands or wetted areas are likely to appear. Among the described rivers are lowland and mountain rivers. Some of them are managed according to the European Water Framework Directive, i.e., in a close-to-nature manner.

Keywords River valley · Wetland · Morphological processes · River channel incision

A. Strużyński (✉) · L. Książek · W. Bartnik · A. Radecki-Pawlik · K. Plesiński · J. Florek · M. Wyrębek · M. Strutyński
Department of Hydraulics Engineering and Geotechnics, University of Agriculture in Kraków, Al. Mickiewicza 24/28, 30-059 Kraków, Poland
e-mail: rmstruzy@cyf-kr.edu.pl

S. Ignar and M. Grygoruk (eds.), *Wetlands and Water Framework Directive*, GeoPlanet: Earth and Planetary Sciences, DOI 10.1007/978-3-319-13764-3_5

5.1 Introduction

Fluvial processes are responsible for developing the actual morphological type of the river channels. Also wetlands found in the terraces are strictly dependent on the river flow regime. The water table connecting main channel and other branches or tributaries varies with the change of the water level. Dependably on the channel incision, land use or other factors, rivers can supply water or drain the terrace. Additionally during floods the intensification of different kinds of erosion or suffosion can appear so the river tends to create new channels or oxbow lakes. Aerial photographs or old maps often reveal the richness of the old channel system. A wide range of morphological structures in rivers and valleys is related to the hydrological and morphological parameters, the most important being: water flow and transported load alimentary, longitudinal slope, bed roughness and bed stability. Wetland ecosystems are part of quality elements for the classification of ecological status within the Water Frame Directive (WFD). While used to be localized in riparian zones, wetlands reflect the good hydromorphological characteristics of water bodies.

Going further, wetlands indicate the close to nature land use as inscribed in the advancement of the local community. From the end of the Second World War up to the early 90s, the Polish government did not pay particular attention to the issue of nature conservation, focusing on the intensification of industrial development or agricultural production instead. The WFD gives a new perspective for the development of local societies. The aim of the article is to stress the consequences of changed intensity of fluvial processes in rivers, their valleys and to analyse possibilities of wetland restoration within the guidelines of WFD but also under current land development. Even if the river training is done in these rivers, natural hydromorphological processes have to be taken into consideration during the decision making. While river ecosystems are strictly depended on the evaluation of these processes, artificial transformation of rivers and their valleys is often reckless. Technical river training and flood defence structures lead to narrowing of the river migration zone and disturb the hydraulic balance in the river channels. Serious problems grow during the intensification of the spatial development and many conflicts between floodplain capacity and human business appear. For this reason, even while needed, the restoration of wetlands in the river valleys is often relinquished. Reintroduction of wetlands in transformed river valleys would be connected to the change of human activities so the renaturization costs may often be unacceptable for the localities or connected to the elongated period of land-use transformation.

5.2 Case Study

5.2.1 Fluvial Processes in Natural Rivers

Rivers always tend to develop a well balanced channel (Bartnik and Książek 2007; Bartnik et al. 2007; Książek et al. 2010). Even if there is a scarcity of the transported material, the adequate longitudinal and cross-section profiles of the river channel can be found (Korpak et al. 2009; Strużyński 2014; Wyżga et al. 2009). The curvature of natural rivers increases proportionally to the transported load alimentation and inversely to the slope of the river.

Mountainuous and lowland rivers differ in the flow dynamics as well as the intensity of fluvial processes. The sources of differences are connected to the retention and slopes of the basin but also to the size of transported material.

Lowland Rivers
Natural rivers modify their channels and valleys due to the fluvial processes appearing the whole year. The highest activity of the flowing water on channel creation appear with the quite low dominant flow which can be valued by the $Q_{75\%}$ (Leopold and Wolman 1957; Radecki-Pawlik 2011; Strużyński et al. 2013). These flows modify morphological parameters of the channel due to the bed and bank erosion or accumulation of bed material and contribute to the channel natural mobility (e.g., meandering, wandering) (Church 1992; Rosgen 1994). Dramatic channel transformations of river runs are very likely to occur during floods. According to the historical data gathered by Łajczak (2006b) on the Nida River, the multichannel system of lowland river can steadily change (Fig. 5.1).

Pictures describing the river system in the given years reveal the high hydromorphological dynamics. Such an activity is frequently recorded in alluvial channels. Two mechanisms may appear in lowland rivers during floods. One is creating

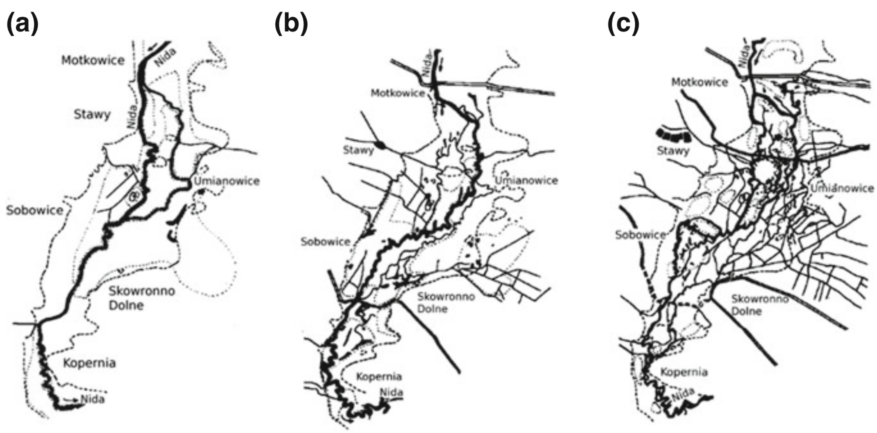

Fig. 5.1 Historical data show numerous changes of the Nida River morphology (*after* Łajczak 2006a). **a** 1839, **b** 1916, **c** 1938

new branches and cutting off the old channels and the other is cutting off the meanders and creating oxbow lakes. Between the active river channel and the old channels, wetlands, bogs or fens may occur.

Mountain Rivers
The unaffected flow of the mountain rivers in their alluvial channels may naturally result in the formation of an incised channel, a stable channel or a channel dominated by accumulation (e.g., braided system). Stable and accumulation liable channels occupy the longest river segments with good conditions to form wetted areas or wetlands. Yet the most adequate conditions can be observed in alluvial parts of the rivers as they create the whole network of new branches and often shift main channels creating old ones (Gorczyca et al. 2011). While the bigger slope is the characteristic trait of mountain rivers as well as narrow valleys, wetlands are strictly connected with three factors, namely: the nature of fluvial processes taking place in the river channel (Strużyński 2014; Wyżga et al. 2010a), human and animal activity (Kłonowska-Olejnik and Radecki-Pawlik 2000), trees transported by the river current during floods (Wyżga and Zawiejska 2005; Faustini and Jones 2003; Radecki-Pawlik et al. 2011). Consequently, the incision of the mountain river channel may easily cause the disappearance of wet areas near the river channel.

5.2.2 Fluvial Processes in Regulated Rivers

Until the XXI century, rivers were regulated mostly with the technical methods. These trends led to narrowing and deepening of the river channels and narrowing of the flood channel. Main stream in regulated rivers had been forced to be as narrow as the bank enforcements. Within so-called hydraulically favourable channels, the flowing water reaches high energies during floods. However, it has to be remembered that even in regulated, straight channels, the fluvial processes exist. Such kind of regulations leads to the decrease of the transported material and to the appearance of the so-called "hungry rivers" in which bed degradation predominate. Regulated rivers cannot create wetlands, which finally tend to be degraded and used for human purposes. Bed incision processes caused the increase of channel capacity, so rivers started intensively drain their valleys.

Lowland Rivers
The process of meandering initiation is well recognized and found often in regulated rivers (Leopold and Wolman 1960; Kitanidis and Kennedy 1984) (Fig. 5.2). The thalweg movement is connected with the secondary currents. The same tendency can be observed in straight, regulated channels.

The aerial picture of the regulated lowland river, which is presented below, shows a distribution sand bars placed at an alternate angle (Fig. 5.3). This indicates non-homogeneous flow velocity distribution within the subsequent cross-sections. The presented riverbed forms move but sustain after frequent spring or summer floods. Regulated rivers are often separated from their valleys with the use of

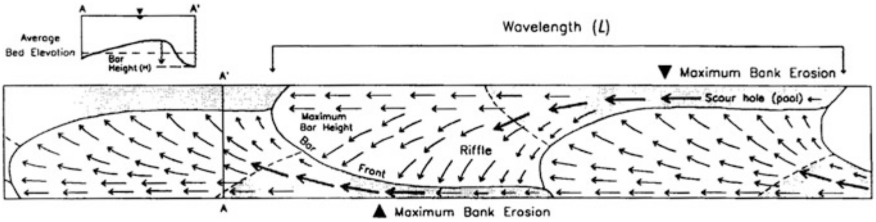

Fig. 5.2 The morphology of single-row alternate *bars* in straight channels with fortified banks (*after* Rhoads and Welford 1991)

Fig. 5.3 Bedforms squeezed in a regulated channel (*Source* Pińczów Aero-club)

embankments (Łajczak 2006a). The banks of regulated rivers should receive proper maintenance as long as natural processes of river channel curving exist. Otherwise, the bank fortifications would be broken by floods allowing the river to regain the natural flow conditions.

Mountain Rivers
Check dams as well as step cascades are mainly used for technical regulation of mountain rivers. The aim of using check dams in the upper run of the streams is to halt excessive load from overburdening the river channel but this also consequences with the increase of the erosion processes in the downstream sections (Wyżga et al. 2008). For this reason, river fall corrections such as steps are introduced, adjusting hydrodynamic balance of the river through minimising load transportation ability.

