Water Policy in the Anthropocene[1]

Challenges in European river basin management in a new geological era – Reflections on how we can react appropriately

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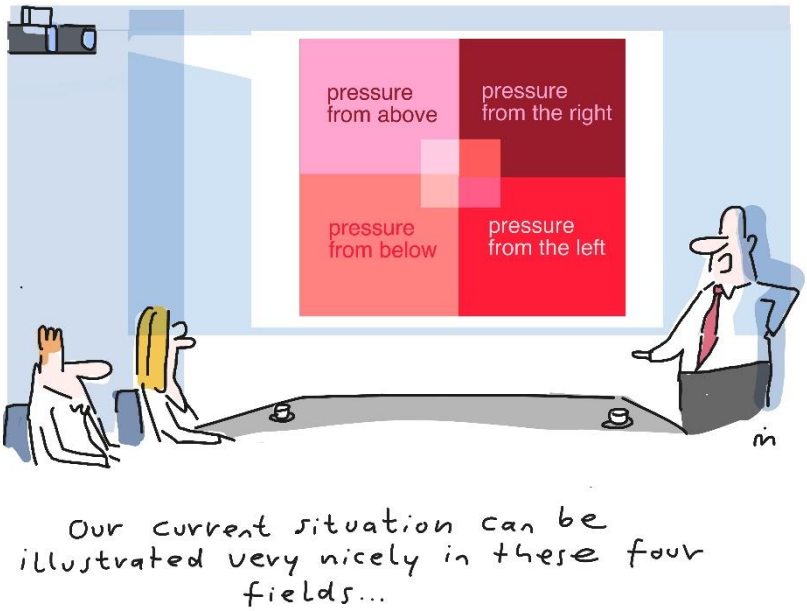

Fig. 1: The Anthropocene is forcing us into action [3]

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[3] All cartoons: www.meissner-cartoons.com

Prologue

In the last two hundred years, our world has developed at a breathtaking pace. Thanks to technological and scientific progress, the relative proportion of the world's population affected by hunger and thirst has fallen, even though more people populate the planet than ever before. In average terms, material wealth is on the increase. Europe, especially, is doing well! The standard of living is high and peace and liberty prevail. Without the restrictions of the pandemic we travelled more than ever before on land and water, and in the air. The globalized economy and consumption have created a system in which goods circulate extensively. Technical infrastructure ensures the provision of services for gigantic cities of and connects rural areas. Communication supplies societies with exponentially growing information. So, is all well and good?

For years now, evidence has unfortunately been growing that critical changes in the environment can jeopardize the positive fruits of progress, i.e. our general prosperity. Especially the younger generation is seriously concerned for its future[4]. Even the sceptics in this regard are aware of these changes but argue that our system is far too robust to be seriously endangered as a result.

How easily accustomed circumstances can change has recently been demonstrated by the Corona pandemic: In no time at all it triggered a worldwide shock wave in the fields of health, welfare and the economy, calling into question the very foundations of our way of life. One could postulate that COVID-19 is just an isolated health event, hardly connected to the ecological state of the earth's system and that therefore no causality exists. But careful! The message is more complex: health protection and environmental protection are closely intertwined[5]. Above all, health crises and environmental crises have a common characteristic, namely their expectability and the imperative transformation of the living world. Both threaten not so much our collective survival as our culture and civilization. *"The monstrous incident of the Corona pandemic must be understood as a* (further) *warning. It underlines the imperative necessity of a comprehensive social-ecological transformation that aims to slow down and, in the midterm, to reverse the ever more sterile downward trend of the foundations of life and, hence, health, and to do so before the catastrophic tipping points are reached. So, in this context message must also be: Flatten the curve![6]"*

The realisation that tipping points can trigger monstrous incidents continues to apply unchanged to climate change and its predicted impacts. Among these are, for Germany, concerns about water as well as the "classic" environmental topics, i.e. the loss of species and biospheres. In fact, the loss of healthy environments and especially the decline in biodiversity, has been a recognised problem since the 1980s, though it remains unsolved. Our

[4] For example the Fridays for Future movement

[5] This is a reference bot hat the interdependencies assumed be the Leopoldina between prior pressures on the environment and health and the important role of the local environment, close to home, for the physical and mental health of those having to stay at home

[6] C. Rosol, J. Renn, R. Schlögl (2020) "Der Schock hat System" – Süddeutsche Zeitung 15.04.2020 – A guest contribution of the co-authors of the Leopoldina statement on the Corona-Pandemic

changes to landscapes combined with air, water and soil pollution are overwhelming the ecosystems – with severe consequences for our future. Nobel Prize winner Paul Crutzen used the term "Anthropocene" to describe these developments – both positive and negative[7]. Its consequences are the issue at hand. Let it be said to both those who consider climate change to be the primary global crisis and to those who call this hysteria: The Anthropocene teaches us that climate change represents only one of at least four major threats. Regarding our future, the scientists who study earth systems are no less concerned with the advancing water crisis, the alarming changes in biodiversity and the increasing social tensions[8].

At the same time, it is untrue that "nothing has been undertaken". "Political Europe" has responded to many of the challenges that have been identified. It has developed beyond being a purely economic community, and today, with its environmental policy, it assumes comprehensive political responsibility for shaping the future sustainably. Hence, since the 1990s, a series of binding European environmental directives, such as the European Water Framework Directive (WFD) or the nature directives, Habitats Directive and Birds Directive ("Natura 2000") have been developed based on UN agreements that are non-binding under international law. Then there are the EU rules for dealing with chemicals (REACH) and rules for defining environmental quality requirements like the Drinking Water Directive. The Commission has even responded to the threat posed by flooding with the Floods Directive (FD). To demonstrate how seriously policy makers take these laws, they often stipulated specific time horizons.

In the meantime, it has become clear that the ambitious objectives of European environmental policy will in many cases most probably not be met within time-frames the originally agreed. This is unsettling. Naturally, and quite rightly, the causes and consequences are the subject of considerable debate. In some cases, such as the Nitrates Directive, there have already been infringement procedures. In other areas, such as the WFD, the efforts of the Member States are being reviewed and increased. Nevertheless, a significant need for action remains. In the light of the de facto consequences it is urgently imperative to understand why reaching the objectives is so difficult. The reasons are – such are the findings of the analysis at hand –:

- To a large extent, the insufficient level or speed of the implementation of the measures already identified as necessary, and this against a backdrop of the urgent necessity for action and short deadlines. This is sometimes the result of technical restrictions, but more often linked to political prioritization issues, partly with conflicting objectives.
- Not inessentially also in the widely underestimated effects of the advancing massively extensive reshaping of the entire environment through human activity. This phenomenon has

[7] Paul Crutzen (2002) The Geology of Mankind, Nature
[8] IESP (2008) Zugspitze Declaration: Dealing Wisely with the Planet - www.ias.tum.de/iesp/literature/memoranda/

come to be described by the scientific community as the Anthropocene.