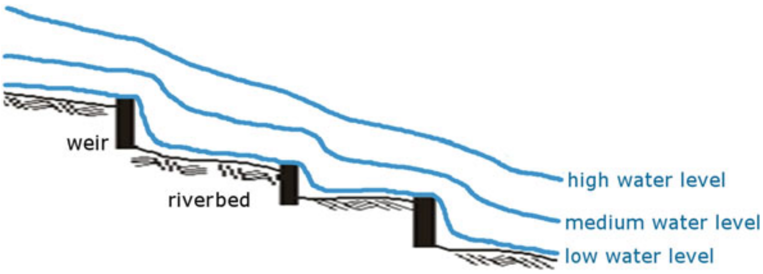

Fig. 5.4 The scheme of the regulated mountain river profile

As a result, the mountain rivers flow with a smaller slope in straight and slightly incised river channels (Fig. 5.4).

Apart from short periods of unusual floods, fluvial processes are "frozen" in these channels. High flows destroy the stable bed cover. However, these phenomena do exist and because of their violent nature they cause damage to river structures (Michalik et al. 1999; Książek, Michalik 2002). Therefore, the regulated watercourses need the periodic application of repair works. At present, the EU countries introduce the Water Frame Directive which creates favoured conditions to improve status of transformed water bodies. It is possible to employ bedload controlling dams instead of traditional check dams (Kopka 1998). Similarly, step cascades may be replaced by using special fish-penetrable structures. These structures ensure the stability of watercourses but simultaneously improve the hydromorphological parameters as well as restore the ecological corridor function of rivers.

5.3 Description of the Research Areas

Wetland restoration reconnaissance was performed in the Upper Vistula Basin (Poland) within the few projects running by the Department of Water Engineering and Geotechnics, the University of Agriculture in Kraków. The examples of performed in situ measurements are presented within the order: (a) the Vistula River near the town of Sandomierz, (b) the Nida River between the village of Rębów and the Pińczów town, (c) the Porębianka Stream in the near outlet sections (Mszana Dolna district), (d) the Czarny Dunajec River at the natural reach in the town of Wróblówka. Although the regarded river reaches differ in many aspects (Table 5.1), they are all located in areas of possible wetland appearance.

The Vistula River

The Vistula River is planned to become a waterway. For this reason the reach near Sandomierz (Fig. 5.5) is embanked and regulated by groins. Flood corridor within

Table 5.1 Parameters of investigated river sections

River	Nida	Vistula	Czarny Dunajec (Kojsówka)	Porębianka
Type	Lowland	Lowland	Highland	Highland
Reach length (km)	6.4 (18.8)	5	1.5	3
Subbasin area (km^2)	3,352	31,810	93.7	72
Slope or the reach (–)	0.00073	0.00017	0.0068	0.0125
Mean diameter, d_m (m)	0.00058	0.0005	–	0.088
$d_{90\%}$ (m)	0.00105	0.0015	–	0.142
Flow discharge $Q_{50\%}$ (m^3 s^{-1})	150	1,832	53.13 (Koniówka)	27
$Q_{1\%}$	450	7,338	252.63 (Koniówka)	191

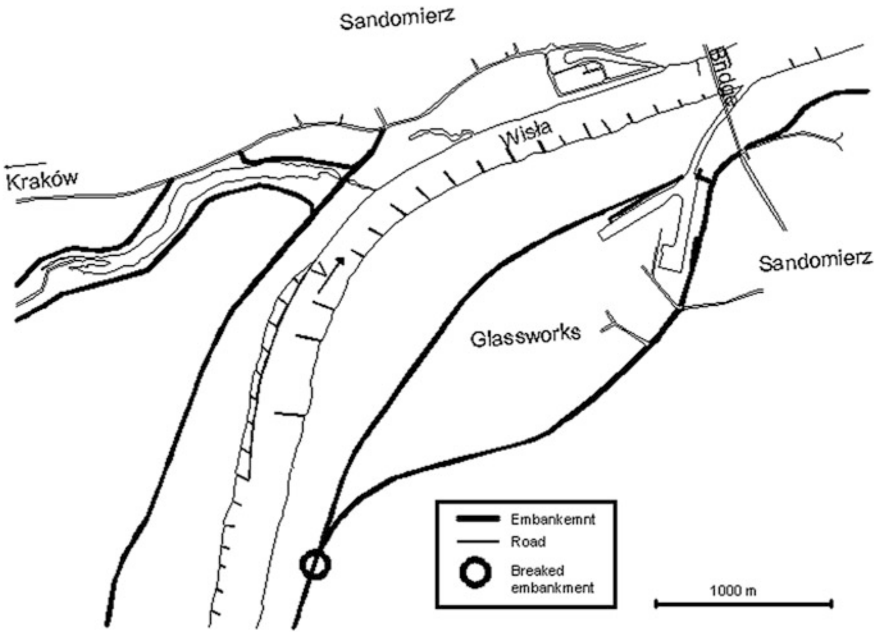

Fig. 5.5 Vistula River in the vicinity of the town Sandomierz

the upper Vistula is narrow. The nearby hills but also terraces are used for fruit production (mainly apples) (Bartnik and Książek 2011; Bartnik et al. 2011).

The right terrace lies currently outside the embankments which were broken during the 2010 spring flood (Bartnik and Książek 2011; Maciejewski et al. 2011). In that spring, flowing water (in May and June) with the peak discharge of 5,270 m^3 s^{-1} outlined the inundation range up to 8.5 km reaching the embankments of the Łęg River. This flood fitted the borders made by the city of Tarnobrzeg and the local villages: Żupawa, Poręby Furmańskie and Gorzyce. Floods indicate that retention areas are too small within the reach of Sandomierz but also in the upstream reaches. While the flood passes the reach with unnaturally high water levels, congested embankments may easily brake. In these cases, inundation was much bigger than expected, appearing as a water retention area of an exceptional importance retention area. At present, the Vistula river flows in the incised channel. This river, however, had favoured the wetland creation due to high frequency of floods as well as impermeable substratum with hight content of organic matter created by inundations. In spite of the fact that the embankments between Kraków and Sandomierz were finalized in the 1920s, there are still oxbow lakes found upstream Sandomierz (Łajczak 2014). After regulation works, fauna and flora still treat the Vistula River as a green corridor. There are environmental protection areas established within the presented reach of the Vistula River and its valley: the Pieprzowe Mountains Nature Park, Nature 2,000 habitat protection area (the Tarnobrzeska Valley of the Vistula River—PLH 18,049), Nature 2,000 habitat protection area (the Pieprzowe Mountains—PLH 260,022) (*Source* http://geoserwis.gdos.gov.pl/mapy/).

The Nida River

The investigated reach of the Nida River is located between the village of Rębów and the town of Pińczów. This lowland river—the left tributary of the Vistula River—can be predominantly regarded as close to nature. Flowing through the central part of Poland it had created in its middle run an "inland delta", a unique multichannel system with numerous wetlands (Fig. 5.6).

The regulation works done in the 1980s become an example of unnecessary and wrong management of the river valley. Spring floods are characteristic for this river. Nida floods its valley every 3–5 years. Additionally, during inundations the embankments are often broken and the "middle delta" stays underwater for a few days (Strużyński 2006). These facts force the local community to adjust their agricultural habits to the existing flow regime. Thanks to this, the main objects found in the Nida river and valley are: regulated channel, oxbow lakes, old channels, wetlands, bogs and grasslands. Besides the Nida itself, there are more water sources in this region: Hajdaszek, Branka and stream from the village of Stawy. Hajdaszek is currently redirected by the local community to the Smuga Umianowicka stream, the Old Nida branch, whose channel bottom is localized lower than the Old Nida branch and drains the valley, which results in marching processes in the middle part of the valley. Branka, the left Nida tributary, flows currently across the valley directly to the regulated Nida channel. In the past the stream supplied left branch of the river called Old Nida (Smuga Umianowicka) in the neighbourhood of the village of Skowronno Górne. The stream flowing from the village of Stawy goes into the old branch near Sobowice village.

The Old Nida system (oxbow lakes or channels supplied currently by Nida tributaries) is characterized by smaller channels of the width ranging from 8 to 15 m. The slope and curvature are responsible in this reach for intensive bedload

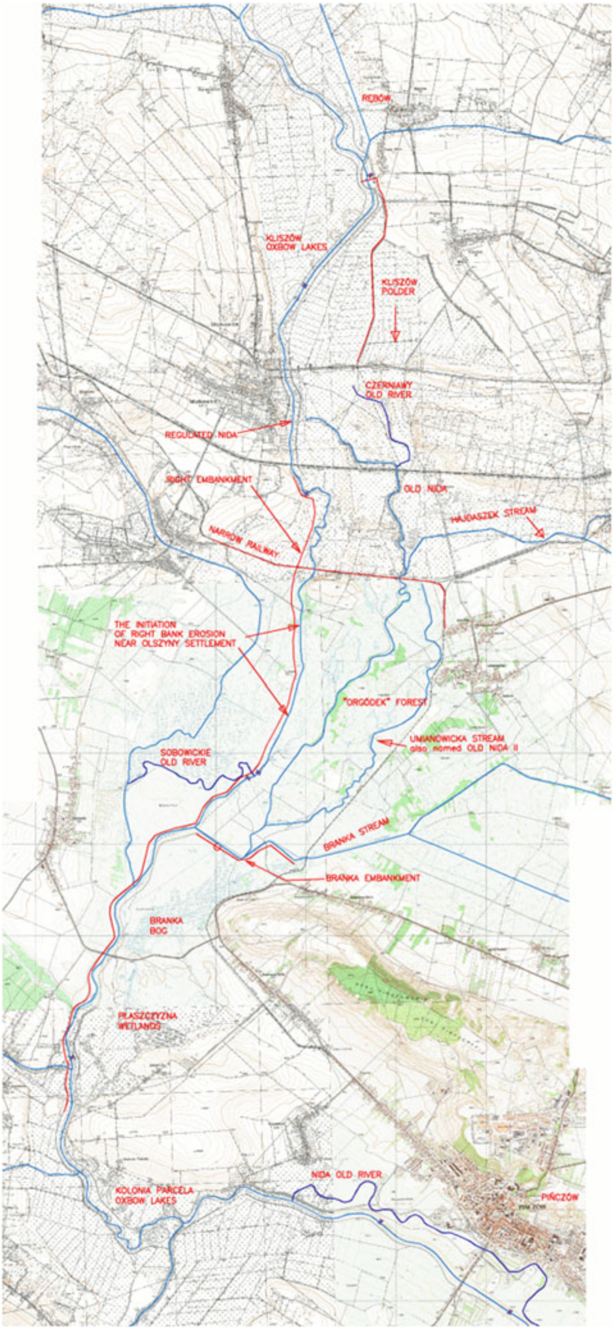

Fig. 5.6 The "middle delta" and its morphological objects

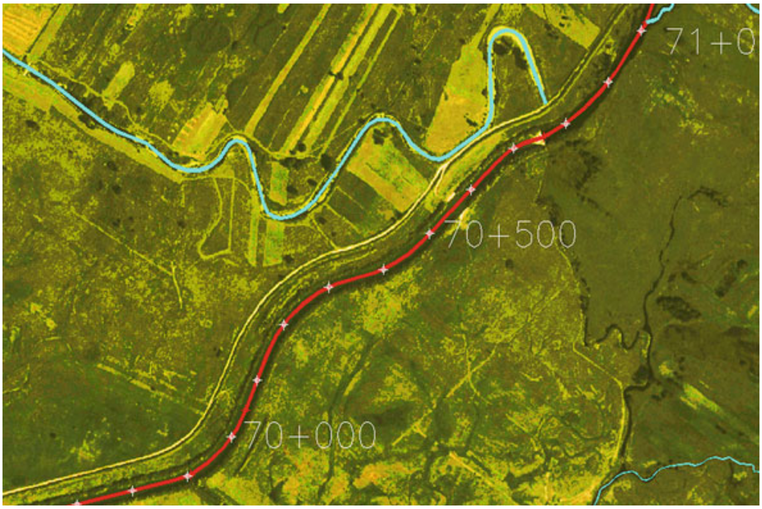

Fig. 5.7 The curvature comparison of the natural (*blue*) and regulated (*red*) river channel

Table 5.2 Expected change of parameters characterizing the river channel flow and the floodplain inundation

Parameter	River width (m)	River depth (m)	Flooded area (Q1 %) (mln m^2)	Valley capacity (Q1 %) (mln m^3)	Water depth in the valley during flood (Q1 %) (m)
Current state	25	0.6	7.6	4.7	1.2
After restoration	14–50	0.4–0.8	11.2	8.7	0.8

transportation and instability of the bed during flood events. The curvature of the natural channel differs dramatically in comparison to the regulated ones (Fig. 5.7).

The multichannel system is well developed. To provide calculations of the flow distribution within the modified or restored river channels, the HEC-RAS calculation has been performed. The parameters of regulated and restored river channels are gathered in Table 5.2.

The comparison of width and depth of the Nida branches shows that the expected width of the natural bed is about 34 m and the depth should vary from 0.5 to 1 m.

As long as the river was natural within the broader valley, it used to redistribute water periodically within the different parts of "delta". The restoration works should start from rebuilding proper connections between the old channels as well as initiating the water redistribution within the whole channel system. There is no certainty that on the sandy substratum of the valley the infiltrated water could be limited to the acceptable level. In the past within the "delta" region Nida had naturally hold one or two main channels (Fig. 5.1). For this reason, only part of the discharge from the main stream should be directed to the Old Nida channel. For better watering of the valley, the surrounding streams should also be used to supply the old channel system and the wetlands in the valley (Bartnik et al. 2004a, b, c).

At present, some species have disappeared from this region. Fortunately, the purpose of the intensification of agriculture production has been changed and the restoration of the old water system can be done. Another good example is the reservoir in Pińczów in which 5 species of molluscs live, including two which have been listed in the "red book of extinct species". The fauna and flora is not limited to molluscs in the Pińczowski Reservoir. In the widened valley, 262 kinds of plants, 51 mollusc, 11 amphibians, 3 reptiles, 160 birds and 16 mammals have been recognised (Bartnik et al. 2004a). Within the presented reach of the Nida River and the valley, the following protected areas had been established:

- National Landscape Parks (Zespół Świętokrzyskich i Nadnidziańskich Parków Krajobrazowych—National Landscape Park of the Valley of the Nida River),
- Nature 2,000 bird directive (Dolina Nidy—PLB260001),
- Nature 2,000 habitat directive (Ostoja Nidziańska PLH260003).

The Porębianka River

The Porębianka River is located in the southern part of Poland in the Gorce Mountains. It is a left tributary of the Mszanka River. Its source lies in the Obidowa Hill (1,000 m a.s.l.). Porębianka is a regulated river. In its upper run the valley is quite narrow and the river structures in the channel are distributed regularly. Bed material has been settled there but below this reach the lack of bedload has been encounted. Within the middle reach in village of Niedźwiedź, from the bridge down

Fig. 5.8 Bedrock channel of the Porębianka River in the region of a local hydropower plant

Fig. 5.9 Ramp—close to nature structure used in mountain rivers

to the RHS regulated reach, the rocky bed had been developed (Fig. 5.8) (Krzemień 1976, 1984; Radecki-Pawlik et al. 2010, 2013; Plesiński et al. 2013).

In this middle run, the river passes also two high steps damming up water for the power plant. The Porębianka in the lower run used to be a braided river but now its channel has been regulated by 25 ramps (rapid hydraulic structures, RHS, Fig. 5.9). After introducing ramps, the channel has straightened and had changed its morphodynamics. As long as floods passing this river are violent, the rapid hydraulic structures will demand periodic reparations.

The Czarny Dunajec River

Czarny Dunajec has its sources in the Tatra mountains. The river joins the Biały Dunajec River in the city of Nowy Targ, creating the Dunajec River. The flow dynamics of the Czarny Dunajec River is high. Nearly the whole area between the village of Podczerwone and the town of Nowy Targ is regulated with step correction and bank fortifications. Below the village of Wróblówka, there is only one, approximately 4 km-long segment of the river in which the channel is not regulated, preserving original character. In the highest two-and-a-half-kilometre-long reach the Czarny Dunajec River is braided and downstream it changes to island-braided (Wyżga et al. 2010b). In the above-mentioned part, the river creates complex bends which mark the migration zone of about 400 m width. There are numerous areas where the terrain is wetted as localized lower (Fig. 5.10). The whole valley is covered with abundant flora. Away from the course, in inundation terraces, there are fields used for agricultural purposes. The area of the river and the valley is protected

Fig. 5.10 The Czarny Dunajec River in the village of Wróblówka

by:—South Małopolska Protected Landscape Area,—Nature 2,000 bird directive (Torfowiska Orawsko-Nowotarskie—PLB12,0007),—Nature 2,000 habitat directive (Torfowiska Orawsko-Nowotarskie—PLH120016).

5.4 Evidence of Wetlands in the Investigated Areas

Presently no wetlands can be found in the valley of the **Vistula River** near Sandomierz (Łajczak 2006b), however numerous meander-shaped terrain forms remain there (Fig. 5.11). Terraces of Vistula river are made of muds and chernozems at a distance from 1 to 6 km from the river channel. This area used to be covered by wetlands. Upstream of Sandomierz, on both terraces, the oxbow lakes and the overgrown lakes exist. In Fig. 5.11 it is indicated that presently many of the well visible bars are forming, which indicates high fluvial activity within the channel of the Vistula River (Fig. 5.11, left—middle part of the picture). This shows that within this reach the transported material can settle outside the current.

Forces connected to secondary current are responsible for creating channel or alternate bars. They probably do not fit the channel run after it was poorly designed or there is no hydraulic balance between fluvial forces and critical forces characterizing movement of bed material. This trend should exist in regulated rivers. As long as Vistula tends to create meanders, the possibility of refreshing wetlands is real. At present the process of restoring wetlands can be started from the network of channels refreshing the existing oxbow lakes.

At present, the **Nida River** is an example where natural and regulated channels can be found in the nearby area (Fig. 5.12). Currently there are two main old channels in the valley (Fig. 5.6). One is the Old Nida, and the other is the Umianowicka Stream

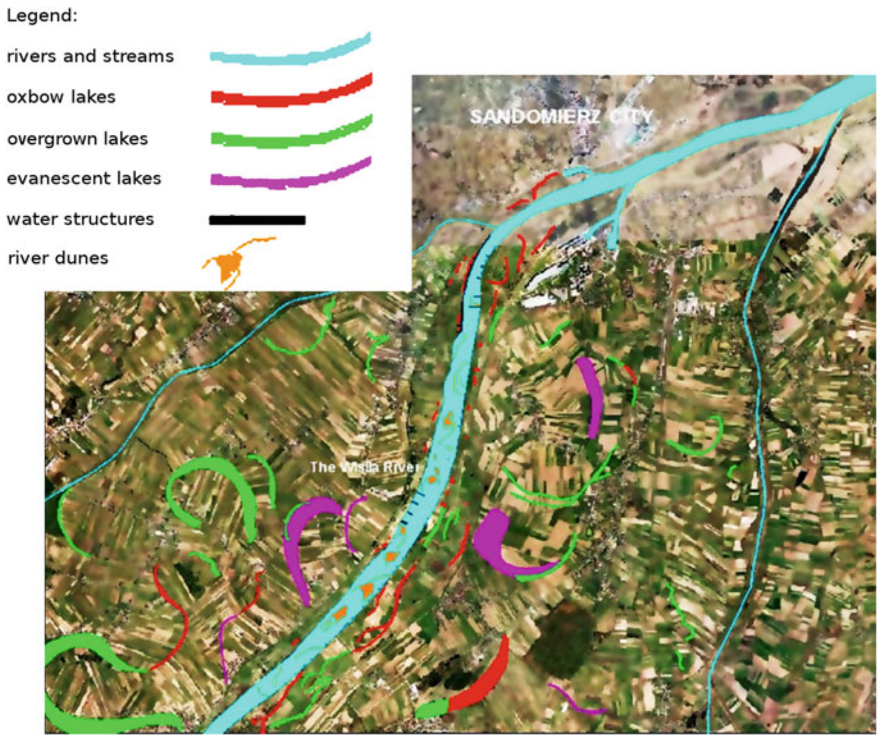

Fig. 5.11 Oxbow lakes and other channel-shape forms within the Vistula River natural migration zone (objects drawn on the satellite image. *Source* geoportal.gov.pl)

Fig. 5.12 Oxbow lakes surrounding the regulated reach of the Nida River in Pińczów (*photo* Aeroklub Pińczów)

Fig. 5.13 The Nida's old river channel during winter

named also the Old Eastern Nida or the Old Nida II. Numerous oxbow lakes and wetlands still exist in the neighbourhood of these channels. Close to the village of Sobowice another active old channel of the Nida is located. In the region of the narrowed valley, the wetland ("Branka bog") created currently by the water flowing in the Branka stream exists. Another hill encroach into the Nida river valley in the neighbourhood of the settlement Kopernia creates conditions for the Płaszczyzna wetlands to exist. Downstream, close to the regulated river, the oxbow lakes are localized. Below of the road bridge and between villages Skowronno and Sobowice the oxbow lakes are left after river training both on the left and the right terrace.