These contexts apply to the whole field of environmental development. However, the reflections presented here put water at the centre of the discussion. The deficient conditions observed in the aquatic environment are – such is the summarised thesis of this paper – direct or indirect consequences of the geological epoch of the *Anthropocene* defined by Crutzen. This *Anthropocene* is more than just a description of a condition. It is in fact a new conception of the "rules of the game" in biological, technical and societal systems that determine our lives. The resulting consequences can only be overcome with the help of knowledge about the systems themselves, their dynamics and the preconditions of their stability. Here, it is especially the theory of *resilience* that comes into play, which describes the behaviour of *complex feedback systems*. These systems are difficult to decode: the possible exceedance of *tipping points* in often inconspicuous *subsystems* have impacts on the whole system that are partly catastrophic, *"chaotic*" and, to make things worse, often delayed. The resulting tasks cannot be managed satisfactorily with conventional "linear" explanations and measures. What is needed is a *dynamic, trans-sectoral* response which must – such is the key finding of this essay – unavoidably accompany the whole Anthropocene era.

Remarkably, – another finding of this analysis – important EU environmental legislation such as the WFD and the FD are, in principle, equipped to deal with these effects. However, the rules of the Anthropocene make broader demands on the process, above all regarding the dynamics and persistence of the status improvements.

What does this mean, especially for the fundamental European Water Framework Directive (WFD) which has its roots in the late 1990ies, a time when our understanding of the Anthropocene was far less advanced than it is now? How good are our strategies?

1 The Changes Caused by the Anthropocene are the Decisive Factors Reshaping our Environment

The Anthropocene is, according to the Nobel Prize winner Paul Crutzen, the "*current, in many ways human-dominated geological epoch"* which in geological terms follows the Holocene. Crutzen goes on to say: *"Unless there is a global catastrophe – a meteorite impact, a world war or a pandemic – mankind will remain a major environmental force for many millennia. A daunting task lies ahead for scientist and engineers to guide society towards environmentally sustainable management during the era of the Anthropocene"*[9].

As a preamble, it should first be noted that in the Anthropocene era our lives have been enriched in manifold ways. These developments are inseparable parts of our culture and the very foundation of our civilisation. However, in the meantime, obvious negative side effects

[9] Crutzen, P. Geology of mankind. Nature 415, 23 (2002). https://doi.org/10.1038/415023a

have begun to take effect to such an extent that re-evaluating our actions has become imperative. Based on Crutzen's explanations, it is indisputable that the task of establishing and maintaining the balance of the planetary ecosystem will not be completed any time soon. Quite the contrary, it will remain a permanent obligation. This naturally also applies to water management. To a certain extent, this insight appears to contradict the ambitious political programmes for which the prescription of certain deadlines for attaining the objectives is necessary, not least so that successes can be documented.

But the essential point is that, like the other environmental norms of the EU, the WFD and its objectives are an expression of a new attitude to the environment, which could – if the transition this has initiated is successful – be interpreted as the beginning of the epoch of *sustainability of the Anthropocene* or an *Anthropocene 2.0*.

1.1 Primary Impacts on our Earth's Environmental System

Primary impacts are those consequences of the Anthropocene which have a more or less direct cause and are easily observable, anywhere on Earth where humans live. This includes both the impacts of targeted and therefore thoroughly intentional cultural accomplishments, e.g. for rivers and lakes and in their catchment areas, and the corresponding unintentional or tolerated unpleasant side-effects.

1.1.1 Practically All Water Courses in Germany Have Been Modified

In Germany, there are practically no surface water bodies of any significance that have not been altered – channelled, straightened, impounded, their banks diked. Many stretches of water may still appear relatively natural, or rather "near-primeval", to the uninitiated observer. In the WFD nomenclature, "high ecological status" could, arguably, be interpreted as a status close to primeval conditions (of the Holocene) and "good ecological status [10]" as a (minimum) requirement for a stable ecosystem (in the Anthropocene). A further admission of a de facto reshaped world is reflected in a relatively late amendment to the draft of the Directive that introduced the comparatively categorical separation of some water bodies into the subset (hydromorphologically) "Heavily Modified Water Bodies" (HMWB), to which different rules apply. At the time, this increased the acceptance of the draft Directive among the EU Member States[11]. That the transition is, in reality, a gradual one and that the majority of waters are at least more or less anthropogenically "modified" is taken into account, methodologically at least, in a certain permeability of the boundaries between HMWB and "natural" water bodies. At the practical implementation level, the search for solutions continues. Guidance for defining and assessing ecological potential for Heavily Modified Water Bodies was, very recently, extended to include an appendix with the aim of incorporating the knowledge gained in almost two decades of WFD implementation into the process, only

[10] General definition of „good status" according to WFD Annex V Table 1.2. The values of the biological quality elements for thesurface 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.

[11] Lanz "EEB Handbook on EU Water Policy" (2001)

eight years before the deadline (2027!)[12]. So it seems that we are becoming increasingly aware that "anthropogenic deviations" are a typical characteristic of our cultural landscapes and that the changes cannot be reversed by realistic means. Reinstating the original conditions (of the Holocene) is, in most cases, neither desirable nor realistic. This means that even for the best possible "rewilding", a gap will always remain compared with the original primeval state - with consequences that, due to an "imperfect" understanding of the system, we cannot even truly appreciate. The implications of these knowledge gaps are discussed in particular in chapter 2.