When planning renaturalisation projects in the "middle delta", it should be taken into consideration that there are still many rare species of fauna and flora living in the valley (Strużyński 2011). On the other hand, some parts of the river valley are still cultivated or used as grazing lands. Consequently, renaturalisation projects should deal with all of the mentioned problems, i.e.: take into account the safety of the passing floods, increase the riverbed stability, restore natural flow conditions in the regulated channel and in the old channels, as well as to improve the ecological state of the whole system (Bartnik et al. 2013). The work should start from redistribution of water flowing trough the whole system existing in the "middle delta" (Fig. 5.13).

As **Porębianka** used to create braided channel, there were no wetlands in this valley but only wetted areas connected to the migration zone of the river. In a mountain region within such areas, high biodiversity can be found. After Korpak (2007) it can be stated unfortunately that between 1975 and 2005 the incised part of

Fig. 5.14 Example of old channel "penetrating" the floodplain (Białka river)

the Porębianka stream channel had increased from 47 to 62 %. Currently the migration zone of the ramp regulated river reaches 50–60 m and the channel width varies from 25 to 30 m. Before regulation works it used to be in the range of 70–150 m. One of the last braided rivers in Polish Carpathians is Białka river in the reach from the Krempachy gorge to its outlet. This river, close to nature, still develops multichannel system in the width of 100–250 m (Struzynski et al. 2011). Additional channel of braided river can penetrate the floodplain, locally indicating the water-table (Fig. 5.14). Within such ponds, many species can pass the larval period (i.e., macrozoobenthos, tadpoles). Within lower run of Porębianka stream there is still a possibility of restoring similar areas. One of the mechanisms which could intensify the morphological transformations is the bedload transport. Braided rivers are heavily loaded by this material. Unfortunately, within the upper sections of the stream, heavy regulation works were performed, blocking the sediment supply.

The **Czarny Dunajec** River within the mentioned reach flows between regulates sections. This influences the fluvial processes which transform the river from curvy to a braided river and closer to the town of Nowy Targ an island—braided channel. Through the braided part, the Nature 2,000 areas cross the valley from its left to the right side. Within the valley, multiple marks of the land-transformed oxbow lakes can be found. The incision of the riverbed exceeds 1.5 m (Fig. 5.15).

This signifies that erosion processes are still taking place, however the bedrock has not been reached yet and the braided character of the Czarny Dunajec River is still preserved. The main danger for this reach is the exploitation of the bed material

Fig. 5.15 The riverbed incision of the braided reach of the Czarny Dunajec

and a limited supply of the material from the regulated upper sections of the Czarny Dunajec River.

5.5 Conclusions

Human changes in fluvial processes are very complex. This results in difficulty of restoring the natural river morphology. Probably the worst are caused by narrowing of river migration zone. When river cannot erode banks and create new branches, the only way to get material for transportation is bed erosion. This is directly connected to the incision processes. Incised river cannot create wetlands.

At a short distance from the town of Sandomierz, the Vistula River had formed meanders which are nowadays in the process of land-transformation. The river is embanked and does not form new hydromorphological structures on the inundation terraces. The reasons of embankment creation were the flood disasters in XIX and XX centuries. During river training, the environmentally precious areas were cut-off. The reason of the agricultural as well as industrial development on the surroundings of the town of Sandomierz where very good soils created by the permanent water logging. The floods, however, encounter negative implications of human accommodation within the river migration zone. While those areas are highly investigated for agricultural use, it might be not easy to restore oxbow lakes or wetlands there. The Water Framework Directive, however, favours restoring of the environment. This is partially still possible. Further development within this area can be designed as sustainable, including works with purposes to refresh existing oxbow lakes with the use of water from local streams or from Vistula itself.

Additionally, while restoring the waterway, many investigations accompanying the restoration could be done.

The Nida River basically flows across the close to nature, cultural landscape. The area of the widened valley, commonly referred to as “the middle delta”, was once very attractive for its morphological structure and fluvial activity, not to mention a great diversity of ecosystem. At present, the area requires serious restoration after introducing unnecessary river-regulating works. The system of the cut-off channels is still recognizable and may well be recreated. Nida, however, used to be very morphologically active, creating new branches and oxbow lakes. After river training, the main channel had been stabilized. The old channels slowly dry and their vulnerable surroundings loose the environmental meaning. Even if some areas are used as grasslands, the dynamics of the river system should be restored. This could be initiated by irrigating the old channels and recurving the regulated river. The system then could slowly rebuild the reach and environmentally precious wetland system.

Porębianka flows in the lower run over the RHS’s. The migration zone is decreased there by about 50 %, but ramp construction lets the bed material to overcome them and to create bars in this river. Currently the best solution for Porębianka river is to limit the human expansion within the river migration zone and to rebuild the river training system in the middle run in villages of Czarna Poręba and Niedźwiedź form weirs to RHS’s. The increase of bedload rate would positively change the flood capacity of the channel. Thus, these investigations could improve the connection between river and its valley as well as the morphological activity of Mszanka River, below the Porębianka outlet. The rebuilt system would create wetted areas much more extensively then presently.

The discussed fragment of the Czarny Dunajec River is formed naturally but endangered by a limited transport of alluvial material. The river migrates aside, and this process slows down the channel incision. However, the process of steady growth of channel flow capacity is already observed in this section; the river may still flow in the braided channel. Thanks to the fens, it makes an excellent place for plant and animal habitats. The future discontinuation of the river outflows onto the valley could be a possible result.

Wetlands are regularly refreshed by flood events. Natural rivers continuously transform their channels, creating oxbow lakes; as a result, the nature enrichment develops. Moreover, they improve the retention conditions in river valleys. The man has always attempted at occupying these areas as their soil fertility makes them very attractive for cultivation. As long as wetlands and oxbow lakes are a result of fluvial processes existing in rivers, human should take into consideration the natural consequences, especially of river channel narrowing. The adequate processes of river channel transformation appear during average or high flows, while during designing processes of river training works mostly average flows are considered. This reflects in long term on river incision.

It is much easier to remedy environmental values in regions which are not urbanized and intensively cultivated or even not used at all. River training often destabilizes fluvial processes but in urbanized basins the whole hydrological, hydraulic and morphological system is transformed. Therefore, the correction and maintenance of environmental values can be undertaken easily in the presented sections of the Nida and Czarny Dunajec Rivers. The Vistula River is under intensive agricultural cultivation which makes it impossible to do complex restoration of the river in question. The rapid hydraulic structures in the referred reach of the Porębianka River had been adopted to prevent the intensive erosion which appeared after the technical regulation of the river in its upstream sections. To improve the wetland creation processes within the presented sections of regulated rivers, the upstream reaches should also be redesigned.

Acknowledgments Financial support for this study was provided by Polish National Science Centre within the projects:–project No N N305 186,537: The description of balanced mountain rivers and streams state on the basis on natural morphological parameters. Financial support of the Department of Hydraulics Engineering and Geotechnics. DS-3322/KIWIG/2013. Procesy hydrodynamiczne w ciekach oraz procesy geodynamiczne powierzchniowych warstw zboczy na obszarze Polski Południowej (Hydrodynamical processes in rivers and geodynamical processes of surfaced layers hillsides in the region of South Poland); BM-4331 "Factors affecting the structure of the beetles (Coleopteria: Carabidae) in the floodplain of mountain rivers". 2012, and National Fund for Environmental Protection and Water Management. Renaturalization of the Nida river valley—The initial case study for the natural resources protection connected to the program "Nature 2,000" realisation plans. 2004. Vistula River activities were supported in part by the local authorities in town of Sandomierz. Authors would also send special thanks to Wiktoria Laszek, Piotr Madej, Paweł Muciek, Miłosz Nitka and Grzegorz Zawadzki who were indispensible in performed field works.

References

Bartnik W, Deńko S, Strużyński A, Zając T (2004a) Renaturyzacja obszaru zlewni Nidy—Koncepcja opracowana dla potrzeb ochrony zasobów przyrodniczych w związku z planami realizacji programu "NATURA 2000" (Renaturalization of Nida River basin—Concept created for protecting of the natural sources in connection to the Nature 2000 Program). Monograph, Drukrol s.c., Kraków (in Polish)

Bartnik W, Deńko S, Strużyński A, Zając T, Zawada M (2004b) Wstępna koncepcja renaturyzacji rzeki Nidy na odcinku delty środkowej (The initial concept of restoring the Nida River on the middle delta reach), Przegląd Naukowy, Inżynieria i Kształtowanie Środowiska, Rocznik XIII, Warszawa, zesz spec 30:220–230 (in Polish)

Bartnik W, Deńko S, Strużyński A, Zając T, Zawada M (2004b) Analiza warunków przyrodniczych i ocena potrzeb renaturyzacji rzeki Nidy na odcinku delty środkowej (Analysis of natural conditions and assesment of restoration needs of the Nida River on the middle delta reach). Przegląd Naukowy, Inżynieria i Kształtowanie Środowiska, Rocznik XIII, Warszawa, Zeszyty Specjalne 30:209–219 in Polish

Bartnik W, Książek L (2007) River and mountain streams training works under the hydrodynamic balance conditions. Infrastruct Ecol Rural Areas 4(2):15–26

Bartnik W, Majewski W, Łapuszek M, Ratomski J (2007) The estimation of hydrodynamical balance of the lower Dunajec below hydro-energy power plant. Infrastruct Ecol Rural Areas 4 (1):21–37

Bartnik W, Książek L (2011) Identyfikacja przyczyn powodzi w 2010 roku na Wiśle w rejonie Sandomierza (Identification of the causes of flooding in 2010, on the Vistula River in the region of Sandomierz). Starzec-Wiśniewska, Bazan S (eds) Zagadnienia ochrony przeciwpowodziowej Zapobieganie wystąpieniu strat i łagodzenie skutków żywiołu w relacji z zagadnieniami zagospodarowania przesterzennego (Issues of flood protection and prospects for development of inland waterways). The regional water management board Gliwice—Kraków—Wrocław, pp 40–48 (in Polish)

Bartnik W, Książek L, Leja M, Wyrębek M, Strutyński M (2011) Evaluation of morphological changes of the Vistula river channel in Sandomierz after the flood in 2010. In: Sobota J (ed) 15th International conference on transport and sedimentation of solid particles, UP we Wrocławiu, pp 223–232

Bartnik W, Zając T, Strużyński A, Bobka A, Wyskiel G (2013) Wykonanie inwentaryzacji i waloryzacji środowiskowo przyrodniczej dla projektu – „Zrównoważony rozwój gospodarczy zlewni rzeki Nidy w związku z obszarami Natura 2000" wraz z dokumentacją przedprojektową do stadium decyzji o środowiskowych uwarunkowaniach zgody na realizację przedsięwzięcia - etap I z III. Regional Board of Water Management. Dev. Kraków. manuscript (in Polish)

Church M (1992) Channel morphology and typology. In: Carlow P, Petts GE (eds) The Rivers Handbook. Blackwell Sci, Malden, Mass, pp 126–143

Faustini JM, Jones JA (2003) Influence of large woody debris on channel morphology and dynamics in steep, boulder-rich mountain streams, western Cascades. Or Elsevier Geomorphol 51:187–205

Gorczyca E, Krzemień K, Łyp M (2011) Contemporary trends in the Białka River channel development in the Western Carpathians, Geographia Polonica, 84. Speciall Issue Part 2:39–53

Kitanidis PK, Kennedy JF (1984) Secondary current and river-meander formation. J Fluid Mech 144:217–229

Kłonowska-Olejnik M, Radecki-Pawlik A (2000) Zróżnicowanie mikrosiedliskowe makrobezkręgowców dennych w obrębie łach korytowych potoku górskiego o dnie żwirowym (Micro-habitat diversification of bottom macrozoobenthos in the gravel bars of mountain streams). XVIII Zjazd Hydrobiologów Polskich (XVIII Association of Polish hydrobiologists). Białystok (In Polish)

Kopka W (1998) Badania modelowe zapór sortujących i dozujących rumowisko wleczone (Modeling of bedload transportation within sorting and dosing dams). PH.D. thesis. manuscript (In Polish)

Korpak J (2007) The influence of river training on mountain channel changes (Polish Carpathian Mountains). Elsevier Geomorphol 92(2007):166–181

Korpak J, Krzemień K., Radecki-Pawlik A (2009)Wpływ budowli regulacyjnych i poboru rumowiska na koryta rzek i potoków górskich – wybrane przykłady z rzek karpackich (The influence of hydraulic structures and bedload exploitation on the channels of mountain streams—chosen examples from the Carpathians). Gospodarka Wodna, Warszawa, Sigma-Not 7:274–281 (in Polish

Krzemień K (1976) Współczesna dynamika koryta potoku Konina w Gorcach (Current dynamics of the Konina Stream riverbed). Folia Geogr Ser Geogr-Physica 7:87–122 (In Polish with English summary)

Krzemeń K (1984) Współczesne zmiany modelowania koryt potoków górskich w Gorcach. (Contemporary changes in mountains riverbed modeling in Gorce Mountains) Zeszyty Naukowe UJ. Prace Geograficzne 59:83–96

Książek L, Michalik A (2002) Some aspects of mountain river bed degradation, 11th Interernation Conference on "Transport and sedimentation of solid particles". Zeszyty Naukowe Akademii Rolniczej we Wrocławiu 438:73–82

Książek L., Michalik A., Nowak J., Połoska-Wróbel A., 2010, Evaluation of hydrodynamic conditions changes on The Smolnik Stream, Infrastructure and Ecology of Rural Areas, 8/1, 93–104, in Polish with English summary

Leopold LB, Wolman MG (1957) River channel patterns—braided, meandering and straight. US Geol Surv Prof Pap 282B:39–85

Leopold LB, Wolman MG (1960) River Meanders. Bull Geol Soc Am 71:769–794

Łajczak A (2006a) Regulacja rzeki a zagrożenie powodziowe, na przykładzie Wisły między Skoczowem i Puławami (River training vs. flood exposure. The example of the river Vistula between Skoczów and Puławy, Poland). Infrastruktura i Ekologia Terenów Wiejskich. 2006/ 4 (1):197–215 (In Polish with English summary)

Łajczak A (2006b) Regulacja rzeki a zagrożenie powodziowe, na przykładzie Nidy (River training vs. flood exposure. The example of the river Nida, Poland). Infrastruktura i Ekologia Terenów Wiejskich 4(1): 217–133 (in Polish with English summary)

Łajczak A (2014) Zmiany w zagrożeniu powodziowym spowodowane regulacją rzeki na przykładzie doliny przedgórskiego biegu Wisły—stan aktualny i możliwości poprawy sytuacji (Changes in the risk of flooding due to river regulation on the example of the Vistula valley foreland—current status and scope for improvement). Scientific Conference Geomorfologia stosowana—Zastosowanie metod badań geomorfologicznych w inżynierii i kształtowaniu środowiska. 4–6 VI 2014. Warsaw University of Life Sciences—SGGW, manuscript (in Polish)

Maciejewski M, Ostojski MS, Walczykiewicz T (eds) (2011) Dorzecze Wisły. Monografia powodzi. Maj czerwiec 2010 (Wistula Watershed. The monograph of the flood. May June 2010). IMGW, Warszawa 236 (in Polish)

Michalik A, Bartnik W, Książek L, Goc A (1999) Zmiany koryta potoku Mszanka wywołane wezbraniami w latach 1995–1997 (changes in Mszanka stream riverbed caused by 1995–1997 freshets), Konferencja Naukowa "Bezpieczeństwo i trwałość budowli wodnych". Zeszyty Naukowe Akademii Rolniczej we Wrocławiu 363 (in Polish)

Plesiński K, Janas M, Radecki-Pawlik A (2013) Analysis of hydraulic parameters in near rapid hydraulic structure (RHS) in Porębianka Stream in Gorce Mountains. Acta Scientiarum Polonorum Formatio Circumiectus 12(1):101–114

Radecki-Pawlik A, Świderska K, Plesiński K (2010) Diversification of hydraulic parameters in near rapid hydraulic structures (RHS). Infrastruct Ecol Rural Areas 1:25–38

Radecki-Pawlik A (2011) Hydromorfologia rzek i potoków górskich (Hydro-morphology of the mountain rivers and streams), Wydawnictwo Uniwersytetu Rolniczego w Krakowie, Kraków, pp. 288 (in Polish)

Radecki-Pawlik A, Wieczorek M, Plesiński K (2011) Diversification of hydrodynamic parameters in close by woody debris. Acta Scientiarum Polonorum Formatio Circumiectus 10(2):35–46

Radecki-Pawlik A (2013) On using artificial rapid hydraulic structures (RHS) within mountain stream channels: some exploitation and hydraulic problems. In: Rowinski R (ed) Experimental and computational solutions of hydraulic problems. GeoPlanet: earth and planetary sciences. Springer, Berlin, pp 101–118. doi:10.1007/978-3-642-30209-1_17

Rhoads BL, Welford MR (1991) Initiation of river meandering. Prog Phys Geogr 15(2):127–156

Rosgen DL (1994) A classification of natural rivers. Catena 22:169–199

Strużyński A (2006) Skutki powodzi roztopowej w roku 2006 w uregulowanym odcinku delty śródlądowej rzeki Nidy (Consequences of the spring flood in 2006 on the regulated part of middle delta in the Nida River). Infrastruktura i Ekologia Terenów Wiejskich, Komisja Technicznej Infrastruktury Wsi PAN/o Kraków, 4/1 - monograph, ISSN 1732-5587, pp 235–247 (in Polish with English summary)

Strużyński A (2011) Flood protection in high valued river ecosystem—middle delta system of the Nida river. Electron J Pol Agr Univ 14(2), Wydawnictwo Akademii Rolniczej we Wroclawiu, ISSN 1505-0297, http://www.ejpau.media.pl/

Strużyński A, Wyrębek M, Strutyński M, Kulesza K (2011) 2011, Cross-Section Changes in the Lower Part of a Mountain River After the Flood in Spring 2010, as Presented by Means of

CCHE2D Program. Exp Methods Hydraul Res Geoplanet: Earth Planet Sci 1:287–297. doi:10.1007/978-3-642-17475-9_21

Strużyński A, Kulesza K, Strutyński M (2013) Bed Stability as a parameter describing the hydromorphological balance of a Mountain river. In: Rowinski P (ed) Experimental and computational solutions of hydraulic problems. GeoPlanet: earth and planetary sciences. Springer, Berlin, pp 249–251. doi:10.1007/978-3-642-30209-1_17

Strużyński A (2014) Ocena stanu oraz identyfikacja zaburzeń procesów fluwialnych w korytach rzek karpackich (Identification of the current state and fluvial processes disturbances in channels of Carpathian rivers). Acta Sci Pol Formatio Circumiectus 12(2):77–89 (in Polish with English summary, graphs and tables)

Wyżga B, Zawiejska J (2005) Wood storage in a wide mountain river: case study of the Czarny Dunajec. Polish Carpathians. Earth Surf Process Landforms 30:1475–1494