Fig. 2: Historical Painting from the collection of the Austrian "Section für Wasserbau" (Water engineering service) (additional texts in white by the authors)

1.1.2 Heavily Modified Catchment Areas

The total reshaping of our landscapes applies even more to those in which water courses flow. This is relevant because water bodies are strongly influenced by conditions in the whole catchment, whether it is groundwater quality and quantity or the corresponding fauna and flora. A recent example is the decimated insect population. Modified, or heavily modified, catchments have an as yet not fully quantifiable impact on water bodies (and all the connected subsystems and metasystems - see 1.3.1). Under which circumstances is reaching "good water body status" even possible here? Which minimum requirements would surrounding landscapes have to fulfil (e.g. regarding the width of riparian buffers and

[12] "Appendix to Guidance Document no. 4 .[…] is based on a more mature common understanding and emerging good practice " ("Steps for defining and assessing ecological potential for improving comparability of Heavily Modified Water Bodies – supplementary guidance to CIS Guidance Document no 4", Draft 24 April 2019)

activities within them)? Furthermore, irrespective of whether or not the authors of the WFD were aware of these issues, these interdependencies are reflected in the indicators used, especially the biological quality components, but also hydrological and chemical or physico-chemical parameters. The "CIS Guidance documents"[13] used at the European level also describe these interconnections. Here, the problem remains that whilst in the CIS papers, at least, the influence of the surrounding landscape has been recognised and mapped to appropriate indicators, the individual Directives have little or no leverage on many of the relevant pressures. Mandatory coordination is only foreseen in some sub-sectors, such as between Natura 2000 and the WFD in relation to biodiversity. The situation is exacerbated by the fact that measures requiring substantial changes in land use, e.g. the implementation of riparian buffer strips or the revitalisation of wetlands, frequently entail very slow legal and ecological adaptation processes. More recent CIS guidance documents[14] follow a fundamentally holistic and adaptive approach even more clearly. However, this cannot compensate a failure to integrate environmental influences comprehensively or remedy land supply shortages, which in turn cause resistance against necessary ecological improvements. Here, too, a residual gap remains, causing further delays to the progress towards good status.

1.1.3 Changes in the Aquatic Coenosis

Aquatic coenosis has undergone an extensive transformation caused by manifold anthropogenic influences. Natural food chains have been profoundly disturbed and can't simply be re-established. An unfavourable distribution of fish species is causing the biomass of algae to increase which is, in turn, changing oxygen availability in gravel river beds, whilst sediment clogging is changing the habitats of many species and juvenile life stages.

1.1.4 Influence of (Harmful) Synthetic Pollutants

The meteorologist and winner of the Nobel Prize for chemistry, Paul Crutzen, identified the vast number and quantity of chemical substances artificially produced or mined by humans as a main characteristic of the Anthropocene. The total sum of relevant activities – the extraction of natural resources and fertilisers, chemicals related to production and consumption – result in emissions and solid, liquid and gaseous waste. This increasing "entropy" is putting pressure on regional ecosystems and progressively also on global ecosystems – affecting air, soils and water.

1.1.5 Evolution of human behaviour

It is not only the population that is growing in many areas (demographic change). Mankind's demands on the way resources are used are also changing. Economic and leisure behaviour still remains on a trajectory towards higher resource consumption which generally also re-

[13] Guidance elaborated within the framework of the "Common Implementation Strategy", e.g. CIS Guidance No 1 "Economics and the Environment – The Implementation Challenge of the Water Framework Directive -WATECO" (2003); CIS Guidance No. 2 "Identification of Water Bodies" (2003); CIS Guidance No 3 „Analysis of Pressures and Impacts" (2003); CIS Guidance No 11 "Planning Processes" (2003)

[14] For example CIS Guidance No 24 "River Basin Management in a Changing Climate" (2009) und CIS Guidance No 31 "Ecologcal flows" (2015)

sults in higher emissions. Even leisure activities that are in themselves harmless and welcome can, if they are confined to limited areas, become a burdensome pressure. Lakes and rivers are magnets. According to a recent poll of the German population[15] more than 60% of respondents regularly seek out water landscapes as a local leisure activity. On one hand, this is to be encouraged, on the other, it can also become a burden for ecosystems, as is highlighted by recently implemented restrictions on canoeing in some reaches of the Isar River to the south of Munich.

Preliminary conclusions (1): The primary manifestations of the Anthropocene in themselves, already pose a challenge for the ecosystem, especially when multiple pressures accumulate. At the time, the founding Mothers and Fathers of the WFD weren't able to fully and comprehensively incorporate the corresponding complexity and consequences into the Directive. Conflicting interests and the arduous search for compromise regarding the wording of the Directive have left their mark[16]. Nevertheless, in principle, the Directive contains the necessary methodologies for dealing with these factors in a dynamic and participative process that comprises comprehensive data collection for the pressures and impacts analysis and a prognosis regarding the achievement of the environmental objectives. Though the scale and extent of the challenges posed by the pressures of the Anthropocene may not have been fully recognised at the time of its conception, the methodology of the Directive is fundamentally suited and increasingly able to meet them.

1.2 Indirect or Secondary Impacts

As well as immediately effective local and regional primary impacts, there are further indirect or secondary effects of the Anthropocene.

Secondary impacts are understood as all those phenomena which

- Have effects that are difficult to recognise or hidden because
- They originate from summation of the effects of primary impacts the dynamics of which not yet understood (complex). They often also have a
- Delayed impact or
- Originate in completely different locations.

They cannot easily be attributed to specific linear pressure-impact relationships, they have originated at different (continental or global) scales, often they cannot be influenced by regional measures and they have a tendency to go unnoticed for long periods of time. These effects are biodiversity loss, climate change or - without making any value judgment on the matter - the development of technical and societal systems (an important example in this context is communication). The transitions between primary and secondary impacts are, by their very nature, gradual.

[15] Rayanov, M., Dehnhardt, A., Glockmann, M., Hartje, V., Hirschfeld, J., Lindow, M., Sagebiel, J., Thiele, J., Welling, M. (2018): Der ökonomische Wert von Flusslandschaften für Naherholung – eine Zahlungsbereitschaftsstudie in vier Regionen Deutschlands – Hydrologie & Wasserbewirtschaftung, 62, (6), 410-422; DOI: 10.5675/HyWa_2018.6_4

[16] See for example "EEB Handbook on EU Water Policy" (Dr Klaus Lanz and Stefan Scheuer, 2001) or "The EU Water Framework Directive: Part 1. European Policy-Making and the Changing Topography of Lobbying" (Maria Kaika and Ben Page 2003)

For the environmental sector, three secondary effects appear to be particularly critical: The change in ecological resilience, climate change and chemical pollution.

1.2.1 General changes in the resilience factors

By altering the ecosystems, the Anthropocene poses the general risk of these systems becoming destabilised. Such effects are apparent at all levels, from primary small scale changes to global impacts. These anthropogenic influences have the tendency to keep multiplying until the so-called system resilience is exceeded and either the whole system or one or more subsystems "tip", i.e. shift into a new, stable, but usually less desirable status. In geological terms, these tipping processes often take thousands of years; in the Anthropocene it may only be decades. Typically, systems all over the planet display a high level of interdependency ("panarchy", see below). "Tiny", small scale developments can accumulate into massive changes in unexpected places and vice versa. Examples for these kinds of interconnections are

- Emissions from our technical world in combination with
- Global deforestation and
- Continued soil degradation including the destruction of terrestrial-aquatic systems
- Leading to climate change, the loss of biodiversity and extreme developments such as water scarcity and even desertification, the collapse of whole ecosystems, the spread of diseases etc.