Wyżga B, Zawiejska J, Radecki-Pawlik A (2008) Określenie wielkości wcięcia si0119 rzek i jego wpływ na hydraulikę przepływów wezbraniowych—przykłady z rzek karpackich. Land Anal 9:402–405

Wyżga B, Zawiejska J, Radecki-Pawlik A (2009) Zróżnicowanie uziarnienia osadów korytowych rzeki górskiej przekształconej przez regulację koryta i eksploatację żwirów. Prace i Studia Geograficzne 44:195–203

Wyżga B, Hajdukiewicz H, Radecki-Pawlik A, Zawiejska J (2010a) Eksploatacja osadów z koryt rzek górskich—skutki środowiskowe i procedury oceny. Gospodarka Wodna, Warszawa, Sigma-Not 6:243–249

Wyżga B, Zawiejska J, Radecki-Pawlik A, Amirowicz A (2010b) A method for the assessment of hydromorphological river quality and its application to the Czarny Dunajec River, Polish Carpathians. Cultural landscapes of river valleys, University of Agriculture in Krakow

Chapter 6
New Vision of the Role of Land Reclamation Systems in Nature Protection and Water Management

Wiesław Dembek

Abstract The chapter is devoted to selected problems that appear between nature protection and some aspects of water management. Basic paradigms of nature protection and the reasons why they are not understood in society are presented. The role of land reclamation in natural environment is described with special attention to its positive aspects. Examples of conflicts between land reclamation and nature protection and chances of their solution are presented. The importance is analysed of small retention and broadly understood reclamation activities for flood control. Exemplary attempts are given of implementing some activities to hamper unproductive water outflow from reclamation networks to the Polish model of common agricultural policy.

Keywords Nature protection · Land reclamation · Flood control · Conflicts · Areas of cooperation

6.1 Introduction, Aim of the Study

The study is aimed at analysing selected problems that appear in the relations between nature protection and land reclamation. The contact zone between the two is a traditional area of conflicts and polemics. Therefore, it is worth thinking for a moment of the sense of the notion "nature protection" and of priorities associated with this type of activity. Nature protection is not a scientific discipline; it is rather a skill based on various fields and disciplines of knowledge. It is mainly based on ecology since it very often deals with maintaining proper relationships between the elements of natural environment which is the domain of that science. Most often reason of misunderstanding is forgetting that both nature protection and ecology are not guided by anthropocentric philosophy and tradition; hence, they do not treat

W. Dembek (✉)
Institute of Technology and Life Sciences, Al. Hrabska 3, 05-090 Falenty, Poland
e-mail: w.dembek@itp.edu.pl

S. Ignar and M. Grygoruk (eds.), *Wetlands and Water Framework Directive*,
GeoPlanet: Earth and Planetary Sciences, DOI 10.1007/978-3-319-13764-3_6

humans as a privileged species. On the contrary, nature protection sees human activity as the main source of disturbance in the natural environment. It seems that this statement is hardly acceptable by man since we are inclined to believe in the superiority of human interests by our child-rearing, school education, religion and any disturbance of these beliefs raises conscious or subconscious protest. Irrespective of various definitions, nature protection in its practical aspect focuses on these elements of biodiversity (species, genes, ecosystems or landscapes) which are presently endangered. In practice, a common species seldom becomes the object of interest from representatives of nature protection. If, however, this species faces a threat, then it becomes the object of their activity, proportional to the scale of endangerment. So, the author does not see a greater interest in the protection of the rook in Poland, of the raven recently increasing in number or of poor fox blamed for posing a threat to many species. Instead, the object of concern is once common species which are now endangered like the partridge, the black grouse, the northern lapwing, wolf etc. It thus appears that man cannot be the object of interest of nature protection specialists since our species is not endangered, especially in the global scale. It also appears that sometimes objectionable thesis that "a frog is more important than man" is most justified since it reflects the sense of nature protection activity. All amphibians in our country are—and probably will be—on the list of protected species, many of them are threatened and so refusing the frog its priority would negate the message every nature "protector" is guided by.

Laborious explanation of the above-mentioned priorities of current nature protection should be a base of each programme of ecological education since our society is permanently fed with inconsistent information on this protection by various groups of interest. Meanwhile, the most important paradigm of currently understood nature protection is to prevent the domination of any of these groups whose interests may be contradictory and may lead to the preference or extermination of various species. For example, dead wood—an important condition of preserving biodiversity in forest ecosystem—is a source of threat for a forester because some xylobionts (organisms living in wood) may pose a deadly threat to tree stands. The hare craved by hunters is hated by orchard owners, as is the starling for which we otherwise hang nesting boxes in parks. Anglers are eager to stock Polish waters with carp—an alien and invasive species which replaces native benthic-feeding fish species. Hunters are happy to see the mouflon and the fallow deer in our forests—both alien to Polish fauna and competitive for the European red deer.

6.2 Environmental Role of Land Reclamation

There are no such land reclamations that would be favourable for nature in the wild. Though it now seems obvious, several years ago one could find slogans on positive role of land reclamation without explaining the environmental context. Nevertheless, one had to agree that there are no really natural places in Poland. This may be a basis for a hypothesis that land reclamations may play a positive environmental role providing the environment is transformed by human activity.

You have to remember that wildlife in Poland almost never feel the excess water. Even disastrous floods were mostly favourable or at least neutral to the natural environment. In most situations the increased amount of water is favourable for nature in agriculturally used areas. There are few situations when decreasing amount of water is beneficial in cultivated areas. This is because, historically, the introduction of crop species under Polish conditions required decreasing the soil moisture in habitats. Grasses from cereal group are the steppe species, "noble" meadow grasses are the species from dry ground habitats and tuber crops consist in part of species from the subtropical zone.

A plant dies of oxygen deficit in soil and not of water excess. It also dies of water deficit but not of the excess of oxygen. It means that the amount of oxygen in root zone is important during drainage and water availability for plant roots is important during irrigation. Most grass species significant as the source of fodder develop optimally at air content in the root zone in the range of 8–12 % per volume (Szuniewicz 1979). Such air content corresponds to ground water levels given in Table 6.1 understood as the distance between water table and land surface. Estimating these depths is an effect of laborious experimental studies of the generations of Polish meadow and soil specialists.

Data from Table 6.1 show that, for most grassland habitats in Poland, the optimum ground water level is ca. 0.5 m beneath the land surface. In the last decades, ground water in these habitats has declined in the middle of the growing season to one or more metre, which had a detrimental effect particularly for meadows situated on shallow non-peat soils.

To continue deliberations on stereotypical formulations which sometimes carry misleading contents, it is worth thinking of the notion of flood. According to traditional definition, flood is a transitory hydrological phenomenon consisting in the rise of river waters which, after exceeding bankfull level, causes the inundation of large areas—river valleys, near-shore or depression areas which leads to measureable social and material losses. Water rising is a high river water level which leads to overflow and flooding the river valley. The reasons of floods are of two kinds: either flood control facilities do not play their role or social and material goods are situated by man in a place exposed to flooding. Considering water rising

Table 6.1 Optimum and extreme for plant survival levels of ground water in soils for grasses grown on permanent lowland grasslands (Szuniewicz et al. 1992)

Soil conditions	Optimum (and extreme) depths of ground water [m]
Poorly decomposed peat	0.80 (0.35–1.10)
Medium decomposed peat	0.65 (0.35–0.95)
Medium and strongly decomposed peat	0.55 (0.30–0.85)
Strongly decomposed peat	0.35 (0.25–0.60)
Shallow non-peat soils	0.35 (0.25–0.50)

as a natural phenomenon desired from the natural point of view, one may conclude that rivers cause water rising while people cause floods. The fact that rivers or other kinds of waters in the environment are not the reason of floods has far-reaching consequences for the philosophy of flood control and the ways of increasing its effectiveness. Noteworthy, in the flood directive (Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks) the question of losses was removed from the flood definition and transferred to the notion of flood risk.

6.3 Land Reclamation and Flood Control from the Nature Protection Point of View

Discussions on flood protection in Poland worsen when the losses caused by flood are tragic in their sizes reality. This favours seeing water management from the anti-crisis standpoint and not as methodical, complex and long-term activities. In the atmosphere of disaster and associated emotions, one often forgets that common interests of nature protection, flood control and land reclamation manifest themselves in flood prevention and not during the action of emergency services. The issues of land reclamation and flood control are closely associated with each other. Floods are not generated in rivers but in the catchment basin, i.e., in areas with functioning reclamation systems. Flood control is facilitated by the increased catchment retentiveness and the increased retentiveness is facilitated by, i.a., appropriate reclamation.

Commonly used are the terms of large and small retention. Large retention means water reserve contained in large, artificial water reservoirs while small retention includes many elements (Mioduszewski 1999, 2009):

- surface water retention, in this number:

  regulation of water outflow from ditches and canals;
  regulation of water outflow from ponds and puddles;
  utilisation of valley retention;
  small water reservoirs—biologically controversial;
  damming natural running waters—as above;

- retention of ground water:

  holding water in reclamation ditches and canals;
  regulation of water outflow from drainage networks;
  phyto-reclamation, agri-reclamation;
  limiting surface runoff;
  increasing soil water capacity;
  counter-erosion measures;
  ponds and infiltration wells;

- soil retention:

  soil loosening;
  increasing humus content;
  liming;
  proper agro-technical measures;
  proper crop rotation—green fields the year round;

- landscape retention:

  complex spatial set of arable lands, meadows, pastures, forests, streams and ponds;
  cluster and lane thickets;
  counter-erosion measures;
  large area of wetlands.

Having in mind that the potential of small retention may be estimated at several billion m^3 and the combined capacity of 10 largest retention reservoirs in Poland is 1.7 billion m^3, one has to notice that applied notions have reversed meaning—the potential of “small retention” is much larger than that of “large retention” but the former is more difficult to control. In the above set of elements composing the so-called small retention surprisingly many fall within the scope of reclamation. Data presented in Table 6.1 show that periodically there is a huge retention reserve. Its size is such that elevation of ground water table in peat soil by 10 cm is equivalent to an increment of several hundred m^3 of water per ha. Data presented in Table 6.2. evidence potential retentive role of reclamation systems.