These types of primary and secondary impacts weaken the global immune system, that is to say the resilience of systems and their subsystems. The systems fall "sick" until tipping points are reached, which then result in regional or earth-systemic fundamental system changes – regionally observable by means of indicators such as insects, fish, health patterns in the general population or other societally relevant reactions (attitudes to leisure pursuits). As ecosystems don't "die", as such, if they are significantly weakened. Instead they evolve, often so radically that the original endemic populations can no longer survive there.

1.2.2 Climate Change (Heavily Modified Earth System)

One global critical development is climate change, which is caused, initially, by emissions from the subsystems (e.g. use of fossil fuels, transport and traffic, draining wetlands, agriculture etc.). However, naturally, this has a significant or even catastrophic effect on the subsystems. The consequent changes can in turn reinforce the impacts at all scales. Especially the example of climate change demonstrates that not only water courses and catchments are changing but that our entire system is being continually and dynamically altered, e.g.

- Rising temperatures of water bodies (currently approx. + 1.5 °C): Shifts in species composition, reduced resilience to nutrient pollution
- Low river flows: unfavourable mixing ratios (waste water/ river discharge), water courses drying up, temporary population collapses
- Torrential precipitation events: increased erosion in the catchment area, increased nutrient pollution and sediment clogging

- Increased nitrate leaching due to non-absorption of nutrients by plants in dry summers
- Changes in groundwater recharge (e.g. in Bavaria over the last 15 years groundwater recharge has been about 15 % below average), loss of previous dilution effects, impact on quantitative and qualitative status
- Increase in extremes (heat stress, drought and extreme precipitation)

The consequences regarding the attainment of objectives in water management and ecology are profound! What's more, even measures taken with the best intentions of mitigating climate change can themselves have side-effects: Wind turbines – impacts on birds, hydropower – fish, solar panels – exploitation of natural resources and chemical pollution, geothermal probes – groundwater. A prominent negative example is the massive incentivisation of the panacea biofuel ("Biogas-boom" in Germany), that led to an explosion of maize fields in the landscape, with all the negative implications.

1.2.3 Ubiquitously Active Substances such as Mercury, Fluorine Compounds or other Substances such as Nitrate

On top of locally occurring substances, there are also highly effective globally utilised substance groups or pollutants that originate locally but are globally transported. Especially the mobilisation of harmful substances through product trade or transported via air or in water are creating global and more or less ubiquitous pressures on the ecosystem.

- For example mercury pollution – both atmospheric and in sediments – practically has to be accepted as a fact, similar to climate change, that can only be mitigated by measures in the very long term
- The situation is similar for emissions from fluorochemistry (especially epr- and polyfluoroalkyl substances, PFAS, or persistent organic pollutants, POP).

Trace Substances, which already have negative impacts at very low concentrations or loads, due to their persistence and mobility (e.g. in combination with toxic, cancerogenic, mutagenic or endocrine disrupting properties) constitute a major challenge, because source-oriented and application-related mitigation measures have to be combined strategically and effectively.

1.2.4 Nutrients as Pollutants

Any substance that could theoretically contaminate the environment is a potential pollutant. This is also true for nutrients that are, on the one hand, essential for plant growth but, on the other, can have ubiquitous negative impacts if excessive amounts are released into the environment: "The dose makes the poison". Consequently, increasing environmental loading with nitrates and phosphates has become a major global problem[17]. This could, in principle, be managed at the regional level (see EU Nitrates Directive), but there are far reaching consequences because the amounts already present in the environment, in soils and in water, can only be removed from the respective cycles in the very long term.

[17] The Lancet Commissions: Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)31788-4/fulltext The Lancet Commissions|Volume 393, ISSUE 10170, P447-492, February 02, 2019

1.3 Dynamic Knowledge Enhancement and Improved Systems Understanding – Acknowledging the Anthropocene Means Rethinking our Actions

From the essence of the primary and secondary impacts of the Anthropocene, a third consequence transpires: we have to continually develop and improve our solutions and methods. The time of linear prognoses and monocausal impact-response logic has passed. The Anthropocene calls into question a range of familiar thinking patterns. This is perhaps the most unpleasant insight of all!

1.3.1 Recognition of the Anthropocene Itself

With the Anthropocene, we have not only decisively taken control of the developments of the world, we have also, in doing so, acquired full responsibility for the future. Mother Nature alone cannot "rescue" us anymore, the rules of play for human survival (though not the survival of life itself!) is increasingly dependent on us. With each of our interventions, this dependence continues to grow and the risk of side-effects increases. This could have a fatal outcome and may prove to be ethically irresponsible.

Instead, our behaviour as a civilisation, must progress from "monadic" behaviour (unconditionally exploiting the environment) to at least "dyadic" behaviour (also respecting the environment). Examples for monadic behaviour are plastic pollution or deforestation[18]. The conclusion is that we have changed this world significantly and are continuing to do so. There is no indication that we will stop this behaviour, not even in the mid-term.

Hence, we are moving progressively from a homogeneous system which was created by Nature and largely stable, into a system that is being reshaped in order to satisfy dominant economic interests but whose ecological properties we don't fully understand.

A benchmark for the future safety for such a reshaped state is system resilience, which is defined in terms of several time-dependent control parameters:

a) Constant systems evolution (adaptive systems), for which maintaining stability is a permanent task
b) Continuous and permanent knowledge enhancement regarding the complex interconnections (i.a. panarchical systems), which requires permanent corrective steering according to the current available information
c) Complicated by a "hysteresis of awareness", i.e. the impacts often take effect years or decades later (slow driving factors), as do the mitigating measures in response. This leads to a greatly delayed learning curve.

As a conclusion: the continuous process of correcting system relevant measures to consciously steer the Anthropocene is a permanent, never-ending task!

RISK- und KNOWLEDGE MANAGEMENT[19]:
An important aspect is the conscious understanding of knowledge, the lack of knowledge including uncertainties and risks. The Anthropocene requires an especially reflected approach to knowledge,

[18] M. Grambow und W. Mauser et al, (2020) Das Anthropozän 2.0 Contribution to the Workshop "Violated Earth – Violent Earth" 20.-22.03.2019, Raithenhaslach www.ias.tum.de/iesp
[19] Wilderer, Renn, Grambow, Molls (2018); Sustainable Riskmanagement" ,Springer

because the attenuating factor of a globally functional ecosystem is significantly weakened by the transformation that is underway. Hence, as well as the knowledge about changes (pressures) and their impact on the aquatic environment, knowledge about knowledge gaps is also gaining importance, as this is where the greatest risks are „concealed" (οἶδα οὐκ εἰδώς)[20].

RESILIENCE THEORY:
Resilience theory is a good explanatory approach for our complex ecological earth systems[21]. It is essentially made up of three fundamental models:

1) System tipping points, which describe a transition from one stable state to another caused by external impulses. These impulses can have significantly delayed effects (slow driving factors).
2) Adaptive cycles, i.e. all subsystems go through typical developmental stages: a stable period, a deterioration period, collapse and then the beginning of a new cycle.
3) Panarchy: The different subsystems are interconnected in a complex manner (i.e. multiple feedback loops). The earth system is composed of all the subsystems. This combines to create an essentially dynamic complex entity, which has the autopoietic (i.e. continually self-creating) tendency to strive towards stable conditions and does so with both uninterrupted dynamism and perpetual change.

Many of nature's adaptive responses to human interference have already occurred over the last decades. It is possible that some system tipping points have already been exceeded but that slow adaptation means that the full implications have not yet become apparent. A retrospective correction of such crossed tipping points is, however, hardly possible even with the greatest of efforts – the dice were cast in the past. The anthropogenic reshaping has changed the resilience behaviour of our aquatic landscapes. One negative example of a tipping point in an aquatic system is the "tipping" (sudden eutrophication) of a water body. A positive example is Lake Constance, where the danger was recognised in time and the turn-around from mesotrophic towards oligotrophic conditions was achieved with targeted measures, before the tipping point was reached.

1.3.2 Practical Implications: Improved Measurement Methods and Increasing Risk Awareness

On the one hand, our increasing knowledge has resulted in the ability to prove or detect the presence of substances using new measurement methods. On the other hand, our risk awareness is evolving. Relevant examples are:

- The revision of the list of priority substances[22] based on recent more risk assessments
- The classification of substances and the adaptation of threshold values. One example are the substances anthracene, fluoranthene oder naphthaline, for which the threshold values were reduced when the relevant German national ordinance (Oberflächengewässerverordnung) was revised in 2016 on the basis of new findings regarding the impacts of these substances on the environment.

[20] Sokrates' "*I know that I know nothing*", so awareness of knowledge gaps as an important part of knowledge– see also chapter 2
[21] B. Walker and D. Salt (2006), Resilience thinking, Island Press
[22] List of priority substances adopted under WFD Article 16

- The ubiquitous detection of pollutants due to targeted screening for substances recently reclassified as potentially hazardous and improved measurement methods.

Fig. 3: It has to be clear that in retrospect, today's knowledge will appear laughably limited

At the same time, scientific advances in the chemical sector are also resulting in new substances being developed, for which the environmental impacts are not wholly predictable. Among these are not only substances of which the chemical properties are not sufficiently known. Even substances which – from a chemical perspective – appear harmless, can have massive impacts. In this context, one could, in retrospect, cite in the introduction of per se innocuous plastic products and the resulting challenges regarding microplastics.

This has far-reaching implications: Every status that, today, is identified as being good could, tomorrow, be downgraded on the basis of new knowledge. And the impacts of the Anthropocene persist with the consequence that the burden of the pressures is increasing.
This implies that measures considered sufficient today may prove insufficient or even counterproductive in future, e.g. the mobilisation of pollutants. This means that perpetual adaptation is necessary and remain be the norm in the foreseeable future.

The foundations for such a permanent process have already been laid in the WFD, but also in the FD[23]. Regarding their content and the essential characteristics of their approaches – both Directives are risk management tools with which these challenges can be – at least partially – met, though by no means in their entirety. The need for the for further efforts towards a sustainable chemical policy has already been recognised and has led to the implementation of European rules (see the REACH regulation EG 1907/2006) as well as to specific

[23] E.g. WFD CIS-Guidance Nr. 1 (WATECO), No. 2 (Identification of Water Bodies), No. 3 (Analysis of Pressures and Impacts), No. 11 (Planning process), No. 24 (River Basin Management in a Changing Climate) and Art. 14 FD

solutions for energy and resource efficiency and process optimisation in product and production-integrated environmental protection. These efforts are also reflected in the current processes at the national level[24].

Preliminary conclusions (2): Calling out the Anthropocene era is currently the most pertinent approach to the assessment of the demands of the present time. It refers to recognised environmental challenges as well as to the findings of system theory. Ultimately, it is also closely related to our cultural history, in that it integrates the ethical concepts of both the Bible and secularised Ethics, from the Enlightenment to the present day. Hence, the need to properly transpose this knowledge into our water policy. This is the subject at the centre of the second part of this essay:

2 The Proper Understanding of and Approach to the Anthropocene – Solutions for a More Stable Environment

2.1 „It's Our Turn"- Measures to Stabilise the "Water-Ecosystem" have to be Implemented Immediately and Quickly[25]

Understanding the Anthropocene teaches us that the challenge of stabilising our regional and global environment is vast and immensely difficult. For some of these issues, we simply do not yet know how we might square them with our accustomed lifestyles. These partly "imperative" conditions of the Anthropocene will lead to delays in reaching the sustainability goal that underlies the EU Directives. But this is by no means an excuse for not doing everything we possibly can today, within the framework of our own responsibilities.

2.1.1 Implementable Within Existing Political Remits

The most immediate responsibility and at the same time the biggest opportunity lies in the competences of national or federal authorities:

- To make sufficient means available by providing the responsible (local) authorities with the necessary human and material resources. This includes long term planning and HR strategy development with sufficient training and suitable (financial) incentives to minimise the risk of skills shortages.

[24] See J. Wagner (2020), "Zum guten Umgang mit Wasser – vom Wasserdialog über die Spurenstoffstrategie zur Nitrat-RL", UPR 3/2020,

[25] See E.U. Weizsäcker (2017), "Come On!: Capitalism, Short-termism, Population and the Destruction of the Planet", Springer

Fig. 4: Economies in infrastructure and the civil service are often the first reaction to financial shortages

Priority setting in the interest of (improved) environmental quality at the subsidiary level: Naturally, responsible authorities (e.g. municipalities) are confronted with competing, often shot term tasks (forced migration, building nursery schools). However, these should never supplant the urgent long term issues, above all the need to ensure a stable ecosystem and especially clean rivers and lakes. Where long term objectives are concerned, lost time can rarely be made up.