The author of the above simulation attributed great importance to soil retention. Water lifting in the network of detailed reclamation ditches in grasslands and—practically not used—regulating the outflow from drainage networks are also of great importance. Though the simulation is of a theoretical character, it shows a potential of the so-called small retention. Below, there is another simulation of the same author pertaining to a real catchment of an area of 9.2 km^2 (Fig. 6.1, Table 6.3).

Table 6.2 Potential possibilities of increasing catchment retentiveness through reclamation measures—an example of the upper Narew River catchment (Kowalewski 2003)

Potential measure	Existing status, mln m^3	Target status, mln m^3
Water lifting in streams and rivers	1.89	3.14
Water lifting in reclamation canals	0.16	0.26
Regulating the outflow from the valley reclamation objects	0.75	2.72
Water lifting in the network of detailed reclamation ditches in grasslands	20.84	41.69
Regulating the outflow from drainage networks in arable lands	20.89	41.79
Small water reservoirs	15.84	31.69
Soil retention	12.76	51.40
Total	73.12	172.70

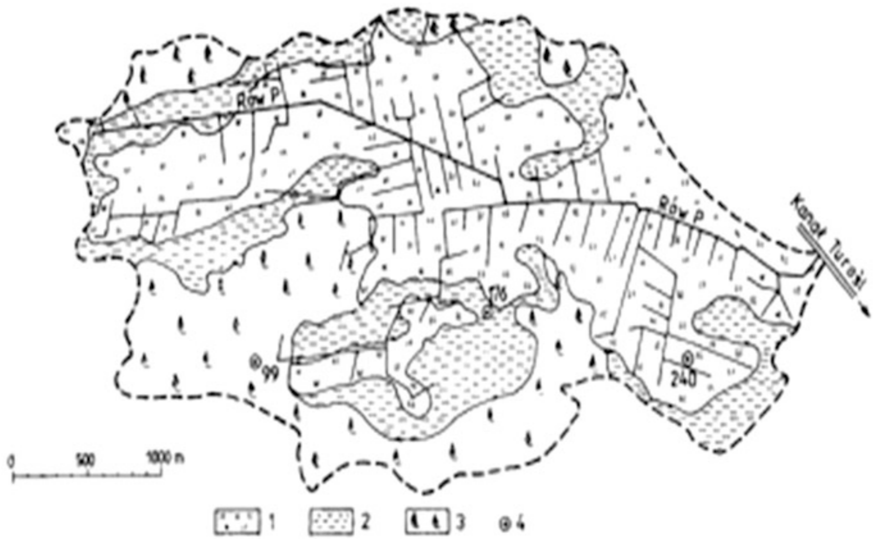

Fig. 6.1 A sketch of the 9.2 km^2 catchment with the network of ditches functioning there (Kowalewski 2003); *1* Grasslands; *2* Arable land; *3* Forests; *4* Grid computing nodes

Table 6.3 Simulation of the retention effects at closed outflow from reclamation ditches in the catchment shown in Fig. 6.1 (Kowalewski 2003)

Simulated action		Hydrological effects	Increment of retention
Variant I	A lack of water lifting in the reclamation network—free outflow of water	Ground water depth in summer—ca. 100 cm	–
Variant II	Closed outflow from the reclamation network since April 1	Ground water depth in summer—0 cm	ca. 386,000 m^3

Completely closed outflow from ditches since April 1 results in the ground water level close to land surface, so it should not be applied in croplands. Such a variant may be considered only for lands abandoned by agriculture.

6.4 Ecosystems that Might Be Significantly Affected by Land Reclamation

Water-related ecosystems constitute 14 % of the Poland's area; most of them are agricultural grounds used as meadows and pastures. There are 135 plant communities in grasslands out of 360 noted in Poland. From among 76 Polish natural habitats environmentally important for Europe and protected by the Habitat Directive (Dyrektywa 92/43/EWG…), 28 are associated with agricultural areas and

Table 6.4 Natural habitats from the list of the Habitat Directive present in agricultural areas and their potential sensitivity to land reclamation

Habitat	Sensitivity to reclamation
Xeric sand calcareous grasslands	None
Semi-natural dry grasslands	None
Species-rich mountain and lowland *Nardus* grasslands	None
Molinia meadows	Very high—may exist in reclaimed areas
Cnidion venosae meadows	High—must be flooded
Lowland and mountain extensively used fresh meadows	Low in lowlands; none in the mountains
Mountain hay meadows	None
Continental salt meadows	Very high—do not exist in reclaimed areas
Calcareous fens	Very high—do not exist in reclaimed areas
Alkaline fens	Very high—do not exist in reclaimed areas

in that number 22 are water related. From among 75 bird species nesting in Poland and protected by the Bird Directive (Dyrektywa 2009/147/WE…), 34 are associated with rural areas including 25 species associated with meadows and pastures (Dembek et al. 2004). Lists of endangered and protected bird species associated with meadows and pastures of the country are much longer.

Selected natural habitats in agricultural areas which Poland is obliged to protect under the Habitat Directive and their sensitivity to reclamation are presented in Table 6.4. Table 6.4 shows that the sensitivity of natural habitats associated with agricultural areas and important for the European Union to activities typical for land reclamations is quite diverse. For some of them (sand calcareous grasslands, dry grasslands, mountain grasslands) reclamation measures have no sense. For others—situated in river valleys—a change in water conditions caused by reclamations results in their elimination. Such habitats include calcareous and alkaline fens, salt meadows and flooded Cnidion venosae meadows.

Noteworthy, the share of mentioned habitats sensitive to reclamations in the total area of grasslands is negligible and of no economic importance. To sum up—under present natural and economic conditions there are no rational reasons to reclaim valuable non-forest ecosystems from the list of the Habitat Directive present in agricultural areas.

Highly sensitive to changes in water conditions are wetland habitats—agriculturally non-productive but often accompanying croplands—listed in the Habitat Directive:

- flooded muddy river banks;
- willow, poplar, alder and ash riparian forests;

- oak-elm-ash riparian forests;
- coniferous and bog forests;
- transitional moors and quaking bogs.

These habitats are rather not endangered by reclamation, however, the protection of the first three habitats is associated with flood control problems described in Sects. 6.3 and 6.6.

6.5 Possibilities of Improving Natural Habitat Through Land Reclamations

Proper water management in habitats transformed by human activity is of great importance for environmental protection. Maintaining ground water levels at a depth optimum for meadow sward facilitates the protection of soil organic matter. This may be achieved by regulated outflow of water from reclamation ditches with the help of water lifting facilities (weirs or permanent sills).

Preservation of riparian rush vegetation, trees and shrubs may contribute to maintaining a mosaic character of the landscape, important for its biodiversity. In reclamation ditches this vegetation is usually removed since it interferes with mechanical conservation works. A lack of this type of vegetation means nonexistence of buffer zones being a filter for dissolved nutrients runoff from surrounding croplands, disappearance of bird sanctuaries for waterfowl and singing birds and finally the overheating of water and its decreased aeration. Radical mowing of bottom plants and de-silting is unfavourable from the nature protection viewpoint. Apart from the disappearance of aquatic and wetland plants and of benthic fauna, a stream devoid of vegetation loses its water purification properties.

Of fundamental importance for biodiversity is to provide an unobstructed flow in streams. Water lifting facilities desired in regulated or artificial streams pose a risk for the role streams play as ecological corridors. The equipment of larger dams with effective fish ladders and proper shaping of permanent sills is important in this aspect.

The question is, whether the abandonment—overgrowing by plants and siltation—of reclamation ditches is favourable from the nature protection viewpoint? Obviously yes, providing it is not associated with the abandonment of adjacent grasslands and when ditches are not equipped with water lifting facilities. Moreover, a lack of such facilities results in accelerated water outflow and increased flood risk.

It is worth mentioning of the importance of properly performed reclamation for the mitigation of climate changes. According to approximate calculations, the intensity of CO_2 release from meadows on peatlands dried in uncontrolled way is by 22 % larger than from irrigated meadows. Maintaining ground water levels at depths given in Table 6.1 would decrease CO_2 emission to the atmosphere by ca. 17,000 tons a day in in the scale of Poland (Czaplak and Dembek 2000).

6.6 Conflicts

It is unavoidable that some priorities of nature protection may come into conflict with the priorities of land reclamations performed for productive purposes. Nevertheless, the author observes proceeding—at least theoretical—concurrence of interests. Definite conflict may arise in the situation of making new reclamations in river valleys. The author passes over the question of actions in rivers which are out of the scope of this paper. Table 6.5 presents examples of such conflicts.