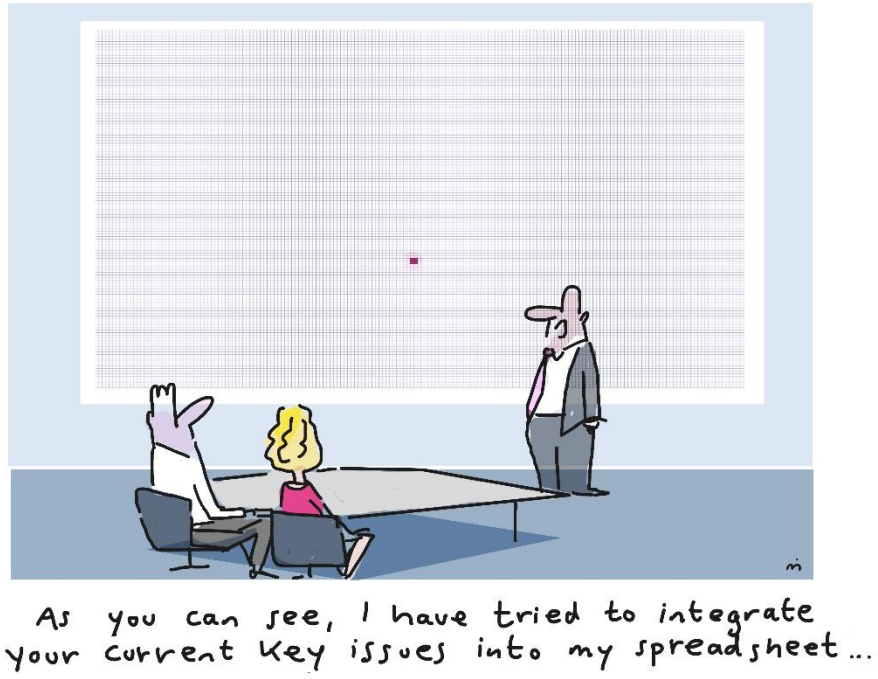

Fig. 5: Priorities are often set according to short-term concerns

- Clear definition and enforcement of existing environmental norms, even when there

are conflicts of interest, e.g. regarding the enforcement of necessary measures even against the interests of strong lobbies. Here, the societally desirable compromise should never come at the expense of the stability of the environment: The "polluter pays" principle, in particular, must be respected where and whenever environmentally relevant interventions are made. If contributions by individuals are required in order to meet general environmental norms and targets (provision of properties, compliance with requirements that impinge on existing water rights), this should be accompanied with compensatory measures in order to minimise societal frictions.

2.1.2 Problems Which Can Only be Solved in Longer Processes, But Have to be Tackled Nonetheless

The means at our disposal and the resulting responsibilities are limited when decisions can't be made within the domestic remit, but instead only together with other nations (in the EU often at the level of supranational norms) or when other "external factors" take effect. Examples for restrictive boundary conditions are:

- Sectoral policies that do not sufficiently support environmental objectives but, nevertheless, take precedence for short term economic reasons (EU agricultural policy or other international trade agreements, free trade, competition),
- Global product policy in the chemical sector which limits the extent to which the development of new products follows responsible and sustainable practices,
- Monetary policy (low interest rates) leading to high property prices or to land becoming scarce (investment in land),
- Set backs due to natural disasters or pandemics (binding human and financial resources).

However, strategic hierarchically superior policy approaches can have a significant impact. The best current example is the European Commission's Green Deal. This ambitious programme demonstrates that "political Europe" is rising to the challenge of delivering a game changing sustainability project for the future. At the same time, it is apparent that environmental policy is still on a dizzying learning curve. Hence, the expected mitigating effects of the Green Deal on the natural environment, and with that the river basins, cannot reasonably be expected to take effect for some time. Regarding the WFD, the necessary improvements will probably only produce measurable effects after the end of the third management cycle.

The European Green Deal[26]
With its focus on clean energy and mobility (carbon neutral EU by 2050), sustainable industry and protection of biodiversity (resources conservation / repair economy / circular economy – preventing pollution vs. revenue from higher consumption) in combination with the new strategy for agriculture ("Farm to Fork"), the European Commission's Green Deal represents an emphatic commitment to decoupling Europe's economic performance from the consumptive use of resources. An actual implementation can only succeed if the respective measures are socially acceptable, a "Just Transition Mechanism" has been proposed to ensure long term funding. Therefore, at this point in time, potential results are difficult to predict and the process will definitely not be completed by 2027.

2.2 New Risk Management and Transparency

2.2.1 Risk Management and the Definition of Targets

Under the conditions of the Anthropocene, many important environmental objectives are simply not attainable in 2027 or any time soon after that. One widespread concern is that this realisation could be used by those under an obligation to act as an excuse for a lack of effort. And if certain lobby groups succeeded in using this to justify widespread exemptions with arguments like "*the objectives are unattainable anyway (because they would entail costs and require changes) and therefore less stringent objectives should be applied globally*", the societal consequences would be even more detrimental. Such interpretations would virtually reverse the understanding of the Anthropocene described above; but judging by the current political debate, they are to be expected. This is why a clear and unambiguous position on this issue is essential:

A stable system status (WFD: good status, FD: successful risk management, Habitats Directive: favourable conservation status) is highly justified as a minimum target, whilst this is not necessarily true for the deadlines[27]. On the contrary: knowledge enhancement will presumably lead to more stringent objectives in future (e.g. for chemicals) and, as the damage becomes apparent and crises multiply, it will also become more obvious just how necessary, but also costly, such positive developments will be in terms of both time and resources.

[26] EU Green Deal: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_de; Just Transition Mechanism: https://ec.europa.eu/info/news/launching-just-transition-mechanism-green-transition-based-solidarity-and-fairness-2020-jan-15_en

[27] Good Status as a declared objective of the WFD is founded in, at least, the instrumental value of aquatic ecosystems and with that at the same time a fundamental issue for quality of life. The – according to the so far widely held interpretation – rigid final deadline in the WFD (Good Status by 2015 or 2027 at the latest…), documents a commitment to speedy and ambitious implementation. However, this isn't compatible with the important message of the necessity for continuous risk management for the protection of the aquatic environment. For the closely related EU Birds and Habitats Directives and for the FD no analogous deadlines have been set. Recognising the laws of the Anthropocene forces us to take an adapted and highly reflected approach to these deadlines.

More or less stringent objectives?
The WFD foresees the possibility of setting less stringent objectives under strict legal conditions[28]. However, as far as it is possible to tell, the current objectives already correspond to a minimum level of resilience (difference between "good status" and "high status"). In addition: if lowering objectives for subsystems causes metasystems to fail to meet the objectives and, in a worst case scenario, leads to a total loss of resilience, this would also be an infringement of the fundamental principles of the WFD[29].

Apart from that, a debate about details relating to potential adaptations, regarding both the objectives themselves and technical and legal aspects, must remain possible. Beyond the laws of Nature, there is no such thing as a "God-given" target. As the example of limit values for pollutants demonstrates, targets are generally derived by weighing up benefits (for society or for individuals?) against potential risk or even harm – also a continual process. However, the discussion of which risks we can/want to accept and whether a particular risk might be more bearable than the burden of the possible measures, requires a state of the art, scientifically valid and transparent deduction of the actual risk[30].

Today, the conventional method of equating „not detectable by measurement" as "non-existent" is definitely no longer tenable. And: the guiding vision of a primeval condition (e.g. a post-glacial world) may often appear unattainable in a world reshaped by the Anthropocene. But, it can definitely serve as a benchmark, for which a natural capacity for resilience can be assumed as a given. An approximation of such natural conditions remains desirable, not least in the absence of alternatives (who could reliably calculate the resilience of the system as a whole?)

The danger of reaching critical tipping points that would severely disrupt or even destroy parts of our environmental system still appears to be growing. Here, climate change stands as a pars pro toto. Therein lies – and of this we must be aware - a fundamental risk to our accustomed civilisation.

Beyond this, knowledge enhancement will most probably result in future objectives being continually better justified and defined on the basis of additional new indicators. Bearing in mind the typical learning curve in understanding of the vulnerability of ecosystems to chemical pollution, rather "stricter" targets are to be expected in many domains (see recent „wake up calls" like the dramatic decline of insect species, marine pollution, fluorinated compounds etc.).

[28] WFD Article 4 (5) WFD „less stringent environmental objectives ": i.e. the objective remains the best possible ecological, chemical or quantitative status, respectively, and the less stringent objective only applies to quality components for which good status is proven to be unattainable. Less stringent objectives are reviewed every 6 years.
[29] WFD Article 4 (8) *„When applying paragraphs 3, 4, 5, 6 and 7, a Member State shall ensure that the application does not permanently exclude or compromise the achievement of the objectives of this Directive in other bodies of water within the same river basin district and is consistent with the implementation of other Community environmental legislation*."
[30] See Grambow / Korck „Environmental and Ecological Aspects of Sustainable Risk Management" in Wilderer et al (2018), „Sustainable Risk Management", Springer, p.55 et seq.

2.2.2 Transparency

Transparency as an element of security:

There is only one answer to these non-trivial processes of deliberation and orientation, as well as to the fears that by abandoning fixed final deadlines, efforts towards attaining the objectives – especially for the WFD – could subside: The processes and decisions, and especially the use of resources as well as basic and supplementary measures, have to be made as transparent as possible to allow for a political, scientific and general critique and debate. This kind of transparency is precisely what is needed to address the concerns of the "other side" that, for example, the stringent targets have to be met within a time frame that is too short to accommodate the necessary adaptive processes. The WFD and other water-related European Water Policy Directives foresee such transparency and participation. But their implementation is far from trivial and will keep us busy far into the next decade, for example the difficult process regarding the Trace Substance Strategy of the German Federal Government and the Nitrates Directive[31]. Moreover, a new system of intermediate milestones or detailed sub-goals ought to be established.

Transparency as motivation:

In WFD related communication is of utmost importance to visualise status assessment at the quality components level and in combination with corresponding pressures data. This does not only apply to the challenges ahead. This is also the best way to improve the presentation of past achievements. Otherwise, there is a risk that all efforts to implement the WFD could be perceived as a "precious waste of effort":

- Loss of motivation for all those involved
- Decreasing willingness to invest in this domain, as it is unlikely to succeed
- Restrictions that had to be accepted by certain groups, such as the farming community, do not produce the desired results → rejection of further measures
- Psychological block: effects of the Anthropocene are too substantial and irreversible – "we may as well give up and live with them."

2.2.3 „One Out – All Out"

If the objectives to be fulfilled are particularly ambitious or if subsystems are connected like links in a chain (the failure of one of element would cause the whole system to fail), the „one out – all out" principle make sense. However, according to resilience theory, ecosystems behave quite differently. As a rule, they will have multiple supports (functional redundancy).

Critics are right to say: „All in" will tend to be the exception. For some parameters, at least, we have to assume that the surrounding environment has been so fundamentally reshaped by primary impacts, e.g. transformed landscapes (heavily modified), or is under such pressure from secondary factors such as ubiquitous pollutants, that it will hardly be possible to shift the respective parameters into the "green zone". This means that there are some water

[31] See J. Wagner (2020), "Zum guten Umgang mit Wasser – vom Wasserdialog über die Spurenstoffstrategie zur Nitrat-RL", UPR 3/2020,

bodies for which, despite improvements for many subsections and quality components – sometimes even reaching good status – the overall cumulative objectives will still not be met.

In the last step of status assessment, the synthesis, the formal WFD requirement for individual water bodies is to assess whether there is a single "red" parameter. If that is the case, the "ideal objective" has not been attained. But does that mean: nothing matters anymore? Or even: let's keep on lowering the objectives until everything is in the "green zone"? That would be a catastrophic fallacy!
Naturally, it is best of all if all the objectives are met. For the resilience of the ecosystem, however, it is far more important that as many parameters as possible are as good as possible. The more that are and the better they are, the better it is overall, i.e. the lower the risk of exceeding critical tipping points.

Conclusion: the greater the pressures on an ecosystem, the more important it is that as many decisive resilience factors as possible are kept functional or rather are in good condition.

2.2.4 Broadening the Scope of the Indicators to Incorporate Human Quality of Life Aspects (Societal Benefits Through Cultural Ecosystem Services)

With the sometimes precarious developments in the world around us, society has been developing an increasing level of awareness, whereby environmental policy is not only seen as purely altruistic nature protection, but also understood as a contribution towards securing the foundations of our own existence and quality of life, from a safe water supply to health and leisure. Consequently, environmental protection is in no way an "enemy of commerce", as it was put recently by a leading economic German policymaker. To the contrary: it is an indispensable pre-condition for a successful life.

To broadly embed this reflective way of thinking into people's political sentiments, the contribution of the WFD to these cultural ecosystem services has to be made significantly more visible.