Best explained problem is the so far traditional source of conflicts mentioned in point 1: drainage. As demonstrated in this paper, water lifting in reclamation systems is the vital interest of nature protection, agriculture and flood control. It allows for utilising large retention resources shown in examples from Tables 6.2 and 6.3. The problem of disruption of continuity of aquatic ecological corridors by dams has been solved long ago. Of course, fish ladders and properly constructed sills would never achieve 100 % efficiency. Nevertheless, ecological benefits from hampering water outflow from regulated streams may in many cases coincide with productive aspects. The problem described in point 3 of Table 6.4 has recently swollen in association with flood risk. As found by practitioners in flood control, trees and shrubs in flood terrace significantly reduce the hydraulic cross-section and influence increase the water level. Hence, a demand for cutting such plants. A need for an individual approach to such problems should be strongly recommended: protection of urban/agricultural areas and valuable habitats, which would not be present if dykes and valley between them were properly maintained. Different solutions are possible, but proper analysis necessary. Also if we want to cease useless quarrels

Table 6.5 Conflicts among land reclamations, flood control and nature protection and possibilities of their solution—examples

Conflict	Reason	Chance of consensus
Drainage	Drainage causing soil degradation and a loss of biodiversity	Possible: water lifting in "non-productive" reaches by permanent sills water lifting in productive reaches by weirs
Hydrotechnical built-up of streams	Breaking continuity of aquatic ecological corridors	Possible: fish ladders by dams appropriately profiled tops of sills
Shrubs and trees between embankments	Water lifting during floods	Possible: in not protected habitats by proper protection of areas outside the embankment
Limitations associated with nature protection near flood embankments	Impossible renovation works	Possible: depends on the endangerment level (rarity) of habitats or species
Beaver	Inundation of croplands perforation of flood embankments	Possible though hardly achievable: costly spillways in dams costly protection of flood embankments permission for population reduction

with the use of stereotypes and slogans. The problem is that trees and shrubs may form valuable plant communities defined in the Habitat Directive as willow, poplar, alder and ash riparian forests. The presence of legally protected natural habitats enforces the protection of areas endangered by flood risk through adequate construction and conservation of flood embankments to avoid such dilemma. Probably in some cases such areas may be overgrown by unidentified shrub communities as a consequence of secondary succession on abandoned grasslands. Removing this vegetation is desired from the point of view of both biodiversity protection and flood control. Limitations associated with nature protection near flood embankments may—in the opinion of flood control specialists—cause problems with renovation of flood embankments. Postulated withdrawing from habitat and species protection in such places seems worth considering. Each case should, however, be analysed separately in view of the size of flood risk and the value of protected elements of the natural environment. In the case of species and habitats of least concern, blocking the possibility of renovation of flood embankments and exposing to costly flood risks seem absurd. A unique in the country and European scale sanctuary of protected species may, however, happen (probably exceptionally) to occur near flood embankments. In such case, considering the construction of an alternative embankment seems reasonable.

The problem of beavers' activity has recently been a constant element of discussions on the efficiency of flood control. The author is not a zoologist and cannot express his opinion in that matter. Knowledge of various source materials allows for a conclusion that problem with beavers appears only during floods. Apart from high water period, beavers do not inhabit flood embankments since there is no necessary water there. During rapid water rising, beavers are enforced to leave their lodges and search for dry land. The first such place is the flood embankment. Under threat, beaver is able to make a lodge there in a short period of time. Noteworthy, during extreme spring floods beavers suffer the greatest population losses among large mammal species since young beavers cannot swim. Moreover, there are no reliable data on beavers' contribution to water leaking through embankments in comparison with other reasons like too low height of embankments, a lack of their conservation or technical defects.

6.7 Examples of Attempts Undertaken to Support Farmers in Hampering Water Outflow from Reclamation Systems

The importance of water retention in reclamation systems to protect biodiversity and to control floods, not colliding with agricultural productive interests, was raised many times in documents know by the author. Beneath there are three examples of these documents.

In the document of the Ministry of Environment (Środowiska 2005): "Strategy of wetland protection in Poland with the action plan" for the years 2006–2013 there is a statement: "/…/Uninterrupted water outflow from reclaimed river valleys caused by a lack of water lifting facilities in drainage ditches is unfavourable in the country scale. It means that most hydrogenic sites in the country are aimlessly drained the year round. Properly organised limitation of water outflow from reclamation networks is realised only sporadically. Meanwhile, properly regulated outflow may support the existence of biocoenotically rich wet meadows—now very rare in the country. Application of scientific principles of water management in river valleys including the principle of retaining post-winter waters to irrigate soil in spring period during intensive plant growth and the principle of maximum accumulation of scarce water resources in summer are commonly neglected /…/".

The document articulates the need of development of wetland protection methods with the operational targets:

- counteracting the unproductive outflow of water from reclaimed habitats,
- dissemination of farming methods in conditions of high soil moisture.

The State Council of Nature Protection in its standpoint on the project: "Programme for the development of rural areas in the years 2007–2013" of May 10 2006 stated that: "/…/ It would be reasonable to orient activities: "Management of agricultural water resources" in a way to create financial preferences for retaining water in reclamation systems through irrigation and regulated outflow. This would have a great importance not only for production but also for water retention and flood control. Extremely important is the variant of micro-retention listed in the activity "Non-productive investments" of the Programme for the Development of Rural Areas /…/".The variant would be of great significance for nature and education. A possibility of installation by farmers small sills on ditches may result in unprecedented breakdown in the system of water management in detailed reclamation networks where farmers were so far mere supplicants, which was ineffective and conserved claiming attitudes."

On August 7, 2006, the Director of the Institute for Land Reclamation and Grassland Farming (now the Institute of Technology and Life Sciences) sent a letter to the Minister of Agriculture and Rural Development: "/…/ Considering the necessity of limiting agricultural losses caused by more and more frequent droughts and floods and the need of preserving natural values of rural areas I submit a request to include actions aimed at improving water balance to the Programme for the Development of Rural Areas for the years 2007–2013.

Agriculture is a branch of economy most exposed to losses due to water deficit or excess. Meanwhile, the course of atmospheric phenomena observed recently and predictions of many climatologists clearly indicate that extreme phenomena resulting in droughts and floods will be more and more frequent. There are justified fears that water deficit in particular will become a barrier limiting the development of country agriculture. In view of the above facts it is indispensable to undertake, as fast as possible, actions in order to improve the structure of water balance in small catchments through increasing retention capacity of agricultural landscape. The *actions should primarily include the creation of "micro-retention" through hampering rapid water outflow from draining reclamation systems and the construction of small water reservoirs. Proposed actions will mitigate economic consequences of droughts and limit disastrous floods and hence will improve the economic status of farms. They will be also an important element of sustainable development of rural areas and of protection of their biodiversity. Moreover, they will form a basis for implementing the Water Framework Directive, Habitat and Bird Directives, which are the fundamentals of creating Natura* 2000 *areas. Water lifting in ditches and small streams and the construction of small water reservoirs will bring both economic and natural benefits. In many cases the development of micro-retention will need some limitations in agricultural production, e.g., due to flooding or excessive soil moisture in lower situated areas. Therefore, the accomplishment of the programme of water balance improvement requires financial support for farmers who undertake agri-environmental activities both during investment and exploitation phases. Due to benefits for the natural environment and agriculture, the activities aimed at increasing water retention should be considered in the Programme for the Development of Rural Areas for the years* 2007–2013. *Studies and analyses performed in our Institute clearly indicate that small investments to increase water resources commonly applied in farms will bring measurable benefits to farmers and the natural environment /…/*".

Examples cited above indicate that there is a significant coincidence of priorities in the questions of nature protection and land reclamation. The priorities—during calm and objective discussion—should be used and bring synergistic effects.

6.8 Conclusions

1. For the necessity of equipment of reclamation ditches with water lifting facilities the standpoint of nature protection is essentially the same as postulates of land reclamation.
2. Increasing catchment retentiveness is extremely important for nature protection; being a task for land reclamation it is identical with the needs of modern understanding of flood control.
3. Drainage systems in arable lands have no significance for the protection of valuable natural habitats; important is, however, the retention of water flowing out of drains.
4. Floods and high levels of ground water in river valleys are, as a rule, very favourable for biodiversity.
5. Vegetation of managed meadows in Poland may exist in summer at water levels much higher than those observed in the last decades in the country.

References

Czaplak I, Dembek W, (2000) Torfowiska Polski jako źródło emisji dwutlenku węgla (Poland's peatlands as a source of CO_2 emission). In: Rolnictwo polskie i ochrona jakości wody. Zeszyty edukacyjne, Wydawnictwo IMUZ, Falenty

Dembek W, Dobrzyńska N, Liro A (2004) Problemy zachowania różnorodności biologicznej na obszarach wiejskich w kontekście zmian wspólnej polityki rolnej. (Problems of biodiversity preservation in rural regions), Woda-Środowisko-Obszary Wiejskie. Rozprawy naukowe i monografie, Nr 11

Dyrektywa 2007/60/WE Parlamentu Europejskiego i Rady z dn. 23 października 2007 r. w sprawie oceny ryzyka powodziowego i zarządzania nim. Dz. Urz. U.E. L 288/27

Dyrektywa 2009/147/WE Parlamentu Europejskiego i Rady z dnia 30 listopada 2009 r. w sprawie ochrony dzikiego ptactwa. Dz. Urz. UE L020

Dyrektywa 92/43/EWG z dnia 21 maja 1992 w sprawie ochrony siedlisk przyrodniczych oraz dzikiej fauny i flory. Dz. Urz. UE L 206

Kowalewski Z (2003) Wpływ retencjonowania wód powierzchniowych na bilans wodny małych zlewni rolniczych (Effect of surface water retention on water balance of small agricultural catchments). Woda—Środowisko—Obszary Wiejskie. Rozprawy naukowe i monografie N 6. Wydawnictwo IMUZ Falenty

Mioduszewski W (1999) Ochrona i kształtowanie zasobów wodnych w krajobrazie rolniczym (Protection and shaping of water resources in agricultural landscape). Wydawnictwo IMUZ Falenty

Mioduszewski W. (2009) Retencjonowanie wód na obszarach wiejskich (water retentioning in rural areas). In: Mioduszewski W, Dembek W (eds) Woda na obszarach wiejskich. Ministerstwo Rolnictwa i Rozwoju Wsi, IMUZ Falenty

Środowiska M (2005) Strategia ochrony obszarów wodno-błotnych w Polsce wraz z planem działań (na lata 2006–2013)

Szuniewicz J (1979) Charakterystyka kompleksów wilgotnościowo-glebowych pod kątem parametrów systemu melioracyjnego (Soil moisture complex characterization and melioration system parameters). In: Okruszko H (ed) Kompleksy wilgotnościowo-glebowe w siedliskach hydrogenicznych i ich interpretacja przy projektowaniu melioracji i zagospodarowania. Biblioteczka Wiadomości IMUZ. Nr 58 s. 29–50

Szuniewicz J, Churska Cz, Churski T, (1992) Potencjalne hydrogeniczne siedliska wilgotnościowe i ich zróżnicowanie pod względem dyspozycyjnych zapasów wody użytecznej (Potential hydrogenic moisture habitats and their differentiation in terms of useful water). In: Hydrogeniczne siedliska wilgotnościowe. Biblioteczka Wiadomości IMUZ Nr 79