Successes are therefore not only to be evaluated in terms of good ecological and chemical status. There is considerable added value provided by the WFD which has received too little attention and has been insufficiently communicated so far: unspoilt (river) landscapes have a high leisure value, and are proven to be conducive to good health[32]. Achievements regarding societal benefits should at least be included in informal evaluations and communicated transparently (e.g. the so-called Isar-Plan (after the river Isar) contributes significantly to recreation and the alleviation of social tensions in the city of Munich). However, this is not to deny that conflicts of interest could occur here too.

[32] Hildebrandt „More Sustainability in Cardiovascular Disease Prevention – Holistic, Practice-Oriented Approaches Taking into Account Environmental Topics" in Wilderer et al (2018) "Sustainable Risk Management, Springer, p. 143 et seq.

It would therefore be important that in addition to progress towards reaching the environmental objectives, the focus is also centred on aiming for positive advancement in the field of cultural ecosystem services. Only then can the societal discussion about the allocation of resources and the acceptance of measures be influenced in a positive way. To this end, indicators would have to be developed to make progress measurable.

3 Conclusions

The impacts of the Anthropocene contribute to the pressures on ecosystems in almost all domains and can reduce the positive effects of the ongoing and completed measures that were implemented with the aim of attaining the set environmental objectives. In the planning process, e.g. for measures according to the WFD, this has only been taken into account in a very generalised way so far, due to the high levels of uncertainty. There is also no reason to assume that the underlying system that governs these processes will be fundamentally different in the decades to come. Coping with the negative impacts of the Anthropocene pre-supposes that global society will evolve towards genuine sustainability, which seems utopian to some fellow humans. The "un-utopian" aspect is that, according to what we know today, this development is imperative, i.e. essential for the survival of our culture and civilization. Viewed realistically, this will certainly be a dynamic and enduring process which will also proceed at very different speeds at the global scale.

- Therefore, the first and most important conclusion is that this process will have to be continued long after the year 2027 – the year in which, according to the WFD, the objectives for all EU waters have to be met.
- For this, not only time is required: only permanent, dynamic responses to changing to physical, chemical and biological boundary conditions will lead to success.

Hence, with its cyclical approach, the WFD, which in the water sector is central to such considerations, is as relevant as ever. But it needs a continuous process beyond 2027 with, at the same time, very ambitious goals.

Fig. 6: Dynamic systems: The WFD is a new permanent task in the Anthropocene

There are also no indications that the noble cause of striving for good ecological status or good ecological potential is in any way wrong. A categorical reduction of the objectives would directly contradict the understanding of how resilient systems come about. The opposite is true: the observed global developments highlight the urgency of more ambitious goals.

Basically, the WFD provides all the necessary tools to restore lost resilience. What is missing is room for manoeuvre which would allow the available options to be applied in a flexible manner on a case by case basis. Cumulative restrictions, e.g.

- Methodological uncertainties (or even disagreement),
- Delays and imponderables regarding the implementation of measures (i.a. because of the growing importance of “deliberation” in the courts),
- Politically motivated restrictions with competing priorities and a lack of coherence between environmental, agricultural and economic policy,
- The influence of unrealistic data models in electronic reporting could also be cited, which values the thinking of consultants above the experience of practitioners on the ground.

Far too often, such obstacles result in insufficient use being made of the opportunities provided by the WFD. In order to, nonetheless, honour our responsibilities in the Anthropocene, we have to optimise these internal rules of play.

We are still a long way from the ideal of a sustainable society. River basin management according to the WFD therefore has to be understood as an evolving process under continually changing boundary conditions. Permanent efforts will be necessary to reverse the trend, reach the objectives and to uphold the progress already made. It is, in many ways, like human health: there will hardly be a 100% healthy human being alive. Illness will inevitably

lead to setbacks. “Pre-existing conditions” don’t make things easier. Nevertheless, the aim of having a healthy body remains.
For water protection policy this means: the progress already made and the measures successfully implemented have to be presented in the updates of the river basin management plans and programmes of measures for the third management cycle, but also all the efforts made to ensure that as many water bodies as possible reach good status by the end of 2027 or at least to implement as many measures as possible. The remaining challenges, tasks and identified required measures also have to be presented as comprehensively and transparently as possible in the third WFD-management plans and programmes of measures (“comprehensive planning and transparency approach”, in German „Vollplanungs- und Transparenzansatz“).

This being so, it stands to reason that further river basin management cycles will be necessary. Therefore, the plans currently under preparation will also have to set out where, according to best current assessments, extensions of the deadlines for reaching the environmental objectives will be necessary beyond 2027, whilst emphatically avoiding any suggestion that the level of ambition for the implementation of measures might be called into question. All German states (Länder) and all EU Member States are still required to implement the maximum amount of effective and targeted measures that is at the same time acceptable to society. However, there are great uncertainties regarding both planning and implementing measures and assessing of the point in time at which the objectives will be met. These uncertainties relate to, for example, natural processes in ecosystems, the identification of pressures and their impacts, including the future shape of EU agricultural policy, or the ability to procure the land need to implement measures. Also, the influence of climate change on the effectiveness of implemented measures can only be predicted with a high level of uncertainty. Collectively, such uncertainties have a decisive impact on water management according to the WFD, which is why they have to be presented in detail and properly explained in the updated river basin management plans and programmes of measures.
Generally speaking, it should be clear to all that the primary and, increasingly, secondary impacts of the Anthropocene mean that in future we will be operating in a world which deviates increasingly from the one to which our aquatic ecosystems have adapted over millennia. In future, the impacts of climate change and other consequences of the Anthropocene could reach an unprecedented extent (“tipping points”) and reduce or even undo the effects of the measures already in place. There are indications that this is already happening in Germany.

The recognised demands of the Anthropocene can only be met if the continuous process already specified in the WFD is perpetuated and strengthened. The deadlines of the WFD might be utopian, but the level of ambition of the WFD itself has to be upheld for reasons of system stability and the safeguarding of prosperity, embedded in the context of risk management. On the way towards an environment that is sustainable and worth living in, we also need ambitious but realistic interim targets. The resources and measures that are deployed have to be opened up to societal critique and

debate with the highest possible level of transparency.

Admittedly, this continuity will make significant demands both on our patience and on our capacities. But there is – to quote Sloterdijk[33]– "*no human right to be spared excessive demands just as much as there is no basic right to only ever be confronted with problems which only require the available resources*" and relatively short time to solve.

Fig. 7… or right in the thick of it?

[33] P. Sloterdijk (2009), „Du musst dein Leben ändern" *("You must change your life")*, p. 699 et seq., Suhrkamp